(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 827 565 B1

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
17.11.1999 Bulletin 1999/46

(21) Application number: **96920232.4**

(22) Date of filing: **16.05.1996**

(51) Int Cl.6: **F01P 3/20**

(86) International application number:
PCT/US96/06994

(87) International publication number:
WO 96/37692 (28.11.1996 Gazette 1996/52)

(54) **SYSTEM FOR CONTROLLING THE TEMPERATURE OF A TEMPERATURE CONTROL FLUID IN AN INTERNAL COMBUSTION ENGINE**

SYSTEM ZUM REGELN DER TEMPERATUR DER KÜHLUNGSFLÜSSIGKEIT IN EINER BRENNKRAFTMASCHINE

SYSTEME DE REGLAGE DE LA TEMPERATURE D'UN FLUIDE DE REGLAGE DE LA TEMPERATURE DANS UN MOTEUR A COMBUSTION INTERNE

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

(30) Priority:
23.05.1995 US 448150
23.05.1995 US 447468
25.09.1995 US 533471
21.12.1995 US 576608
21.12.1995 US 576713
21.12.1995 US 576609

(43) Date of publication of application:
11.03.1998 Bulletin 1998/11

(73) Proprietor: **Hollis, Thomas J.**
Medford, NJ 08055 (US)

(72) Inventor: **Hollis, Thomas J.**
Medford, NJ 08055 (US)

(74) Representative: **W.P. THOMPSON & CO.**
Eastcheap House
Central Approach
Letchworth, Hertfordshire SG6 3DS (GB)

(56) References cited:
EP-A- 0 492 241
DE-A- 2 517 236
US-A- 4 095 575

- **PATENT ABSTRACTS OF JAPAN vol. 008, no. 177 (M-317), 15 August 1984 & JP,A,59 068545 (NIPPON JIDOSHA BUHIN SOGO KENKYUSHO KK;OTHERS: 01), 18 April 1984,**

EP 0 827 565 B1

Description

Cross-Reference to Related Application

[0001] This application is related to co-pending International application No. PCT/US95/11742, with an international filing date of September 12, 1995, and entitled "SYSTEM FOR CONTROLLING TO FLOW OF TEMPERATURE CONTROL FLUID", and is related to co-pending International application No. PCT/US96/01278, with an international filing date of February 2, 1996, and entitled "SYSTEM FOR MAINTAINING ENGINE OIL AT AN OPTIMUM TEMPERATURE". The entire disclosures of both of these International applications is incorporated herein by reference. This application is also related to U.S. Patents 5,458,096, 5,463,986, 5,467,745, 5,505,164 and 5,507,251, which are all incorporated herein by reference in their entirety.

Field of the Invention

[0002] This invention relates to a system for heating and cooling an internal combustion gasoline or diesel engine by controlling the flow of temperature control fluid to and from an exhaust heat assembly positioned adjacent to an exhaust manifold.

Background of the Invention

[0003] Page 169 of the *Goodheart- Willcox automotive encyclopedia,* The Goodheart-Willcox Company, Inc., South Holland, Illinois, 1995 describes that as fuel is burned in an internal combustion engine, about one-third of the heat energy in the fuel is converted to power. Another third goes out the exhaust pipe unused, and the remaining third must be handled by a cooling system. This third is often underestimated and even less understood.

[0004] Most internal combustion engines employ a pressurized cooling system to dissipate the heat energy generated by the combustion process. The cooling system circulates water or liquid coolant through a water jacket which surrounds certain parts of the engine (e.g., block, cylinder, cylinder head, pistons). The heat energy is transferred from the engine parts to the coolant in the water jacket. In hot ambient air temperature environments, or when the engine is working hard, the transferred heat energy will be so great that it will cause the liquid coolant to boil (i.e., vaporize) and destroy the cooling system. To prevent this from happening, the hot coolant is circulated through a radiator well before it reaches its boiling point. The radiator dissipates enough of the heat energy to the surrounding air to maintain the coolant in the liquid state.

[0005] In cold ambient air temperature environments, especially below zero degrees **Fahrenheit** (degree Celsius = 5/9·(degree Fahrenheit-32)), or when a cold engine is started, the coolant rarely becomes hot enough to boil. Thus, the coolant does not need to flow through the radiator. Nor is it desirable to dissipate the heat energy in the coolant in such environments since internal combustion engines operate most efficiently and pollute the least when they are running relatively hot. A cold running engine will have significantly greater sliding friction between the pistons and respective cylinder walls than a hot running engine because oil viscosity decreases with temperature. A cold running engine will also have less complete combustion in the engine combustion chamber and will build up sludge more rapidly than a hot running engine. In an attempt to increase the combustion when the engine is cold, a richer fuel is provided. All of these factors lower fuel economy and increase levels of hydrocarbon exhaust emissions.

[0006] To avoid running the coolant through the radiator, coolant systems employ a thermostat. The thermostat operates as a one-way valve, blocking or allowing flow to the radiator. Figs. 40-42 (described below) and Fig. 2 of **U.S. Patent No. 4,545,333** show typical prior art thermostat controlled coolant systems. Most prior art coolant systems employ wax pellet type or bimetallic coil type thermostats. These thermostats are self-contained devices which open and close according to precalibrated temperature values.

[0007] Coolant systems must perform a plurality of functions, in addition to cooling the engine parts. In cold weather, the cooling system must deliver hot coolant to heat exchangers associated with the heating and defrosting system so that the heater and defroster can deliver warm air to the passenger compartment and windows. The coolant system must also deliver hot coolant to the intake manifold to heat incoming air destined for combustion, especially in cold ambient air temperature environments. or when a cold engine is started. Ideally, the coolant system should also reduce its volume and speed of flow when the engine parts are cold so as to allow the engine to reach an optimum hot operating temperature. Since one or both of the intake manifold and heater need hot coolant in cold ambient air temperatures and/or during engine start-up, it is not practical to completely shut off the coolant flow through the engine block.

[0008] Practical design constraints limit the ability of the coolant system to adapt to a wide range of operating environments. For example, the heat removing capacity is limited by the size of the radiator and the volume and speed of coolant flow. The state of the self-contained prior art wax pellet type or bimetallic coil type thermostats is typically controlled only by coolant temperature.

[0009] Numerous proposals have been set forth in the prior art to more carefully tailor the coolant system to the needs of the vehicle and to improve upon the relatively inflexible prior art thermostats.

[0010] **U.S. Patent No. 4,484,541** discloses a vacuum operated diaphragm type flow control valve which replaces a prior art thermostat valve in an engine cooling system. When the coolant temperature is in a predetermined range, the state of the diaphragm valve is controlled in response to the intake manifold vacuum. This allows the engine coolant system to respond more closely to the actual load on the engine. **U.S. Patent No. 4,484,541** also discloses in Fig. 4 a system for blocking all coolant flow through a bypass passage when the diaphragm valve allows coolant flow into the radiator. In this manner, all of the coolant circulates through the radiator (i.e., none is diverted through the bypass passage), thereby shortening the cooling time.

[0011] **U.S. Patent No. 4,399,775** discloses a vacuum operated diaphragm valve for opening and closing a bypass for bypassing a wax pellet type thermostat valve. During light engine load operation, the diaphragm valve closes the bypass so that coolant flow to the radiator is controlled by the wax pellet type thermostat. During heavy engine load operation, the diaphragm valve opens the bypass, thereby removing the thermostat from the coolant flow path. By-passing the thermostat increases the volume of cooling water flowing to the radiator, thereby increasing the thermal efficiency of the engine.

[0012] **U.S. Patent No. 4,399,776** discloses a solenoid actuated flow control valve for preventing coolant from circulating in the engine body in cold engine operation, thereby accelerating engine warm-up. This patent also employs a conventional thermostat valve.

[0013] **U.S. Patent No. 4,545,333** discloses a vacuum actuated diaphragm flow control valve for replacing a conventional thermostat valve. The flow control valve is computer controlled according to sensed engine parameters.

[0014] **U.S. Patent No. 4,369,738** discloses a radiator flow regulation valve and a block transfer flow regulation valve which replace the function of the prior art thermostat valve. Both of those valves receive electrical control signals from a controller. The valves may be either vacuum actuated diaphragm valves or may be directly actuated by linear motors, solenoids or the like. In one embodiment of the invention disclosed in this patent, the controller varies the opening amount of the radiator flow regulation valve in accordance with a block output fluid temperature.

[0015] **U.S. Patent No. 5,121,714** discloses a system for directing coolant into the engine in two different streams when the oil temperature is above a predetermined value. One stream flows through the cylinder head and the other stream flows through the cylinder block. When the oil temperature is below the predetermined value, a flow control valve closes off the stream through the cylinder block. Although this patent suggests that the flow control valve can be hydraulically actuated, no specific examples are disclosed. The flow control valve is connected to an electronic control unit (ECU). This patent describes that the ECU receives signals from an outside air temperature sensor, an intake air temperature sensor, an intake pipe vacuum pressure sensor, a vehicle velocity sensor, an engine rotation sensor and an oil temperature sensor. The ECU calculates the best operating conditions of the engine cooling system and sends control signals to the flow control valve and to other engine cooling system components.

[0016] **U.S. Patent No. 5,121,714** employs a typical prior art thermostat valve **108** for directing the cooling fluid through a radiator when its temperature is above a preselected value. This patent also describes that the thermostat valve can be replaced by an electrical-control valve, although no specific examples are disclosed.

[0017] **U.S. Patent No. 4,744,336** discloses a solenoid actuated piston type flow control valve for infinitely varying coolant flow into a servo controlled valve. The solenoids receive pulse signals from an electronic control unit (ECU). The ECU receives inputs from sensors measuring ambient temperature, engine input and output coolant temperature, combustion temperature, manifold pressure and heater temperature.

[0018] One prior art method for tailoring the cooling needs of an engine to the actual engine operating conditions is to selectively cool different portions of an engine block by directing coolant through different cooling jackets (i.e., multiple circuit cooling systems). Typically, one cooling jacket is associated with the engine cylinder head and another cooling jacket is associated with the cylinder block.

[0019] For example, **U.S. Patent No. 4,539,942** employs a single cooling fluid pump and a plurality of flow control valves to selectively direct the coolant through the respective portions of the engine block. **U.S. Patent No. 4,423,705** shows in Figs. 4 and 5 a system which employs a single water pump and a flow divider valve for directing cooling water to head and block portions of the engine.

[0020] Other prior art systems employ two separate water pumps, one for each jacket. Examples of these systems are given in **U.S. Patent No. 4,423,705** (see Fig. 1), **U.S. Patent No. 4,726,324. U.S. Patent No. 4,726,325 and U.S. Patent No. 4,369,738**.

[0021] Still other prior art systems employ a single water pump and single water jacket, and vary the flow rate of the coolant by varying the speed of the water pump.

[0022] **U.S. Patent No. 5,121,714** discloses a water pump which is driven by an oil hydraulic motor. The oil hydraulic motor is connected to an oil hydraulic pump which is driven by the engine through a clutch. An electronic control unit (ECU) varies the discharge volume of the water pump according to selected engine parameters.

[0023] **U.S. Patent No. 4,079,715** discloses an electromagnetic clutch for disengaging a water pump from its drive means during engine start-up or when the engine coolant temperature is below a predetermined level.

[0024] Published application nos. **JP 55-35167** and **JP 53-136144** (described in column 1, lines 30-62 of **U.S. Patent No. 4,423,705**) disclose clutches associated with the driving mechanism of a water pump so that the pump can be stopped under cold engine operation or when the cooling water temperature is below a predetermined value.

[0025] The goal of all engine cooling systems is to maintain the internal engine temperature as close as possible to a predetermined optimum value. Since engine coolant temperature generally tracks internal engine temperature. the prior art approach to controlling internal engine temperature control is to control engine coolant temperature. Many problems arise from this approach. For example, sudden load increases on an engine may cause the internal engine temperature to significantly exceed the optimum value before the coolant temperature reflects this fact. If the thermostat is in the closed state just before the sudden load increase, the extra delay in opening will prolong the period of time in which the engine is unnecessarily overheated.

[0026] Another problem occurs during engine start-up or warm-up. During this period of time, the coolant temperature rises more rapidly than the internal engine temperature. Since the thermostat is actuated by coolant temperature, it often opens before the internal engine temperature has reached its optimum value, thereby causing coolant in the water jacket to prematurely cool the engine. Still other scenarios exist where the engine coolant temperature cannot be sufficiently regulated to cause the desired internal engine temperature.

[0027] When the internal engine temperature is not maintained at an optimum value, the engine oil will also not be at the optimum temperature. Engine oil life is largely dependent upon wear conditions. Engine oil life is significantly shortened if an engine is run either too cold or too hot. As noted above, a cold running engine will have less complete combustion in the engine combustion chamber and will build up sludge more rapidly than a hot running engine. The sludge contaminates the oil. A hot running engine will prematurely break down the oil. Thus, more frequent oil changes are needed when the internal engine temperature is not consistently maintained at its optimum value.

[0028] Prior art cooling systems also do not account for the fact that the optimum oil temperature varies with ambient air temperature. As the ambient air temperature declines, the internal engine components lose heat more rapidly to the environment and there is an increased cooling effect on the internal engine components from induction air. To counter these effects and thus maintain the internal engine components at the optimum operating temperature, the engine oil should be hotter in cold ambient air temperatures than in hot ambient air temperatures. Current prior art cooling systems cannot account for this difference because the cooling system is responsive only to coolant temperature.

[0029] Additionally, in order to control the flow of coolant between the cylinder head and the engine block, prior an cooling systems incorporated complicated valving arrangements which must be separately mounted to the engine and which occupy a significant amount of valuable engine compartment space. **U.S. Patent Nos. 4,539,942** and **5,121,714** illustrate typical cooling fluid control systems with complex valving arrangements.

[0030] Prior an cooling systems have also not taken full advantage of the heat generated during combustion of the air/fuel mixture. As discussed above, approximately one third of heat generated during the combustion of the fuel/air mixture is transferred through the exhaust system. Several prior art systems have attempted to utilize this heat for improving the efficiency of an engine. For example, **U.S. Patent No. 4,079,715** discloses a prior art method for using exhaust gases to heat the intake air. Special exhaust passageways are attached to the exhaust manifold and direct the exhaust gases through or adjacent to the intake manifold thereby permitting convection of the exhaust gas heat to the intake air.

[0031] A second prior art method for utilizing the heat in the exhaust gases is disclosed on pages 229 of the *Goodheart-Willcox automotive encyclopedia,* The Goodheart-Willcox Company, Inc., South Holland, Illinois, 1995. This method requires the incorporation of a special duct or "crossover passage" around the exhaust manifold that traps the heat which is otherwise dissipated. This trapped heated air is then routed to the intake manifold where it preheats the intake air.

[0032] These prior art methods all require the addition of special, relatively heavy ducting which must be designed to be thermally compatible with the temperatures in the exhaust gases. Additionally, these systems have all been limited to heating the intake air. Hence, the prior art methods have not utilized the heat in the exhaust gases to assist in preheating the engine and/or the engine oil.

[0033] **U.S. Patent No. 4,258,676** discloses an engine temperature system which includes a heat exchanger located between the exhaust gas and engine coolant flows. A coolant sensor is used to actuate a valve for controlling flow of the exhaust gas into the heat exchanger.

[0034] Another problem not solved by prior art systems is that in a typical internal combustion engine, it is ideal to heat the air entering the intake manifold to about **120 degrees Fahrenheit**. Heating the intake air to temperatures higher than about **130 degrees Fahrenheit** reduces combustion efficiency. This is due to the fact that air expands as it is heated. Consequently, as the air volume expands, the number of oxygen molecules per unit volume decreases. Since combustion requires oxygen, reducing the amount of oxygen molecules in a given volume decreases combustion efficiency. Prior art cooling jackets typically deliver coolant through the intake manifold at all times. When an engine is running hot, the coolant temperature is typically in a range from about **220 to about 260 degrees Fahrenheit**. Thus, the coolant may be significantly hotter than the ideal temperature of the intake manifold. Nevertheless, prior art cooling systems continue to deliver hot coolant through the intake manifold, thereby maintaining the intake manifold temperature in an excessively high range.

[0035] Additionally, the prior art systems do not sense ambient air temperature, and therefore do not determine when it is desirable to preheat the intake air. Although preheating intake combustion air is not beneficial in all environments, preheating the air in relatively cold ambient temperature environments (*e.g.,* below 20°F. (-6°C)) provides many benefits, including improved fuel economy, reduced emissions and the creation of a supercharging effect.

[0036] **U.S. Patent No. 3,397,684** discloses a supercharged diesel engine with a combustion air cooler for removing the heat of compression of the supercharger and a preheater for heating all of the combustion air within the cooler heat exchanger for cold weather starting and initial operation. In order to heat up the combustion air of the engine during starting of the engine, a heating apparatus is interconnected into the engine cooling liquid circulatory system.

[0037] While many of the prior art systems address the problem of cooling an internal combustion engine, none have provided a workable, cost efficient system. Accordingly, a need therefore exists for a system which optimally controls the flow of a fluid in a cooling system and which requires minimal modifications to the current engine arrangement.

Summary of the Invention

[0038] The present invention provides systems and methods for controlling the temperature of a liquid cooled internal combustion engine. The systems disclosed utilize a novel heating arrangement which controls the flow of temperature control fluid to and from an exhaust heat assembly located adjacent to an the engine exhaust manifold. The systems disclosed also control flow of temperature control fluid through various components of the engine for efficiently transferring heat to and from the control fluid.

[0039] In one embodiment, the system includes an exhaust manifold for exhausting heated gases which result from combustion of the air/fuel mixture in the engine. An exhaust input tube directs a flow of temperature control fluid from the engine cooling system and an exhaust output tube directs the flow of temperature control fluid back to the engine. An exhaust heat assembly is connected to the exhaust input and output tubes and channels the flow of temperature control fluid from the exhaust input tube to the exhaust output tube. The exhaust heat assembly is located adjacent or in close proximity to the exhaust manifold and is designed to permit heat transfer from the heated gases flowing in the exhaust manifold to the temperature control fluid in the exhaust heat assembly.

[0040] The exhaust heat assembly includes a heating conduit which is in contact or immediately adjacent to the manifold. First and second spacers are mounted on opposite ends of the heating conduit for preventing or minimizing the passage of heat from the heating conduit to the exhaust input and output tubes.

[0041] In one embodiment of the invention, the exhaust heat assembly receives a flow of temperature control fluid from a water pump in the engine. The water pump preferably has at least one flow restrictor valve located within the water pump which is adapted to control the flow of temperature control fluid flowing within the water pump. The flow restrictor valve is actuatable between a first position and a second position. The first position of the flow restrictor valve permits flow of temperature control fluid directly into the engine block. The second position of the flow restrictor valve restricts the flow into the engine block and, instead, directs a portion of flow of the temperature control fluid to the exhaust heat assembly.

[0042] In one operational mode of the invention, the novel exhaust heat assembly works in conjunction with a temperature control system for maintaining the temperature of the engine lubricating oil at or near its optimum operating temperature. For example, during engine warm-up or in cold environments when the temperature of the temperature control fluid is relatively cold, the flow restrictor valves in the water pump are in their second position which prevents or inhibits the flow of temperature control fluid through the engine block and, instead, directs a flow of temperature control fluid to the exhaust heat assembly along the exhaust input tube. The temperature control fluid is quickly heated by the heat flowing through the exhaust manifold and is recirculated back to the engine through the exhaust output tube.

[0043] In another embodiment of the invention, the heated temperature control fluid flowing through the exhaust output tube is directed into a heat exchanger positioned within the oil pan of the engine. This results in the transfer of heat from the temperature control fluid to the engine oil. Accordingly, the engine oil is heated as quickly as possible during engine warm-up.

[0044] In yet another embodiment of the invention. the heated temperature control fluid flowing through the exhaust output tube is directed into the intake manifold for heating the intake air prior to combustion. From the intake manifold, the heated temperature control fluid is preferably routed to the oil pan and the passenger compartment heater assembly.

[0045] After the engine has sufficiently warmed, the flow restrictor or flow control valves are actuated into their first position permitting flow of temperature fluid along the flow channels into the engine block. This stops the flow of temperature control fluid along the exhaust input tube.

[0046] A pressurization system is also disclosed for controlling actuation of flow control valves in the temperature control system. The pressurization system includes a housing which has a chamber formed in it. An input injector is in communication with the housing and is adapted to channel a flow of pressurized fluid into the chamber. An output injector is also in communication with the housing and is adapted to channel a flow of pressurized fluid out of the chamber. Fluid flow control means is connected to the housing and has at least one fluid outlet. The fluid outlet is adapted to direct a flow of pressurized fluid to a flow control valve to control actuation of the valve. The fluid flow control means has an open position for allowing a flow of pressurized fluid out of the fluid outlet and a closed position for preventing fluid flow out of the fluid outlet. The fluid flow control means receives signals from an engine computer for controlling actuation of the fluid flow control means between its open and closed positions.

[0047] First and second solenoids are preferably connected to the injectors and receive signals from the engine computer for controlling actuation of the injectors between their open and closed positions.

[0048] In one embodiment, the fluid control means includes a solenoid with at least one and preferably three fluid outlets formed in it. Each outlet directs a flow of pressurized fluid to a prescribed flow control valve. The solenoid controls flow along each outlet based on signals received from the engine computer.

[0049] An inlet line supplies a flow of fluid to the housing. The fluid is preferably hydraulic fluid. An outlet line channels a flow of fluid from the housing to a fluid reservoir.

[0050] The foregoing and other features and advantages of the present invention will become more apparent in light of the following detailed description of the preferred embodiments thereof, as illustrated in the accompanying figures.

Brief Description of the Drawings

[0051] For the purpose of illustrating the invention, there is shown in the drawings a form which is presently preferred: it being understood. however. that this invention is not limited to the precise arrangements and instrumentalities shown.

[0052] Figure 1 is a side view of an internal combustion engine incorporating the novel water pump/engine block bypass system according to the present invention.

[0053] Figure 2 is an enlarged view of the preferred hydraulic solenoid injector system for use with the novel water pump/ engine bypass system.

[0054] Figure 3 is an enlarged partial section view of one embodiment of the novel water pump design illustrating the flow restrictor valves.

[0055] Figure 4 is a section view of one embodiment of the flow restrictor valves according to the present invention.

[0056] Figure 5 is a diagrammatical plan view of the flow circuits of the temperature control fluid through the cylinder heads and the intake manifold according to the present invention.

[0057] Figure 6A is a diagrammatical side view of the flow circuit of the temperature control fluid through the engine block, cylinder heads, and radiator in a fully warmed engine according to the present invention.

[0058] Figure 6B is a diagrammatical side view of the flow circuit of the temperature control fluid through the cylinder heads, the intake manifold and the oil pan during engine warm-up according to the present invention.

[0059] Figure 7A through 7G are embodiments of the temperature control curves useful in controlling the opening and closing of the valves in the present invention. Figure 7H is a plot of the actual engine oil temperature when the temperature control curve is shifted according to the present invention.

[0060] Figure 8 is one embodiment of the novel exhaust heat assembly according to the present invention.

[0061] Figure 9 is side view of the invention taken along lines 9-9 in Figure 8 and illustrates the shape of the heating conduit and one method of attaching the exhaust heat assembly to the engine.

[0062] Figure 10 is another embodiment of the novel exhaust heat assembly according to the present invention.

[0063] Figure 11 is side view of the invention taken along lines 11-11 in Figure 10 and illustrates another method of attaching and routing the exhaust heat assembly to the engine.

[0064] Figure 12 is a diagrammatical plan view of the flow circuits of the temperature control fluid through the cylinder heads and the intake manifold according to one embodiment of the exhaust heat assembly of the present invention.

[0065] Figure 13 is a graphical illustration of the actual temperature measured on the engine exhaust manifold of a GM 3800 V6 engine.

[0066] Figure 14 is a graphical comparison of the actual engine oil temperature to the optimum oil temperature for various temperature control systems.

[0067] Figure 15 is schematic side view of an internal combustion engine incorporating the present invention and showing the various temperature control fluid flow paths through the engine.

[0068] Figures 16A and 16B are sectional views of one embodiment of a control valve for controlling flow of temperature control fluid through an engine.

[0069] Figure 17 is a diagrammatical plan view of an engine incorporating an exhaust heat assembly according to the present invention.

[0070] Figure 17A is a sectional view of an air induction system used with the present invention taken along line 3A in Figure 3.

[0071] Figure 18 is a sectional view of a hydraulic solenoid injector assembly according to the present invention useful for controlling actuation of control valves.
[0072] Figure 19 is a sectional view of an electronic engine temperature control valve according to the present invention.
[0073] Figure 20 illustrates two temperature control curves according to the present invention.
[0074] Figures 21A and 22B illustrate two alternate curves for producing a scaled temperature threshold value according to the present invention.
[0075] Figures 22A through 22D illustrate various stages of a free flow buoyancy check valve according to the present invention.
[0076] Figure 23 is a graph of the pressure/vacuum pressures within the water pump illustrating a preferred location for a vent bleed line.
[0077] Figure 24 is an alternate configuration of a solenoid pressurization system for controlling only one flow control valve.

Description of the Preferred Embodiments

[0078] While the invention will be described in connection with a preferred embodiment. it will be understood that it is not intended to limit the invention to that embodiment. On the contrary. it is intended to cover all alternatives. modifications and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.
[0079] Certain terminology is used herein for convenience only and is not be taken as a limitation on the invention. Particularly, words such as "upper," "lower," "left," "right," "horizontal," "vertical," "upward," and "downward" merely describe the configuration shown in the figures. Indeed, the valves and related components may be oriented in any direction. For example while a vertically oriented radiator is illustrated in the figures, a horizontally oriented radiator is well within the scope of the invention. The terms "inhibiting" and "restricting" are intended to cover both partial and full prevention of fluid flow. The valves for controlling the flow of temperature control fluid are generally referred to as "flow control valves" or "flow restrictor valves". These terms are intended to define any valve capable of controlling flow of fluid along a conduit.
[0080] Figure 1 illustrates an internal combustion engine generally designated with numeral 10. The internal combustion engine 10 depicted is a transverse mounted V-6 engine similar to a GM 3800 engine. The internal combustion engine includes a radiator 12 mounted in the forward facing portion of an engine compartment (not shown). Conventionally mounted to the aft of the radiator 12, between the radiator 12 and the engine 10, is a air circulation fan 14 adapted for drawing cool air through the radiator core 12C. A radiator outlet tube 18 is attached to the lower portion of radiator 12 and extends to and attaches with an inlet port 20 on a water pump 16. A radiator inlet tube 22 extends from the engine 10 and attaches to the upper portion of the radiator 12. The radiator inlet and outlet tubes 18, 22 direct temperature control fluid in to and out of the radiator 12 as will be discussed in more detail hereinbelow.
[0081] The internal combustion engine illustrated includes an engine block 24 and two cylinder heads 26 mounted to the upper portions of the engine block 24. Attached to the lower portion of the engine block 24 is an oil pan 28 which provides a reservoir for hydraulic engine lubricating oil. A oil pump (not shown) is located within the oil pan 28 and operates to direct hydraulic lubricating oil to the various members being driven within the engine. An intake manifold 30 is shown mounted between the cylinder heads 26 on the upper portion of the engine 10. The intake manifold directs a flow of air into the combustion chamber of the engine for mixing with the fuel.
[0082] The water pump 16 is attached to the engine block 24 and includes a rotatably mounted pulley 32. The pulley 32 is rotated by means of a belt 34 which, in turn, is driven by a drive mechanism (not shown). Rotation of the pulley 32 by the belt 34 produces corresponding rotation within the water pump 16. The water pump 16 has two primary modes of operation in the present invention. In the first mode of operation, the water pump functions in a similar fashion as a conventional water pump. The pulley 32 drives an internally mounted impeller (shown in Figure 3) which directs the flow of temperature control fluid entering into the water pump 16 from its inlet port 20. The rotary motion of the impellers produces centrifugal forces on the temperature control fluid which cause the fluid to flow toward block inlet ports 36, 38 formed in the engine block 24. The block inlet ports 36, 38 are connected to the engine block water jacket (not shown) which surrounds the cylinders of the engine.
[0083] Upon entering the water jacket of the engine block 24 in the first mode of operation, the temperature control fluid flows through the engine block water jacket and then enters into the water jacket surrounding the cylinder heads 26. The effect of this temperature control fluid flow is the cooling of the engine block and cylinder heads through the removal of the heat generated during engine operation. This will be discussed below in more detail.
[0084] For the sake of brevity, when discussing the flow of temperature control fluid in the engine, it should be understood that the fluid flows through water jackets formed within the engine. For example, when discussing the flow of temperature control fluid through the engine block, it should be understood that the fluid is flowing through the water

jacket of the engine block.

[0085] In the second mode of the water pump operation, the temperature control fluid circulating in the water pump 16 is not directed into the engine block 24 but, instead, is channeled directly into the cylinder heads 26. In order to do so, the water pump 16 has mounted thereto at least one hydraulically operated flow restrictor valve 40. The flow restrictor valve 40 is located so as to be capable of impeding the flow of the temperature control fluid from the impellers into the block inlet ports 36, 38. In the embodiment shown in Figure 1, there are two flow restrictor valves 40. 42 mounted on the water pump 16. The first flow restrictor valve 40 prevents or restricts flow of temperature control fluid into the leftmost or aft block inlet port 36. The second flow restrictor valve 42 prevents or restricts flow of temperature control fluid into the rightmost or forward block inlet port 38.

[0086] The flow restrictor valves 40, 42 are actuatable between a first "open" position or state and a second "restricted" position or state. In the first or open position, the temperature control fluid is permitted to flow substantially unrestricted into the engine inlet ports 36. 38 (e.g., first mode of water pump 16 operation). In the second or restricted position the temperature control fluid is substantially inhibited from entering the engine block inlet ports 36. 38 (e.g., second mode of water pump 16 operation).

[0087] The actuation of the flow restrictor valves 40, 42 is achieved by means of a hydraulic solenoid injector system (generally designated 44). The hydraulic injector system 44 controls the flow of a hydraulic fluid to and from the flow restrictor valves 40, 42 for actuating the valves between the first unrestricted position and the second restricted position. The preferred embodiment of the hydraulic solenoid injector system 44 is shown in more detail in Figure 2 and includes input and output hydraulic fluid injectors 46, 48. Attached to the hydraulic fluid injectors 40, 42 are first and second solenoids 50, 52. The solenoids are designed to receive signals on control lines 54, 56 from an engine computer unit (ECU) for controlling the opening and closing of their respective hydraulic injectors 46, 48.

[0088] A source of pressurized hydraulic fluid (not shown) is connected to the housing 58 of the hydraulic solenoid injector system 44 through fluid inlet connector 60. In the preferred embodiment, the source of pressurized hydraulic fluid is engine lubrication oil flowing either directly from the oil pump or, more preferably, from an oil filter. The oil filter prevents debris from entering into the hydraulic injectors causing damage and/or malfunction. When the input hydraulic injector is open, a flow of pressurized hydraulic fluid enters into the fluid inlet connector 60, passes through the input hydraulic injector 46 and into passageway 64. This results in the filling of chamber 66 provided that the output hydraulic injector is closed. From the chamber 66, the hydraulic fluid is provided to the flow restrictor valves 40, 42 via supply line 68.

[0089] The output hydraulic injector 48 controls the emptying or depressurization of the chamber 66. The opening of the output hydraulic injector 48 causes the hydraulic fluid in chamber 66 to drain along passage 70 and through fluid outlet connector 72. A hydraulic fluid line from the fluid outlet connector 72 leads to a hydraulic fluid reservoir, such as the engine oil pan.

[0090] In the preferred embodiment, the hydraulic injectors are Siemens Deka II modified hydraulic fluid injectors. Details of these injectors are provided in the above-referenced related patent applications. Other injectors can be readily substituted therefor without departing from the scope of the invention.

[0091] Referring back to Figure 1, in the illustrated embodiment, the hydraulic solenoid injector system 44 provides pressurized fluid for actuating both flow restrictor valves 40 and 42. The supply line 68 extends from the housing 58 and provides the flow of hydraulic fluid to the valves. The supply line 68 includes a tee member or splitter 74 which diverts part of the hydraulic fluid to each flow restrictor valve 40, 42. While a single hydraulic solenoid injector system 44 is utilized in the illustrated embodiment, it should be understood that separate hydraulic solenoid injector systems could be utilized to control each flow restrictor valve.

[0092] Figure 3 is an enlargement of one embodiment of the novel water pump according to the present invention. As stated above an impeller 76 is rotatably mounted within the water pump 16 and directs the entering temperature control fluid in a circular pattern. This produces centrifugal forces on the temperature control fluid which cause the fluid to flow along first and second flow channels 80, 82. The flow channels 80, 82 extend from the impeller 76 to the block inlet ports 36, 38, respectively. Accordingly, when temperature control fluid flows from the radiator 12 into the water pump 16, it is driven in a circular fashion by the impeller 76 and directed down channels 80, 82 into block inlet ports 36, 38 leading into the engine block 24. The impeller 76 and flow channels 80, 82 are conventional in the art and do not need to be discussed further.

[0093] Also shown mounted to the water pump 16 in Figure 3 are the flow restrictor valves 40, 42. As stated above, the flow restrictor valves 40, 42 are designed to prohibit or restrict flow of temperature control fluid along channels 80, 82 and into ports 36, 38. Each flow restrictor valve includes a piston 84 and a blade shut-off 86. The piston 84 is slidably disposed within a housing 90 and includes a pressure receiving surface 92 and a biasing spring 94. The actuation of the piston 84 translates the blade shutoff 86 between the first or open position and the second or restricted position. As discussed above, the open position of the flow restrictor valve permits flow of temperature control fluid along channels 80, 82 and into ports 36, 38, while the restricted position of the flow restrictor valve prevents flow or restricts flow along channels 80, 82.

[0094] The splitter 74 in the hydraulic fluid supply line 68 separates the hydraulic fluid flow along two lines 96, 98. Each line is directed to a separate flow restrictor valve 40, 42. When the input hydraulic injector is open, each line conveys hydraulic fluid into the housing of its respective flow restrictor valve. The hydraulic fluid fills a chamber 100 located between the housing 90 and the pressure receiving surface 92 of the piston 84. The filling of chamber 100 with pressurized fluid causes the pressure receiving surface 92 to compress the biasing spring 94.

[0095] The piston 84 is preferably mechanically connected to the blade shut-off 86 such that displacement of the piston 84 causes the blade shut-off 86 to translate between the first and second positions. In a preferred embodiment, the piston 84 is directly connected to the blade shut-off through an integral piston rod 85, such that translation of the piston 84 provides corresponding translation of the blade shut-off without need for intermediate mechanical connections. Figure 4 illustrates this type of flow restrictor valve. As shown, the flow restrictor valve 40 is mounted directly onto the water pump 16 such that displacement of the piston 84 causes direct actuation of the blade shut-off.

[0096] While it is preferable to locate the blade shut-off 86 adjacent to the piston 84 so as to permit its direct actuation, the actual engine configuration may prohibit this. For example, in the GM 3800 V6 transverse mounted engine, the location of various engine components proximate to the water pump prevents mounting the pistons 84 of both flow restrictor valves directly in line with their respective blade shut-offs. Referring to the embodiment illustrated in Figure 3, one flow restrictor valve 40 is configured so as to have the blade shut-off located directly in line with the piston. The second flow restricting valve, designated by the numeral 42, has its piston 84 located apart from the blade shut-off 86. A push-pull cable 102 is utilized to connect the piston 84 to the blade shut-off 86. The cable 102 has a push rod 104 slidably mounted within the cable sleeve 105. One end of the push rod 104 is attached to the piston 84. The opposite end of the push rod 104 is connected to the blade shut-off 86. Pressurization of the chamber 100 so as to produce translation of the piston 84 and compression of the biasing spring 94 causes the push rod 104 to slide within cable sleeve 105. This, in turn, causes the blade shut-off 86 to slide into the water pump 16, from its open position (permitting flow of temperature control fluid along flow channel 82) to its restricted position (prohibiting or restricting flow of temperature control fluid along flow channel 82).

[0097] In the preferred embodiment, the diameter of the piston 84 is between about 0.50 inches and about 2.0 inches (1 inch = 25.4 mm). More preferably the diameter of the piston 84 is about 13/16 inches. One or more seals 91 are preferably positioned between the piston 84 and the housing 90 to prevent the leakage of hydraulic fluid. The preferred spring rate for the biasing spring 94 is approximately 5 lbf/in (1 lbf/in = 0.175 N/mm). Furthermore, approximately 15 psi (1 psi = 6895 Pa) hydraulic pressure is provided to actuate the piston 84.

[0098] It should be appreciated that alternate embodiments of the flow restrictor valves could be substituted into the water pump design without departing from the scope of this invention. For example, the piston 84 could be replaced by a diaphragm valve arrangement which provides translation of the push rod 104. Furthermore, it is also possible to eliminate the biasing spring and, instead, utilize the elastomeric properties of the diaphragm to provide the biasing needed. The hydraulic solenoid injection system could also be replaced by a pneumatic system which supplies a pressurized gas such as air. Still further modifications are possible such as utilizing linear actuators and/or other electromechanical devices to actuate the blade shut-off. Those skilled in the art, after having read the instant specification, would readily be capable of modifying the configurations shown without detracting from the operability of the invention.

[0099] Figure 4 illustrates a sectional view of the flow restricting valve 40 showing some additional features of this particular valve. As stated above, the piston 84 is slidably disposed within the housing 90. The housing 90 has a cover 107 threadingly engaged with the housing for permitting access to the piston 84 and the biasing spring 94 for replacing and/or repairing these elements. The housing 90 of at least one of the flow restrictor valves (which, in the illustrated figure is the flow restrictor valve designated by the numeral 40) includes a bypass passageway 106 which is adjacent to the flow channel 80. The bypass passageway is attached to and in fluidic communication with the first flow channel 82 of the water pump 16. Hence, the bypass passageway 106 provides a second conduit along which the temperature control fluid can flow. The bypass passageway 106 has a bypass outlet 108 which connects with at least one bypass tube 110.

[0100] As illustrated, the blade shut-off 86 of the flow restrictor valve 40 is in the open position wherein the temperature control fluid is permitted to flow substantially unrestricted along first flow channel 82 and into the block inlet port 36. In this position, the blade shut-off 86 blocks or restricts the flow of temperature control fluid along the bypass passageway 106. When the flow restrictor valve 40 is actuated into its second or restricted position, the blade shut-off 86 is positioned within the first flow channel 82 preventing flow of temperature control fluid along flow channel 82 and into the block inlet port 36. In this position, the piston rod 85 is located at the entrance to the bypass passageway 106. The piston rod 85 is configured to permit the passage of temperature control fluid along the bypass passageway 106. In order to do so. the piston rod 85 is preferably formed either with a width that is dimensionally smaller than the width of the bypass passageway entrance, or has one or more apertures formed through it to permit the passage of temperature control fluid. In the preferred embodiment, the piston rod 85 has a cylindrical shape, the diameter of which is less than the width of the bypass passageway entrance. The diameter of the piston rod 85 is approximately 3/16ths of an inch. The opening to the bypass passageway is preferably about 1/2 inch high by 1 inch long. Accordingly, when the flow restrictor valve 40 is in its restricted position, the temperature control fluid is prevented or inhibited from passing directly into the engine block 24 through the block inlet port 36 and, instead, is permitted along the bypass passageway 106 and into the bypass tube 110.

[0101] Referring back to Figures 1 and 3, the bypass tube 110 connects with cylinder head input lines 112 for directing a flow of temperature control fluid along a bypass circuit to the cylinder heads 26. In a straight or inline engine, one cylinder head input line 112 would be utilized for channeling the temperature control fluid in the bypass circuit to the cylinder head. However, the illustrated embodiment is for a V6 engine which has separate cylinder heads. Accordingly, it is preferable that the bypass circuit include two cylinder head input lines 112 for channeling the temperature control fluid. As shown, the bypass tube 110 is split at a 'Y' joint separating the flow of temperature control fluid into the two cylinder head input lines 112. The two cylinder head input lines 112 are, preferably, balanced so as to provide substantially equal flow to the cylinder heads. Alternately, two bypass tubes 110 could be attached to the housing 90 for directing separate flows of the temperature control fluid. Accordingly, when the flow restrictor valve 40 is in its second or restricted position, the flow of temperature control fluid from the water pump 16 is channeled directly to the cylinder heads 26.

[0102] In Figure 5 a plan view of the engine is shown with the cylinder head input lines 112 attached to the cylinder heads 26. The flow of temperature control fluid is shown by the arrows in the figure. As can be seen, the flow of temperature control fluid enters the cylinder heads 26 at the attachment of the cylinder head input lines 112. The temperature control fluid flows across and around the cylinder heads to the aft portion of the cylinder head, which in the illustrated configuration is the rightmost portion of the engine. At this location, the temperature control fluid is directed along passageways 114 into the intake manifold 30.

[0103] The water jacket of intake manifold 30 is configured with two separate channels 116 separated by a wall 118. Both channels permit flow of temperature control fluid in the direction of the water pump as shown by the dashed arrows. One of the channels 116_A in the intake manifold directs the flow of temperature control fluid to the heater assembly (not shown). More specifically, a heater tube 120 is attached to and in fluid communication with channel 116_A of the intake manifold for receiving a flow of temperature control fluid. The temperature control fluid flowing in channel 116_A is directed through heater tube 120 to the heater assembly for providing heating and defrost capabilities in the passenger compartment of the vehicle. The heater assembly is conventional in the art and does not need to be discussed in any further detail.

[0104] The second channel 116_B in the intake manifold 30 directs a flow of temperature control fluid to a return tube 122. The return tube 122 channels the temperature control fluid either back to the water pump assembly 16 or, more preferably, to a heat exchanger located within the oil pan 28. As shown in Figure 1, return tube 122 attaches to the oil pan 28 at a first opening 124. Located within the oil pan 28 is a heat exchanger through which the flow of temperature control fluid from the return tube 122 flows. The heat exchanger transfers the heat from the temperature control fluid to the oil thereby assisting in the heating of the oil. A preferred arrangement for utilizing temperature control fluid for heating engine oil is discussed in detail in Internation application No. PCT/UC96/01278 which has been incorporated herein by reference.

[0105] The temperature control fluid is directed out of the oil pan through a second opening 126 and along outlet tube 128. The outlet tube 128 preferably attaches to the inlet tube 18 leading to the water pump 16. Various methods of attaching the two tubes can be practiced within the scope of this invention and are well known to those skilled in the art. Alternately, the outlet tube can attach to a separate opening formed in the water pump 16. In still another alternate embodiment, the return tube 122 could be formed integral with the engine. The engine can be configured with an internal flow path through the cylinder heads and engine block to the oil pan.

[0106] Referring again to Figure 5, a flow control valve is shown positioned on the rightmost portion of the engine, and is generally designated with the numeral 130. The flow control valve 130 controls the flow of temperature control fluid between the cylinder head 26, the intake manifold 30. and the radiator 12. In the preferred embodiment of the invention, the flow control valve is an electronic engine temperature control (EETC) valve, similar to the type disclosed in International application No. PCT/US95/11742 which has been incorporated herein by reference. The EETC valve 130 is actuatable between a first or open state and second or closed state. The first or open state permits a substantially unrestricted flow of the temperature control fluid from the cylinder head 26 into the intake manifold 30. In the second or closed state, the EETC valve prevents or inhibits at least a portion of the flow of the temperature control fluid from the cylinder head 26 to the intake manifold 30. Instead, in the second state, at least a portion of the temperature control fluid is directed from the cylinder head 26 into the radiator inlet tube 22 which leads to the radiator 12.

[0107] More specifically, when the EETC valve 130 is in its second or closed state, the flow of temperature control fluid from the cylinder head 26 into the channel 116_B of intake manifold is inhibited. As a result, preferably little or none of the temperature control fluid flows into return tube 122 and into the water pump 16 or the oil pan 28. Instead this temperature control fluid is directed into the radiator 12. However, the closed position of the EETC valve 130 preferably does not prevent the flow of temperature control fluid along channel 116_A. As a consequence, the heater assembly (not shown) continues to receive a flow of temperature control fluid. Hence, the heater/defrost capabilities of the system remain generally unaffected by the operation of the EETC valve 130.

[0108] Under hot weather conditions, the air flowing through the intake manifold will already be sufficiently preheated (approximately **120 degrees Fahrenheit**). Additional preheating by means of the temperature control fluid is, therefore, not needed. Similarly, under hot weather conditions, the engine oil will be operating closer to the optimum engine oil temperature value. Hence, heating of the engine oil with temperature control fluid is also not needed. Accordingly, the EETC valve in the preferred system prevents the flow of temperature control fluid through the channel 116_B of the intake manifold.

[0109] As stated above, the flow of temperature control fluid along channel 116_A is not prevented by actuation of the EETC valve 130. This permits full use of the heating/defrost systems during cold weather conditions. During hot weather conditions, the heater/defrost systems will, naturally, be in their closed positions. Accordingly, there will be no flow of temperature control fluid through the intake manifold, although temperature control fluid will remain within channel 116_A. This "trapped" temperature control fluid acts as an insulator, reducing the amount of heat which is radiated from the cylinder heads.

[0110] Alternately, the EETC valve 130 could be modified to have a third position or state wherein flow along channel 116_A is also inhibited when the ambient temperature is above a predetermined value. This would permit the full circulation of the temperature control fluid through the radiator 12 in situations where the heater/defrost capabilities are not likely to be needed (e.g., summertime).

[0111] Figures 6A and 6B are schematic representations of the fluid flow paths in the preferred embodiment. The solid arrows in Figure 6A illustrate the flow path of the temperature control fluid during normal operation of the engine when the temperature control fluid is relatively hot and the engine is fully warmed. In this embodiment, the temperature control fluid enters the block 24 from the water pump 16 and passes through a plurality of channels 132 formed between the engine block 24 and the cylinder head 26. The temperature control fluid flows through the cylinder head 26 and into passageway 114. Since the temperature of the temperature control fluid is relatively hot, the EETC valve 130 is in its second or closed position prohibiting temperature control fluid flow into channel 116_B of the intake manifold and permitting temperature control fluid flow along radiator inlet tube 22 and into the radiator 12 for cooling. The cooled temperature control fluid is then recirculated back to the water pump 16.

[0112] The dashed arrows in Figure 6B illustrate the flow of temperature control fluid during engine warm up/start up. In this embodiment, the engine is relatively cold and, therefore, it is desirable to heat up the engine as quickly as possible. Accordingly, the preferred temperature control system directs the temperature control fluid through the hottest area of the engine (e.g., cylinder heads) and the areas of the engine which need the heat the most (e.g., intake manifold and engine oil). This results in faster heating of the engine oil and, hence, the faster overall heating of the engine. The flow restrictor valves 40, 42 in the water pump 16 are actuated into their closed or restricted position, preventing the flow of temperature control fluid into the engine block 24. The temperature control fluid is, instead, directed through the bypass passageway 106 and into the cylinder input lines 112. These input lines channel the temperature control fluid directly into the cylinder heads 25 so as to permit quick heating of the fluid. The temperature control fluid then passes though passageway 114. During engine warm up. the EETC valve 130 is in its first or open position preventing or inhibiting flow of temperature control fluid to the radiator 12. The temperature control fluid is permitted to flow along both channels 116_A and 116_B in the intake manifold 30. The fluid in channel 116_B flows into the return tube 122 and. as stated above, is preferably directed through the oil pan 28 to assist in heating the oil up as quickly as possible. The dashed arrows in Figure 6B illustrate this preferred flow circuit through the oil pan 28 during engine warm up. During extremely cold weather conditions, the circuit illustrated in Figure 6B may continue for a significant amount of time. It is also conceivable that during a particular operation of the engine. the temperature conditions may prevent the valves from ever closing.

[0113] Also shown in Figures 6A and 6B is the routing of the hydraulic lines from oil pan 28, which is the preferred hydraulic fluid reservoir/source, to the hydraulic solenoid injector system 44. A filter 131 is shown located along the pressurized hydraulic fluid inlet line. A second line designated 200 is also shown tapping off of the pressurized hydraulic inlet line. This second line feeds pressurized hydraulic fluid to the EETC valve which, preferably, has its own hydraulic solenoid injector system (not shown).

[0114] The operation of a preferred system according to the present invention will now be discussed in more detail. When the engine is initially started the oil in the oil pan is typically very cold, as is the engine itself. In order to heat up the oil and the engine toward their optimum operating temperatures, it is desirable to minimize the amount of cooling that is provided by the temperature control fluid. Furthermore. as discussed in the related applications referenced above, it is desirable to direct the heat generated by the combustion of the fuel/air mixture in the cylinders to the locations where the heat is needed the most. The combustion of the fuel/air mixture generates a significant amount of heat in and around the cylinder heads while generating very little heat in the block itself. In order to heat up the engine block, engine oil and intake manifold as quickly as possible, it is desirable to harness the heat generated around the cylinder heads and transfer it in some fashion to these other components. The preferred system controls the flow of temperature control fluid through the engine to efficiently transfer the heat generated in the cylinder heads to the intake manifold and the oil pan. By directing the heat to the intake manifold, the system preheats the intake of the induction air preparing it for proper fuel mixture to provide effective and efficient combustion. Furthermore, by directing the heat from the cylinder heads to the oil pan it is possible to heat the oil towards its optimum temperature as quickly as possible. The engine block will naturally heat up as a consequence of the warmer engine lubricating oil and cylinder piston wall friction.

[0115] In order to achieve this warm up operation, the ECU of the present invention utilizes the EETC valve 130 in conjunction with the flow restrictor valves 40, 42 mounted on the water pump 16 to control the flow of temperature control fluid. More particularly, referring to Figures 6A and 6B, the ECU 900 receives signals from sensors located in and around the engine which are indicative of the engine operating state and ambient conditions. The ECU 900 utilizes these signals, in combination with predetermined temperature control curves or values, for controlling the state of the valves.

[0116] For example, in one embodiment of the invention, the ECU 900 receives signals indicative of the ambient air temperature 210, the engine oil temperature 212, and the temperature control fluid temperature 214. The ECU 900 compares these signals to one or more temperature control curves. In the preferred embodiment, the ECU 900 compares the engine oil temperature 212 to an optimum engine oil temperature curve. The ECU 900 determines the operating state of the engine based on this comparison (e.g., normal, high or extremely high load). The ECU 900 then compares the actual temperatures of the ambient air 210 and the temperature control fluid 214 to a predetermined curve or set of points for determining the desired state or position of the EETC valve 130 and the flow restrictor valves 40, 42. The set of points preferably defines a curve which is a function of at least ambient air temperature and temperature control fluid temperature. A portion of the preferred curve has a non-zero slope. Figures 7A through 7F are examples of suitable temperature control curves. Co-pending International application No. PCT/US96/01278 discusses in detail the utilization of temperature control curves for controlling the state of EETC and restrictor type valves. The ECU 900 sends control signals along lines 54, 56 to the solenoids 50, 52 to open and close the hydraulic fluid injectors 46, 48. This, in turn, causes the opening and closing of the flow restrictor valves 40, 42 as required. The ECU 900 also sends signals 216 to the solenoids (not shown) of the EETC 130 to place it in its open or closed state as determined by the temperature control curves.

[0117] In an alternate embodiment of the invention, the ECU 900 compares the actual oil temperature against an optimum engine oil temperature value or series of values defining a curve. If the actual oil temperature is above the optimum engine oil temperature value, then the ECU 900 adjusts the Normal temperature control curve instead of switching to a High Load curve. Specifically, the ECU 900 shifts the Normal temperature curve downward a predetermined amount so as to reduce the temperature of the temperature control fluid which causes actuation of the valves between their states of positions. In one embodiment of the invention, for every one degree **Fahrenheit** that the actual engine oil temperature is above the optimum engine oil temperature there is a corresponding two degree **Fahrenheit** decrease in the temperature control fluid temperature component which produces actuation of the valves. This effectively results in a downward shifting of the temperature control curve. Different engine configurations will, of course, result in different amounts that the temperature control fluid temperature component is shifted downward for a one degree rise in actual engine oil temperature. For example, a one degree rise in actual oil temperature above the optimum oil temperature value may produce a decrease in the actuation temperature of the temperature control fluid within a range of between 1 and 10 degrees. Furthermore, it is contemplated that the amount of downward shifting of the temperature component may not be constant (e.g., the amount of downward shifting may increase as the difference between the actual oil temperature and the optimum oil temperature increases).

[0118] In yet another embodiment, the amount of downward shifting of the temperature control fluid temperature component may also vary with changes in ambient temperature. For example, at 0 degrees ambient air temperature, every one degree that the actual oil temperature is above the optimum oil temperature produces a one degree decrease in the temperature control fluid temperature component. At 50 degrees ambient air temperature, every one degree that the actual oil temperature is above the optimum oil temperature produces a two degree decrease in the temperature control fluid temperature component. At 80 degrees ambient air temperature, every one degree that the actual oil temperature is above the optimum oil temperature produces a three degree decrease in the temperature control fluid temperature component. This embodiment of the invention may be graphically illustrated as shown in Figure 7F wherein a control curve is selected by the ECU depending on the sensed ambient temperature. Although linear curves are illustrated in the exemplary embodiment, it should be understood that alternate non-linear curves may be incorporated for each ambient temperature. It is also contemplated that a single curve may be utilized for shifting the temperature control curve. One axis of the plot would represent the sensed ambient temperature. The second axis would represent the ratio of a one degree increase in engine oil over the corresponding downward shifting of the temperature control curve (e.g., 1/1, 1/2 or 1/3).

[0119] Alternately, it may be preferable to wait until the actual oil temperature exceeds the optimum oil temperature value by a set amount before altering the temperature control curve. For example, for every 3 degree increase in the actual engine oil temperature above the optimum oil temperature value there is a corresponding decrease in the set point temperature of the temperature control fluid which directs actuation of the valve.

[0120] Figure 7E graphically illustrates this aspect of the invention. A series of identical temperature control curves are shown for a plurality of actual sensed engine oil temperatures. Each dashed line (NC') represents a shifted-down version of the solid "normal" temperature control curve (NC). It should be readily apparent that only one particular curve or value would be utilized for a given sensed engine oil temperature. In an alternate arrangement, an equation and/or scaling factor instead of a separate curve may be utilized to alter the value at which actuation occurs according to the normal curve.

[0121] In many instances, altering the temperature control fluid component based only on the amount that the actual engine oil temperature exceeds the optimum engine oil value would be sufficient. However, in the preferred embodiment, it is also desirable to monitor the engine load to determine how much altering of the temperature control curves is required to maintain the actual engine oil temperature at or near the optimum oil temperature.

[0122] One method for varying or altering the temperature control curve is by monitoring the rate of change of the actual engine oil temperature. Referring to Figure 7G, an exemplary curve is illustrated which depicts the rate of change of the actual engine oil temperature versus the scaling factor for the temperature control fluid component and/or for determining the downward shifting of the temperature control curve. If the detected rate of change of the actual oil temperature is relatively low (R_1), the downward shifting of the temperature control curves is also small (S_1). If, on the other hand, the detected rate of change of actual oil temperature is large (R_2) which is indicative of a high loading condition, then the downward shifting of the temperature control curve is also relatively large (S_2). Although the exemplary curve depicts a linear curve other curve shapes, such as exponential, logarithmic, curvilinear, etc., may be substituted therefor. Furthermore, a step function may instead be utilized which provides a different amount of downward shifting of the temperature control curve for different detected rates of change of the actual engine oil.

[0123] During use, when the engine computer detects that the actual sensed oil temperature exceeds the optimum oil temperature, the computer then determines rate of change of the actual engine oil temperature. The engine computer determines a scaling factor from this rate of change. The scaling factor is then applied to the normal temperature curve to shift the curve downward. The engine computer continues to monitor the rate of change in the actual oil temperature and shifts the temperature control curve accordingly. Delays can be incorporated into the system to minimize the amount of shifting of the temperature control curve that occurs.

[0124] An analytically determined curve illustrating the effect of the above embodiment is shown in Figure 7H. The curve shown is for a constant ambient temperature of 60°F (15°C). From time t_0 to time t_1, the engine computer controls the opening and closing of the EETC valve and restrictor valves according to a normal temperature control curve (level 1). At time t_1, the engine computer detects an increase in the actual oil temperature above the optimum engine oil temperature value (approximately 235°F (112°C) in the illustrated embodiment) which is preferably determined from an optimum engine oil temperature curve similar to the one shown in Figure 7C. This is indicative of an increase in engine load. The engine computer either applies a predetermined factor for downward shifting of the temperature control curve (e.g., 2 degree drop in TCF for each 1 degree rise in engine oil temperature) or, more preferably, the engine computer determines a rate of change of the engine oil temperature and from that rate calculates the amount of downward shifting of the temperature control curve required.

[0125] The EETC valve is opened according to the new shifted temperature control curve (level 2), causing the immediate drop in the temperature control fluid as shown between time t_1 and t_2. The engine oil however, will continue to rise until the cooling effect of the temperature control fluid begins to cool the engine oil.

[0126] The engine computer continues to monitor the actual engine oil temperature. At time t_2, the temperature of the temperature control fluid stabilizes at the new shifted temperature control fluid valve. If the actual engine oil is still above the optimum engine oil temperature, the engine computer determines the rate of change of engine oil temperature between time t_1 and t_2. The high rate of change indicates a continued high engine load condition. Accordingly, based on this determined rate, the engine computer determines an additional amount of downward shifting of the temperature control curve that is required. The EETC valve is then controlled based on the this second shifted temperature control curve (level 3).

[0127] At time t_3 the engine computer determines a rate of change of the engine oil temperature between time t_2 and t_3. Since the new rate of change in the illustrated example is less than the previous rate of change, the engine computer does not shift the temperature control curve downward. Instead, the engine computer continues to control the EETC valve based on the level 3 temperature control curve.

[0128] At time t_5 the engine computer determines a rate of change of the engine oil temperature between time t_4 and t_5. Since the new rate of change in the illustrated example is decreasing, the engine computer shifts the temperature control curve upward back toward the first or normal level. As a result, the temperature control fluid temperature continues to heat up while the engine oil decreases in temperature and begins to return to its optimal operating temperature.

[0129] Since the reheating of the temperature control fluid is a slow process, as illustrated by the time period between time t_5 and t_6, it is important not to drop the temperature control fluid to an unnecessarily low temperature so as to maintain the engine oil as close to the optimum engine oil as possible.

[0130] It should be understood that the sensed ambient air temperature will affect rate or slope of the temperature control fluid temperature curve in Figure 7H. For example, at hot ambient temperatures, the temperature slope of the temperature control fluid between time t_5 and t_6 will be steeper than at low ambient temperatures. This is due to the fact that at lower temperatures (e.g., zero degrees ambient) it is more preferable that the engine oil remains at a higher temperature for a longer period of time to increase heater and defroster capabilities. The cold ambient temperature reduces the likelihood that the engine oil will become excessively hot. In warmer ambient temperatures, it is desirable to maintain the engine oil closer to its optimum valve so as to prevent overheating. The temperature slope of the temperature control fluid is, thus, steeper at these warmer temperatures.

[0131] An alternate method for determining the engine load is by monitoring the intake manifold vacuum pressure. The sensed intake manifold pressure generally provides an accurate indication of the current engine load. For example, if the sensed intake manifold vacuum is less than about 4 inches Hg, (13546 Pa), the engine is operating under a high load condition. Accordingly, a first predetermined scaling factor or curve can be selected for reducing or replacing the temperature control curve. If, however, the intake manifold vacuum is less than about 2 inches Hg, (6773 Pa), then the engine is operating under an extremely load condition. In this case, a second scaling factor or curve is selected for varying the normal temperature control curve.

[0132] Another method for determining engine load is through the monitoring of the commanded engine acceleration. For example, a high commanded engine acceleration is indicative of a high engine load condition. The amount of engine acceleration can be determined from a variety of methods, such as the accelerator pedal displacement, a signal from the fuel injection system, etc. Depending on the commanded acceleration, a predetermined factor and/or curve is selected for varying the normal temperature control curve.

[0133] In both the commanded engine acceleration method and the intake manifold air pressure method, a rate monitoring system similar to the one discussed above with respect to the engine oil temperature could also be incorporated to further optimize these methods.

[0134] Based on the above discussion, those skilled in the art would readily understand and appreciate that various modifications can be made to the exemplary embodiments disclosed and are well within the scope of this invention. For example, the temperature control curves themselves may be replaced by one or more equations for controlling the actuation of the valves. In yet another embodiment, fuzzy logic controllers could be implemented for controlling the actuation of the valves and/or varying of the temperature control curves.

[0135] The varying or downward shifting of the temperature control curves as discussed above is preferably limited to between approximately 50°F - 70°F (10°C - 21°C). This is intended to prevent substantial degradation in the capabilities of the heater/defroster systems by maintaining the temperature control fluid at a reasonably high temperature.

[0136] Referring back to Figure 4, inhibiting the flow of temperature control fluid through the engine block 24 and through the radiator 12 results in a temperature control fluid circuit which transfers heat from the cylinder heads 26 through the intake manifold 30 and into the oil pan 28. The dashed arrows in Figure 4 indicate the flow path or circuit of the temperature control fluid during engine warm up. As stated above, the flow path transitions through the cylinder heads 26, the intake manifold 30, the oil pan 28 and back to the water pump 16. The closed state of EETC valve 130 prevents flow of temperature control fluid to the radiator 12 and the restricted positions of the flow restrictor valves 40, 42 prevent flow of temperature control fluid into the engine block 24.

[0137] Although there is no flow of temperature control fluid in the engine block 24, there is still a substantial amount of fluid already present in the block. Since there is no pressure forcing the fluid in the engine block 24 to circulate, it will not flow up through the channels 132 formed between the water jackets of the engine block 24 and the cylinder heads 26. The flow of temperature control fluid through the cylinder heads 26 and over the channels 132 functions effectively as a dam to further prevent the flow of temperature control fluid from the engine block 24 into the cylinder heads 26. A significant quantity of temperature control fluid is, therefore, trapped within the engine block 24 and naturally heat up on its own. The reduced amount or mass of temperature control fluid which is circulated by the preferred system around the engine during warm-up/start-up will heat up quicker and, accordingly, heat the engine and oil up significantly faster. In actuality, the temperature control fluid trapped within the engine block acts as an "insulator" to retain valuable heat within the engine circuit. It is expected that the temperature of the temperature control fluid entering the cylinder heads (after circulation through the engine oil pan and water pump) will be approximately 30 °F to 50°F (-1°C to 10°C) warmer than the temperature of the temperature control fluid trapped within the engine block water jacket. This should be low enough to prevent "thermal shock" yet be significant enough to improve engine warm-up for better engine out exhaust emissions and fuel economy especially for short durations of engine operation, e.g., delivery vans, etc.

[0138] In a GM 3800 V6 engine, the preferred configuration reduces the mass of temperature control fluid circulating by between approximately forty to fifty percent during warm-up. This results in the quicker heat up of the engine towards its optimum operating temperature, yielding reduced exhaust emissions and quicker heater/defrost capabilities. Also, by raising the temperature of the oil in the oil pan to above 195° Fahrenheit (90° Celsius), it is possible to reduce or eliminate sludge buildup and also maintain the engine oil at or near its optimum temperature. This should result in better extreme cold weather fuel economy.

[0139] As stated above, an EETC valve is the preferred valve for controlling the flow of temperature control fluid between the engine and the radiator. While an EETC valve has been chosen as the preferred valve, other valves may be utilized in its stead for controlling the fluid flow between the engine and the radiator. A standard thermostat could also be used in place of the EETC valve disclosed above. However, since a thermostatic valve is limited to controlling the flow of fluid based on the temperature of the fluid, it is not designed to maintain the temperature of the engine oil at or near its optimum temperature. Accordingly, it is not a preferred valve.

[0140] Referring back to Figure 6B, after the ECU 900 determines that the engine has warmed up and the oil is running at or near its optimum temperature, the EETC valve 130 is actuated into its second or closed position so as to permit flow of temperature control fluid from the cylinder heads 26 toward the radiator 12. Furthermore, at some point after the engine has begun to warm up, the flow restrictor valves 40, 42 are actuated into their open or unrestricted position which inhibits flow of temperature control fluid into the bypass passageway 106 and, instead, permits flow of temperature control fluid along flow channels 80, 82 of the water pump 16. This permits the flow of temperature control fluid to enter into the block inlet ports 36. 38. The flow of temperature control fluid in this mode of operation is indicated by the solid arrows in Figure 6A. The fluid flows directly into the engine block 24 and through the series of channels 132 formed between the engine block 24 and the cylinder head 26 as shown.

[0141] It is also contemplated that one or more restrictor valves may be incorporated into the engine block 24 to reduce the flow of temperature control fluid through the channels 132 between the block and the cylinder head to further optimize the system. Figures 6A and 6B illustrate two restrictor valves in phantom (identified by the numeral 400) positioned within the engine block 24. Suitable restrictor valves are discussed in Internation application No. PCT/US95/11742 and U.S. Patent 5.463,986.

[0142] Another feature of the invention involves the utilization of the heat present in the engine exhaust to further heat the temperature control fluid. As discussed above, approximately one third of heat generated during the combustion of the fuel/air mixture is transferred through the exhaust system. The present invention utilizes the heat in the exhaust gases to assist in heating up the temperature control fluid during warm-up of the engine. Accordingly, the increased temperature of the temperature control fluid helps to bring the engine and the engine oil up to their optimum operating temperatures significantly faster than prior art systems. The present invention has particular use in diesel engines where the additional heat significantly increases the engine efficiency.

[0143] Figures 8 and 9 illustrate an embodiment of the invention which incorporates a novel means for harnessing the heat of the exhaust gases. In this embodiment, the bypass tube 110, which leads from the water pump 16 and connects to the cylinder head input lines 112, is split so as to direct at least a portion of the temperature control fluid flow to the exhaust manifold 140 along the exhaust input tube 141. The exhaust input tube 141 attaches with an exhaust heat assembly generally designated 142.

[0144] The exhaust heat assembly 142 extends along or adjacent to at least a portion of the exhaust manifold 140. The exhaust heat assembly 142 includes a heating conduit 144 that is directly in contact with or adjacent to the exhaust manifold 140. The heat from exhaust gases in the exhaust manifold 140 is conducted through the walls of the exhaust manifold 140 and the heating conduit 144 and into the temperature control fluid. In order to maximize the amount of heat transfer into the temperature control fluid, it is preferable that the heating conduit 144 be shaped so as to conform to the exhaust manifold 140. For example, as illustrated, the side 144_A of the heating conduit 144 which is directly in contact with the exhaust manifold 140 is preferably configured relatively large in size so as to permit a significant amount of heat transfer into the heating conduit 144. The heating conduit 144 is made from material which is capable of withstanding the excessive temperatures which exist in and/or around the exhaust manifold 140. However, the material chosen must also be capable of readily transferring the heat from the exhaust manifold 140 to the temperature control fluid which flows within the heating conduit 144. In the preferred embodiment, the heating conduit is made from stainless steel, and has a wall thickness of approximately 0.090 inches. The shape of the heating conduit 144 will vary depending on the engine exhaust manifold configuration.

[0145] Since the heating conduit 144 is exposed to the excessive temperatures of manifold, it is likely to also be at an excessively high temperature. Accordingly, it is not desirable to attach the exhaust input tube 141, which contains the temperature control fluid and which is typically made from a rubber material, directly to the heating conduit 144. Instead, the exhaust heat assembly 142 preferably includes a first spacer 146 which is located between the heating conduit 144 and the return tube 141. The first spacer 146 is preferably made from a non-conductive or minimally conductive material such as ceramic. The exhaust input tube 141 attaches to the first spacer 146 in conventional fashion so as to permit the flow of temperature control fluid into the inlet of the heating conduit 144. Furthermore, in order to dissipate the heat of the heating conduit 144 slightly before engaging with the spacer 146, the heating conduit 144 extends approximately six inches on either side of its engagement with the exhaust manifold 140.

[0146] The outlet side of heating conduit 144 attaches to a second spacer 148, which is also preferably made from ceramic material. The second spacer 148 directs the flow of temperature control fluid from the heating conduit 144 to an exhaust return tube 152. The exhaust return tube 152 conveys the heated temperature control fluid into either the water pump 16 or, more preferably, into the oil pan 28 for transferring the heat from the temperature control fluid to the engine oil. If, as is preferred, the heated temperature control fluid is directed to the oil pan 28, then the return tube 122 from channel 116_B of the intake manifold 30 does not also need to be directed through the oil pan 28. Instead, the return tube 122 can attach directly to the inlet 20 of the water pump 16.

[0147] A crimp joint 149 is utilized to attach the spacers 146, 148 to the heating conduit 144. The crimp joint 149 includes a soft metallic seal 150, such as copper or high temperature synthetic material.

[0148] In the preferred embodiment of the exhaust heat assembly 142, a valving arrangement 154 is located between the second spacer 148 and the exhaust return tube 152. The valving arrangement is designed to permit temperature control fluid flow in only one direction. That is, the valving arrangement 154 permits the heated temperature control fluid to flow from the heating conduit 144 into the exhaust return tube 152 and toward the oil pan and/or water pump 16. The valving arrangement 154, however, does not permit the temperature control fluid to flow back into the heating conduit 144. This is particularly important when the flow of temperature control fluid into the exhaust heat assembly 142 is shut off, such as after the engine oil has been warmed to a predetermined temperature. In this operational mode, the flow restrictor valves 40, 42 will be in their open state, inhibiting flow of temperature control fluid into the exhaust input tube 141 and, accordingly, the exhaust heat assembly 142. However, there is ordinarily no valve to stop the flow of temperature control fluid from the water pump 16 back along the exhaust return tube 152 to the exhaust heat assembly 142. The valving arrangement 154 of the present invention prevents any back flow of temperature control fluid from entering the heating conduit 144.

[0149] In the embodiment illustrated, a check ball valve is the valve of choice, although a spring type flapper valve could readily be substituted without detracting from the invention. Since the valving arrangement is separated from the heating conduit 144 by a ceramic spacer 148, the valve will not experience extreme temperatures. Therefore, it can be made from a lightweight material such as glass-filled nylon or aluminum.

[0150] While the above embodiment directs substantially the entire flow of temperature control fluid flowing through the exhaust heat assembly 142 into the oil pan 28, it is also possible to split the flow of temperature control fluid in the exhaust return tube 152, such that a portion of the flow is directed towards the oil pan 28 with the remainder of the flow directed into the water pump 16 or through another engine preheat system, such as an air induction preheat system. Those skilled in the art should readily appreciate that various modifications to this system can be practiced within the scope of this invention.

[0151] Another embodiment of the engine exhaust heat assembly is illustrated in Figures 10 through 12 and generally designated by the numeral 300. In this embodiment the heat of the exhaust gases flowing through the engine manifold 140 is transferred to the temperature control fluid flowing through the exhaust heat assembly 142 as described above. In this embodiment, instead of directing the heated temperature control fluid into and through the oil pan 28, the heated temperature control fluid is channeled through the intake manifold and/or the heater assembly for heating the passenger compartment.

[0152] The heated temperature control fluid which exits from the valving arrangement 154 is channeled by an exhaust output tube 302 directly to the intake manifold 30. The exhaust output tube 302 enters the intake manifold 30 through opening 304. The heated temperature control fluid, which enters the intake manifold 30 at opening 304, mixes with the flow of temperature control fluid flowing into the intake manifold 30 from the cylinder heads 26. This combined flow of temperature control fluid flows along channels 116_A and 116_B. The heated temperature control fluid flows through the intake manifold and preferably exits through return tube 122 and heater tube 120. The heater tube 120 directs a portion of the temperature control fluid to the heater assembly (not shown) for heating the passenger compartment. The return tube 122 preferably channels a portion of the temperature control fluid to the engine oil pan 28 for heating the engine lubricating oil. This arrangement of the return tube 122 and heater tube 120 has been described in detail above with respect to Figures 1 through 6B.

[0153] When the engine oil and/or temperature control fluid reaches a predetermined temperature, the flow restrictor valves 40, 42 in the water pump 16 stop the flow of temperature control fluid through the exhaust heat assembly 142. Accordingly, temperature control fluid no longer enters the intake manifold through opening 304. As discussed above, the valving arrangement 154 is preferably a one-way flow valve which prevents the temperature control fluid in the exhaust output tube 302 from flowing back into the exhaust heat assembly 142.

[0154] The above embodiments disclose the channeling of fluid through a single exhaust heat assembly. However, a second exhaust heat assembly could be mounted to the exhaust manifolds on the opposite side of the block as shown in phantom in Figure 8. In this embodiment, a second exhaust input tube (not shown) would preferably tap off of the bypass tube 110.

[0155] In yet a further embodiment of the invention (not shown), the heated temperature control fluid from the exhaust heat assembly 142 can be channeled directly from the exhaust manifold to the heater assembly for heating the passenger compartment.

[0156] Those skilled in the art would understand and appreciate that various other embodiments for channeling the heated temperature control fluid to and from the exhaust heat assembly 142 are possible and well within the scope of this invention.

[0157] Referring to Figure 13, a graphical illustration is shown of the actual temperature of the exhaust manifold as measured on a GM 3800 V6 engine. The temperatures were measured from a cold start condition. As is readily apparent, the temperature of the exhaust manifold increases from a cold start temperature to over 600 degrees Fahrenheit (315°C) in approximately four minutes. This exemplifies the amount of heat that is lost through the engine exhaust. The present invention harnesses this heat and directs it back to the engine for optimally controlling the engine temperature. The point designated 'X' on the curve represents the point at which the engine ignition was turned off. The temperature in the exhaust manifold immediately begins to drop back toward the ambient temperature.

[0158] It should be noted that in the above embodiments, the engine has been described as a V-6 engine and accordingly there are two flow paths of temperature control fluid through the engine block 24 (e.g., two engine block inlets 36, 38) and also two flow paths of temperature control fluid through the cylinder heads 26. However, the invention is also applicable to an embodiment wherein there is a single flow path of temperature control fluid into the engine block 24 and/or through the cylinder heads 26. In such an embodiment, a single flow restrictor valve would be required to inhibit the flow of temperature control fluid into the block 24 and to direct the flow of temperature control fluid into the cylinder heads 24. Those skilled in the art would readily be capable of practicing the present invention on an engine of such a configuration based on the teachings of this present application. Additionally. specific engine configurations may necessitate further changes to the exemplary embodiments illustrated and discussed above. These changes and/or modifications are also within the scope and purview of this invention.

[0159] Figure 14 graphically compares the actual engine oil temperature to the optimum engine oil temperature for various temperature control systems disclosed in the above-referenced related applications. As can readily be seen, a system according to one preferred embodiment of the invention, which utilizes the exhaust heat assembly in combination with the novel water pump design, maintains the actual engine oil temperature closer to the desired optimum engine oil temperature.

[0160] Figure 15 illustrates an internal combustion engine generally designated with numeral 10. The configuration of the engine in this embodiment is preferably similar to the embodiments disclosed above. In this embodiment, an alternate valve for controlling flow from the water pump 16 to the exhaust heat assembly is generally designated by the numeral 40.

[0161] Referring to Figures 16A and 16B the flow restrictor valve 40 includes first and second housing portions 1100, 1101. The first housing portion 1100 is crimped into engagement with the second housing portion 1101. Alternate attachment mechanisms, such as threads, are well within the scope of the invention. The flow restrictor valve 40 is actuatable between a first "normal flow" position or state and a second "exhaust heating flow" position or state. In the first position, shown in Figure 16A, an actuatable piston 1104 prevents the temperature control fluid from flowing through a passageway 1102 in the first housing portion 1100 leading to the exhaust heat assembly 1142. The piston 1104 includes a pressure head 1106 and a sealing head 1108. The pressure head 1104 is slidably disposed within a chamber 1110 within the first housing portion 1100 and has a pressure receiving surface 1112 formed thereon. A fluid line 1114 is connected to the first housing portion 1100 and is in fluid communication with the chamber 1110. The fluid line 1114 is operative for directing a pressurized medium into the chamber 1110 for increasing the pressure therein. As will be discussed in more detail below, this increase in pressure is designed to displace the pressure head 1106 and the piston 1104. In a preferred embodiment, the fluid line is threaded into an insert 1113. The insert 1113, in turn. is mounted to the first housing portion 1100 by means of a cap 1115. Attachment of the cap 1115 to the first housing portion 1100 is provided by a crimp joint 1117 as shown. Alternately, the cap 1115 may be threaded into engagement with the first housing portion 1100. Flow of the medium is channeled out of the fluid line 1114, through the insert 1113 and into the chamber 1110.

[0162] The sealing head 1108 is slidably disposed within the passageway 1102 in the first housing portion 1100. The sealing head 1108 is designed to prevent temperature control fluid from passing through the passageway 1102 when the valve 40 is in its first position. A shaft 1116 extends between and attaches to the sealing head 1108 and the piston head 1106. In the embodiment illustrated, the shaft 1116 is formed integral with the sealing head 1108 and is threaded into engagement with the piston head 1106. A variety of alternate attachment means can be substituted for the illustrated embodiment.

[0163] As is apparent from Figures 16A and 16B, pressurization of the chamber 1110 produces displacement of the pressure head 1106. This results in concurrent displacement of the sealing head 1108. A biasing spring 1118 is located within the first housing portion 1100 between the pressure head 1106 and a seat 1120. The biasing spring 1118 urges the pressure head 1106 away from the passageway 1102 and opposes any displacement of piston 1104 caused by pressure in the chamber 1110.

[0164] A valve inlet 1122 channels temperature control fluid to the passageway 1102. The passageway 1102 communicates with a valve conduit 1124 formed in the second housing portion 1101. The valve conduit 1124, in turn, communicates with one or more valve outlets 1126 which permit fluid flow out of the valve 40. Exhaust input tubes 141 are attached to the valve outlets 1126 and communicate with the exhaust heat assembly 142. Attachment between the exhaust heat inlet tubes 141 and the valve outlets 1126 is provided by crimps.

[0165] When the valve 40 is in its first position (shown in Figure 16A), the sealing head 1108 prevents the temperature control fluid from flowing through the passageway 1102 to the valve conduit 1124 and valve outlets 1126.

[0166] The second position of the valve 40 is shown in Figure 16B. In this position, at least a portion of the temperature control fluid is allowed to flow through the passageway 1102, along the valve conduit 1124, and out of the valve 40 through the valve outlets 1126. From the valve 40, the temperature control fluid is permitted to flow to the exhaust heat assembly 142. In this second position of the flow restrictor valve 40, a sufficient amount of fluid medium has been supplied to the chamber 1110 to overcome the spring force associated with the biasing spring 1118 and to force the piston 1104 to slide within the first housing portion 1100. This causes compression of the spring 1118 and moves the sealing head 1108 out of the passageway 1102, thus permitting fluid to flow therethrough.

[0167] Seals 1128 may be placed between the walls of the first housing portion 1100 and the pressure head 1106 and sealing head 1108 to prevent leakage of the pressurizing medium into the valve inlet 1122. The seals 1128 are preferably POLYPAK® retention seals manufactured by Parker-Hannifin Corp., Cleveland. OH, VITON® elastomer seals manufactured by E.I. Du Pont De Nemours & Co., Wilmington, DE, or teflon O-rings.

[0168] Due to the high temperatures associated with the exhaust heat assembly 142, high temperature seals 1130 are preferably utilized at the attachment of the exhaust manifold inlet tubes 141 to the valve outlets 1126. The high temperature seals are preferably radial O-rings. To provide further sealing, a secondary seal 1132 may also be incorporated. This secondary seal 1132 is preferably a soft copper flange seal. The high temperatures of the exhaust heat assembly 142 also require the addition of a high temperature radial O-ring seal between the first and second housing portions 1100, 1101.

[0169] As discussed above, the valve 40 has first and second housing portions 1100, 1101. One reason for utilizing two housing portions is the need to prevent or minimize heat transfer from the exhaust heat assembly 142. Related application Serial Number 08/447,468 discusses in detail the temperature related problems associated with the exhaust heating assembly 142. To prevent conduction of the heat to the water pump 16, it is desirable to manufacture the valve 40 from a high temperature non-conductive material, such as ceramic. However, due to the high cost associated with the manufacture of ceramic components, it is preferable that only a portion of the valve 40 (e.g., the second housing portion 1101) be made from ceramic material. The remainder of the valve 40 (e.g., the first housing portion 1100, the cap 1115) may be made from a less costly material, such as aluminum or plastic, thereby designating the valve as a bi-material valve. An O-ring seal 1134 is preferably utilized at the attachment of the second housing portion 1101 to the first housing portion 1100 and between the cap 1115 and the first housing portion 1100.

[0170] It should be appreciated that modifications could be made to the flow restrictor valve 40 without departing from the scope of this invention. For example, the piston 1104 could be replaced by a diaphragm valve arrangement which provides translation of the sealing head 1108. Furthermore, it is also possible to eliminate the biasing spring 1118 and, instead, utilize the elastomeric properties of the diaphragm to provide the biasing needed. Alternately, a rotary valve may be utilized to control flow to the exhaust heat assembly 142. Those skilled in the art, after having read the instant specification, would readily be capable of modifying the above valve configuration without detracting from the operability of the invention.

[0171] The flow restrictor valve 40 is located between the water pump 16 and the exhaust heat assembly 142. Preferably the flow restrictor valve 40 is attached directly to an outlet on the water pump 16 and controls the flow of temperature control fluid to a heating conduit 144 in the exhaust heat assembly 142. Referring to Figures 17 and 17A, the exhaust heat assembly 142 is illustrated with a second flow restrictor valve 41 mounted downstream of the heating conduit 144. The second valve 41 is similar in configuration and operates is a similar manner as the first flow restrictor valve 40. The second flow restrictor valve 41 has a first position wherein flow of temperature control fluid through the valve 41 is inhibited and a second position wherein the flow of the temperature control fluid is allowed.

[0172] The second flow restrictor valve 41 controls the flow of the temperature control fluid from the heating conduit 144 of the exhaust heat assembly 142 and to various components in or on the engine. For example, in one embodiment, the second flow restrictor valve 41 controls flow of the temperature control fluid to an air induction system (designated by numeral 150 in Figure 15) for heating air entering a throttle prior to mixture with fuel. This embodiment is discussed in detail hereinbelow. In an alternate embodiment (not shown), the temperature control fluid is channeled from the second flow restrictor valve 41 directly to the conductive tubes 220 in the oil pan 28.

[0173] As discussed above, the flow restrictor valves 40, 41 are actuatable between first and second positions. The actuation is achieved by means of a pressurization system, such as a hydraulic solenoid injector system (generally designated 44 in Figure 2 and 15). The hydraulic injector system 44 controls the flow of a fluid medium, such as hydraulic fluid, to and from the flow restrictor valves 40, 41 for actuating the valves between their first and second positions. A preferred embodiment of the hydraulic solenoid injector system 44 is shown in more detail in Figures 15 and 18 and includes input and output hydraulic fluid injectors 46, 48. Attached to the hydraulic fluid injectors 46, 48 are first and second solenoids 50, 52. The solenoids are designed to receive signals on control lines 54, 56 from an engine computer unit (ECU) 900 for controlling the opening and closing of their respective hydraulic injectors 46, 48.

[0174] A source of pressurized fluid is connected to a housing 58 of the hydraulic solenoid injector system 44 through fluid inlet connector 60. In the preferred embodiment, the source of pressurized fluid is engine lubrication oil flowing either directly from the oil pump or, more preferably, from an oil filter (designated by the numeral 3 in Figure 15). The oil filter 3 prevents debris from entering into the hydraulic injectors causing damage and/or malfunction. The filter is preferably replaceable. When the input hydraulic injector 46 is open, a flow of pressurized hydraulic fluid enters into the fluid inlet connector 60, passes through the input hydraulic injector 46 and into passageway 64. This results in the filling and pressurizing of chamber 66 provided that the output hydraulic injector 48 is closed. From the chamber 66, the hydraulic fluid is provided to the flow restrictor valves 40, 41 via supply lines.

[0175] The output hydraulic injector 48 controls the emptying or depressurization of the chamber 66. The opening of the output hydraulic injector 48 causes the hydraulic fluid in chamber 66 to drain along passage 70 and through fluid outlet connector 72. A hydraulic fluid line from the fluid outlet connector 72 leads to a hydraulic fluid reservoir, such as the engine oil pan 28.

[0176] In the preferred embodiment, the hydraulic injectors are Siemens Deka II modified hydraulic fluid injectors. Details of these injectors are provided in the above-referenced related patent applications. Other solenoid-type injectors can be readily substituted therefor without departing from the scope of the invention.

[0177] The hydraulic solenoid injector system 44 also preferably includes a third solenoid 74 mounted to the housing 58 and in communication with the chamber 66. The third solenoid 74 is preferably a multi-way solenoid which provides a means for controlling fluid flow over one or more supply lines 76 leading to the flow restrictor valves 40, 41 and an electronic engine temperature control valve (EETC) 130. In the illustrated embodiment, the third solenoid controls flow of a fluid medium along three supply lines (designated by numerals 76_A, 76_B and 76_C). Each supply line channels a flow of fluid for pressurizing a valve. While three supply lines are shown in the preferred embodiment, alternate configurations are possible and well within the purview of the claims. Supply line 76_A supplies pressurized fluid to the flow restrictor valve 40 which controls flow of the temperature control fluid leading to the exhaust heat assembly 142 from the water pump 16. Supply line 76_B supplies pressurized fluid to the flow restrictor valve 41 located downstream from the exhaust heat assembly 142 which controls flow of temperature control fluid from the exhaust heat assembly to the engine. Supply line 76_C supplies pressurized fluid to the EETC valve 130 which controls flow of temperature control fluid between the engine and the radiator. The specific construction of the solenoid should be readily apparent to those skilled in the art based on the foregoing discussion and the following details on its operation.

[0178] During use the hydraulic solenoid injector system 44 is filled and drained of pressurized fluid such as hydraulic oil. To assist in the drainage, the injectors 46, 48 are mounted on opposite sides of a central plane and are angled with respect to that plane with the fill and drain openings located at the lowest point in the housing 58. Passages 64 and 70 are similarly angled downward from the chamber 66. Consequently, when it is desired to drain the hydraulic solenoid injector system, the natural force of gravity assists in draining the passages 64, 70 and injectors 46, 48.

[0179] As discussed above, the hydraulic solenoid injector system 44 provides pressurized fluid for actuating both flow restrictor valves 40, 41 and the EETC valve 130. The EETC valve 130 is shown in Figure 15 controlling the flow of the temperature control fluid to the radiator 12. An alternate position for the EETC valve is shown in phantom and designated with the numeral 130'. U.S. Patent No. 5,458,096 provides a detailed discussion of various embodiments of the EETC valve 130 and their operation and is incorporated herein by reference.

[0180] One preferred embodiment of the EETC valve 130 is shown in Figure 19. In this embodiment, a fluid line 1131 from the hydraulic solenoid injection system 44 supplies a flow of pressurized fluid into a chamber 1132 within the valve 1130. The filling of the chamber 1132 with the pressurized fluid causes a flexible diaphragm 1134 to displace a valve member 1136 compressing a spring 1137. Displacement of the valve member 1136 permits temperature control fluid to flow along the channel 1138 leading to the radiator 12. The draining of the chamber 1132, in combination with the energy stored in the compressed spring 1137, causes the valve member 1136 to reciprocate back into its first position shown in the figure.

[0181] Exemplary control curves are shown in Figure 20 for use by the ECU 900 in controlling the actuation of the valves. The two curves shown are functions of an engine operating parameter and ambient condition. Preferably the curves are a function of engine oil temperature and ambient air temperature. Related application Serial No. 08/390,711, discusses how the internal engine components lose heat more rapidly to the environment as the ambient air temperature decreases. By controlling the temperature of the temperature control fluid or coolant according to a predetermined temperature control curve, it is possible to effectively control the temperature of the engine. However, in order to account of environmental changes and/or changes in the engine state, it has been determined that the actual engine oil temperature should be monitored and maintained at or near its optimum temperature. The optimum engine oil temperature will typically be higher in colder ambient air temperatures to counter the increased cooling effect of the air on the engine components.

[0182] The illustrated curves are optimum engine temperature curves. These curves are preferably utilized in conjunction with temperature control curves for controlling the temperature of the engine.

[0183] For the sake of simplicity, the engine temperature curves will be described as being a function of engine oil temperature and ambient air temperature. However, it should be understood that various alternate engine parameters and/or ambient conditions which may be utilized within the scope of the present invention. If alternate engine parameters are utilized, they are preferably indicative of the temperature of the engine oil. It is also contemplated that a fixed optimum engine oil temperature value may be utilized in the temperature control system (i.e., not a function of ambient air temperature). However, utilizing a fixed engine oil temperature value will not necessarily optimally control the temperature control system so as to minimize engine exhaust emissions.

[0184] In the illustrated embodiment curve A is utilized for determining the state of the engine (e.g., load condition, temperature state, etc.) This curve is utilized in conjunction with either a temperature control curve or a set of predetermined temperature values for controlling the actuation of the EETC valve. The specifics of this curve and how it is utilized for controlling flow of temperature control fluid is discussed in detail in related Internation application No. PCT/US96/01278 and U.S. Patent 5,507,251, which have been incorporated by reference. The curve is defined by a set of predetermined values preferably having an ambient air temperature component and an engine oil temperature component. In the preferred embodiment, the engine oil temperature component varies with the ambient air temperature component as follows:

$$T_{\text{ENGINE OIL TEMPERATURE}} = f\, T_{\text{AMBIENT AIR TEMPERATURE}}$$

where $T_{\text{ENGINE OIL TEMPERATURE}}$ is the temperature of the engine oil measured at a predetermined location. and $T_{\text{AMBIENT AIR TEMPERATURE}}$ is the temperature of the ambient air measured at a predetermined location. The locations where both temperatures are measured will determine the resulting curve. For example. measuring the temperature of ambient air temperature entering the radiator as compared with ambient air under the engine hood will produce two different control curves.

[0185] In a preferred embodiment, the temperature for the engine oil is measured in the oil pan and the temperature for the ambient air is measured either outside the engine compartment or in an air cleaner mounted on the engine. However, those skilled in the art would readily be capable of producing control curves for use in the instant invention based on ambient air temperatures and engine oil temperatures as measured at any location related to the engine.

[0186] While curve A has been discussed as varying with ambient air temperature and illustrated as a non-linear curve, it is also contemplated that curve A may be a step function or series of step functions which define the relationship between ambient air temperature and engine oil temperature. These alternate embodiments are all well within the purview of the claims.

[0187] As stated above, the engine oil temperature curve is utilized in conjunction with a temperature control curve for determining the appropriate state of the EETC valve. Specifically, the comparison of the actual engine oil temperature to the optimum engine oil temperature (for a given ambient air temperature) determines an adjustment factor for adjusting the temperature control curve. While it is also contemplated that the engine oil temperature curve can be utilized for directly actuating the EETC valve, it is not preferred since there is a significant time lag between the actuation of the EETC valve and the resulting actual engine oil temperature.

[0188] Figure 20 also illustrates an exemplary embodiment of a second curve (curve B) which is also shown as a function of ambient air temperature and engine oil temperature. Curve B is shown positioned below Curve A and is utilized for controlling actuation of the flow restrictor valves 40, 41 which control flow of temperature control fluid to and from the exhaust heat assembly 142. As with curve A, curve B can be embodied in various other configurations (e.g., can be a fixed value, can be a function of an ambient condition and an engine parameter, etc.). In the embodiment illustrated, the curve is defined by a set of predetermined values preferably having an ambient air temperature component and an engine oil temperature component. In the preferred embodiment, the engine oil temperature component varies with the ambient air temperature component as follows:

$$T'_{\text{ENGINE OIL TEMPERATURE}} = f\, T'_{\text{AMBIENT AIR TEMPERATURE}}$$

where $T'_{\text{ENGINE OIL TEMPERATURE}}$ is the temperature of the engine oil measured at a predetermined location, and $T'_{\text{AMBIENT AIR TEMPERATURE}}$ is the temperature of the ambient air measured at a predetermined location. The locations where both temperatures are measured will determine the resulting curve.

[0189] It is also contemplated that only one control curve is utilized and that a second temperature threshold value be determined by scaling the control curve. Referring to Figures 20, 21A and 21B, a first threshold temperature value is determined by comparing a sensed ambient air temperature to curve A. This threshold value is then utilized for controlling one or more values, such as the EETC valve. A second threshold value for controlling additional valves is determined by scaling the first threshold value. A scaling factor is determined by comparing the sensed ambient air temperature to a second curve. The scaling factor is then utilized with the first threshold temperature value for determining the second threshold temperature value.

[0190] For example, if the curve in Figure 21A is utilized, the scaling factor and the first threshold temperature value are multiplied for determining the second threshold temperature value. If the curve in Figure 21B is utilized, the scaling factor is subtracted from the first threshold temperature value to determine the second threshold temperature value. Alternate methods for determining the threshold temperature values should be readily apparent to those skilled in the art and are well within the purview of the claims.

[0191] The combination of curve A and curve B define three regions or zones designated I, II, and III, each zone relating to a state or position of the various valves. A clear understanding of the invention will be achieved when the curves are described in combination with the operation of the overall temperature control system, the hydraulic solenoid injection system 44 and the ECU 900.

[0192] The ECU 900 receives signals from one or more sensors which are indicative of an ambient air temperature and an engine oil temperature. The ECU 900 compares these signals or sensed temperatures to the curves shown in Figure 20. (Alternately, the ECU 900 compares the signals to sets of predetermined values or to fixed values preferably having an ambient air temperature component and an engine oil temperature component.) If the combination of the measured ambient air temperature and engine oil temperature falls within Zone I, the engine is in a relatively cold state and the engine oil is well below its optimum operating temperature. It is therefore desirable to heat-up the engine oil as quickly as possible. This state typically occurs when the engine is initially started or if the vehicle is in a relatively cold environment.

[0193] In order to heat-up the engine oil toward its optimum operating temperature as quickly as possible, the temperature control system controls the flow of the temperature control fluid so as to harness the heat generated by the exhaust manifold 140 and transfer it to the engine oil. To achieve this, the ECU 900 sends signals to the hydraulic solenoid injection system 44 (Figure 4) to open the input fluid injector 46 (and close the output fluid injector 48 if it is open). The pressurized hydraulic fluid then fills chamber 66. When the pressure of the fluid within the chamber 66 reaches a minimum of about 20 psi (as determined by a pressure sensor), the ECU 900 sends a signal to the third solenoid 74 to actuate it so as to permit pressurized fluid flow along supply line 76_A. This causes the flow restrictor valve 40 controlling flow from the water pump to the exhaust heat assembly 142 to actuate from its first position (inhibiting flow of temperature control fluid to the exhaust heat assembly 142) to its second position (permitting flow of temperature control fluid to the exhaust heat assembly 142).

[0194] At this point, the flow restrictor valve 41 located downstream of the heating conduit 144 is in its first position wherein flow of temperature control fluid is inhibited from flowing out of the exhaust heat assembly 142 and back to the engine. Also at this point, the EETC valve 130 is in an unactuated position (since the sensed engine oil temperature and ambient air temperatures are below Curve A). Flow of temperature control fluid to the radiator is, thus, inhibited and cooling of the temperature control fluid by the radiator is prevented. A corollary of preventing flow of temperature control fluid into the radiator is that the significant quantity of fluid in the radiator is not directed into the engine water jacket. Hence, a reduced mass of temperature control fluid circulates through the system. The smaller mass of circulating temperature control fluid will, as a consequence, heat up significantly faster.

[0195] In this mode of operation of the temperature control system, a flow of temperature fluid is channeled into the heating conduit 144 of the exhaust heat assembly 142 adjacent to the exhaust manifold 140. The heat from the exhaust manifold 14 is conducted to temperature control fluid thereby raising its temperature.

[0196] A temperature sensor mounted on or in the heating conduit 144 measures the temperature of the temperature control fluid in the heating conduit 144 and sends a signal to the ECU 900. When the temperature of the temperature control fluid within the heating conduit 144 reaches a predetermined threshold value, the ECU 900 sends a signal to the third solenoid 74 to provide a flow of pressurized fluid along supply line 76_B which leads to the flow restrictor valve 41 located downstream from the heating conduit 144. This pressurized fluid causes the flow restrictor valve 41 to actuate into its second position wherein a flow of temperature control fluid is permitted along an exhaust return tube 152 and to the air induction system 150 or the oil pan 28.

[0197] In an alternate arrangement, the ECU 900 opens both flow restrictor valves 40, 41 so as to permit an immediate flow of temperature control fluid to the oil pan or induction air system. This, however, is not the preferred method since the initial flow of temperature control fluid will not be sufficiently heated to provide any additional heating of the engine oil. On the contrary, the initial flow of temperature control fluid may be colder than the component *(e.g.,* oil pan) to which it is sent. As a result, the component will initially decrease in temperature. It is more preferable, therefore, to prevent the temperature control fluid from flowing to the desired component until it has been sufficiently heated.

[0198] It may also be desirable to vary the amount of opening of the flow restrictor valves 40, 41 so as to control the rate of flow of temperature control fluid through the exhaust heat assembly 142. That is, the amount of opening of the valves can be related to the temperature of the temperature control fluid. This will minimize any problems that may develop from sudden drastic temperature changes.

[0199] The ECU 900 continues to monitor the engine oil temperature and ambient air temperature and compares the measured signals against the curves in Figure 20 or against predetermined values which define the curves. When the ECU 900 receives an engine oil temperature signal which, when combined with the ambient air signal, falls within Zone II, the engine oil is warm enough such that additional heating is not required. The ECU 900 sends signals to the hydraulic solenoid injection system 44 to change the valve positions accordingly.

[0200] Specifically, the ECU 900 sends signals to actuate flow restrictor valve 40 leading to the exhaust heat assembly 142 into its first position wherein flow to the exhaust heat assembly 142 is prevented. This is accomplished by sending signals to close the input injector 46 (if it has not been previously closed) and open the output injector 48. This produces depressurization of the chamber 66. The ECU also sends a signal to the third solenoid 74 to open supply line 76_A (if it is not already open) permitting the pressurized fluid in the flow restrictor valve 40 to drain into chamber 66 and out through outlet connector 72 to the reservoir.

[0201] It is preferable that the flow restrictor valve 41 positioned downstream from the exhaust heat assembly 142 is simultaneously closed with flow restrictor valve 40. This is achieved by sending a signal to the third solenoid 74 to open supply line 76_B (if it is not already open) thereby permitting the pressurized fluid in the flow restrictor valve 41 to drain into chamber 66 and out of the hydraulic solenoid injector assembly 44.

[0202] The ECU 900 continues to monitor the engine oil temperature and ambient air temperature. If the ECU 900 receives an engine oil temperature signal which. when combined with the ambient air signal. falls within Zone III, the temperature of the engine oil is above its optimum value. At this point it is desirable to circulate at least a portion of the temperature control fluid through the radiator 12.

[0203] In order to accomplish this, the ECU 900 adjusts or shifts a temperature control curve which governs actuation of the EETC valve. (Alternately, the ECU adjusts or shifts one or more desired temperature control fluid temperature values.) This results is signals being sent to actuate the EETC valve 130 into is second position wherein the temperature control fluid is permitted to flow toward the radiator. (If the temperature control system instead has an EETC valve 130' as shown in phantom, then the valve is opened to allow a flow of fluid from the radiator and to the engine.) The signals cause the input injector 46 to open and the output injector 48 to close. This results in a supply of pressurized fluid entering chamber 66. The ECU also sends a signal to the third solenoid 74 to open supply line 76_C permitting the pressurized fluid to flow to the EETC valve 130 and fill its chamber 132 (Figure 5). This produces displacement of valve member 136, thereby permitting temperature control fluid to flow along channel 138 and to the radiator 12.

[0204] If the ECU 900 subsequently determines that the combined temperature of the engine oil and ambient air has dropped from Zone III back to Zone II, the ECU depressurizes supply line 76_C by sending signals to close the input injector 46, open the output injector 48 and open supply line 76_C. Thus, the pressurized fluid in the EETC valve 130 is allowed to drain into chamber 66 and out through outlet connector 72 to the reservoir.

[0205] It should be noted that, in the preferred temperature control system, the EETC valve is never in its open position (permitting flow to the radiator for cooling) when the exhaust heat assembly 142 is being utilized.

[0206] In each of the above sequences of operation, the ECU 900 closes the input injector 46 after actuating the valves into their desired positions. This traps pressurized fluid within chamber 66 and any open supply line 76. A pressure sensor (not shown) monitors pressure within the chamber 66. If the pressure within the chamber 66 falls below a threshold value (indicative of a fluid leak), the ECU 900 opens the input injector 46 to supply additional pressurized fluid to chamber 66. Alternately, the ECU can close the supply line 76 which has been pressurized. thereby locking the associated valve in its desired position.

[0207] It may be necessary to dither the injectors 46, 48 (i.e., controlled opening and closing of the injectors) to assist in draining the hydraulic solenoid injector assembly 44. International application No. PCT/US96/01278 discusses in detail several methods for dithering hydraulic solenoid injectors to assist in emptying a hydraulic fluid supply line. These methods can readily be applied to emptying the fluid supply lines after they have been depressurized. Preferably, the ECU 900 dithers the input and output injectors 46, 48 and the supply lines 76 when the engine has been shut-off.

[0208] While the ECU 900 has been described as sending signals to actuate solenoids and injectors, it is also contemplated that the signals from the ECU 900 can, instead, control linear actuators and/or other electro-mechanical flow control mechanisms. Those skilled in the art, after having read the instant specification, would readily be capable of modifying the configurations shown without detracting from the operability of the invention. Figure 24 illustrates one alternate configuration of a solenoid valve 44' in a pressurization system for controlling one flow control valve, such as an EETC valve. The solenoid valve 44' includes an input line 60 and an output line 72. The input and output lines feed an internal chamber 66' which is in communication with a supply line 76'. Electrical signals from an engine commuter are sent by the solenoid valve 44' to control flow of hydraulic fluid from the chamber 66' to the supply line 76'.

[0209] Referring back to Figure 15, the illustrated embodiment provides a novel arrangement of hydraulic lines which minimize the number of connections which may be subject to leakage. By mounting the hydraulic solenoid injector assembly 44 at a remote location and utilizing the multi-way solenoid 74, it is possible to route a single hydraulic line to each valve for controlling actuation of the valve. The utilization of a single injection system also reduces the overall cost and complexity of the temperature control system.

[0210] As discussed above, when the ECU determines that the combination of the engine oil temperature and ambient air temperature falls within Zone II of the curve in Figure 20, it sends signals to actuate the flow restrictor valves 40, 41 into their first positions. This will trap some temperature control fluid within heating conduit 144. As the trapped temperature control fluid heats up, it will begin to convert to high pressure steam. If this steam is not vented, it may eventually cause damage to the temperature control system and may result in the degradation of the fluid itself. In order to evacuate the steam from the heating conduit 144, a pressure escape port 200 (Figures 2A and 2B) is preferably incorporated into at least one of flow restrictor valves 40, 41. The pressure escape port 200 is an aperture formed in the second housing of the flow restrictor valve and is in fluid communication with the heating conduit 144. The pressure escape port may be formed integral with or separately attached to the housing.

[0211] Referring to Figures 15 and 19, the pressure escape port 1200 is connected through a tube 1202 to a pressure relief valve 1204 which is in communication with a portion of the housing 1206 of the EETC valve 130. The pressure escape port 1200, tube 1202 and pressure relief valve 1204 provide a means for channeling or venting the pressurized steam out of the heating conduit 144.

[0212] A preferred embodiment of the pressure relief valve 1204 includes an insert 1208 which retains a ball 1210 within a compartment 1212. The insert 1208 has a passage 1209 formed through it which is in communication with the tube 1202. A spring 1214 biases the ball away from a wall 1215 of the compartment 1212 and toward the insert 1208. A pressure relief orifice 1216 is formed through the wall 1215 and permits fluid communication between the compartment 1212 and the channel 138 of the EETC valve 130. In the illustrated embodiment, the insert 1208 and the tube 1202 are both threadingly engaged with the housing 1206. Alternate attachment mechanisms are possible.

[0213] The sizing and configuration of the tube 1202 and pressure relief valve 1204 is preferably determined so as to prevent the liquid in the heating conduit 144 from becoming too hot after it has turned to steam. The temperature of the exhaust manifold 140 can reach upwards of 1500 degrees Fahrenheit (815°C). If the trapped temperature control fluid is exposed to this excessive temperature for a prolonged period of time, the temperature control fluid may begin to break down (i.e., the mixture of the water and glycol may begin to separate). Accordingly, the tube 1202 and the pressure relief valve 1204 are preferably designed to quickly vent the exhaust heat assembly 142 so as to result in dry tubes. It is also desirable, when designing the tube 1202 and the pressure relief valve 1204, to minimize the noise associated by the steam passing through the pressure relief valve 1204 and into the radiator. In one preferred embodiment, the tube 1202 has a diameter of approximately 0.25 inches. The diameter of the insert passage is approximately 0.375 inches. The pressure relief orifice has a diameter that is preferably between about 0.150 inches to about 0.180 inches.

[0214] When the ball 1210 is in the position shown, fluid communication between the EETC valve 130 and the tube 1202 is prevented. This position typically occurs when there is a relatively low amount of pressure in the exhaust heating assembly 142. As pressure builds up in the exhaust heating assembly 142, the pressure on the tube side of the ball 1210 increases and eventually overcomes the spring force of the spring 1214. As a result, the ball 1210 is forced away from the insert 1208 permitting fluid communication between the tube 1202 and the EETC valve 130. In one preferred embodiment, the pressure needed to overcome the spring force is approximately 15 psi. Figures 17 and 17A illustrate the alternate mounting of the tube 1202 to the flow restrictor valve 41 located downstream from the exhaust heat assembly 142.

[0215] The novel pressure relief system described above permits pressure in the exhaust heat assembly 142 to be vented to the radiator before any damage to the temperature control system can occur. Alternate methods for venting the high pressure steam from the exhaust heat assembly 142 can be readily substituted for the above method and are well within the purview of the invention. For example, the steam can be vented into an fluid overflow bottle associated with the radiator. However, doing so may require the incorporation of baffles (not shown) into the bottle to reduce the noise of as the steam enters. Alternately, the steam can be channeled directly into the radiator. Venting to the radiator (either by means of the EETC valve or directly into the radiator) is preferred so as to quickly circulate and cool the heat temperature steam in the radiator. It is contemplated that a considerable amount of temperature control fluid in the radiator will be displaced by the steam since steam occupies a considerably larger volume than the condensed liquid. To accommodate this additional volume of fluid media, a larger fluid overflow bottle may be required.

[0216] The above described system will accurately and efficiently assist in maintaining the engine oil at or near its optimum temperature. It is, however, anticipated that as the temperature control system switches between channeling temperature control fluid to the exhaust heat assembly 142 and the engine block pockets of air may develop. This is likely to occur when the flow restrictor valves 40, 41 are opened so as to permit temperature control fluid to flow into the exhaust heater assembly 142. Prior to opening, the exhaust heat assembly 142 would contain a sizable amount of trapped air. Upon opening of the valves 40, 41, the flow of temperature control fluid will force the air in the heating conduit 144 to flow through the temperature control system. Trapped air within the system tends to reduce the cooling and heating capabilities of the system and, thus, reduce its overall efficiency.

[0217] Air pockets may also develop within the water pump 16 during operation of the temperature control system. Variations in suction and pressurization within the water pump 16 during the different phases of operation of the temperature control system could lead to the formation of small air pockets within the system. These air pockets, similar to the air pockets generated in the exhaust heat assembly 142, may eventually travel through the system resulting in reduced efficiency.

[0218] To remedy these problems the present system incorporates a free flow buoyancy check valve 800 which is attached to the radiator fluid overflow container 802, commonly known as an overflow bottle. Referring to Figure 17, a schematic is shown of a portion of the fluid overflow bottle 802 illustrating the attachment of the free flow buoyancy check valve 800 to the fluid overflow bottle 802 and to the water pump 16. The free flow buoyancy check valve 800 provides a means for directly channeling a flow of temperature control fluid from the fluid overflow container 802 and into the water pump 16 when it is required. By channeling this additional source of fluid to the water pump 16, it is possible to reduce the amount of air pockets that develop within the water pump 16 when the it is not receiving a sufficient amount of temperature control fluid to accommodate the demand imposed by the temperature control system. The free flow buoyancy check valve 800 provides additional fluid to help reduce the demand.

[0219] Also shown is an air bleed tube 804 attached between the water pump 16 and the fluid overflow container 802. The air bleed tube 804 is designed to bleed or vent trapped air out of the water pump 16 and channel it to the fluid overflow container. As discussed above, air bubbles that develop in the system will reduce the efficiency of the overall temperature control system. By attaching a vent line to the water pump 16, it is possible to vent out these air pockets as they circulate. Referring to Figure 23, a graph of pressure/vacuum in the water pump is illustrated. The vent line is preferably affixed to the water pump 16 so as to be in communication with the interior cavity approximately at the transition between the suction and pressure pressures. This ensures that air will be vented air of the water pump along the vent line as opposed to being drawn in. The air bleed tube 804 is attached to the fluid overflow container 802 at an upper location where it will vent the air from the water pump 16 to the fluid overflow container 802. Preferably the attachment is above the water line in the fluid overflow container 802, otherwise bubbling in the container will occur. The vent line can be made from any suitable material and preferably has a diameter between approximately 0.060 inches and 0.080 inches.

[0220] Referring to Figure 22A, a preferred configuration of the free flow buoyancy check valve 800 is shown in more detail. The valve 800 is mounted directly to the bottom of the fluid overflow container 802. The valve 800 includes a housing 806 with a check valve outlet 808 formed thereon. The check valve outlet 808 is connected via an overflow outlet tube 810 to the water pump 16. The overflow outlet tube 810 functions as a conduit for channeling fluid between the check valve outlet 808 and the interior of the water pump 16. In a preferred embodiment, the overflow outlet tube attaches to the inlet tube leading into the water pump 16.

[0221] The housing 806 also includes a chamber 812 for channeling fluid between the check valve outlet 808 and the fluid overflow container 802. A cap assembly 814 is mounted to an end of the housing 806 and controls flow of temperature control fluid between the chamber 812 and the fluid overflow container 802. In one embodiment, the cap assembly 814 includes split ring portions 816 and a diffuser cap 818. The split ring portions 816 engage with a locking seat 820 formed in the housing 806. When installed within the locking seat 820, the ring portions 816 lock the diffuser cap 818 to the housing 806. The diffuser cap 818 preferably has a semi-circular dome 822 which extends into the fluid overflow container 802 when the diffuser cap 818 is attached to the housing 806. The diffuser cap 818 also has a channel 824 formed in it which is adapted to conduct fluid from the chamber 812 through a plurality of holes 826 formed in the diffuser cap 818 and into the fluid overflow container 802.

[0222] The present invention also incorporates in the valve housing a control means for controlling flow through the valve. In one embodiment, the control means comprises a ball 828 which is movably disposed within the chamber 812 between the check valve outlet 808 and the cap assembly 814. The ball 828 is configured to seat on an upper ball seat 832 surrounding the channel 824 and on a lower ball seat 834 surrounding the check valve outlet 808. When the ball seats against the upper ball seat 832, flow of temperature control fluid is prevented from passing through the channel 824. Similarly, when the ball seats against the lower ball seat 834, e.g., in a low fluid level condition, air is prevented from passing through the check valve outlet 808. Thus, the ball check valve prevents passage of air into the temperature control system and maintains a waterhead in the tube up to the seat 834.

[0223] A spring 830 is located between the ball 828 and the cap assembly 814. The spring 830 biases the ball 828 away from the cap assembly 814 so as to prevent the ball 828 from seating on the upper ball seat 832 surrounding the channel 824. Preferably the spring 830 does not bias the ball 828 into seating on the lower ball seat 834. The spring is preferably made from stainless steel, although other materials can be readily substituted therefor.

[0224] Figures 22A through 22D illustrate various stages of operation of the free flow buoyancy check valve 800. In Figure 22A, the valve 800 is shown in a first stage wherein the water pump 16 is not receiving a sufficient flow of temperature control fluid. This shortage of fluid in the water pump 16 creates a draw or suction along overflow outlet tube 810 resulting in temperature control fluid flowing from the fluid overflow container 802, through the chamber 812 and out the check valve outlet 808. This flow of temperature control fluid is channeled directly into the water pump 16 for mixing with the fluid already contained therein.

[0225] Figure 22B illustrates a second stage wherein the water pump 16 is receiving a sufficient amount of temperature control fluid and, therefore, additional fluid is not needed. That is, the fluid pressure within the water pump creates a back pressure flow of temperature control fluid along the overflow outlet tube 810 and into the valve 800 from the water pump 16. This flow of temperature control fluid creates pressure within the chamber which forces the ball 828 to compress the spring 830 until the ball 828 seats against the upper ball seat 832. The seating of the ball 828 against the upper ball seat 832 prevents flow of temperature control fluid into the fluid overflow container 802.

[0226] Figures 22C and 22D illustrate third and fourth stages of the valve 800 wherein the fluid overflow container has a very low level of temperature control fluid contained within it, in Figure 22C, the water pump 16 is not receiving a sufficient flow of temperature control fluid. This creates a draw or suction along overflow outlet tube 810. Since the fluid overflow container 802 does not have sufficient fluid to accommodate the draw from the water pump 16, air will be drawn into the water pump 16 unless the valve 800 is closed. As shown, the ball 828 is designed to seat against the lower ball seat 834 when the fluid in the fluid overflow container 802 is low so as to seal or close the valve 800. This prevents air in the fluid overflow container from being drawn into the overflow outlet tube 810.

[0227] Figure 22D, illustrates the fourth stage wherein the water pump 16 is receiving a sufficient flow of temperature control fluid. As a result, a flow of temperature control fluid flows from the water pump 16 to the valve 800 along overflow outlet tube 810. Since there is no fluid within the fluid overflow container to counter the flow of temperature control fluid, the fluid flow easily forces the ball 828 to seat against the upper ball seat 834 sealing the channel 824. Flow of temperature control fluid into the fluid overflow container 802 is, thus, prevented.

[0228] In one preferred embodiment, the channel 824 is approximately 1/4" diameter and the check valve outlet 808 has an internal diameter of approximately 5/16" diameter. The channel and outlet 808 should be sized so as to only require a small amount of back pressure to seat the ball 828 on the upper seat. The housing 806 is shown as being formed integral with the fluid overflow container. However, it is contemplated that the housing 806 can be a separate component which is mounted to the fluid overflow container 802 and can be made from any suitable material. The ball 828 is preferably made from plastic material so as to permit it to float within the chamber 812. Again other materials may be substituting without detracting from the invention.

[0229] In an alternate embodiment of the invention, the ball 828 is made from hollow stainless steel or aluminum and the lower ball seat 834 has two electrical contacts formed thereon which do not contact one another. In this embodiment, when the ball 828 is seated within the lower ball seat 834 (i.e., low fluid level in the fluid overflow container), the metallic material of the ball 828 provides electrical continuity between two contacts. This electrical continuity can be utilized to trigger a light displayed on a dashboard for indicating a low fluid level in the fluid overflow container 802.

[0230] The novel overflow free flow buoyancy check valve 800 configuration described above provides a flow of temperature control fluid between the water pump 16 and the fluid overflow container 802 when additional fluid is needed. The valve 800 also prevents air from being drawn into the water pump 16 from the fluid overflow container 802 when the temperature control fluid within the container 802 is low. The ball 828 also prevents the fluid from leaving the temperature control fluid circuit in the engine whether or not there is temperature control fluid in the container. In order to provide a sufficient amount of pressure for the system, it is contemplated that the fluid overflow container 802 should be designed so as to produce approximately 1 foot of temperature control fluid pressure head. This pressure head should provide sufficient pressure to allow the system to operate efficiently.

[0231] The free flow buoyancy check valve 800 can be configured in other ways for controlling flow of temperature control fluid (e.g., hydraulic valve, solenoid valve, etc.) Additionally, while the preferred system channels temperature control fluid from the fluid overflow container to the water pump, other sources (e.g., radiator) and destinations (e.g., water pump inlet tube) for the fluid flow may be utilized and are well within the scope of the invention.

[0232] The above described temperature control system has particular utilization in the diesel engine industry. Diesel engines typically operate at a significantly lower temperature than standard automobile internal combustion engines. The lower temperatures of these engines results in increased oil sludge build-up. To diminish the development of sludge, the engine oil must frequently be changed. Truck diesel engines typically utilize 10 to 16 quarts of engine oil and, therefore, frequent engine oil changes can become quite expensive. The present invention significantly improves the condition of the engine oil by maintaining its temperature at or near an optimum temperature. As a result, the time between engine oil changes can be extended, thus reducing the cost of operating the diesel engine.

[0233] Referring back to Figure 15, the temperature control system preferably includes a system for preheating intake air flowing through an intake manifold of an internal combustion engine. As discussed above, the heated temperature control fluid is then channeled from the exhaust heat assembly 140 along at least one conduit to a heat exchanger 150, where heat energy is transferred to the intake air.

[0234] The intake air enters the engine through the air cleaner (not shown) and is channeled to the intake manifold 30. A throttle valve located within a throttle body (not shown) regulates the air flow.

[0235] In the preferred embodiment, heat energy is transferred to the intake air as it flows through the heat exchanger 150 mounted to the engine within the flow of intake air, preferably between the air cleaner and the throttle body. In alternate embodiments, the heat exchanger 150 can be mounted in the air cleaner or downstream of the throttle body.

[0236] The heat exchanger 150 consists of a panel of high capacity heat transferring aluminum fins which allow a laminar flow of the intake air as it passes through. The fins are heated by heat conductive tubes 151 made of aluminum or copper, which are wrapped around the periphery of the panel. Temperature control fluid circulates through the tubes 151 when the ambient air temperature falls below a predetermined value *(e.g.,* 20°F. (-6°C)). Heat energy is transferred from the temperature control fluid to the fins where it is transmitted into the passing flow of air. This results in the heating of the intake air. The fuel line may also be heated with the temperature control fluid flowing to or from the heat exchanger 150.

[0237] When the temperature control fluid discharges from the tubes 151 of the heat exchanger 150, it flows through the oil pan 28 and to the water pump 16 for recirculation through the engine. The flow of the temperature control fluid to the heat exchanger 150 is preferably regulated by opening and closing the control valve 41. The ECU 900 preferably controls actuation of the control valve as discussed above.

[0238] Figures 17 and 17A are schematic representations of an electronic engine temperature control system which includes the system for preheating intake air. In that embodiment, the heat exchanger 150 is enclosed in a plastic cover 150_C which provides insulation.

[0239] Although the heat exchanger 150 in the preferred embodiment consists of a panel of aluminum fins, other types of heat exchangers known in the art may be used in the system. For example, the heat exchanger simply may comprise a length of conduit, disposed in the air flow, of sufficient length for radiating heat to the air. Such a conduit could be straight, coiled, or some other configuration. These and other embodiments will be apparent to persons skilled in the art.

[0240] Several variables must be taken into account when designing the heat exchanger 150. For example, the length and other dimensions of the heat exchanger will be determined in part by the anticipated conditions, including the expected ranges of temperatures and flows of the temperature control fluid. These variables will be taken into account by those persons skilled in the art.

[0241] The temperature of the heated intake air may be maintained optimally between 120°F and 130°F (48°C and 54°C) through a secondary system which further regulates the flow of temperature control fluid based on feedback regarding the intake air temperature downstream of the heat exchanger 150. As discussed above, the present invention provides a system for heating the intake air to assist in combustion. When it is determined that the intake air has reached a high enough temperature, the secondary system stops or reduces the flow of temperature control fluid to the heat exchanger 150.

[0242] The intake air temperature is detected by a sensor located in the throttle body. However, the sensor may be located anywhere downstream of the heat exchanger 150. The sensor provides a signal to the ECU 900, which produces control signals for regulating the position of control valve 41, which in turn regulates the flow of temperature control fluid through heat exchanger 150.

[0243] In one embodiment, the ECU 900 compares the sensed intake air temperature to a predetermined threshold value (e.g., 120°F (48°C)). If the sensed intake air temperature exceeds the threshold value, the ECU 900 closes the control valve 41. In an alternate embodiment, the ECU 900 compares the intake air temperature and the sensed engine oil temperature to threshold values (e.g., 120°F and 220°F (48°C and 104°C) respectively). If both threshold values are exceeded, then the control valve 41 is actuated into its closed position or state.

[0244] However, it may be desirable to have a curve, instead of a single threshold value, which controls the state of the control valve 41. It may also be desirable to control the amount and/or rate of flow of temperature control fluid based on intake air temperature. For example, as the intake air approaches a predetermined value (e.g., 120°F (48°C)), the rate of flow of the temperature control fluid to the heat exchanger 150 can be reduced.

[0245] Figure 15 includes a schematic representation of the fluid flow paths in the preferred embodiment of the system. The dashed arrows in Figure 15 illustrate the flow path of the temperature control fluid during normal operation of the engine when the temperature control fluid is relatively hot and the engine is fully warmed. The solid arrows in Figure 1 illustrate the flow of temperature control fluid during engine warmup/startup.

[0246] While the preferred embodiments utilize hydraulic fluid for controlling the state or position of the flow restrictor valves and EETC valve, other fluid media may be utilized, such as water, temperature control fluid, air, etc. Alternately, electro-mechanical devices may be utilized for controlling the valves.

Claims

1. A temperature control system for controlling the temperature of an internal combustion engine, the engine including an engine block, a cylinder head, a radiator, an intake manifold, an exhaust manifold for exhausting heated gases from engine, and an oil pan, the system including a flow of temperature control fluid operative for heating and cooling the internal combustion engine, the system comprising:

   a first temperature sensor for sensing the temperature of temperature control fluid;
   an exhaust input tube adapted to direct a flow of temperature control fluid from the engine;
   an exhaust output tube adapted to direct a flow of temperature control fluid to the engine;
   an exhaust heat assembly connected to the exhaust input and output tubes and adapted for channeling a flow of temperature control fluid from the exhaust input tube to the exhaust output tube, the exhaust heat assembly

being located adjacent to the exhaust manifold and adapted to permit heat transfer from the heated gases in the exhaust manifold to the temperature control fluid in the exhaust heat assembly; characterized by:
a second temperature sensor for sensing a temperature indicative of the temperature of engine oil;
a first flow control valve in fluid communication with the exhaust input tube; and
an engine computer for controlling the flow of the temperature control fluid through the exhaust heat assembly by actuating the first flow control valve, the engine computer receiving signals from the first and second temperature sensors, the engine computer actuating the first flow control valve so as to permit the flow of temperature control fluid along the input exhaust tube and into the exhaust heat assembly when the sensed temperature indicative of the temperature of the engine oil is below a first predetermined value and the engine computer actuating the flow control valve so as to prevent the flow of temperature control fluid along the input exhaust tube and through the exhaust heat assembly when the sensed temperature of the temperature control fluid is above a second predetermined value.

2. A system according to claim 1 wherein the exhaust heat assembly comprises a heating conduit with first and second ends, a first spacer attached to the first end of the heating conduit, and a second spacer attached to the second end of the heating conduit.

3. A system according to claim 1 wherein the exhaust heat assembly further comprises a control valve mounted to the output tube for controlling the flow of temperature control fluid to the engine and preventing the flow of temperature control fluid into the exhaust heat assembly.

4. A system according to claim 1, the engine including a water pump for circulating a temperature control fluid, wherein the exhaust input tube receives a flow of temperature control fluid from the water pump.

5. A system according to claim 1, the engine including an oil pan, wherein the exhaust output tube directs a flow of temperature control fluid to the oil pan.

6. A system according to claim 1, the engine including an intake manifold, wherein the exhaust output tube directs a flow of temperature control fluid to the intake manifold.

7. A system according to claim 1, the engine including a passenger compartment heater assembly, wherein the exhaust output tube directs a flow of temperature control fluid to the passenger compartment heater assembly.

8. A system according to claim 1 further comprising:

a water pump adapted for directing a temperature control fluid into the engine, the water pump including

a housing,
an impeller rotatably mounted within the housing, the impeller adapted for circulating the flow of temperature control fluid, and
at least one flow channel for directing the flow of temperature control fluid into the engine block;

wherein the flow control valve is adapted for controlling the flow of temperature control fluid along the flow channel, the flow control valve being mounted to the water pump housing and being actuatable between a first position and a second position, the flow control valve permitting flow of temperature control fluid along the flow channel when in its first position and restricting the flow of temperature control fluid along the flow channel when in its second position: and wherein the exhaust input tube is adapted to direct a flow of temperature control fluid from the engine when the flow control valve is in its second position.

9. A system according to claim 1 further comprising a solenoid injection system for controlling actuation of the flow control valve, the solenoid injection system including:

a housing having a chamber formed therein;
an inlet line connected to the housing and adapted to supply a flow of fluid into the housing;
an outlet line connected to the housing and adapted to channel a flow of fluid out of the housing;
an input injector connected to the housing and in communication with the chamber and the inlet line, the input injector having an open position adapted for channeling a flow of pressurized fluid from the inlet line into the chamber and a closed position adapted for preventing a flow of pressurized fluid from the inlet line into the

chamber;
a first solenoid connected to the input injector operative for actuating the input injector between its open and closed positions, the first solenoid adapted to receive a signal from the engine computer for controlling actuation of the input injector;
an output injector connected to the housing and in communication with the chamber and the outlet line, the output injector having an open position adapted for channeling a flow of fluid out of chamber and into the outlet line and a closed position adapted for preventing a flow of fluid out of the chamber and into the outlet line;
a second solenoid connected to the output injector operative for actuating the output injector between its open and closed positions, the second solenoid adapted to receive a signal from an engine computer for controlling actuation of the output injector; and
a third solenoid connected to the housing and in fluid communication with the chamber, the third solenoid having at least one fluid supply line connected thereto, the supply line adapted to channel a flow of pressurized fluid to the flow control valve for controlling actuation of the valve, the third solenoid having an open position for permitting flow of pressurized fluid along the supply line and a closed position for inhibiting fluid flow along the supply line, and wherein the third solenoid is adapted to receive signals from an engine computer for controlling flow of pressurized fluid along the supply line.

10. A system according to claim 1 further comprising a solenoid injection system for controlling the actuation of the flow control valve, the solenoid injection system including:

a housing having a chamber formed therein;
input means in communication with the housing for channeling a flow of fluid into the chamber;
output means in communication with the housing for channeling a flow of fluid out of the chamber; and
a solenoid connected to the housing and positioned within the chamber, the solenoid having at least one fluid outlet adapted to direct a flow of pressurized fluid to the flow control valve for controlling actuation of the valve, the solenoid having an open position for allowing a flow of pressurized fluid out of the fluid outlet and a closed position for preventing fluid flow out of the fluid outlet, the solenoid being adapted to receive signals from the engine computer for controlling the solenoid between its open and closed positions.

11. A system according to claim 1 further comprising a pressurization system for controlling actuation of the flow control valve, the pressurization system including:

a housing having a chamber formed therein;
an input injector in communication with the housing for channeling a flow of pressurized fluid into the chamber;
an output injector in communication with the housing for channeling a flow of pressurized fluid out of the chamber; and
fluid flow control means connected to the housing and having at least one fluid outlet adapted to direct a flow of pressurized fluid to the flow control valve to control actuation thereof, the fluid flow control means having an open position for allowing a flow of pressurized fluid out of the fluid outlet and a closed position for preventing fluid flow out of the fluid outlet, the fluid flow control means being adapted to receive signals from the engine computer for controlling actuation of the fluid flow control means between its open and closed positions.

12. A system according to claim 1 further comprising an injection system for controlling actuation of the flow control valve, the injection system including:

a housing having a chamber formed therein;
an inlet line connected to the housing and adapted to supply a flow of fluid into the housing;
an outlet line connected to the housing and adapted to channel a flow of fluid out of the housing;
an input injector connected to the housing and in communication with the chamber and the inlet line, the input injector having an open position adapted for channeling a flow of pressurized fluid from the inlet line into the chamber and a closed position adapted for preventing a flow of pressurized fluid from the inlet line into the chamber;
a first solenoid connected to the input injector operative for actuating the input injector between its open and closed positions, the first solenoid being adapted to receive a signal from the engine computer for controlling actuation of the input injector;
an output injector connected to the housing and in communication with the chamber and the outlet line, the output injector having an open position adapted for channeling a flow of fluid out of chamber and into the outlet line and a closed position adapted for preventing a flow of fluid out of the chamber and into the outlet line;

a second solenoid connected to the output injector operative for actuating the output injector between its open and closed positions, the second solenoid being adapted to receive a signal from the engine computer for controlling actuation of the output injector; and

a third solenoid connected to the housing and in fluid communication with the chamber, the third solenoid having at least one supply line connected thereto, the supply line being adapted to channel a flow of pressurized fluid to the flow control valve for controlling actuation of the valve, the third solenoid having an open position for permitting flow of pressurized fluid along the supply line and a closed position for inhibiting fluid flow along the supply line, and wherein the third solenoid is adapted to receive signals from the engine computer for controlling flow of pressurized fluid along the supply line.

13. A system according to claim 1 further comprising a pressurization system for controlling actuation of the flow control valve, the pressurization system including:

a housing having a chamber formed therein;

input line attached to the housing and adapted for channeling a flow of pressurized fluid into the chamber;

output line attached to the housing for channeling a flow of fluid out of the chamber; and

a solenoid connected to the housing and positioned within the chamber, the solenoid having at least one fluid outlet adapted to direct a flow of pressurized fluid to at least the first flow control valve for controlling actuation of the valve, the solenoid having an open position for allowing a flow of pressurized fluid out of the fluid outlet and a closed position for preventing fluid flow out of the fluid outlet, the solenoid being adapted to receive signals from the engine computer for controlling the solenoid between its open and closed positions.

14. A system according to claim 1 wherein the flow control valve includes:

first and second housing portions connected to one another, the first housing portion having an aperture in fluid communication with the engine, the second housing portion having at least one valve outlet adapted for permitting fluid communication with the exhaust heat assembly, and wherein the second housing portion is made from a high temperature material which minimizes conduction of heat;

a passageway formed between the first and second housing which permits communication of temperature control fluid between the two housing portions; and

a piston slideably disposed within the housing portions, the piston having a sealing portion and a pressure receiving portion, the sealing portion sealing the passageway between the first and second housing portions, the pressure receiving portion being located in a chamber within the first housing portion and having a surface for receiving a pressurized medium, the pressurized medium adapted to slide the piston within the valve.

15. A system according to claim 1 further comprising:

a check valve for controlling flow of temperature control fluid between a radiator fluid overflow container and a water pump in the internal combustion engine, the check valve including

a housing in communication with the fluid overflow container and adapted to receive a flow of temperature control fluid therefrom, the housing having a valve chamber formed therein for channeling a flow of temperature control fluid, the housing also being in communication with the water pump and adapted to channel a flow of temperature control fluid between the valve chamber and the water pump.

16. A system according to claim 1 further comprising a check valve for controlling flow of temperature control fluid between a radiator fluid overflow container and a water pump, the check valve including:

a housing in communication with the fluid overflow container and adapted to receive a flow of temperature control fluid therefrom, the housing having a chamber formed therein for channeling a flow of temperature control fluid, the housing also being in communication with the water pump and adapted to channel a flow of temperature control fluid between the chamber and the water pump, and means for controlling flow of temperature control fluid through the housing, the means for controlling flow having a first position adapted for permitting fluid flow to the water pump, and a second position adapted for preventing fluid air flow from the fluid overflow container to the water pump.

17. A system according to claim I further comprising:

an fluid overflow container;

a water pump; and

a check valve in communication with the fluid overflow container and the water pump and adapted to control flow of temperature control fluid between the fluid overflow container and the water pump.

18. A system according to claim 2 wherein the heating conduit is made from a material which permits heat transfer and wherein the first and second spacers are made from a material which restricts heat transfer.

19. A system according to claim 18 wherein the first and second spacers are made from ceramic material.

20. A system according to claim 18 wherein the heating conduit is made from stainless steel.

21. A system according to claim 18 wherein the heating conduit extends past the exhaust manifold a predetermined distance to permit heat to dissipate from the heating conduit.

22. A system according to claim 8 wherein the exhaust output tube is adapted to direct a flow of temperature control fluid to the intake manifold of the engine.

23. A system according to claim 8 wherein the exhaust output tube is adapted to direct a flow of temperature control fluid to the engine oil pan of the engine.

24. A system according to claim 8 wherein the flow control valve is mounted in the water pump, the system further comprising a second flow control valve mounted in the water pump, and wherein one of the flow control valves includes a bypass passageway adapted for channeling a flow of temperature control fluid out of the water pump when the flow control valve is in its second position.

25. A system according to claim 8 further comprising a hydraulic solenoid injector in fluidic communication with the flow control valves and adapted for supplying the flow control valve with a flow of pressurized fluid, the hydraulic solenoid injector system receiving signals from the engine computer for controlling the delivery of a pressurized fluid to the flow control valve, the pressurized fluid controlling the actuation of the flow control valve.

26. A system according to claim 8 wherein the water pump further includes at least one tube connected to the cylinder head for directing a flow of temperature control fluid to the cylinder head when the flow control valve is in its second position.

27. A system according to claim 8 further comprising a heat exchanger located within the oil pan for channeling a flow of temperature control fluid and wherein the water pump is adapted to receive a flow of temperature control fluid from the heat exchanger in the oil pan when the flow control valve is in its closed state.

28. A system according to claim 8 wherein the exhaust heat assembly is connected to a heat exchanger located within the engine oil pan by an exhaust return tube, and wherein the temperature control fluid flows from the exhaust heating assembly to the heat exchanger through the exhaust return tube.

29. A system according to claim 8 wherein the engine further includes an intake manifold for directing the flow of intake air, the system further comprising at least one channel located within the intake manifold adapted to receive a flow of temperature control fluid for heating the intake air, and wherein the flow control valve inhibits at least a portion of the temperature control fluid flow through the intake manifold channel when the flow control valve is in its closed state.

30. A system according to claim 23, the engine including a passenger compartment heater assembly and wherein the exhaust output tube is adapted to direct a flow of temperature control fluid to the heater assembly.

31. A system according to claim 24 wherein the bypass passageway channels a flow of temperature control fluid from the water pump to the cylinder head when the flow control valve is in its second position.

32. A system according to claim 9 wherein the input injector is located within an input compartment formed in the housing. the input compartment being in fluidic communication with the inlet line, the input injector being adapted to direct a flow of temperature control fluid from the input compartment into the chamber. and wherein the output injector is located within an output compartment formed in the housing. the output compartment being in fluidic communication with the outlet line. the output injector being adapted to direct a flow of temperature control fluid out of the chamber and into the output compartment.

33. A system according to claim 9 wherein there are a plurality of supply lines, one of the supply lines being adapted to direct a flow of pressurized fluid to an electronic engine temperature control valve which controls flow of temperature control fluid between an engine and a radiator, the flow of pressurized fluid being adapted to produce actuation of the valve, a second supply line being adapted to direct a flow of pressurized fluid to the first flow control valve, and a third supply line being adapted to direct a flow of pressurized fluid to at least a second flow control valve positioned at another end of the exhaust heat assembly, the second flow control valve adapted to control flow of temperature control fluid out of the exhaust heat assembly.

34. A system according to claim 33 wherein the housing has a central plane and wherein the input and output compartments are located on either side of the central plane and are angled with respect to the central plane.

35. A system according to claim 10 further comprising:

an inlet formed in the housing for directing a flow of fluid into the housing and to the input means; and
an outlet formed in the housing for directing a flow of fluid out of the housing and to the output means.

36. A system according to claim 10 wherein the input means includes an injector for injecting a flow of fluid into the chamber; and wherein the output means includes an injector for injecting a flow of fluid out of the chamber.

37. A system according to claim 9, 10, 11, 12 or 13 wherein the fluid is hydraulic fluid.

38. A system according to claim 10, 11, 12 or 13 wherein the fluid outlet is adapted to direct a flow of pressurized fluid to an electronic engine temperature control valve which controls flow of temperature control fluid between an engine and a radiator, the flow of pressurized fluid being adapted to produce actuation of the valve.

39. A system according to claim 11 wherein the fluid flow control means is a flow control valve.

40. A system according to claim 39 wherein the flow control valve is a solenoid.

41. A temperature control system according to claim 1 further comprising:

a third sensor for sensing an ambient condition and for providing an ambient condition signal indicative thereof; and
a second control valve in fluid communication with the exhaust output tube;
wherein the engine computer controls actuation of the second control valve, and wherein the first predetermined value varies as a function of the ambient condition, the engine computer determining the first predetermined value based on the sensed ambient condition.

42. A system according to claim 41 wherein the temperature indicative of the temperature of the engine oil is the engine oil temperature.

43. A system according to claim 41 further comprising a pressurization system for providing a source of pressurized fluid to at least one of the flow control valves, the pressurized fluid actuating the valve between its first and second positions, the pressurization system receiving the signal from the engine computer and controlling the valves in accordance with that signal.

44. A system according to claim 41 wherein the temperature indicative of the engine oil is engine oil temperature and wherein the ambient condition is ambient air temperature.

45. A system according to claim 41 wherein the first control valve includes an actuatable valve member which is slideably mounted within a housing, the valve having a chamber formed between the housing and a portion of the valve member, the chamber being in communication with a pressurization system which supplies a pressurized medium into the chamber for sliding valve member within the housing.

46. A system according to claim 41 wherein the second flow control valve comprises:

first and second housing portions connected to one another, the first housing portion having an aperture in fluid communication with the engine, the second housing portion having at least one valve outlet in fluid communication with the exhaust heat assembly, and wherein the second housing portion is made from a high temperature material which minimizes conduction of heat;
a passageway formed between the first and second housing which permits communication of temperature control fluid between the two housing portions; and
a piston slideably disposed within the housing portions, the piston having a sealing portion and a pressure receiving portion, the sealing portion sealing the passageway between the first and second housing portions, the pressure receiving portion being located in a chamber within the first housing portion and having a surface for receiving a pressurized medium, the pressurized medium adapted to slide the piston within the valve.

47. A system according to claim 46 wherein the sealing portion seals the passageway when the valve is in its first position thereby preventing the passage of temperature control fluid between the first and second housing portions, and wherein the passageway is unsealed when the valve is in its second position and when the surface of the pressure receiving portion receives the pressurized medium so as to allow a flow of temperature control fluid between the first and second housing portions.

48. A system according to claim 46 further comprising a pressure escape port formed within the second housing portion for allowing a flow of temperature control fluid to vent out of the second housing portion.

49. A system according to claim 46 further comprising means for venting steam from within the second housing portion.

50. A system according to claim 41 wherein the temperature indicative of the temperature of the engine oil is the temperature of the engine block.

51. A system according to claim 42 wherein the second predetermined value varies with the sensed ambient condition.

52. A system according to claim 43 wherein the pressurization system controls the first and second flow control valves.

53. A system according to claim 52 wherein the pressurization system provides pressurized hydraulic fluid into a chamber formed in the flow control valve, the pressurized hydraulic fluid causing a piston to move within the valve between first and second positions of the valve.

54. A system according to claim 52 wherein the pressurized hydraulic fluid is provided from a high pressure side of an oil pump associated with the engine.

55. A system according to claim 14 wherein the sealing portion seals the passageway when the valve is in its first position thereby preventing the passage of temperature control fluid between the first and second housing portions, and wherein the passageway is unsealed when the valve is in its second position and when the surface of the pressure receiving portion receives the pressurized medium so as to allow a flow of temperature control fluid between the first and second housing portions.

56. A system according to claim 14 further comprising a pressure escape port formed within the second housing portion for allowing a flow of temperature control fluid to vent out of the second housing portion.

57. A system according to claim 14 wherein the second housing portion is made from ceramic material.

58. A system according to claim 14 wherein the pressure receiving portion is a pressure head which reciprocates within the chamber, the piston further comprising a spring disposed between the pressure head and the first housing portion which biases the pressure head so as to place the flow control valve in its first position, and wherein the spring is compressed by the piston head when the surface on the pressure head receives the pressurized medium.

59. A system according to claim 14 wherein the first housing portion is made from aluminum material.

60. A system according to claim 48 wherein the pressure escape port is in fluid communication with the first control valve.

61. A system according to claim 48 further comprising a tube attached to the pressure escape port and in communication with the radiator for channeling a flow of pressurized steam from the second housing portion to the radiator.

62. A system according to claim 49 wherein the pressure relief valve is a ball check valve.

63. A system according to claim 60 further comprising a pressure relief valve attached to the first control valve, and a tube extending between and attached to the pressure relief valve and the pressure escape port, the tube and the pressure relief valve permitting fluid communication between the second housing portion and the first control valve.

64. A system according to claim 15 wherein communication between the water pump and the valve chamber is provided by an outlet tube which has one end attached to the water pump and another end attached to a check valve outlet formed on the valve housing and in communication with the valve chamber.

65. A system according to claim 15 further comprising:

a cap attached to the valve housing and having a channel formed therein which is adapted to conduct fluid flow between the fluid overflow container and the valve chamber;
a ball slidably disposed within the valve chamber and adapted to seal the channel in the cap to prevent fluid flow therethrough when the housing receives a flow of pressurized fluid from the water pump, the ball furthermore being adapted to seal the check valve outlet to prevent flow therethrough when the fluid overflow container has a low level of fluid contained therein; and
a spring disposed between the ball and the cap for biasing the ball away from sealing the channel.

66. A system according to claim 64 wherein the valve housing is formed integral with the fluid overflow container.

67. A system according to claim 64 further comprising means disposed within the valve housing for controlling flow of temperature control fluid between the fluid overflow container and the water pump.

68. A system according to claim 67 wherein the means for controlling flow of temperature control fluid includes a cap attached to the valve housing and having a channel formed therein which is adapted to conduct fluid flow between the fluid overflow container and the valve chamber.

69. A system according to claim 68 wherein the means for controlling flow of temperature control fluid further includes a ball slidably disposed within the valve chamber and adapted to seal the channel in the cap to prevent fluid flow therethrough when the valve housing receives a flow of pressurized fluid from the water pump, the ball furthermore being adapted to seal the check valve outlet to prevent flow therethrough when the fluid overflow container has a low level of fluid contained therein.

70. A system according to claim 69 wherein the means for controlling flow of temperature control fluid further includes a biasing means disposed between the ball and the cap for biasing the ball away from sealing the channel.

71. A system according to claim 17 wherein the check valve includes:

a housing;
a chamber formed within the housing for conducting a flow of temperature control fluid between a cap and an check valve outlet, the cap being in communication with the fluid overflow container, and the check valve outlet being in communication with the water pump.

72. A system according to claim 17 wherein the cap is attached to the housing and has a channel formed therein which is adapted to conduct fluid flow between the fluid overflow container and the chamber; the valve further comprising a ball slidably disposed within the chamber and adapted to seal the cap channel to prevent fluid flow therethrough when the housing receives a flow of pressurized fluid from the water pump, the ball furthermore being adapted to seal the check valve outlet to prevent flow therethrough when the fluid overflow container has a low level of fluid contained therein; and a spring disposed between the ball and the cap for biasing the ball away from sealing the cap channel.

73. A system according to claim 17 wherein the check valve includes a chamber; and a means disposed within the chamber for controlling flow of temperature control fluid between the fluid overflow container and the water pump.

74. A system according to claim 17 wherein communication between the water pump and the check valve is provided by an outlet tube which has one end attached to the water pump and another end attached to a check valve outlet formed on the valve.

75. A system according to claim 17 wherein the check valve is formed integral with the fluid overflow container.

76. A system according to claim 17 further comprising an air bleed tube disposed between and attached to the water pump and the fluid overflow container, the air bleed tube adapted to vent air from within the water pump.

77. A system according to claim 76 wherein the air bleed tube is mounted on the water pump at a point where the fluid transitions between vacuum and pressure.

78. A system according to claim 1 further comprising:

an intake manifold for admitting a flow of intake air into the engine;
a throttle body having a throttle valve, the throttle body located within the flow of intake air;
a heat exchanger mounted to the engine and disposed within the flow of intake air, the heat exchanger adapted for receiving a flow of heated temperature control fluid from the exhaust heat assembly and for discharging said flow of temperature control fluid into a passageway leading from the heat exchanger, the heat exchanger including at least one heat exchanging element for transferring heat from the temperature control fluid to the intake air;
a third sensor for sensing an actual ambient air temperature and for providing a signal indicative thereof; and
a second control valve for regulating the flow of temperature control fluid to the heat exchanger, the second control valve having an open state and a closed state;
wherein the engine computer controls the actuation of the second flow control valve based on signals from the first, second and third sensors.

79. A system according to claim 78 wherein the heat exchanger is mounted downstream of the throttle body.

80. A system according to claim 78 wherein the heat exchanger is mounted in the air cleaner.

81. A system according to claim 78 wherein the heat exchanger is mounted between the air cleaner and the throttle body.

82. A system according to claim 78 wherein the heat exchanging element for transferring heat from the temperature control fluid to the intake air is a heat conductive tube.

83. A system according to claim 78 wherein the temperature indicative of the engine oil temperature is the temperature of the oil in the oil pan.

84. A system according to claim 78 further comprising a fourth sensor for sensing the temperature of the flow of intake air downstream of the heat exchanger, the fourth sensor providing a signal indicative of the temperature of the intake air to the engine computer, the engine computer comparing the signal to a threshold value for determining the desired state of the control valve, the engine computer providing signals to the control valve to place the control valve into the desired state.

85. A method for controlling the flow of temperature control fluid, the temperature control fluid being operative for heating and cooling an internal combustion engine, the internal combustion engine including an engine block, a cylinder head, an oil pan, an exhaust manifold, and a flow control valve for controlling the flow of temperature control fluid, the method comprising the steps of:

sensing a temperature of a temperature control fluid;
comparing the sensed temperature control fluid temperature to a predetermined temperature control fluid temperature value;

the method characterized by:

sensing a temperature indicative of the temperature of an engine oil;

comparing the sensed temperature indicative of the engine oil temperature to a predetermined engine oil temperature value;
actuating the flow control valve so as to allow temperature control fluid to flow to an exhaust manifold heating assembly mounted on the exhaust manifold when the sensed temperature indicative of the engine oil temperature is below the predetermined engine oil temperature value; and
actuating the flow control valve so as to prevent the flow of temperature control fluid to the exhaust manifold heating assembly when the sensed temperature of the temperature control fluid is above the predetermined temperature control fluid temperature value.

86. A method according to claim 85 further comprising the steps of:

determining a set of predetermined temperature control values based on the comparison of the sensed temperature indicative of the engine oil temperature to the predetermined engine oil temperature value; and
sensing an ambient air temperature;
wherein the step of comparing the sensed temperature control fluid temperature also involves comparing the sensed ambient air temperature to a set of predetermined temperature control values for determining a desired position of the valve.

87. A method according to claim 85 further comprising the steps of:

sensing an ambient air temperature;
comparing the sensed temperature indicative of the engine oil temperature and the sensed ambient air temperature to a set of predetermined temperature control values for determining a desired position of a second control valve, the second control valve controlling flow of temperature control fluid to a heat exchanger through which intake air passes;
actuating the second control valve so as to permit the flow of heated temperature control fluid to the heat exchanger.

88. A method according to claim 85, the engine further including a pressurization system having at least one input injector and at least one output injector mounted within a housing, each injector having an open position for permitting fluid flow along a passageway and a closed position for preventing fluid flow along a passageway, the method further comprising the steps of:

supplying a flow of fluid to the input injector from a fluid source;
placing the input injector into its open position;
placing the output injector into its closed position;
filling a chamber within the housing with the supplied fluid;
controlling a solenoid so as to open a supply line to the flow control valve for providing a supply of fluid from the housing to the valve, the supply of fluid operative for actuating the flow control valve; and
closing the input injector after the flow control valve has been actuated so as to trap fluid within the chamber.

89. A method according to claim 85, the engine further including a solenoid pressurization system having at least one solenoid valve which is in fluidic communication with the flow control valve, the solenoid valve having an open position for permitting fluid flow along a supply line and a closed position for preventing fluid flow along a supply line, the method comprising the steps of:

supplying a flow of fluid to the solenoid valve from a pressurized fluid source;
receiving a signal from the engine computer
directing a flow of pressurized fluid along the supply line;
controlling the solenoid so as to open a supply line to the flow control valve
directing a flow of pressurized fluid along the supply line, the supply of fluid operative for actuating the flow control valve; and
closing the solenoid after the flow control valve has been actuated.

90. A method according to claim 86 wherein the step of determining a set of predetermined temperature control values comprises varying an initial set of predetermined temperature control values as a function of the amount that the sensed temperature indicative of the engine oil temperature exceeds the predetermined engine oil temperature value.

91. A method according to claim 86 wherein the step of determining a set of predetermined temperature control values comprises the steps of providing an initial set of predetermined temperature control values which has at least a temperature control fluid temperature component, and adjusting the temperature control fluid temperature component as a function of the amount that the sensed temperature indicative of the engine oil temperature exceeds the predetermined engine oil temperature value.

92. A method according to claim 86 wherein the step of determining a set of predetermined temperature control values comprises selecting a set of predetermined temperature control values based on the comparison of the sensed temperature indicative of the engine oil temperature to the predetermined engine oil temperature value.

93. A method according to claim 87 further comprising the step of channeling the flow of the temperature control fluid from the heat exchanger into a passageway leading to an oil pan.

94. A method according to claim 87 further comprising the steps of:

detecting the temperature of the flow of intake air downstream of the heat exchanger;
comparing the detected temperature of the flow of intake air to a predetermined value for determining a desired position of the second control valve: and
actuating the second control valve so as to place the valve in the desired position for controlling the flow of the temperature control fluid to the heat exchanger.

95. A method according to claim 85 further comprising the steps of:

receiving an ambient condition signal;
varying the predetermined engine oil temperature value as a function of the ambient condition signal after the sensed temperature indicative of the engine oil temperature value exceeds an initial engine oil temperature threshold.

96. A method according to claim 85 wherein the temperature indicative of the temperature of the engine oil is the engine oil temperature.

97. A method according to claim 85 wherein the predetermined temperature control fluid value varies as a function of the comparison of the sensed temperature indicative of the engine oil temperature to the predetermined engine oil temperature value.

98. A method according to claim 95 wherein the temperature indicative of the temperature of the engine oil is engine oil temperature and wherein the ambient condition is ambient air temperature.

99. A method according to claim 85 wherein the temperature indicative of the temperature of the engine oil is the temperature of the engine block.

100. A method according to claim 99 further comprising the step of venting pressurized steam from the conduit adjacent to the exhaust manifold after the flow control valves have been placed into their first position inhibiting flow along the conduit.

Patentansprüche

1. Temperatursteuersystem zur Steuerung der Temperatur eines Verbrennungsmotors, wobei der Motor einen Motorblock, einen Zylinderkopf, einen Kühler, einen Ansaugkrümmer, einen Auspuffkrümmer zum Ausstoßen von erhitzen Gasen aus dem Motor und eine Ölwanne einschließt, wobei das System einen Strom von Temperatursteuerflüssigkeit für das Erhitzen und Kühlen des Verbrennungsmotors einschließt und folgendes umfaßt:

einen ersten Temperaturfühler zum Fühlen der Temperatur der Temperatursteuerflüssigkeit,

ein Abgaseinlaßrohr, das zur Führung eines Stroms der Temperatursteuerflüssigkeit von dem Motor fort angepaßt ist, ein Abgasauslaßrohr, das zur Führung eines Stroms der Temperatursteuerflüssigkeit hin zu dem Motor angepaßt ist,

eine Abgaswärmeeinrichtung, die mit den Abgaseinlaß- und -auslaßrohren verbunden ist und für ein Leiten eines Stroms der Temperatursteuerflüssigkeit von dem Abgaseinlaßrohr zu dem Abgasauslaßrohr angepaßt ist, wobei die Abgaswärmeeinrichtung angrenzend an den Auspuffkrümmer angeordnet ist und für einen Wärmetransport der heißen Gase in dem Abgaskrümmer zu der Temperatursteuerflüssigkeit in der Abgaswärmeeinrichtung angepaßt ist,

gekennzeichnet durch

einen zweiten Temperatursensor, der eine Temperatur fühlt, welche die Temperatur des Motoröls anzeigt,

ein erstes Stromventil, das in durchgängiger Verbindung mit dem Abgaseinlaßrohr steht, und

einen Motorcomputer zur Steuerung des Stroms der Temperatursteuerflüssigkeit durch die Abgaswärmeeinrichtung durch Betätigen des ersten Stromventils, wobei der Motorcomputer von dem ersten und zweiten Temperatursensor Signale empfängt und der Motorcomputer ferner das erste Stromventil betätigt, um einen Strom der Temperatursteuerflüssigkeit entlang dem Abgaseinlaßrohr und in die Abgaswärmeeinrichtung zu ermöglichen, wenn die gefühlte Temperatur, welche die Temperatur des Motoröls anzeigt, unterhalb eines ersten vorbestimmten Werts liegt, und der Motorcomputer das Stromventil derart betätigt, daß der Strom der Temperatursteuerflüssigkeit entlang dem Abgaseinlaßrohr und durch die Abgaswärmeeinrichtung unterbunden ist, wenn die gefühlte Temperatur der Temperatursteuerflüssigkeit oberhalb eines zweiten vorbestimmten Wertes liegt.

2. System nach Anspruch 1, dadurch gekennzeichnet, daß die Abgaswärmeeinrichtung einen Heizleiter mit einem ersten und einem zweiten Ende, einem ersten an dem ersten Ende des Heizleiters befestigten Abstandshalter und einem zweiten Abstandshalter, der an dem zweiten Ende des Heizleiters befestigt ist, aufweist.

3. System nach Anspruch 1, dadurch gekennzeichnet, daß die Abgaswärmeeinrichtung zusätzlich ein Steuerventil aufweist, das an dem Auslaßrohr zur Steuerung des Stroms der Temperatursteuerflüssigkeit zu dem Motor und zur Sperrung des Stroms der Temperatursteuerflüssigkeit in die Abgaswärmeeinrichtung befestigt ist.

4. System nach Anspruch 1, dadurch gekennzeichnet, daß der Motor eine Wasserpumpe zur Zirkulation der Temperatursteuerflüssigkeit aufweist, wobei das Abgaseinlaßrohr den Strom der Temperatursteuerflüssigkeit von der Wasserpumpe aufnimmt.

5. System nach Anspruch 1, dadurch gekennzeichnet, daß der Motor eine Ölwanne aufweist, wobei das Abgasauslaßrohr einen Strom der Temperatursteuerflüssigkeit in die Ölwanne richtet.

6. System nach Anspruch 1, dadurch gekennzeichnet, daß der Motor einen Einlaßkrümmer einschließt, wobei das Abgasauslaßrohr einen Strom der Temperatursteuerflüssigkeit hin zu dem Einlaßkrümmer richtet.

7. System nach Anspruch 1, dadurch gekennzeichnet, daß der Motor eine Fahrgastinnenraum-Wärmeeinrichtung einschließt, wobei das Abgasauslaßrohr den Strom der Temperatursteuerflüssigkeit hin zu der Fahrgastinnenraum-Wärmeeinrichtung richtet.

8. System nach Anspruch 1, dadurch gekennzeichnet, daß zusätzlich folgendes vorgesehen ist:

eine Wasserpumpe, die für ein Richten einer Temperatursteuerflüssigkeit in den Motor angepaßt ist und die folgendes einschließt:

ein Gehäuse,

ein drehbar in dem Gehäuse befestigtes Gebläserad, wobei das Gebläserad für eine Zirkulation des Stroms der Temperatursteuerflüssigkeit angepaßt ist, und

mindestens einen Flußkanal, um den Strom der Temperatursteuerflüssigkeit in den Motorblock zu richten, wobei das Stromventil zur Steuerung des Stroms der Temperatursteuerflüssigkeit entlang dem Flußkanal angepaßt und an dem Wasserpumpengehäuse befestigt ist sowie zwischen einer ersten Position und einer zweiten Position bewegbar ist, wobei das Stromventil in seiner ersten Position es zuläßt, daß der Strom der Temperatursteuerflüssigkeit entlang dem Flußkanal fließt, und das Stromventil den Strom der Temperatursteuerflüssigkeit entlang dem Flußkanal beschränkt, wenn es sich in seiner zweiten Position befindet, und wobei das Abgaseinlaßrohr für ein Richten eines Stroms der Temperatursteuerflüssigkeit von dem Motor fort angepaßt ist, wenn das Stromventil sich in seiner zweiten Position befindet.

9. System nach Anspruch 1, dadurch gekennzeichnet, daß zusätzlich ein Solenoideinspritzsystem zur Steuerung der Betätigung des Stromventils vorgesehen ist, wobei das Solenoideinspritzsystem folgendes umfaßt:

ein Gehäuse mit einer in diesem geformten Kammer,

eine Einlaßleitung, die mit dem Gehäuse verbunden ist und für eine Versorgung eines Flüssigkeitsstroms in das Gehäuse angepaßt ist,

eine Auslaßleitung, die mit dem Gehäuse verbunden ist und für ein Leiten eines Flüssigkeitsstroms aus dem Gehäuse angepaßt ist,

einen Einlaßinjektor, der mit dem Gehäuse verbunden ist und in Verbindung mit der Kammer und der Einlaßleitung steht, wobei der Einlaßinjektor eine geöffnete Position, die für ein Leiten eines Stroms von unter Druck stehender Flüssigkeit von der Einlaßleitung in die Kammer angepaßt ist, und eine geschlossene Position besitzt, in der ein Strom der unter Druck stehenden Flüssigkeit von der Einlaßleitung in die Kammer verhindert ist,

einen ersten mit dem Einlaßinjektor verbundenen Solenoiden, der für eine Betätigung des Einlaßinjektors zwischen seiner geöffneten und geschlossenen Position dient, wobei der erste Solenoid für einen Empfang eines Signals von dem Motorcomputer zur Steuerung der Betätigung des Einlaßinjektors angepaßt ist,

ein Auslaßinjektor, der mit dem Gehäuse verbunden ist und mit der Kammer sowie der Auslaßleitung in Verbindung steht, wobei der Auslaßinjektor eine geöffnete Position besitzt, die für ein Leiten eines Flüssigkeitsstroms aus der Kammer und in die Auslaßleitung angepaßt ist, und eine geschlossene Position besitzt, die zur Verhinderung eine Flüssigkeitsstroms aus der Kammer und in die Auslaßleitung angepaßt ist,

ein zweiter Solenoid, der mit dem Auslaßinjektor für eine Betätigung des Auslaßinjektors zwischen seiner geöffneten und geschlossenen Position verbunden ist, wobei der zweite Solenoid für eine Aufnahme eines Signals von dem Motorcomputer zur Steuerung der Betätigung des Auslaßinjektors angepaßt ist, und

ein dritter Solenoid, der mit dem Gehäuse verbunden ist und in durchgängiger Verbindung mit der Kammer steht, wobei der dritte Solenoid mindestens eine mit diesem verbundene erste Flüssigkeitsversorgungsleitung besitzt, die für ein Leiten eines Stroms von unter Druck stehender Flüssigkeit zu dem Stromventil zur Steuerung der Betätigung des Ventils angepaßt ist, dabei besitzt der dritte Solenoid eine offene Position, um einen Fluß der unter Druck stehenden Flüssigkeit entlang der Versorgungsleitung zu gestattet, und eine geschlossene Position, um den Flüssigkeitsstrom entlang der Versorgungsleitung zu unterbinden, wobei der dritte Solenoid zum Empfang von Signalen von dem Motorcomputer zur Steuerung der unter Druck stehenden Flüssigkeit entlang der Versorgungsleitung angepaßt ist.

10. System nach Anspruch 1, dadurch gekennzeichnet, daß zusätzlich ein Solenoideinspritzsystem zur Steuerung der Betätigung des Stromventils vorgesehen ist, wobei das Solenoideinspritzsystem folgendes einschließt:

ein Gehäuse mit einer in diesem geformten Kammer,

Einlaßmittel, die für ein Leiten eines Flüssigkeitsstroms in die Kammer in Verbindung mit dem Gehäuse stehen,

Auslaßmittel, die für eine Leiten eines Flüssigkeitstroms aus der Kammer in Verbindung mit dem Gehäuse stehen, und

einen Solenoid, der mit dem Gehäuse verbunden ist und innerhalb der Kammer positioniert ist, wobei der

Solenoid mindestens einen Flüssigkeitsauslaß besitzt, der angepaßt ist, um einen Strom von unter Druck stehender Flüssigkeit zu dem Stromventil zur Steuerung der Betätigung des Ventils zu richten, wobei der Elektromotor eine geöffnete Position besitzt, um einen Fluß der unter Druck stehenden Flüssigkeit aus dem Flüssigkeitsauslaß zu ermöglichen, und eine geschlossene Position, um einen Flüssigkeitsstrom aus dem Flüssigketisauslaß zu unterbinden, wobei der Solenoid für die Aufnahme von Signalen von dem Motorcomputer zur Steuerung des Solenoiden zwischen seiner geöffneten und seiner geschlossenen Position angepaßt ist.

11. System nach Anspruch 1, dadurch gekennzeichnet, daß zusätzlich ein Druckerzeugungssystem zur Steuerung der Betätigung des Stromventils vorgesehen ist, wobei das Druckerzeugungssystem aufweist:

ein Gehäuse mit einer darin geformten Kammer,

einen Einlaßinjektor, der für ein Leiten eines Stroms von unter Druck stehender Flüssigkeit in die Kammer mit dem Gehäuse in Verbindung steht,

einen Auslaßinjektor, der für ein Leiten eines Stroms von unter Druck stehender Flüssigkeit aus der Kammer mit dem Gehäuse in Verbindung steht, und

Flüssigkeitstromsteuermittel, die mit dem Gehäuse verbunden sind und wenigstens einen Flüssigkeitsauslaß besitzen, der für ein Richten eines Stroms von unter Druck stehender Flüssigkeit zu dem Stromventil zur Steuerung dessen Betätigung gerichtet ist, wobei die Flüssigkeitstromsteuermittel eine geöffnete Position besitzen, um einen Fluß von unter Druck stehender Flüssigkeit aus dem Flüssigkeitsauslaß zu gestatten, und eine geschlossene Position, um einen Flüssigkeitsfluß aus dem Flüssigkeitsauslaß zu verhindern, wobei die Flüssigkeitstromsteuermittel derart angepaßt sind, daß sie Signale von dem Motorcomputer für die Steuerung der Betätigung der Flüssigkeitsstromsteuermittel zwischen ihrer offenen und geschlossenen Position empfangen.

12. System nach Anspruch 1, dadurch gekennzeichnet, daß zusätzlich ein Einspritzsystem zur Steuerung der Betätigung des Stromventils vorgesehen ist, wobei das Einspritzsystem folgendes aufweist:

ein Gehäuse mit einer in diesem geformten Kammer,

eine Einlaßleitung, die mit dem Gehäuse verbunden und angepaßt ist, einen Flüssigkeitsstrom in das Gehäuse zu versorgen,

eine Auslaßleitung, die mit dem Gehäuse verbunden und angepaßt ist, einen Flüssigkeitsstrom aus dem Gehäuse zu leiten,

einen Einlaßinjektor, der mit dem Gehäuse verbunden ist und in Verbindung mit der Kammer und der Einlaßleitung steht, wobei der Einlaßinjektor eine geöffnete Position, die für ein Leiten eines Stroms von unter Druck stehender Flüssigkeit von der Einlaßleitung in die Kammer angepaßt ist, und eine geschlossene Position besitzt, in der ein Strom von unter Druck stehender Flüssigkeit von der Einlaßleitung in die Kammer verhindert ist,

einen ersten mit dem Einlaßinjektor verbundenen Solenoid, der für eine Betätigung des Einlaßinjektors zwischen seiner offenen und geschlossenen Position dient, wobei der erste Solenoid für eine Aufnahme eines Signals von dem Motorcomputer zur Steuerung der Betätigung des Einlaßinjektors angepaßt ist,

einen Auslaßinjektor, der mit dem Gehäuse verbunden ist und mit der Kammer sowie der Auslaßleitung in Verbindung steht, wobei der Auslaßinjektor eine offene Position, die für ein Leiten eines Flüssigkeitsstroms aus der Kammer und in die Auslaßleitung angepaßt ist, und eine geschlossene Position besitzt, die zur Verhinderung eines Flüssigkeitsstroms aus der Kammer sowie in die Auslaßleitung angepaßt ist,

einen zweiten mit dem Auslaßinjektor verbundenen Solenoid, der zur Betätigung des Auslaßinjektors zwischen seiner geöffneten und geschlossenen Position dient, wobei der zweite Solenoid zum Empfang von Signalen von dem Motorcomputer zur Steuerung der Betätigung des Einlaßinjektors angepaßt ist, und einen dritten Solenoid, der mit dem Gehäuse verbunden ist und in durchgängiger Verbindung mit der Kammer steht, wobei der dritte Solenoid mindestens eine mit dieser verbundene erste Flüssigkeitsversorgungsleitung besitzt, wobei die Versorgungsleitung für ein Leiten eines Stroms von unter Druck stehender Flüssigkeit zu dem Stromventil zur Steuerung der Betätigung des Ventils angepaßt ist, dabei besitzt der dritte Solenoid eine geöffnete Position, um einen Fluß der unter Druck stehenden Flüssigkeit entlang der Versorgungsleitung zu ermöglichen, und eine geschlossene Position, um den Flüssigkeitsstrom entlang der Versorgungsleitung zu unterbinden, und wobei der dritte Solenoid zum Empfang von Signalen von dem Motorcomputer zur Steuerung der unter Druck stehenden Flüssigkeit entlang der Versorgungsleitung angepaßt ist.

13. System nach Anspruch 1, dadurch gekennzeichnet, daß zusätzlich ein Druckerzeugungssystem zur Steuerung der Betätigung des Stromventils vorgesehen ist, wobei das Druckerzeugungssystem aufweist:

ein Gehäuse mit einer darin geformten Kammer,

eine Einlaßleitung, die an dem Gehäuse befestigt ist und für ein Leiten eines Stroms von unter Druck stehender Flüssigkeit in die Kammer angepaßt ist,

eine Auslaßleitung, die an dem Gehäuse befestigt ist und für ein Leiten eines Flüssigkeitsstroms aus der Kammer angepaßt ist, und einen Solenoid, der mit dem Gehäuse verbunden und innerhalb der Kammer angeordnet ist, wobei der Solenoid mindestens einen Flüssigkeitsauslaß besitzt, der für ein Richten eines Stroms von unter Druck stehender Flüssigkeit zu mindestens einem Stromventil zur Steuerung der Betätigung des Ventil angepaßt ist, wobei der Solenoid wenigstens eine geöffnete Position aufweist, um einen Fluß von unter Druck stehender Flüssigkeit aus dem Flüssigkeitsauslaß zu gestatten, und eine geschlossene Position, um einen Flüssigkeitsstrom aus dem Flüssigkeitsauslaß zu verhindern, wobei der Solenoid für eine Aufnahme von Signalen von dem Motorcomputer zur Steuerung des Solenoiden zwischen seiner offenen und geschlossenen Position angepaßt ist.

14. System nach Anspruch 1, dadurch gekennzeichnet, daß das Stromventil folgendes einschließt:

einen ersten und zweiten Gehäuseabschnitt, die miteinander verbunden sind, wobei der erste Gehäuseabschnitt eine Öffnung besitzt, die durchgängig mit dem Motor verbunden ist, der zweite Gehäuseabschnitt mindestens einen Ventilauslaß besitzt, der für eine durchgängige Verbindung mit der Abgaswärmeeinrichtung angepaßt ist, und wobei der zweite Gehäuseabschnitt aus einem hochwarmfesten Material hergestellt ist, das die Wärmeleitung minimiert,

einen Durchgang, der zwischen dem ersten und zweiten Gehäuseabschnitt geformt ist und der eine Verbindung der Temperatursteuerflüssigkeit zwischen den zwei Gehäuseabschnitten ermöglicht, und

einen Kolben, der verschiebbar innerhalb des Gehäusebereichs angeordnet ist und der einen Abdichtbereich und einen Druckaufnahmebereich besitzt, wobei der Abdichtbereich den Durchgang zwischen dem ersten und zweiten Gehäusebereich abdichtet und der Druckaufnahmebereich in dem ersten Gehäusebereich angeordnet ist und eine Oberfläche zur Aufnahme eines unter Druck stehenden Mediums aufweist, wobei das unter Druck stehende Medium für ein Verschieben des Kolbens innerhalb des Ventils vorgesehen ist.

15. System nach Anspruch 1 zusätzlich mit

einem Absperrventil zur Steuerung des Stroms der Temperatursteuerflüssigkeit zwischen einem Kühlerflüssigkeitsüberlaufbehälter und einer Wasserpumpe in einem Verbrennungsmotor, wobei das Absperrventil

ein Gehäuse einschließt, das in Verbindung mit dem Flüssigkeitsüberlaufbehälter steht und angepaßt ist, einen Strom der Temperatursteuerflüssigkeit von diesem aufzunehmen, wobei das Gehäuse eine in diesem geformte Ventilkammer besitzt, um einen Strom von Temperatursteuerflüssigkeit zu leiten, wobei das Gehäuse ebenfalls in Verbindung mit der Wasserpumpe steht und für ein Leiten eines Stroms der Temperatursteuerflüssigkeit zwischen der Ventilkammer und der Wasserpumpe ausgebildet ist.

16. System nach Anspruch 1, dadurch gekennzeichnet, daß zusätzlich ein Absperrventil zur Steuerung des Stroms der Temperatursteuerflüssigkeit zwischen einem Kühlerflüssigkeitsüberlaufbehälter und einer Wasserpumpe aufweisend, wobei das Absperrventil ein Gehäuse, das in Verbindung mit dem Flüssigkeitsüberlaufbehälter steht und angepaßt ist, einen Strom der Temperatursteuerflüssigkeit von diesem aufzunehmen, wobei das Gehäuse eine in diesem geformte Ventilkammer besitzt, um einen Strom von Temperatursteuerflüssigkeit zu leiten, wobei das Gehäuse ebenfalls in Verbindung mit der Wasserpumpe steht und für ein Leiten eines Stroms der Temperatursteuerflüssigkeit zwischen der Ventilkammer und der Wasserpumpe ausgebildet ist, und Mittel zur Steuerung der Temperatursteuerflüssigkeit durch das Gehäuse einschließt, wobei die Mittel zur Steuerung des Stroms eine erste Position, die zur Ermöglichung eines Flüssigkeitsstroms zu der Wasserpumpe angepaßt ist, und eine zweite Position zur Verhinderung eines Flüssigkeits-Luftstroms von dem Flüssigkeitssüberlaufbehälter zu der Wasserpumpe besitzen.

17. System nach Anspruch 1, dadurch gekennzeichnet, daß zusätzlich folgendes vorgesehen ist:

ein Flüssigkeitsüberlaufbehälter,

eine Wasserpumpe und

ein Absperrventil, das mit dem Flüssigkeitsüberlaufbehälter und der Wasserpumpe in Verbindung steht und zur Steuerung der Temperatursteuerflüssigkeit zwischen dem Flüssigkeitsüberlaufbehälter und der Wasserpumpe angepaßt ist.

18. System nach Anspruch 2, dadurch gekennzeichnet, daß der Heizleiter aus einem Material besteht, das einen Wärmetransport gestattet, und daß der erste und zweite Abstandshalter aus einem Material bestehen, das den Wärmetransport begrenzt.

19. System nach Anspruch 18, dadurch gekennzeichnet, daß der erste und der zweite Abstandshalter aus einem keramischen Material hergestellt ist.

20. System nach Anspruch 18, dadurch gekennzeichnet, daß der Heizleiter aus einem nichtrostenden Stahl hergestellt ist.

21. System nach Anspruch 18, dadurch gekennzeichnet, daß der Heizleiter sich über den Auspuffkrümmer bis zu einem vorbestimmten Abstand erstreckt, um eine Hitzeabgabe von dem Heizleiter zu ermöglichen.

22. System nach Anspruch 8, dadurch gekennzeichnet, daß das Abgasauslaßrohr für ein Richten eines Stroms von Temperatursteuerflüssigkeit zu dem Einlaßkrümmer des Motors angepaßt ist.

23. System nach Anspruch 8, dadurch gekennzeichnet, daß das Abgasauslaßrohr für ein Richten eines Stroms von Temperatursteuerflüssigkeit zu der Ölwanne des Motors angepaßt ist.

24. System nach Anspruch 8, dadurch gekennzeichnet, daß das Stromventil an der Wasserpumpe befestigt ist, wobei das System weiterhin ein zweites Stromventil aufweist, das an der Wasserpumpe befestigt ist, und daß eines von den Stromventilen einen Umgehungsdurchgang einschließt, der für ein Leiten einer Temperatursteuerflüssigkeit aus der Wasserpumpe angepaßt ist, wenn das Stromventil sich in seiner zweiten Position befindet.

25. System nach Anspruch 8, dadurch gekennzeichnet, daß zusätzlich ein hydraulischer Solenoidinjektor in durchgängiger Verbindung mit den Stromventilen steht und zur Versorgung der Stromventile mit einem Strom von unter Druck stehender Flüssigkeit angepaßt ist, wobei das hydraulische Solenoidinjektrosystem Signale von dem Motorcomputer zur Steuerung der Versorgung der Stromventile mit unter Druck stehender Flüssigkeit empfängt, wobei die unter Druck stehende Flüssigkeit die Betätigung des Stromventils steuert.

26. System nach Anspruch 8, dadurch gekennzeichnet, daß die Wasserpumpe weiterhin mindestens ein Rohr umfaßt, das mit dem Zylinderkopf verbunden ist, um einen Strom von Temperatursteuerflüssigkeit in den Zylinderkopf zu leiten, wenn das Stromventil sich in seiner zweiten Position befindet.

27. System nach Anspruch 8, dadurch gekennzeichnet, daß zusätzlich ein Wärmetauscher innerhalb der Ölwanne angeordnet ist, um einen Strom der Temperatursteuerflüssigkeit zu leiten, und wobei die Wasserpumpe angepaßt ist, um einen Strom der Temperatursteuerflüssigkeit von dem Wärmetauscher in der Ölwanne aufzunehmen, wenn das Stromventil sich in seinem geschlossenen Zustand befindet.

28. System nach Anspruch 8, dadurch gekennzeichnet, daß die Abgaswärmeeinrichtung mit einem Wärmetauscher, der innerhalb der Motorölwanne angeordnet ist, durch ein Abgasrückführrohr verbunden ist und daß die Temperatursteuerflüssigkeit von der Abgaswärmeeinrichtung zu dem Wärmetauscher durch das Abgasrückführrohr fließt.

29. System nach Anspruch 8, dadurch gekennzeichnet, daß der Motor zusätzlich einen Einlaßkrümmer zum Leiten des Stroms der Einlasserluft einschließt, wobei das System zusätzlich mindestens einen Kanal, der innerhalb des Einlaßkrümmers angeordnet und zur Aufnahme eines Stroms von Temperatursteuerflüssigkeit zur Erwärmung der Einlasserluft angepaßt ist, aufweist, und daß das Stromventil mindestens einen Teil der Temperatursteuerflüssigkeit durch den Einlaßkrümmerkanal behindert, wenn das Stromventil sich in seinem geschlossenen Zustand befindet.

30. System nach Anspruch 23, dadurch gekennzeichnet, daß der Motor eine Fahrgastinnenraum-Wärmeeinrichtung einschließt und daß das Abgasauslaßrohr angepaßt ist, um den Strom der Temperatursteuerflüssigkeit zu der Wärmeeinrichtung zu richten.

31. System nach Anspruch 24, dadurch gekennzeichnet, daß die Umgehungsdurchgangskanäle einen Strom der Temperatursteuerflüssigkeit von der Wasserpumpe zu dem Zylinderkopf leiten, wenn das Stromventil sich in seiner zweiten Position befindet.

32. System nach Anspruch 9, dadurch gekennzeichnet, daß der Einlaßinjektor innerhalb eines in dem Gehäuse geformten Einlaßfaches angeordnet ist, wobei das Einlaßfach in einer durchgängigen Verbindung mit der Einlaßleitung steht und wobei der Einlaßinjektor für ein Richten eines Stroms der Temperatursteuerflüssigkeit von dem Einlaßfach in die Kammer angepaßt ist, und daß der Auslaßinjektor innerhalb eines in dem Gehäuse geformten Auslaßfaches angeordnet ist, wobei das Auslaßfach in einer durchgängigen Verbindung mit der Auslaßleitung steht und wobei der Auslaßinjektor für ein Richten eines Stroms der Temperatursteuerflüssigkeit aus der Kammer und in das Auslaßfach angepaßt ist.

33. System nach Anspruch 9, dadurch gekennzeichnet, daß mehrere Versorgungsleitungen vorgesehen sind, wobei eine der Versorgungsleitungen vorgesehen ist, um einen Strom einer unter Druck stehenden Flüssigkeit hin zu einem elektronischen Motortemperatursteuerventil zu leiten, das den Strom der Temperatursteuerflüssigkeit zwischen einem Motor und einem Kühler steuert, wobei der Strom von unter Druck stehender Flüssigkeit zum Hervorrufen einer Betätigung des Ventils vorgesehen ist, eine zweite Versorgungsleitung für ein Richten eines Stroms von unter Druck stehender Flüssigkeit zu dem ersten Stromventil vorgesehen ist und eine dritte Versorgungsleitung angepaßt ist, um einen Strom von unter Druck stehender Flüssigkeit wenigstens bis zu einem zweiten Stromventil, das an einem anderen Ende der Abgaswärmeeinrichtung angeordnet ist, zu leiten, wobei das zweite Stromventil angepaßt ist, um den Strom der Temperatursteuerflüssigkeit aus der Abgaswärmeeinrichtung zu steuern.

34. System nach Anspruch 33, dadurch gekennzeichnet, daß das Gehäuse eine Mittelebene besitzt und daß das Einlaß- und das Auslaßfach auf beiden Seiten der Mittelebene angeordnet ist sowie in bezug auf die Mittelebene einen Winkel einschließt.

35. System nach Anspruch 10, dadurch gekennzeichnet, daß zusätzlich folgendes vorgesehen ist:

ein Einlaß, der in dem Gehäuse zum Richten eines Flüssigkeitsstroms in das Gehäuse und hin zu den Einlaßmitteln geformt ist, und

ein Auslaß, der in dem Gehäuse zum Richten eines Flüssigkeitsstroms aus dem Gehäuse und hin zu den Auslaßmitteln geformt ist.

36. System nach Anspruch 10, dadurch gekennzeichnet, daß die Einlaßmittel einen Injektor zum Spritzen eines Flüssigkeitsstroms in die Kammer einschließen und daß die Auslaßmittel einen Injektor zum Spritzen eines Flüssigkeitsstroms aus der Kammer einschließen.

37. System nach Anspruch 9, 10, 11, 12 oder 13, dadurch gekennzeichnet, daß die Flüssigkeit eine hydraulische Flüssigkeit ist.

38. System nach Anspruch 10, 11, 12 oder 13, dadurch gekennzeichnet, daß der Flüssigkeitsauslaß zum Richten eines Stroms von unter Druck stehender Flüssigkeit hin zu einem elektronischen Motortemperatursteuerventil, das den Strom der Temperatursteuerflüssigkeit zwischen dem Motor und dem Kühler steuert, angepaßt ist, wobei der Strom von unter Druck stehender Flüssigkeit dafür angepaßt ist, eine Betätigung des Ventils hervorzurufen.

39. System nach Anspruch 11, dadurch gekennzeichnet, daß die Flüssigkeitssteuereinrichtung ein Stromventil ist.

40. System nach Anspruch 39, dadurch gekennzeichnet, daß das Stromventil ein Solenoid ist.

41. Temperatursteuersystem nach Anspruch 1 zusätzlich folgendes aufweisend:

einen dritten Sensor zum Fühlen einer Umgebungsbedingung und zum Bereitstellen eines Umgebungsbedingungssignals, das diese anzeigt, und

ein zweites Steuerventil in einer durchgängigen Verbindung mit einem Abgasauslaßrohr,

wobei der Motorcomputer die Betätigung des zweiten Steuerventils steuert und den ersten vorbestimmten Wert als Funktion der Umgebungsbedingung variiert und der Motorcomputer auf der gefühlten Umgebungsbedingung basierend den ersten vorbestimmten Wert bestimmt.

42. System nach Anspruch 41, dadurch gekennzeichnet, daß die Temperatur, welche die Temperatur des Motoröls anzeigt, die Motoröltemperatur ist.

43. System nach Anspruch 41, dadurch gekennzeichnet, daß zusätzlich eine Druckerzeugungseinrichtung vorgesehen ist, um eine Quelle von unter Druck stehender Flüssigkeit für mindestens eines der Stromventile bereitzustellen, wobei die unter Druck stehende Flüssigkeit das Ventil zwischen seiner ersten und seiner zweiten Position betätigt, hierbei empfängt das Druck erzeugende System das Signal des Motorcomputers und steuert die Ventile in Übereinstimmung mit diesem Signal.

44. System nach Anspruch 41, dadurch gekennzeichnet, daß die Temperatur, welche die des Motoröls anzeigt, die Motoröltemperatur ist und daß die Umgebungsbedingung die Umgebungslufttemperatur ist.

45. System nach Anspruch 41, dadurch gekennzeichnet, daß das erste Steuerventil ein betätigbares Ventilelement einschließt, das verschiebbar innerhalb des Gehäuses befestigt ist, wobei das Ventil eine zwischen dem Gehäuse und einem Bereich des Ventilelements geformte Kammer besitzt, die in Verbindung mit einem Druckerzeugungssystem steht, das die Kammer mit einem unter Druck stehenden Medium versorgt, um das Ventilelement innerhalb des Gehäuses zu verschieben.

46. System nach Anspruch 41, dadurch gekennzeichnet, daß ein zweites Stromventil folgendes aufweist:

erste und zweite Gehäuseabschnitte, die miteinander verbunden sind, wobei der erste Gehäuseabschnitt eine Öffnung, die in durchgängiger Verbindung mit dem Motor steht, aufweist, wobei der zweite Gehäuseabschnitt mindestens einen Ventilauslaß besitzt, der in durchgängiger Verbindung mit der Abgaswärmeeinrichtung steht, und wobei der zweite Gehäuseabschnitt aus einem hochwarmfesten Material, das die Wärmeleitung minimiert, hergestellt ist,

einen Durchgang, der zwischen dem ersten und zweiten Gehäuse geformt ist, der den Durchgang von Temperatursteuerflüssigkeit zwischen den zwei Gehäuseabschnitten ermöglicht, und

einen verschiebbaren innerhalb des Gehäuseabschnitts angeordneten Kolben, wobei der Kolben einen Abdichtbereich und einen Druckaufnahmebereich besitzt, wobei der Abdichtbereich den Durchgang zwischen dem ersten und zweiten Gehäuseabschnitt abdichtet und der Druckaufnahmebereich in der Kammer innerhalb des ersten Gehäuseabschnitts angeordnet ist sowie eine Oberfläche zur Aufnahme eines unter Druck stehenden Mediums, das für ein Verschieben des Kolbens innerhalb der Kammer vorgesehen ist, besitzt.

47. System nach Anspruch 46, dadurch gekennzeichnet, daß der Abdichtbereich den Durchgang abdichtet, wenn das Ventil sich in seiner ersten Position befindet, wodurch der Durchtritt von Temperatursteuerflüssigkeit zwischen dem ersten und zweiten Gehäuseabschnitt verhindert wird, und daß der Durchgang nicht abgedichtet ist, wenn das Ventil sich in seiner zweiten Position befindet und wenn die Oberfläche des Druckaufnahmebereichs das unter Druck stehende Medium aufnimmt, um so ein Fließen der Temperatursteuerflüssigkeit zwischen dem ersten und dem zweiten Gehäuseabschnitt zu ermöglichen.

48. System nach Anspruch 46, dadurch gekennzeichnet, daß zusätzlich eine Druckentweichöffnung innerhalb des zweiten Gehäuseabschnitts vorgesehen ist, um es einem Strom von Temperatursteuerflüssigkeit zu ermöglichen, den zweiten Gehäuseabschnitt zu entlüften.

49. System nach Anspruch 46, dadurch gekennzeichnet, daß zusätzliche Mittel für einen Entlüftungsstrom aus dem zweiten Gehäuseabschnitt vorgesehen sind.

50. System nach Anspruch 41, dadurch gekennzeichnet, daß die Temperatur, welche die Temperatur des Motoröls anzeigt, die Motorblocktemperatur ist.

51. System nach Anspruch 42, dadurch gekennzeichnet, daß der zweite vorbestimmte Wert mit der gefühlten Umgebungsbedingung variiert.

52. System nach Anspruch 43, dadurch gekennzeichnet, daß das Druckerzeugungssystem das erste und zweite Stromventil steuert.

53. System nach Anspruch 52, dadurch gekennzeichnet, daß das Druckerzeugungssystem eine hydraulische Flüssigkeit in einer in dem Stromventil geformten Kammer bereitstellt, wobei die unter Druck stehende hydraulische Flüssigkeit einen Kolben dazu veranlaßt, sich innerhalb des Ventils zwischen einer ersten und einer zweiten Position zu bewegen.

54. System nach Anspruch 52, dadurch gekennzeichnet, daß die unter Druck stehende hydraulische Flüssigkeit von einer Hochdruckseite einer mit dem Motor verbundenen Ölpumpe bereitgestellt ist.

55. System nach Anspruch 14, dadurch gekennzeichnet, daß der Abdichtbereich den Durchgang abdichtet, wenn das Ventil sich in seiner ersten Position befindet, um dadurch den Durchgang von Temperatursteuerflüssigkeit zwischen dem ersten und zweiten Gehäuseabschnitt zu verhindern, und daß der Durchgang nicht abgedichtet ist, wenn das Ventil sich in seiner zweiten Position befindet und wenn die Oberfläche des Druckaufnahmebereichs ein unter Druck stehendes Medium aufnimmt, um einen Strom der Temperatursteuerflüssigkeit zwischen dem ersten und zweiten Gehäuseabschnitt zu ermöglichen.

56. System nach Anspruch 14, dadurch gekennzeichnet, daß eine Druckentweichauslaß in dem zweiten Gehäuseabschnitt geformt ist, um einem Strom von Temperatursteuerflüssigkeit es zu ermöglichen, den zweiten Gehäuseabschnitt zu entlüften.

57. System nach Anspruch 14, dadurch gekennzeichnet, daß der zweite Gehäuseabschnitt aus einem keramischen Material hergestellt ist.

58. System nach Anspruch 14, dadurch gekennzeichnet, daß der Druckaufnahmebereich ein Druckkopf ist, der sich innerhalb der Kammer hin und herbewegt, wobei der Kolben zusätzlich eine Feder aufweist, die zwischen dem Druckkopf und dem ersten Gehäuseabschnitt angeordnet ist, wobei die Feder den Druckkopf vorspannt, um das Stromventil in seiner ersten Position zu plazieren, und daß die Feder durch den Kolbenkopf komprimiert wird, wenn die Oberfläche auf dem Druckkopf das unter Druck stehende Medium aufnimmt.

59. System nach Anspruch 14, dadurch gekennzeichnet, daß der erste Gehäuseabschnitt aus einem Aluminiummaterial hergestellt ist.

60. System nach Anspruch 48, dadurch gekennzeichnet, daß die Druckausweichöffnung in durchgängiger Verbindung mit dem ersten Steuerventil steht.

61. System nach Anspruch 48, dadurch gekennzeichnet, daß zusätzlich ein Rohr an der Druckausweichöffnung befestigt ist und in Verbindung mit dem Kühler steht, um einen Strom von unter Druck stehendem Dampf von dem zweiten Gehäuseabschnitt zu dem Kühler zu leiten.

62. System nach Anspruch 49, dadurch gekennzeichnet, daß das Überdruckventil ein Kugelventil ist.

63. System nach Anspruch 60, dadurch gekennzeichnet, daß zusätzlich ein Überdruckventil an dem ersten Steuerventil befestigt ist und ein Rohr sich zwischen Druckentweichauslaß und dem Überdruckventil erstreckt, das an dem Überdruckventil befestigt ist, wobei das Rohr und das Überdruckventil eine durchgängige Verbindung zwischen dem zweiten Gehäuseabschnitt und dem ersten Steuerventil ermöglichen.

64. System nach Anspruch 15, dadurch gekennzeichnet, daß die Verbindung zwischen der Wasserpumpe und der Ventilkammer durch ein Auslaßrohr bereitgestellt wird, das an einem Ende an der Wasserpumpe und an dem anderen Ende an einem Absperrventilauslaß, der an dem Ventilgehäuse ausgebildet ist und in Verbindung mit der Ventilkammer steht, befestigt ist.

65. System nach Anspruch 15, zusätzlich folgendes aufweisend:

eine Kappe, die an dem Ventilgehäuse befestigt ist und einen in dieser geformten Kanal besitzt, der zum Leiten eines Flüssigkeitsstroms zwischen dem Flüssigkeitsüberlaufbehälter und der Ventilkammer angepaßt ist,

einen verschiebbaren Ball, der innerhalb der Ventilkammer angeordnet ist und für ein Abdichten des Kanals in der Kappe ausgelegt ist, um einen Flüssigkeitsstrom durch diese zu verhindern, wenn das Gehäuse einen Strom von unter Druck stehender Flüssigkeit von der Wasserpumpe aufnimmt, wobei der Ball zusätzlich für ein Abdichten des Absperrventilausgangs angepaßt ist, um einen Strom durch diesen zu verhindern, wenn der Flüssigkeitsüberlaufbehälter einen niedrigen Level von darin enthaltender Flüssigkeit erreicht hat, und

eine Feder, die zwischen dem Ball und der Kappe angeordnet ist, um den Ball entfernt von einem Abdichten des Kanals vorzuspannen.

66. System nach Anspruch 64, dadurch gekennzeichnet, daß das Ventilgehäuse einstückig mit dem Flüssigkeitsüberlaufbehälter geformt ist.

67. System nach Anspruch 64, dadurch gekennzeichnet, daß zusätzlich ein Mittel innerhalb des Ventilgehäuses zur Steuerung der Temperatursteuerflüssigkeit zwischen dem Flüssigkeitsüberlaufbehälter und der Wasserpumpe vorgesehen ist.

68. System nach Anspruch 67, dadurch gekennzeichnet, daß das Mittel zur Steuerung der Temperatursteuerflüssigkeit eine an dem Ventilgehäuse befestigte Kappe einschließt und einen in dieser geformten Kanal besitzt, der zum Leiten eines Flüssigkeitsstroms zwischen dem Flüssigkeitsüberlaufbehälter und der Ventilkammer angepaßt ist.

69. System nach Anspruch 68, dadurch gekennzeichnet, daß das Mittel zur Steuerung des Stroms der Temperatursteuerflüssigkeit zusätzlich einen verschiebbaren Ball einschließt, der innerhalb der Ventilkammer angeordnet ist und zum Abdichten des Kanals in der Kappe angepaßt ist, um einen Flüssigkeitsstrom durch diese zu verhindern, wenn das Ventilgehäuse einen Strom von unter Druck stehender Flüssigkeit von der Wasserpumpe aufnimmt, wobei der Ball zusätzlich dazu ausgebildet ist, den Absperrventilauslaß abzudichten, um einen Fluß durch diesen zu verhindern, wenn der Flüssigkeitsüberlaufbehälter einen niedrigen Level von darin enthaltender Flüssigkeit besitzt.

70. System nach Anspruch 69, dadurch gekennzeichnet, daß das Mittel zur Steuerung des Stroms der Temperatursteuerflüssigkeit zusätzlich eine Vorspanneinrichtung einschließt, die zwischen dem Ball und der Kappe angeordnet ist, um den Ball entfernt von einem Abdichten des Kanals vorzuspannen.

71. System nach Anspruch 17, dadurch gekennzeichnet, daß das Absperrventil folgendes einschließt:

ein Gehäuse,

eine Kammer, die innerhalb des Gehäuses zum Leiten eines Stroms von Temperatursteuerflüssigkeit zwischen einer Kappe und einem Absperrventilauslaß geformt ist, wobei die Kappe in Verbindung mit dem Flüssigkeitsüberlaufbehälter steht und der Absperrventilausgang in Verbindung mit der Wasserpumpe steht.

72. System nach Anspruch 17, dadurch gekennzeichnet, daß die Kappe an dem Gehäuse befestigt ist und einen in dieser geformten Kanal besitzt, der zum Leiten eines Flüssigkeitsstroms zwischen Flüssigkeitsüberlaufbehälter und Kammer vorgesehen ist, wobei das Ventil zusätzlich einen verschiebbaren Ball aufweist, der innerhalb der

Kammer angeordnet ist und zum Abdichten des Kappenkanals angepaßt ist, um das Strömen von Flüssigkeit durch diese zu verhindern, wenn das Gehäuse einen Strom von unter Druck stehender Flüssigkeit von der Wasserpumpe aufnimmt, wobei der Ball weiterhin dafür angepaßt ist, den Absperrventilauslaß abzudichten, um ein Fließen durch diesen zu verhindern, wenn der Flüssigkeitsüberlaufbehälter einen geringen Stand von in diesem enthaltender Flüssigkeit aufweist, und eine Feder zwischen dem Ball und der Kappe angeordnet ist, um den Ball entfernt von einem Abdichten des Kanals vorzuspannen.

73. System nach Anspruch 17, dadurch gekennzeichnet, daß das Absperrventil eine Kammer einschließt und ein Mittel innerhalb der Kammer zur Steuerung des Stroms der Temperatursteuerflüssigkeit zwischen dem Flüssigkeitsüberlaufbehälter und der Wasserpumpe angeordnet ist.

74. System nach Anspruch 17, dadurch gekennzeichnet, daß die Verbindung zwischen der Wasserpumpe und dem Absperrventil durch ein Auslaßrohr vorgesehen ist, dessen eines Ende an der Wasserpumpe befestigt und dessen anderes Ende an dem auf dem Ventil geformten Absperrventilauslaß befestigt ist.

75. System nach Anspruch 17, dadurch gekennzeichnet, daß das Absperrventil einstückig mit dem Flüssigkeitsüberlaufbehälter geformt ist.

76. System nach Anspruch 17, dadurch gekennzeichnet, daß zusätzlich ein Entlüfterrohr zwischen dem Flüssigkeitsüberlaufbehälter und der Wasserpumpe, an welcher es befestigt ist, angeordnet ist, wobei das Entlüfterrohr zum Entlüften von Luft aus der Wasserpumpe heraus angepaßt ist.

77. System nach Anspruch 76, dadurch gekennzeichnet, daß das Entlüfterrohr an der Wasserpumpe in einem Punkt befestigt ist, in dem die Flüssigkeit von Vakuum zu Druck übergeht.

78. System nach Anspruch 1, zusätzlich aufweisend:

einen Einlaßkrümmer zum Einlassen eines Stroms von Einlasserluft in den Motor,

einen Drosselkörper, der ein Drosselventil besitzt, wobei der Drosselkörper innerhalb des Stroms der Einlasserluft angeordnet ist,

einen Wärmetauscher, der an dem Motor befestigt ist und innerhalb des Stroms von Einlasserluft angeordnet ist, wobei der Wärmetauscher zur Aufnahme eines Stroms der aufgeheizten Temperatursteuerflüssigkeit von der Abgaswärmeeinrichtung und zum Ausstoßen des Stroms von Temperatursteuerflüssigkeit in den von dem Wärmetauscher fortführenden Durchgang ausgebildet ist, wobei der Wärmetauscher mindestens ein Wärme austauschendes Element für den Wärmetransport von der Temperatursteuerflüssigkeit hin zu der Einlasserluft einschließt,

einen dritten Sensor zum Fühlen einer aktuellen Umgebungstemperatur und zum Bereitstellen eines Signals, das diese anzeigt, und

ein zweites Steuerventil zur Regulierung des Stroms von Temperatursteuerflüssigkeit hin zu dem Wärmetauscher, wobei das zweite Steuerventil einen geöffneten und einen geschlossenen Zustand besitzt,

wobei der Motorcomputer die Betätigung des zweiten Stromventils basierend auf Signalen von dem ersten, zweiten und dritten Sensoren steuert.

79. System nach Anspruch 78, dadurch gekennzeichnet, daß der Wärmetauscher stromabwärts von dem Drosselkörper befestigt ist.

80. System nach Anspruch 78, dadurch gekennzeichnet, daß der Wärmetauscher innerhalb eines Luftreinigers montiert ist.

81. System nach Anspruch 78, dadurch gekennzeichnet, daß der Wärmetauscher zwischen dem Luftreiniger und dem Drosselkörper befestigt ist.

82. System nach Anspruch 78, dadurch gekennzeichnet, daß das Wärme tauschende Element für den Wärmetransport von der Temperatursteuerflüssigkeit zu der Einlasserluft ein wärmeleitendes Rohr ist.

83. System nach Anspruch 78, dadurch gekennzeichnet, daß die Temperatur, welche die Motoröltemperatur anzeigt, die Temperatur des Öls in der Ölpfanne ist.

84. System nach Anspruch 78, dadurch gekennzeichnet, daß zusätzlich ein vierter Sensor zum Fühlen der Temperatur des Stroms der Einlasserluft stromabwärts von dem Wärmetauscher vorgesehen ist, wobei der vierte Sensor ein Signal bereitstellt, das die Temperatur der Einlasserluft dem Motorcomputer anzeigt, dabei vergleicht der Motorcomputer das Signal mit einem Schwellwert, um einen angestrebten Zustand des Steuerventils zu bestimmen, wobei der Computer Signale für das Steuerventil bereitstellt, um das Steuerventil in seinen gewünschten Zustand zu versetzen.

85. Verfahren zur Steuerung des Stroms von Temperatursteuerflüssigkeit, wobei die Temperatursteuerflüssigkeit dazu dient einen Verbrennungsmotor zu erhitzen und zu kühlen, wobei der Verbrennungsmotor einen Motorblock, einen Zylinderkopf, eine Ölwanne, einen Auspuffkrümmer und ein Stromventil zur Steuerung des Stroms von Temperatursteuerflüssigkeit aufweist, wobei das Verfahren die folgenden Verfahrensschritte beinhaltet:

Fühlen einer Temperatur von einer Temperatursteuerflüssigkeit, Vergleichen der gefühlten Temperatur der Temperatursteuerflüssigkeit mit einem vorbestimmten Wert der Temperatur der Temperatursteuerflüssigkeit,

gekennzeichnet durch

Fühlen einer Temperatur, welche die Temperatur eines Motoröls anzeigt,

Vergleichen der gefühlten Temperatur, welche die Motoröltemperatur anzeigt, mit einem vorbestimmten Wert der Motoröltemperatur,

Betätigen des Stromventils damit Temperatursteuerflüssigkeit zu einer Auspuffkrümmer-Wärmeeinrichtung fließen kann, die an dem Auspuffkrümmer befestigt ist, wenn die gefühlte Temperatur, welche die Motoröltemperatur anzeigt, unterhalb des vorbestimmten Wertes der Motoröltemperatur liegt, und

Betätigen der Stromventile derart, daß der Strom der Temperatursteuerflüssigkeit gehindert wird, zu der Auspuffkrümmer-Wärmeeinrichtung zu fließen, wenn die gefühlte Temperatur der Temperatursteuerflüssigkeit oberhalb des vorbestimmten Wertes für die Temperatursteuerflüssigkeit liegt.

86. Verfahren nach Anspruch 85, dadurch gekennzeichnet, daß zusätzlich folgende Verfahrensschritte vorgesehen sind:

Bestimmen eines Satzes von vorbestimmten Temperatursteuerwerten, die auf einem Vergleich der gefühlten Temperaturen, welche die Motoröltemperatur anzeigen, mit dem vorbestimmten Motoröltemperaturwert basieren, und

Fühlen der Umgebungslufttemperatur,

wobei der Vergleichsschritt der gefühlten Temperatur der Temperatursteuerflüssigkeit ebenfalls ein Vergleichen mit einer gefühlten Umgebungslufttemperatur mit einem Satz von vorbestimmten Temperatursteuerwerten zur Bestimmung einer gewünschten Position des Ventils einschließt.

87. Verfahren nach Anspruch 85, dadurch gekennzeichnet, daß zusätzlich die folgenden Verfahrensschritte vorgesehen sind:

Fühlen einer Umgebungslufttemperatur,

Vergleichen der gefühlten Temperatur, welche die Temperatur des Motoröls anzeigt, und der gefühlten Umgebungslufttemperatur mit einem Satz von vorbestimmten Temperatursteuerwerten zur Bestimmung einer gewünschten Position von einem zweiten Steuerventil, wobei das zweite Steuerventil den Strom der Temperatursteuerflüssigkeit hin zu einem Wärmetauscher, durch welchen die Einlasserluft passiert, steuert, Betätigen des zweiten Steuerventils derart, daß ein Strom von erwärmter Temperatursteuerflüssigkeit hin zu dem Wärmetauscher fließt.

88. Verfahren nach Anspruch 85, dadurch gekennzeichnet, daß der Motor zusätzlich ein Druckerzeugungssystem einschließt, das mindestens einen Einlaßinjektor und mindestens einen Auslaßinjektor, der innerhalb des Gehäuses montiert ist, besitzt, wobei jeder Injektor eine offene Position, um Flüssigkeit durch einen Durchgang fließen zu lassen, und eine geschlossene Position besitzt, um das Fließen der Flüssigkeit entlang dem Durchgang zu verhindern, wobei das Verfahren zusätzlich die folgenden Verfahrensschritte aufweist:

Versorgen eines Flüssigkeitsstroms hin zu dem Injektor von einer Flüssigkeitsquelle aus,

Setzen des Einlaßinjektors in seine offene Position,

Setzen des Auslaßinjektors in seine geschlossene Position,

Füllen einer Kammer innerhalb des Gehäuses mit der bereitgestellten Flüssigkeit,

Steuern eines Solenoiden, um eine Versorgungsleitung zu dem Stromventil zu öffnen, um eine Versorgung von Flüssigkeit von dem Gehäuse hin zu dem Ventil bereitzustellen, wobei die Versorgung von Flüssigkeit zur Betätigung des Stromventils dient, und

Schließen des Einlaßinjektors, nachdem das Stromventil betätigt wurde, um Flüssigkeit innerhalb der Kammer zu sammeln.

89. Verfahren nach Anspruch 85, dadurch gekennzeichnet, daß der Motor zusätzlich ein Solenoid-Druckerzeuungssystem einschließt, das mindestens ein Solenoidventil besitzt, welches in durchgängiger Verbindung mit einem Stromventil steht, wobei das Solenoidventil eine offene Position besitzt, um einen Flüssigkeitsstrom entlang der Versorgungsleitung zu ermöglichen, und eine geschlossene Position, um eine Flüssigkeitsstrom entlang der Versorgungsleitung zu verhindern, wobei das Verfahren die folgenden Verfahrensschritte aufweist:

Versorgen eines Flüssigkeitsstroms hin zu dem Solenoidventil aus einer Quelle für unter Druck stehende Flüssigkeit,

Empfangen eines Signals von dem Motorcomputer,

Richten eines Stroms von unter Druck stehender Flüssigkeit entlang der Versorgungsleitung,

Steuern des Solenoiden derart, daß eine Versorgungsleitung hin zu dem Stromventil geöffnet wird,

Lenken eines Stroms von unter Druck stehender Flüssigkeit entlang der Versorgungsleitung, wobei die Versorgung mit Flüssigkeit zur Betätigung des Stromventils dient, und

Schließen des Solenoiden nachdem das Stromventil betätigt wurde.

90. Verfahren nach Anspruch 86, dadurch gekennzeichnet, daß der Verfahrensschritt des Bestimmens eines Satzes von vorbestimmten Temperatursteuerwerten eine Variation eines ursprünglichen Satzes von vorbestimmten Temperatursteuerwerten als eine Funktion des Betrags, um den die gefühlte Temperatur, welche die Temperatur des Motoröls anzeigt, den vorbestimmten Wert der Motoröltemperatur übersteigt, aufweist.

91. Verfahren nach Anspruch 86, dadurch gekennzeichnet, daß der Verfahrensschritt des Bestimmens eines Satzes von vorbestimmten Temperatursteuerwerten die Schritte aufweist, einen ursprünglichen Satz von vorbestimmten Temperatursteuerwerten bereitzustellen, das mindestens einen Temperaturanteil der Temperatursteuerflüssigkeit besitzt, und den Temperaturanteil der Temperatursteuerflüssigkeit als eine Funktion des Betrags, um den die gefühlte Temperatur, welche die Temperatur des Motoröls anzeigt, den vorbestimmten Motoröltemperaturwert übersteigt, anzupassen.

92. Verfahren nach Anspruch 86, dadurch gekennzeichnet, daß der Verfahrensschritt des Bestimmens eines Satzes von Temperatursteuerwerten ein Auswählen eines Satzes von vorbestimmten Temperaturen, welche die Motoröltemperatur anzeigen, basierend auf dem Vergleich der gefühlten Temperaturen, welche die Motoröltemperatur anzeigen, mit den vorbestimmten Motoröltemperaturwerten beinhaltet.

93. Verfahren nach Anspruch 87, dadurch gekennzeichnet, daß zusätzlich der Verfahrensschritt des Leit'ens des Stroms der Temperatursteuerflüssigkeit von dem Wärmetauscher in einen zu der Ölwanne führenden Durchgang umfaßt ist.

94. Verfahren nach Anspruch 87, dadurch gekennzeichnet, daß zusätzlich folgende Verfahrensschritte vorgesehen sind:

Detektieren der Temperatur des Einlasserluftstroms stromabwärts von dem Wärmetauscher,

Vergleichen der detektierten Temperatur des Stroms der Einlasserluft mit einem vorbestimmten Wert zur Bestimmung einer gewünschten Position des zweiten Steuerventils und

Betätigen des zweiten Steuerventils, um das Ventil in die gewünschte Position zur Steuerung des Stroms der Temperatursteuerflüssigkeit hin zu dem Wärmetauscher zu bringen.

95. Verfahren nach Anspruch 85, dadurch gekennzeichnet, daß zusätzlich die Verfahrensschritte vorgesehen sind:

Empfangen eines Umgebungsbedingungssignals,

Variieren des vorbestimmten Motoröltemperaturwertes als eine Funktion des Umgebungsbedingungssignals nachdem die gefühlte Temperatur, welche die Motoröltemperatur anzeigt, einen ursprünglichen Motoröltemperaturschwellwert übersteigt.

96. Verfahren nach Anspruch 85, dadurch gekennzeichnet, daß die Temperatur, welche die Temperatur des Motoröls anzeigt, die Motoröltemperatur ist.

97. Verfahren nach Anspruch 85, dadurch gekennzeichnet, daß der vorbestimmte Wert der Temperatursteuerflüssigkeit als eine Funktion des Vergleichs der gefühlten Temperatur, welche die Motoröltemperatur anzeigt, mit dem vorbestimmten Motoröltemperaturwert variiert.

98. Verfahren nach Anspruch 95, dadurch gekennzeichnet, daß die Temperatur, welche die Temperatur des Motoröls anzeigt, die Motoröltemperatur ist und daß die Umgebungsbedingung die Temperatur der Umgebungslufttemperatur ist.

99. Verfahren nach Anspruch 85, dadurch gekennzeichnet, daß die Temperatur, welche die Temperatur des Motoröls anzeigt, die Temperatur des Motorblocks ist.

100. Verfahren nach Anspruch 99, dadurch gekennzeichnet, daß zusätzlich der Verfahrensschritt des Entlüftens des unter Druck stehenden Dampfs von dem an den Auspuffkrümmer angrenzenden Leiter erfolgt, nachdem die Stromventile in ihrer ersten Position, die eine Fließen entlang dem Leiter verhindert, plaziert ist.

Revendications

1. Système de commande de température pour commander la température d'un moteur à combustion interne, le moteur comprenant un bloc moteur, une culasse, un radiateur, une tubulure d'admission, une tubulure d'échappement pour évacuer les gaz chauffés provenant du moteur, et un carter d'huile, le système comprenant un débit de fluide de commande de température servant à chauffer et à refroidir le moteur à combustion interne, le système comprenant :

un premier capteur de température pour détecter la température du fluide de commande de température ;
un tube d'entrée d'échappement destiné à diriger un débit de fluide de commande de température provenant du moteur ;
un tube de sortie d'échappement destiné à diriger un débit de fluide de commande de température vers le moteur ;

un dispositif de chaleur d'échappement relié au tube d'entrée d'échappement et au tube de sortie d'échappement, ce dispositif étant destiné à canaliser un débit de fluide de commande de température du tube d'entrée d'échappement vers le tube de sortie d'échappement, le dispositif de chaleur d'échappement étant placé au voisinage de la tubulure d'échappement et servant à permettre un transfert de chaleur des gaz chauffés se trouvant dans la tubulure d'échappement, vers le fluide de commande de température se trouvant dans le dispositif de chaleur d'échappement ;

caractérisé par :

un second capteur de température pour détecter une température indiquant la température de l'huile du moteur ;
une première soupape de commande de débit en communication de fluide avec le tube d'entrée d'échappement ; et
un ordinateur de moteur pour commander le débit de fluide de commande de température à travers le dispositif de chaleur d'échappement, en actionnant la première soupape de commande de débit, l'ordinateur de moteur recevant des signaux du premier capteur de température et du second capteur de température, l'ordinateur de moteur actionnant la première soupape de commande de débit pour permettre l'écoulement du fluide de commande de température le long du tube d'échappement d'entrée et vers l'intérieur du dispositif de chaleur d'échappement lorsque la température détectée indiquant la température de l'huile du moteur, est au-dessous d'une première valeur prédéterminée, et l'ordinateur de moteur actionnant la soupape de commande de débit pour empêcher l'écoulement du fluide de commande de température le long du tube d'échappement d'entrée et à travers le dispositif de chaleur d'échappement lorsque la température détectée du fluide de commande de température est au-dessus d'une seconde valeur prédéterminée.

2. Système selon la revendication 1,
dans lequel
le dispositif de chaleur d'échappement comprend un conduit de chauffage muni d'une première extrémité et d'une seconde extrémité, une première pièce d'écartement fixée à la première extrémité du conduit de chauffage, et une seconde pièce d'écartement fixée à la seconde extrémité du conduit de chauffage.

3. Système selon la revendication 1,
dans lequel
le dispositif de chaleur d'échappement comprend en outre une soupape de commande montée sur le tube de sortie pour commander l'écoulement de fluide de commande de température vers le moteur, et pour empêcher l'écoulement de fluide de commande de température dans le dispositif de chaleur d'échappement.

4. Système selon la revendication 1, le moteur comprenant une pompe à eau pour faire circuler un fluide de commande de température,
dans lequel
le tube d'entrée d'échappement reçoit un débit de fluide de commande de température provenant de la pompe à eau.

5. Système selon la revendication 1, le moteur comprenant un carter d'huile,
dans lequel
le tube de sortie d'échappement dirige un débit de fluide de commande de température vers le carter d'huile.

6. Système selon la revendication 1, le moteur comprenant une tubulure d'admission,
dans lequel
le tube de sortie d'échappement dirige un débit de fluide de commande de température vers la tubulure d'admission.

7. Système selon la revendication 1, le moteur comprenant un dispositif de chauffage du compartiment des passagers,
dans lequel
le tube de sortie d'échappement dirige un débit de fluide de commande de température vers le dispositif de chauffage du compartiment des passagers.

8. Système selon la revendication 1,
comprenant en outre une pompe à eau destinée à diriger un fluide de commande de température dans le moteur,

la pompe à eau comprenant :

- un carter,
- un circulateur monté en rotation dans le carter, le circulateur étant destiné à faire circuler le débit de fluide de commande de température, et
- au moins un canal d'écoulement pour diriger le débit de fluide de commande de température dans le bloc moteur ;

dans lequel

la soupape de commande de débit est destinée à commander le débit de fluide de commande de température le long du canal d'écoulement, la soupape de commande de débit étant montée sur le carter de pompe à eau et pouvant être actionnée entre une première position et une seconde position, cette soupape de commande de débit permettant l'écoulement du fluide de commande de température le long du canal d'écoulement lorsqu'elle se trouve dans sa première position, et limitant l'écoulement du fluide de commande de température le long du canal d'écoulement lorsqu'elle se trouve dans sa seconde position ; et
le tube d'entrée d'échappement est destiné à diriger un débit de fluide de commande de température à partir du moteur lorsque la soupape de commande de débit se trouve dans sa seconde position.

9. Système selon la revendication 1,
comprenant en outre un système d'injection à solénoïde pour commander l'actionnement de la soupape de commande de débit, le système d'injection à solénoïde comprenant :

- un carter comportant une chambre formée dans celui-ci ;
- une conduite d'entrée reliée au carter et destinée à fournir un débit de fluide dans le carter ;
- une conduite de sortie reliée au carter et destinée à canaliser un débit de fluide hors du carter ;
- un injecteur d'entrée relié au carter et en communication avec la chambre et avec la conduite d'entrée, l'injecteur d'entrée comportant une position d'ouverture destinée à canaliser un débit de fluide sous pression de la conduite d'entrée vers l'intérieur de la chambre, et une position de fermeture destinée à empêcher un écoulement de fluide sous pression de la conduite d'entrée vers l'intérieur de la chambre ;
- un premier solénoïde relié à l'injecteur d'entrée et servant à actionner l'injecteur d'entrée entre sa position d'ouverture et sa position de fermeture, le premier solénoïde étant destiné à recevoir un signal provenant de l'ordinateur de moteur pour commander l'actionnement de l'injecteur d'entrée ;
- un injecteur de sortie relié au carter et en communication avec la chambre et la conduite de sortie, l'injecteur de sortie comportant une position d'ouverture destinée à canaliser un écoulement de fluide hors de la chambre et vers l'intérieur de la conduite de sortie, ainsi qu'une position de fermeture destinée à empêcher un écoulement de fluide hors de la chambre et dans la conduite de sortie ;
- un second solénoïde relié à l'injecteur de sortie, servant à actionner l'injecteur de sortie entre sa position d'ouverture et sa position de fermeture, le second solénoïde étant destiné à recevoir un signal provenant d'un ordinateur de moteur, pour commander l'actionnement de l'injecteur de sortie ; et
- un troisième solénoïde relié au carter et en communication de fluide avec la chambre, le troisième solénoïde comportant une conduite d'alimentation de fluide reliée à celui-ci, la conduite d'alimentation étant destinée à canaliser un débit de fluide sous pression vers la soupape de commande de débit, pour commander l'actionnement de la soupape, le troisième solénoïde comportant une position d'ouverture pour permettre l'écoulement de fluide sous pression le long de la conduite d'alimentation, et une position de fermeture pour empêcher l'écoulement de fluide le long de la conduite d'alimentation,

dans lequel
le troisième solénoïde est destiné à recevoir des signaux d'un ordinateur de moteur, pour commander le débit de fluide sous pression le long de la conduite d'alimentation.

10. Système selon la revendication 1,
comprenant en outre un système d'injection à solénoïde pour commander l'actionnement de la soupape de commande de débit, le système d'injection à solénoïde comprenant :

- un carter muni d'une chambre formée dans celui-ci ;
- des moyens d'entrée en communication avec le carter pour canaliser un écoulement de fluide dans la chambre ;

- des moyens de sortie en communication avec le carter pour canaliser un écoulement de fluide hors de la chambre ; et
- un solénoïde relié au carter et positionné à l'intérieur de la chambre, ce solénoïde comportant au moins une sortie de fluide destinée à diriger un débit de fluide sous pression vers la soupape de commande de débit, pour commander l'actionnement de la soupape, le solénoïde comportant une position d'ouverture pour permettre l'écoulement de fluide sous pression hors de la sortie de fluide, et une position de fermeture pour empêcher l'écoulement de fluide hors de la sortie de fluide, le solénoïde étant destiné à recevoir des signaux provenant de l'ordinateur de moteur, pour commander le solénoïde entre sa position d'ouverture et sa position de fermeture.

11. Système selon la revendication 1,
comprenant en outre un système de pressurisation pour commander l'actionnement de la soupape de commande de débit, le système de pressurisation comprenant :

- un carter muni d'une chambre formée dans celui-ci ;
- un injecteur d'entrée en communication avec le carter pour canaliser un écoulement de fluide sous pression vers l'intérieur de la chambre ;
- un injecteur de sortie en communication avec le carter pour canaliser un écoulement de fluide sous pression hors de la chambre ; et
- des moyens de commande de débit de fluide reliés au carter et comportant au moins une sortie de fluide destinée à diriger un débit de fluide sous pression vers la soupape de commande de débit, pour commander l'actionnement de celle-ci, les moyens de commande de débit de fluide comportant une position d'ouverture pour permettre un écoulement de fluide sous pression hors de la sortie de fluide, et une position de fermeture pour empêcher l'écoulement de fluide hors de la sortie de fluide, les moyens de commande de débit de fluide étant destinés à recevoir des signaux provenant de l'ordinateur de moteur, pour commander l'actionnement des moyens de commande de débit de fluide entre leur position d'ouverture et leur position de fermeture.

12. Système selon la revendication 1,
comprenant en outre un système d'injection à pour commander l'actionnement de la soupape de commande de débit, le système comprenant :

- un carter muni d'une chambre formée dans celui-ci,
- une conduite d'entrée reliée au carter et destinée à fournir un débit de fluide dans le carter ;
- une conduit de sortie reliée au carter et destinée à canaliser un débit de fluide hors du carter ;
- un injecteur d'entrée relié au carter et en communication avec la chambre et la conduite d'entrée, l'injecteur d'entrée comportant une position d'ouverture destinée à canaliser un écoulement de fluide sous pression de la conduite d'entrée vers l'intérieur de la chambre, et une position de fermeture destinée à empêcher un écoulement de fluide sous pression de la conduite d'entrée vers l'intérieur de la chambre ;
- un premier solénoïde relié à l'injecteur d'entrée, servant à actionner l'injecteur d'entrée entre sa position d'ouverture et sa position de fermeture, le premier solénoïde étant destiné à recevoir un signal provenant de l'ordinateur de moteur, pour commander l'actionnement de l'injecteur d'entrée ;
- un injecteur de sortie relié au carter et en communication avec la chambre et la conduite de sortie, l'injecteur de sortie comportant une position d'ouverture destinée à canaliser un écoulement de fluide hors de la chambre et vers l'intérieur de la conduite de sortie, ainsi qu'une position de fermeture destinée à empêcher un écoulement de fluide hors de la chambre et vers l'intérieur de la conduite de sortie ;
- un second solénoïde relié à l'injecteur de sortie, servant à actionner l'injecteur de sortie entre sa position d'ouverture et sa position de fermeture, le second solénoïde étant destiné à recevoir un signal provenant de l'ordinateur de moteur, pour commander l'actionnement de l'injecteur de sortie ; et
- un troisième solénoïde relié au carter et en communication de fluide avec la chambre, le troisième solénoïde comportant au moins une conduite d'alimentation reliée à celui-ci, la conduite d'alimentation étant destinée à canaliser un écoulement de fluide sous pression vers la soupape de commande de débit, pour commander l'actionnement de la soupape, le troisième solénoïde comportant une position d'ouverture pour permettre l'écoulement de fluide sous pression le long de la conduite d'alimentation, et une position de fermeture pour empêcher l'écoulement de fluide le long de la conduite d'alimentation, le troisième solénoïde étant destiné à recevoir des signaux provenant de l'ordinateur de moteur, pour commander l'écoulement de fluide sous pression le long de la conduite d'alimentation.

13. Système selon la revendication 1, comprenant en outre un système de pressurisation pour commander l'actionnement de la soupape de commande de débit, le système de pressurisation comprenant :

- un carter muni d'une chambre formée dans celui-ci ;
- une conduite d'entrée fixée au carter et destinée à canaliser un débit de fluide sous pression vers l'intérieur de la chambre ;
- une conduite de sortie fixée au carter pour canaliser un écoulement de fluide hors de la chambre ; et
- un solénoïde relié au carter et positionné à l'intérieur de la chambre, le solénoïde comportant au moins une sortie de fluide destinée à diriger un écoulement de fluide sous pression vers au moins la première soupape de commande de débit, pour commander l'actionnement de la soupape, le solénoïde comportant une position d'ouverture pour permettre un écoulement de fluide sous pression hors de la sortie de fluide et une position de fermeture pour empêcher l'écoulement de fluide hors de la sortie de fluide, le solénoïde étant destiné à recevoir des signaux provenant de l'ordinateur de moteur, pour commander le solénoïde entre sa position d'ouverture et sa position de fermeture.

14. Système selon la revendication 1,
dans lequel
la soupape de commande de débit comprend :

- une première partie de carter et une seconde partie de carter reliées l'une à l'autre, la première partie de carter comportant une ouverture en communication de fluide avec le moteur, la seconde partie de carter comportant au moins une sortie de soupape destinée à permettre la communication de fluide avec le dispositif de chaleur d'échappement, et la seconde partie de carter étant réalisée dans un matériau pour haute température qui minimise la conduction de chaleur ;
- un passage formé entre le premier carter et le second carter pour permettre la communication du fluide de commande de température entre les deux parties de carter ; et
- un piston monté en glissement dans les parties de carter, le piston comportant une partie de joint d'étanchéité et une partie de réception de pression, la partie de joint d'étanchéité scellant le passage entre la première partie de carter et la seconde partie de carter, la partie de réception de pression étant placée dans une chambre à l'intérieur de la première partie de carter, et comportant une surface destinée à recevoir un fluide sous pression, le fluide sous pression étant destiné à faire glisser le piston à l'intérieur de la soupape.

15. Système selon la revendication 1,
comprenant en outre :
un clapet de retenue pour commander le débit de fluide de commande de température entre un réservoir de trop-plein de fluide de radiateur et une pompe à eau, dans le moteur à combustion interne, le clapet de retenue comprenant :
un carter en communication avec le réservoir de trop-plein de fluide et destiné à recevoir de celui-ci un débit de fluide de commande de température, le carter comportant une chambre de soupape formée dans celui-ci pour canaliser un débit de fluide de commande de température, le carter étant également en communication avec la pompe à eau et servant à canaliser un débit de fluide de commande de température entre la chambre de soupape et la pompe à eau.

16. Système selon la revendication 1,
comprenant en outre un clapet de retenue pour commander le débit de fluide de commande de température entre un réservoir de trop-plein de fluide de radiateur et une pompe à eau, le clapet de retenue comprenant :
un carter en communication avec le réservoir de trop-plein de fluide et destiné à recevoir de celui-ci un fluide de commande de température, le carter comportant une chambre formée dans celui-ci pour canaliser un débit de fluide de commande de température, le carter étant également en communication avec la pompe à eau et servant à canaliser un débit de fluide de commande de température entre la chambre et la pompe à eau, ainsi que des moyens pour commander le débit de fluide de commande de température à travers le carter, les moyens de commande de débit comportant une première position destinée à permettre l'écoulement de fluide vers la pompe à eau, et une seconde position destinée à empêcher l'écoulement d'air fluide du réservoir de trop-plein de fluide vers la pompe à eau.

17. Système selon la revendication 1,
comprenant en outre :

- un réservoir de trop-plein de fluide ;
- une pompe à eau ; et
- un clapet de retenue en communication avec le réservoir de trop-plein de fluide et avec la pompe à eau, ce clapet de retenue étant destiné à commander le débit de fluide de commande de température entre le réservoir de trop-plein de fluide et la pompe à eau.

18. Système selon la revendication 2, dans lequel

le conduit de chauffage est réalisé dans un matériau permettant un transfert de chaleur, et
la première pièce d'écartement et la seconde pièce d'écartement sont réalisées dans un matériau qui limite le transfert de chaleur.

19. Système selon la revendication 18, dans lequel
la première pièce d'écartement et la seconde pièce d'écartement sont réalisées dans un matériau de céramique.

20. Système selon la revendication 18, dans lequel
le conduit de chauffage est réalisé en acier inoxydable.

21. Système selon la revendication 18, dans lequel
le conduit de chauffage s'étend au-delà de la tubulure d'échappement sur une distance prédéterminée, pour permettre à la chaleur de se dissiper du conduit de chauffage.

22. Système selon la revendication 8, dans lequel
le tube de sortie d'échappement est destiné à diriger un débit de fluide de commande de température vers la tubulure d'admission du moteur.

23. Système selon la revendication 8, dans lequel
le tube de sortie d'échappement est destiné à diriger un débit de fluide de commande de température vers le carter d'huile du moteur.

24. Système selon la revendication 8, dans lequel
la soupape de commande de débit est montée dans la pompe à eau, le système comprenant en outre

une seconde soupape de commande de débit montée dans la pompe à eau, et
l'une des soupapes de commande de débit comprend un passage de dérivation destiné à canaliser un débit de fluide de commande de température hors de la pompe à eau lorsque la soupape de commande de débit se trouve dans sa seconde position.

25. Système selon la revendication 8, comprenant en outre
un injecteur hydraulique à solénoïde en communication de fluide avec les soupapes de commande de débit, et destiné à fournir un débit de fluide sous pression à une soupape de commande de débit, le système d'injecteur hydraulique à solénoïde recevant des signaux de l'ordinateur de moteur pour commander la distribution d'un fluide sous pression à la soupape de commande de débit, le fluide sous pression commandant l'actionnement de la soupape de commande de débit.

26. Système selon la revendication 8, dans lequel
la pompe à eau comprend en outre au moins un tube relié à la culasse pour diriger un débit de fluide de commande de température vers la culasse lorsque la soupape de commande de débit se trouve dans sa seconde position.

27. Système selon la revendication 8,
comprenant en outre un échangeur de chaleur placé à l'intérieur du carter d'huile pour canaliser un débit de fluide de commande de température,
dans lequel
la pompe à eau est destinée à recevoir un débit de fluide de commande de température provenant de l'échangeur de chaleur se trouvant dans le carter d'huile, lorsque la soupape de commande de débit est dans son état de fermeture.

28. Système selon la revendication 8,
dans lequel

le dispositif de chaleur d'échappement est relié, par un tube de retour d'échappement, à un échangeur de chaleur placé à l'intérieur du carter d'huile du moteur, et
le fluide de commande de température s'écoule du dispositif de chaleur d'échappement vers l'échangeur de chaleur, en passant par le tube de retour d'échappement.

29. Système selon la revendication 8,
dans lequel

le moteur comprend en outre une tubulure d'admission pour diriger le débit d'air d'admission, le système comprenant en outre au moins un canal placé à l'intérieur de la tubulure d'admission et destiné à recevoir un débit de fluide de commande de température pour chauffer l'air d'admission, et
la soupape de commande de débit empêche une partie au moins du fluide de commande de température de s'écouler à travers le canal de tubulure d'admission lorsque la soupape de commande de débit est dans son état de fermeture.

30. Système selon la revendication 23,
le moteur comprenant un dispositif de chauffage du compartiment des passagers,
dans lequel
le tube de sortie d'échappement est destiné à diriger un débit de fluide de commande de température vers le dispositif de chauffage.

31. Système selon la revendication 24,
dans lequel
le passage de dérivation canalise un débit de fluide de commande de température de la pompe à eau vers la culasse lorsque la soupape de commande de débit est dans sa seconde position.

32. Système selon la revendication 9,
dans lequel

l'injecteur d'entrée est placé à l'intérieur d'un compartiment d'entrée formé dans le carter, le compartiment d'entrée étant en communication de fluide avec la conduite d'entrée, l'injecteur d'entrée étant destiné à diriger un débit de fluide de commande de température du compartiment d'entrée vers l'intérieur de la chambre, et
l'injecteur de sortie est placé à l'intérieur d'un compartiment de sortie formé dans le carter, le compartiment de sortie étant en communication de fluide avec la conduite de sortie, l'injecteur de sortie étant destiné à diriger un débit de fluide de commande de température hors de la chambre et vers l'intérieur du compartiment de sortie.

33. Système selon la revendication 9,
dans lequel
on utilise un certain nombre de conduites d'alimentation, l'une des conduites d'alimentation étant destinée à diriger un débit de fluide sous pression vers une soupape de commande électronique de température de moteur qui commande le débit de fluide de commande de température entre un moteur et un radiateur, le débit de fluide sous pression étant destiné à produire l'actionnement de la soupape, une seconde conduite d'alimentation étant destinée à diriger un débit de fluide sous pression vers la première soupape de commande de débit, et une troisième conduite d'alimentation étant destinée à diriger un débit de fluide sous pression vers au moins une seconde soupape de commande de débit positionnée à une autre extrémité du dispositif de chaleur d'échappement, la seconde soupape de commande de débit étant destinée à commander le débit de fluide de commande de température

sortant du dispositif de chaleur d'échappement.

34. Système selon la revendication 33, dans lequel

le carter comporte un plan central, et
les compartiments d'entrée et de sortie sont placés de chaque côté du plan central et forment un angle avec ce plan central.

35. Système selon la revendication 10, comprenant en outre :

une entrée formée dans le carter pour diriger un débit de fluide vers l'intérieur du carter et vers les moyens d'entrée ; et
une sortie formée dans le carter pour diriger un débit de fluide hors du carter et des moyens de sortie.

36. Système selon la revendication 10, dans lequel

les moyens d'entrée comprennent un injecteur pour injecter un débit de fluide dans la chambre, et
les moyens de sortie comprennent un injecteur pour injecter un débit de fluide hors de la chambre.

37. Système selon la revendication 9, 10, 11, 12 ou 13, dans lequel le fluide est un fluide hydraulique.

38. Système selon la revendication 10, 11, 12 ou 13, dans lequel la sortie de fluide est destinée à diriger un débit de fluide sous pression vers une soupape de commande électronique de température de moteur qui commande le débit de fluide de commande de température entre un moteur et un radiateur, le débit de fluide sous pression étant destiné à produire l'actionnement de la soupape.

39. Système selon la revendication 11, dans lequel les moyens de commande de débit de fluide consistent en une soupape de commande de débit.

40. Système selon la revendication 39, dans lequel la soupape de commande de débit est une soupape à solénoïde.

41. Système de commande de température selon la revendication 1, comprenant en outre :

- un troisième capteur pour détecter une condition ambiante et pour fournir un signal de condition ambiante indicatif de celle-ci ; et
- une seconde soupape de commande en communication de fluide avec le tube de sortie d'échappement ;

dans lequel

l'ordinateur de moteur commande l'actionnement de la seconde soupape de commande, et
la première valeur prédéterminée varie en fonction de la condition ambiante, l'ordinateur de moteur déterminant la première valeur prédéterminée sur la base de la condition ambiante détectée.

42. Système selon la revendication 41, dans lequel la température indicative de la température de l'huile du moteur est la température d'huile du moteur.

43. Système selon la revendication 41, comprenant en outre un système de pressurisation pour fournir une source de fluide sous pression à l'une au moins des soupapes de commande de débit, le fluide sous pression actionnant la soupape entre sa première position et sa seconde position, le système de pressurisation recevant le signal provenant de l'ordinateur de moteur, et commandant les soupapes en fonction de ce signal.

44. Système selon la revendication 41,
dans lequel

l'indication de température de l'huile du moteur est la température d'huile moteur, et
la condition ambiante est la température d'air ambiante.

45. Système selon la revendication 41,
dans lequel
la première soupape de commande comprend un élément de soupape actionnable qui est monté en glissement à l'intérieur d'un carter, la soupape comportant une chambre formée entre le carter et une partie de l'élément de soupape, la chambre étant en communication avec un système de pressurisation qui fournit un fluide sous pression dans la chambre pour faire glisser l'élément de soupape à l'intérieur du carter.

46. Système selon la revendication 41,
dans lequel
la seconde soupape de commande de débit comprend :

- une première partie de carter et une seconde partie de carter reliées l'une à l'autre, la première partie de carter comportant une ouverture en communication de fluide avec le moteur, la seconde partie de carter comportant au moins une sortie de soupape en communication de fluide avec le dispositif de chaleur d'échappement, et la seconde partie de carter étant réalisée dans un matériau pour haute température qui minimise la conduction de chaleur ;
- un passage formé entre la première partie de carter et la seconde partie de carter pour permettre la communication de fluide de commande de température entre les deux parties de carter ; et
- un piston monté en glissement à l'intérieur des parties de carter, le piston comportant une partie de joint d'étanchéité et une partie de réception de pression, la partie de joint d'étanchéité scellant le passage entre la première partie de carter et la seconde partie de carter, la partie de réception de pression étant placée dans une chambre à l'intérieur de la première partie de carter, et comportant une surface destinée à recevoir un fluide sous pression, le fluide sous pression étant destiné à faire glisser le piston à l'intérieur de la soupape.

47. Système selon la revendication 46,
dans lequel

la partie de joint d'étanchéité scelle le passage lorsque la soupape se trouve dans sa première position, pour empêcher ainsi le passage de fluide de commande de température entre la première partie de carter et la seconde partie de carter, et
le passage est descellé lorsque la soupape se trouve dans sa seconde position et lorsque la surface de la partie de réception de pression reçoit le fluide sous pression, de manière à permettre un écoulement de fluide de commande de température entre la première partie de carter et la seconde partie de carter.

48. Système selon la revendication 46,
comprenant en outre
un port d'échappement de pression formé à l'intérieur de la seconde partie de carter pour permettre à un débit de fluide de commande de température d'être évacué de la seconde partie de carter.

49. Système selon la revendication 46,
comprenant en outre
des moyens pour vider la vapeur de l'intérieur de la seconde partie de carter.

50. Système selon la revendication 41,
dans lequel
la température indicative de la température de l'huile du moteur, est la température du bloc moteur.

51. Système selon la revendication 42, dans lequel la seconde valeur prédéterminée varie avec la condition ambiante détectée.

52. Système selon la revendication 43, dans lequel le système de pressurisation commande la première soupape de commande de débit et la seconde soupape de commande de débit.

53. Système selon la revendication 52, dans lequel le système de pressurisation fournit du fluide hydraulique sous pression dans une chambre formée à l'intérieur de la soupape de commande de débit, le fluide hydraulique sous pression produisant le mouvement d'un piston à l'intérieur de la soupape, entre la première position et la seconde position de la soupape.

54. Système selon la revendication 52, dans lequel le fluide hydraulique sous pression est fourni par le.côté haute pression d'une pompe à huile associée au moteur.

55. Système selon la revendication 14, dans lequel

la partie de joint d'étanchéité scelle le passage lorsque la soupape se trouve dans sa première position, pour empêcher ainsi le passage de fluide de commande de température entre la première partie de carter et la seconde partie de carter, et

le passage est descellé lorsque la soupape se trouve dans sa seconde position et lorsque la surface de la partie de réception de pression reçoit le fluide sous pression, de manière à permettre un débit de fluide de commande de température entre la première partie de carter et la seconde partie de carter.

56. Système selon la revendication 14, comprenant en outre un port d'échappement de pression formé à l'intérieur de la seconde partie de carter pour permettre à un débit de fluide de commande de température d'être évacué de la seconde partie de carter.

57. Système selon la revendication 14, dans lequel la seconde partie de carter est réalisée dans un matériau de céramique.

58. Système selon la revendication 14, dans lequel

la partie de réception de pression est une tête de pression qui va et vient à l'intérieur de la chambre, le piston comprenant en outre un ressort disposé entre la tête de pression et la première partie de carter pour pousser la tête de pression de manière à placer la soupape de commande de débit dans sa première position, et

le ressort est comprimé par la tête de piston lorsque la surface formée sur la tête de pression reçoit le fluide sous pression.

59. Système selon la revendication 14, dans lequel la première partie de carter est réalisée dans un matériau d'aluminium.

60. Système selon la revendication 48, dans lequel le port d'échappement de pression est en communication de fluide avec la première soupape de commande.

61. Système selon la revendication 48, comprenant en outre un tube fixé au port d'échappement de pression et en communication avec le radiateur, pour canaliser un débit de vapeur sous pression de la seconde partie de carter vers le radiateur.

62. Système selon la revendication 49, dans lequel la soupape de sûreté de pression est un clapet de retenue à bille.

63. Système selon la revendication 60, comprenant en outre

une soupape de sûreté de pression attachée à la première soupape de commande, et
un tube s'étendant et se fixant entre la soupape de sûreté de pression et le port d'échappement de pression, le tube et la soupape de sûreté de pression permettant une communication de fluide entre la seconde partie de carter et la première soupape de commande.

64. Système selon la revendication 15, dans lequel a communication entre la pompe à eau et la chambre de soupape est assurée par un tube de sortie comportant une extrémité fixée à la pompe à eau et une autre extrémité fixée à une sortie de clapet de retenue formée sur le carter de soupape et communiquant avec la chambre de soupape.

65. Système selon la revendication 15, comprenant en outre :

- un capot fixé au carter de soupape et dans lequel est formé un canal destiné à conduire un débit de fluide entre le réservoir de trop-plein de fluide et la chambre de soupape ;
- une bille montée en glissement à l'intérieur de la chambre de soupape est destinée à sceller le canal dans le capot pour empêcher un débit de fluide à travers celui-ci lorsque le carter reçoit un débit de fluide sous pression provenant de la pompe à eau, la bille étant en outre destinée à sceller la sortie du clapet de retenue pour empêcher un débit à travers celui-ci lorsque le récipient de trop-plein de fluide contient un niveau de fluide bas ; et
- un ressort disposé entre la bille et le capot pour pousser la bille de manière à l'écarter de sa position scellant le canal.

66. Système selon la revendication 64, dans lequel le carter de soupape est formé d'une seule pièce avec le réservoir de trop-plein de fluide.

67. Système selon la revendication 64, comprenant en outre des moyens disposés à l'intérieur du carter de soupape pour commander un débit de fluide de commande de température entre le réservoir de trop-plein de fluide et la pompe à eau.

68. Système selon la revendication 67, dans lequel les moyens servant à commander le débit de fluide de commande de température comprennent un capot fixé au carter de soupape et dans lequel est formé un canal destiné à conduire un débit de fluide entre le réservoir de trop-plein de fluide et la chambre de soupape.

69. Système selon la revendication 68, dans lequel les moyens servant à commander le débit de fluide de commande de température comprennent en outre une bille montée en glissement à l'intérieur de la chambre de soupape et destinée à sceller le canal formé dans le capot, pour empêcher un débit de fluide à travers celui-ci lorsque le carter de soupape reçoit un débit de fluide sous pression provenant de la pompe à eau, la bille étant en outre destinée à sceller la sortie du clapet de retenue pour empêcher un débit à travers celui-ci lorsque le réservoir de trop-plein de fluide contient un niveau de fluide bas.

70. Système selon la revendication 69, dans lequel les moyens pour commander le débit de fluide de commande de température comprennent en outre un moyen de poussée disposé entre la bille et le capot pour pousser la bille de manière à l'écarter de sa position de fermeture étanche du canal.

71. Système selon la revendication 17,
dans lequel
le clapet de retenue comprend :

un carter ; et
une chambre formée à l'intérieur du carter pour conduire un débit de fluide de commande de température entre un capot et une sortie de clapet de retenue, le capot étant en communication avec le réservoir de trop-plein de fluide, et la sortie du clapet de retenue étant en communication avec la pompe à eau.

72. Système selon la revendication 17,
dans lequel
le capot est fixé au carter et comporte un canal formé dans celui-ci et destiné à conduire un débit de fluide entre le réservoir de trop-plein de fluide et la chambre ; le clapet comprenant en outre une bille montée en glissement à l'intérieur de la chambre et destinée à fermer de manière étanche le canal du capot pour empêcher un débit de fluide à travers celui-ci lorsque le carter reçoit un débit de fluide sous pression provenant de la pompe à eau, la bille étant en outre destinée à fermer de manière étanche la sortie du clapet de retenue pour empêcher un débit à travers celui-ci lorsque le réservoir de trop-plein de fluide contient un niveau de fluide bas ; et un ressort étant disposé entre la bille et le capot pour pousser la bille de manière à l'écarter de sa position de fermeture étanche du canal du capot.

73. Système selon la revendication 17,
dans lequel
le clapet de retenue comprend une chambre et un moyen disposé à l'intérieur de la chambre pour commander le débit de fluide de commande de température entre le réservoir de trop-plein de fluide et la pompe à eau.

74. Système selon la revendication 17,
dans lequel
la communication entre la pompe à eau et le clapet de retenue est assurée par un tube de sortie qui comporte une extrémité fixée à la pompe à eau et une autre extrémité fixée à une sortie de clapet de retenue formée sur le clapet.

75. Système selon la revendication 17,
dans lequel
le clapet de retenue est formé d'une seule pièce avec le réservoir de trop-plein de fluide.

76. Système selon la revendication 17,
comprenant en outre
un tube de purge d'air disposé entre la pompe à eau et le réservoir de trop-plein de fluide, en étant fixé à ceux-ci, le tube de purge d'air étant destiné à évacuer l'air de l'intérieur de la pompe à eau.

77. Système selon la revendication 76,
dans lequel
le tube de purge d'air est monté sur la pompe à eau en un point où le fluide passe par une transition entre le vide et la pression.

78. Système selon la revendication 1,
comprenant en outre :

- une tubulure d'admission pour admettre un débit d'air d'admission à l'intérieur du moteur ;
- un corps d'étranglement comportant un registre d'air, le corps d'étranglement étant placé à l'intérieur du débit d'air d'admission ;
- un échangeur de chaleur monté sur le moteur et disposé à l'intérieur du débit d'air d'admission, l'échangeur de chaleur étant destiné à recevoir un débit de fluide de commande de température chauffé provenant du dispositif de chaleur d'échappement, et à décharger ce débit de fluide de commande de température dans un

passage arrivant de l'échangeur de chaleur, cet échangeur de chaleur comprenant au moins un élément d'échange de chaleur pour transférer la chaleur du fluide de commande de température à l'air d'admission ;

- un troisième capteur pour détecter une température d'air ambiante réelle et pour fournir un signal indicatif de celle-ci ; et
- une seconde soupape de commande pour réguler le débit de fluide de commande de température vers l'échangeur de chaleur, la seconde soupape de commande ayant un état ouvert et un état fermé ;

dans lequel
l'ordinateur de moteur commande l'actionnement de la seconde soupape de commande de débit sur la base de signaux provenant du premier capteur, du second capteur et du troisième capteur.

79. Système selon la revendication 78,
dans lequel
l'échangeur de chaleur est monté en aval du corps d'étranglement.

80. Système selon la revendication 78,
dans lequel
l'échangeur de chaleur est monté dans l'épurateur d'air.

81. Système selon la revendication 78,
dans lequel
l'échangeur de chaleur est monté entre l'épurateur d'air et le corps d'étranglement.

82. Système selon la revendication 78,
dans lequel
l'élément d'échange de chaleur pour transférer la chaleur du fluide de commande de température vers l'air d'admission, est un tube conducteur de chaleur.

83. Système selon la revendication 78,
dans lequel
la température indicative de la température d'huile du moteur est la température de l'huile se trouvant dans le carter d'huile.

84. Système selon la revendication 78,
comprenant en outre
un quatrième capteur pour détecter la température du débit d'air d'admission en aval de l'échangeur de chaleur, ce quatrième capteur fournissant à l'ordinateur de moteur un signal indiquant la température de l'air d'admission, l'ordinateur de moteur comparant ce signal à une valeur de seuil pour déterminer l'état voulu de la soupape de commande, l'ordinateur de moteur fournissant à la soupape de commande des signaux destinés à placer cette soupape de commande dans l'état voulu.

85. Procédé pour commander le débit de fluide de commande de température, ce fluide de commande de température servant à chauffer et à refroidir un moteur à combustion interne, le moteur à combustion interne comprenant un bloc moteur, une culasse, un carter d'huile, une tubulure d'échappement, et une soupape de commande de débit pour commander le débit de fluide de commande de température, le procédé comprenant les étapes consistant à :

- détecter la température d'un fluide de commande de température ; et
- comparer la température détectée du fluide de commande de température, à une valeur de température prédéterminée du fluide de commande de température ;

caractérisé par :

- la détection d'une température indicative de la température d'huile d'un moteur ;
- la comparaison de la température détectée indicative de la température d'huile du moteur, à une valeur de température d'huile prédéterminée du moteur ;
- l'actionnement de la soupape de commande de débit pour permettre au fluide de commande de température de s'écouler vers un dispositif de chauffage de tubulure d'échappement monté sur la tubulure d'échappement, lorsque la température détectée indicative de la température d'huile du moteur est au-dessous de la valeur

de température d'huile prédéterminée du moteur ; et

- l'actionnement de la soupape de commande de débit pour empêcher l'écoulement de fluide de commande de température vers le dispositif de chauffage de tubulure d'échappement lorsque la température détectée du fluide de commande de température est au-dessus de la valeur de température prédéterminée du fluide de commande de température.

86. Procédé selon la revendication 78,
comprenant en outre les étapes consistant à :

- déterminer un jeu de valeurs de commande de température prédéterminées basées sur la comparaison de la température détectée indicative de la température d'huile du moteur, avec la valeur de température d'huile prédéterminée du moteur ; et
- détecter une température d'air ambiante ;

dans lequel
l'étape de comparaison de la température détectée du fluide de commande de température implique également une comparaison de la température d'air ambiante détectée, à un jeu de valeurs de commande de température prédéterminées, pour déterminer une position voulue de la soupape.

87. Procédé selon la revendication 85,
comprenant en outre les étapes consistant à :

- détecter une température d'air ambiante ;
- comparer la température détectée indicative de la température d'huile du moteur et la température d'air ambiante détectée, à un jeu de valeurs de commande de température prédéterminées, pour déterminer une position voulue d'une seconde soupape de commande, la seconde soupape de commande commandant le débit de fluide de commande de température vers un échangeur de chaleur à travers lequel passe l'air d'admission ; et
- actionner la seconde soupape de commande de manière à permettre l'écoulement de fluide de commande de température chauffé vers l'échangeur de chaleur.

88. Procédé selon la revendication 85, le moteur comprenant en outre un système de pressurisation comportant au moins un injecteur d'entrée et au moins un injecteur de sortie montés à l'intérieur d'un carter, chaque injecteur ayant une position d'ouverture pour permettre un débit de fluide le long d'un passage, et une position de fermeture pour empêcher un débit de fluide le long d'un passage,
procédé comprenant en outre les étapes consistant à :

- fournir à l'injecteur d'entrée un débit de fluide provenant d'une source de fluide ;
- placer l'injecteur d'entrée dans sa position d'ouverture ;
- placer l'injecteur de sortie dans sa position de fermeture ;
- remplir une chambre située à l'intérieur du carter, par le fluide fourni ;
- commander un solénoïde pour ouvrir une conduite d'alimentation vers la soupape de commande de débit, de manière à fournir à la soupape une alimentation de fluide provenant du carter, l'alimentation de fluide servant à actionner la soupape de commande de débit ; et
- fermer l'injecteur de sortie après que la soupape de commande de débit ait été actionnée de manière à piéger le fluide à l'intérieur de la chambre.

89. Procédé selon la revendication 85, le moteur comprenant en outre un système de pressurisation à solénoïde muni d'au moins une soupape à solénoïde ou électrovanne en communication de fluide avec la soupape de commande de débit, l'électrovanne ayant une position d'ouverture pour permettre un débit de fluide le long d'une conduite d'alimentation, et une position de fermeture pour empêcher un débit de fluide le long d'une conduite d'alimentation,
procédé comprenant les étapes consistant à :

- fournir à l'électrovanne un débit de fluide provenant d'une source de fluide sous pression ;
- recevoir un signal provenant de l'ordinateur de moteur ;
- diriger un débit de fluide sous pression le long de la conduite d'alimentation ;
- commander le solénoïde pour ouvrir une conduite d'alimentation vers la soupape de commande de débit ;
- diriger un débit de fluide sous pression le long de la conduite d'alimentation, le fluide d'alimentation servant

à actionner la soupape de commande de débit ; et
- fermer le solénoïde de l'électrovanne après que la soupape de commande de débit ait été actionnée.

90. Procédé selon la revendication 86,
dans lequel
l'étape de détermination d'un jeu de valeurs de commande de température prédéterminées comprend la variation d'un jeu initial de valeurs de commande de température prédéterminées en fonction de la quantité dont la température détectée, indicative de la température d'huile du moteur, dépasse la valeur de température d'huile prédéterminée du moteur.

91. Procédé selon la revendication 86,
dans lequel
l'étape de détermination d'un jeu de valeurs de commande de température prédéterminées comprend les étapes consistant à fournir un jeu initial de valeurs de commande de température prédéterminées ayant au moins une composante de température de fluide de commande de température, et à régler la composante de température de fluide de commande de température en fonction de la quantité dont la température détectée, indicative de la température d'huile du moteur, dépasse la valeur de température d'huile prédéterminée du moteur.

92. Procédé selon la revendication 86,
dans lequel
l'étape de détermination d'un jeu de valeurs de commande de température prédéterminées comprend la sélection d'un jeu initial de valeurs de commande de température prédéterminées sur la base de la comparaison de la température détectée, indicative de la température d'huile du moteur, avec la valeur de température d'huile prédéterminée du moteur.

93. Procédé selon la revendication 87,
comprenant en outre
l'étape de canalisation du débit de fluide de commande de température de l'échangeur de chaleur vers l'intérieur d'un passage conduisant à un carter d'huile.

94. Procédé selon la revendication 87,
comprenant en outre les étapes consistant à :

- détecter la température du débit d'air d'admission en aval de l'échangeur de chaleur ;
- comparer à une valeur prédéterminée la température détectée du débit d'air d'admission, pour déterminer une position voulue de la seconde soupape de commande ; et
- actionner une seconde soupape de commande pour placer la soupape dans la position voulue de manière à commander le débit de fluide de commande de température vers l'échangeur de chaleur.

95. Procédé selon la revendication 85,
comprenant en outre les étapes consistant à :

- recevoir un signal de condition ambiante ; et
- faire varier la valeur de température d'huile prédéterminée du moteur en fonction du signal de condition ambiante après que la température détectée, indicative de la valeur de température d'huile du moteur, ait dépassé un seuil de température d'huile initial du moteur.

96. Procédé selon la revendication 85,
dans lequel
la température indicative de la température d'huile du moteur est la température de l'huile du moteur.

97. Procédé selon la revendication 85,
dans lequel
la valeur de fluide de commande de température prédéterminée varie en fonction de la comparaison de la température détectée, indicative de la température d'huile du moteur, avec la valeur de température d'huile prédéterminée du moteur.

98. Procédé selon la revendication 95,

dans lequel
la température indicative de la température d'huile du moteur est la température de l'huile du moteur, et la condition ambiante est la température d'air ambiante.

99. Procédé selon la revendication 85,
dans lequel
la température indicative de la température d'huile du moteur est la température du bloc moteur.

100. Procédé selon la revendication 99,
comprenant en outre
l'étape d'évacuation de la vapeur sous pression provenant du conduit adjacent à la tubulure d'échappement, après que les soupapes de commande de débit aient été placées dans leur première position empêchant un débit le long du conduit.

FIG. 2

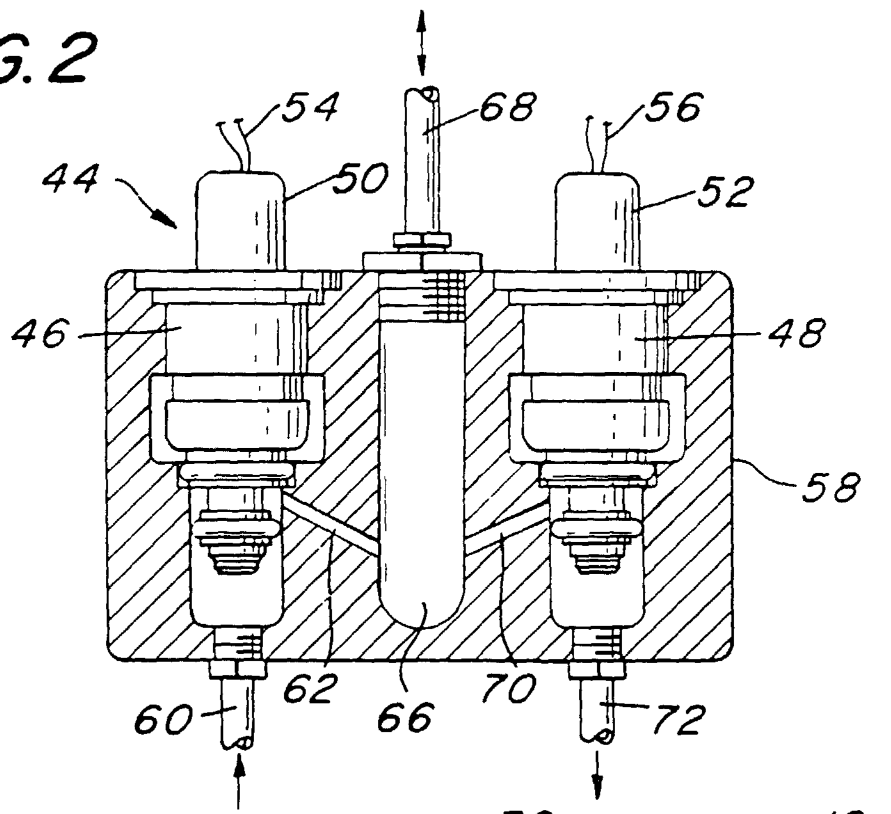
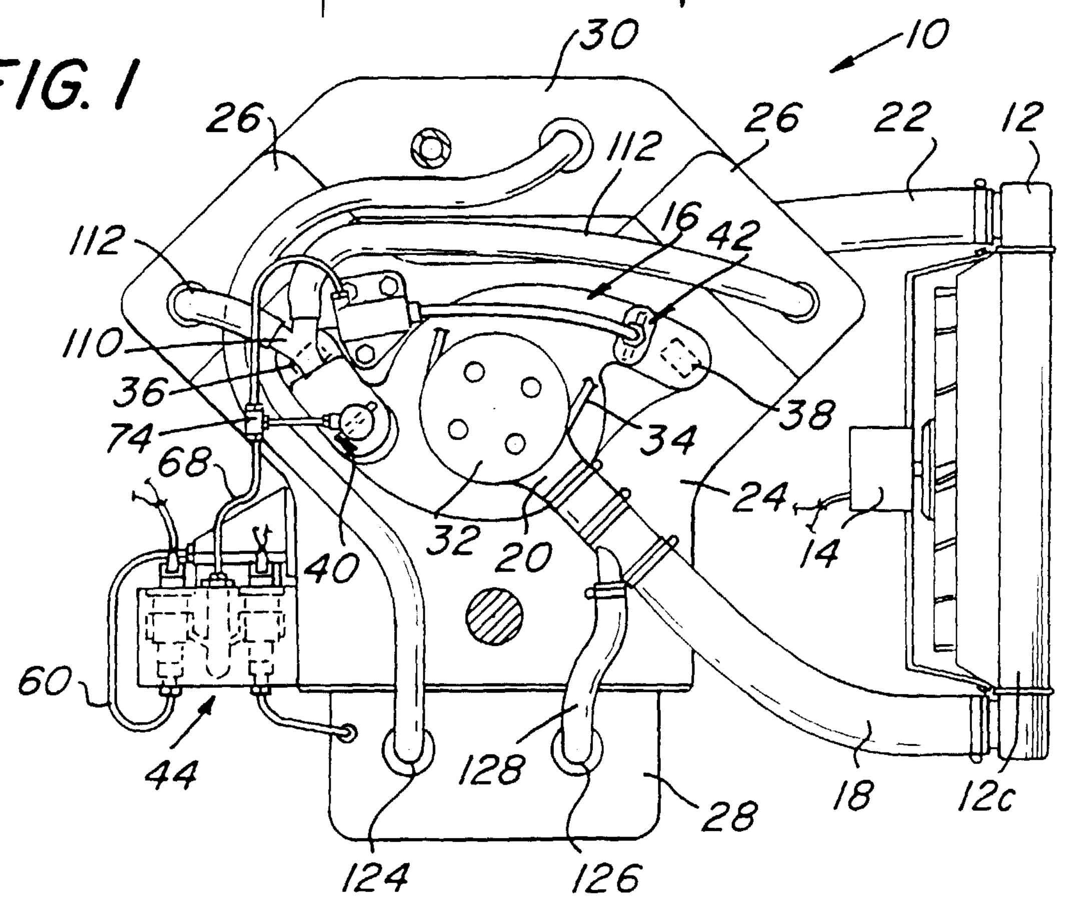

54
68
56
44
50
52
46
48
58
62
66
70
60
72

FIG. 1


30
10
26
26
22
12
112
112
16
42
110
36
38
74
34
68
24
40
32
20
14
60
44
128
18
12c
28
124
126

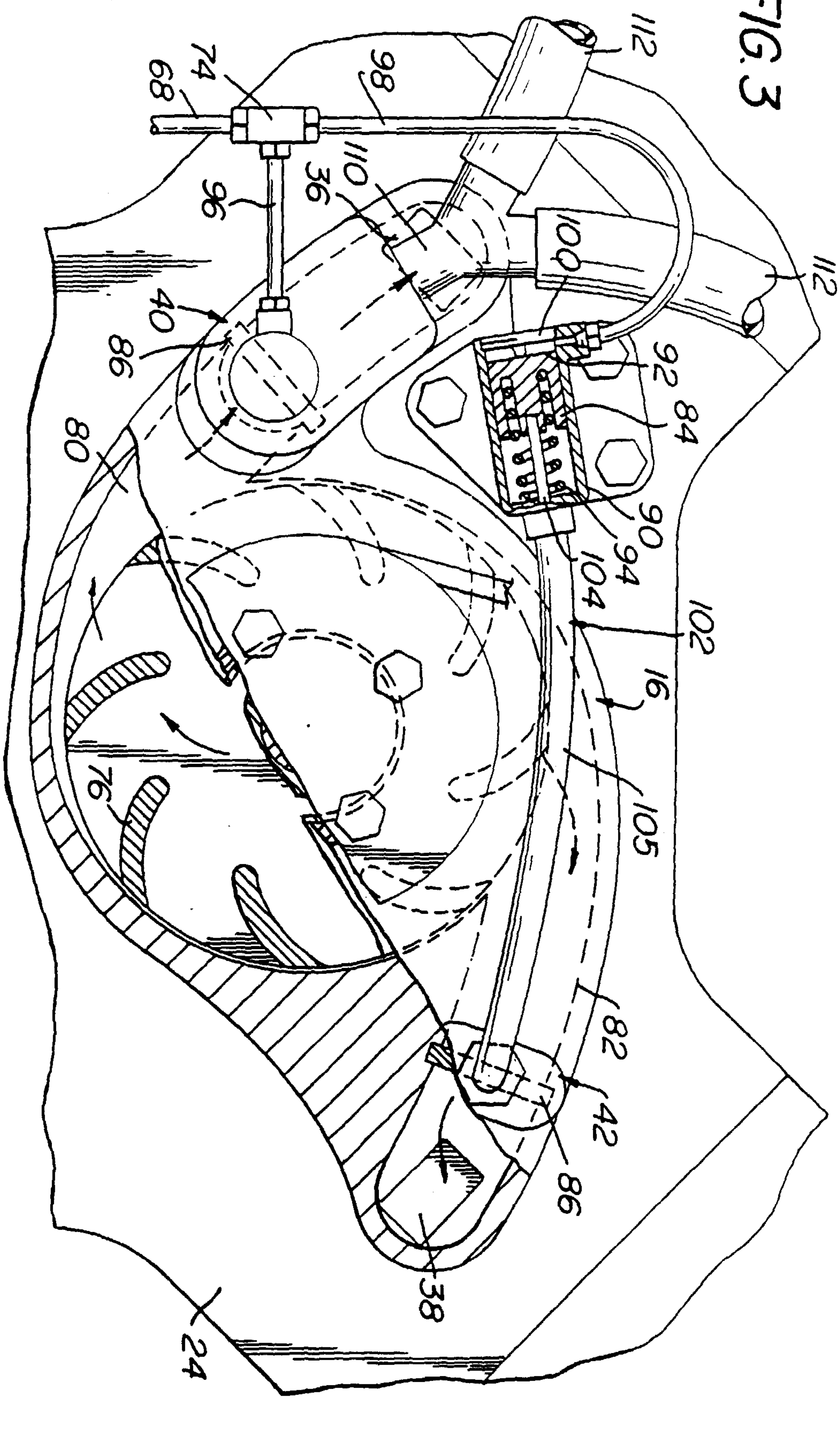

112
98
74
68
110
36
96
100
112
40
86
92
84
80
90
94
104
102
16
76
105
82
42
86
38
24

FIG. 3

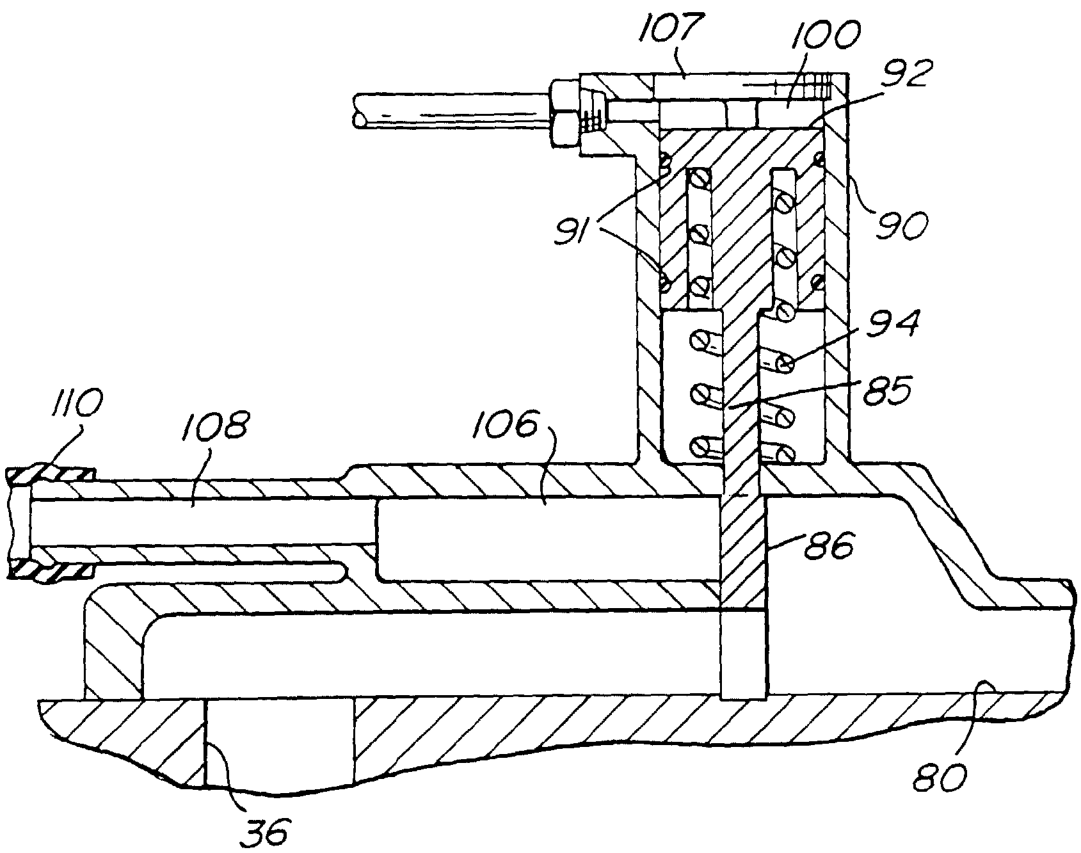


FIG.4

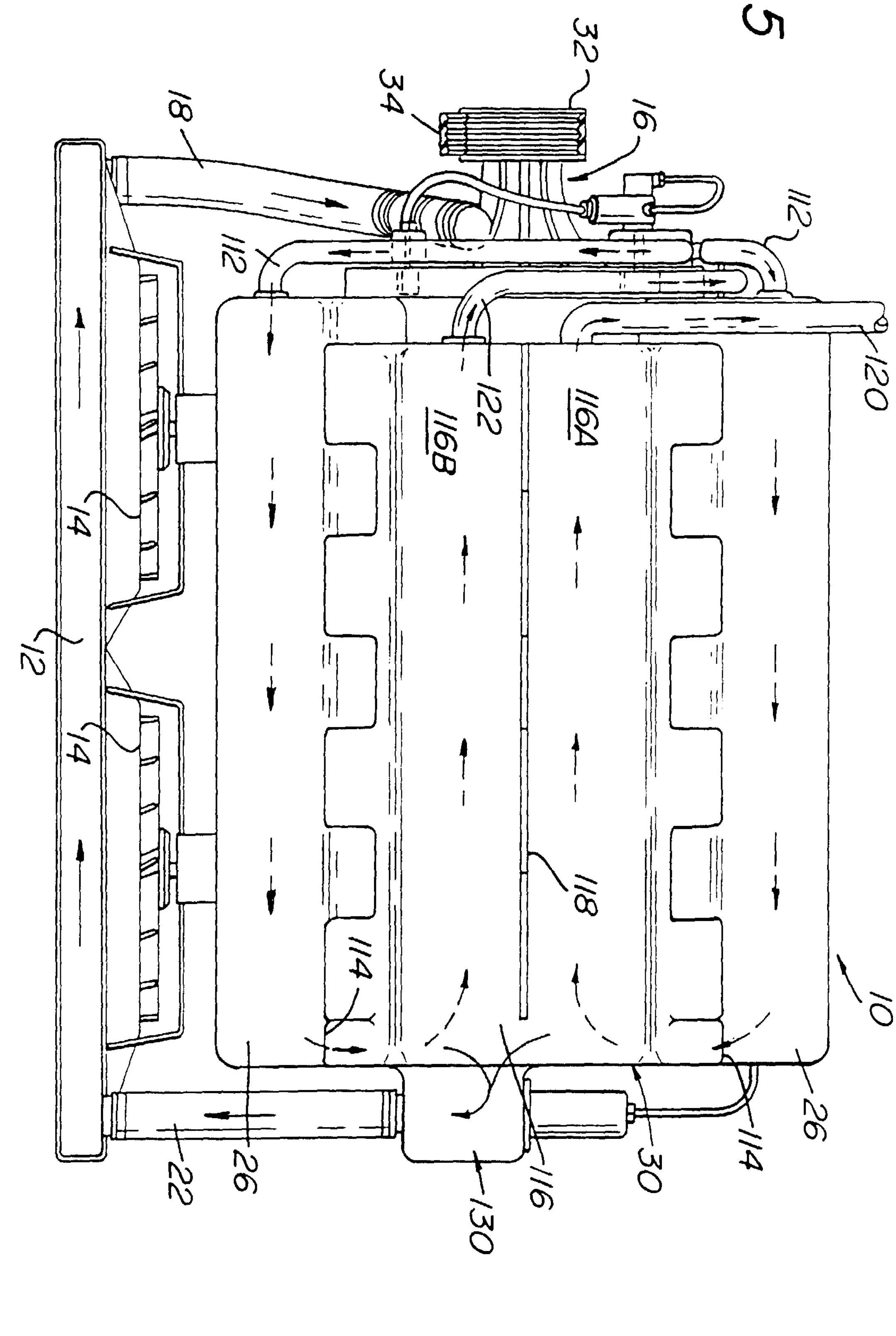

32
34
16
18
112
112
120
122
116A
116B
14
14
12
118
114
114
10
26
26
22
30
116
130

FIG.5

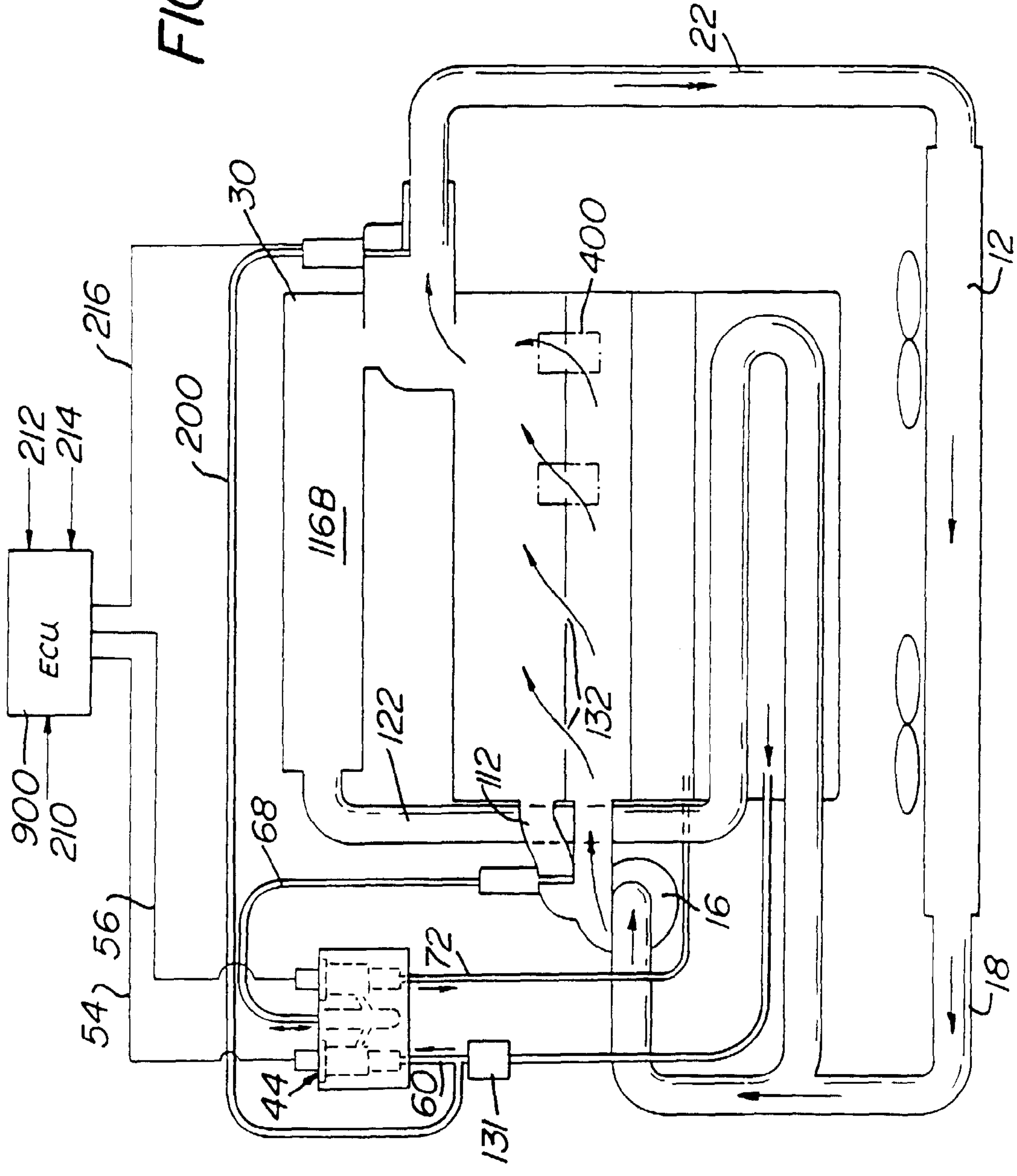
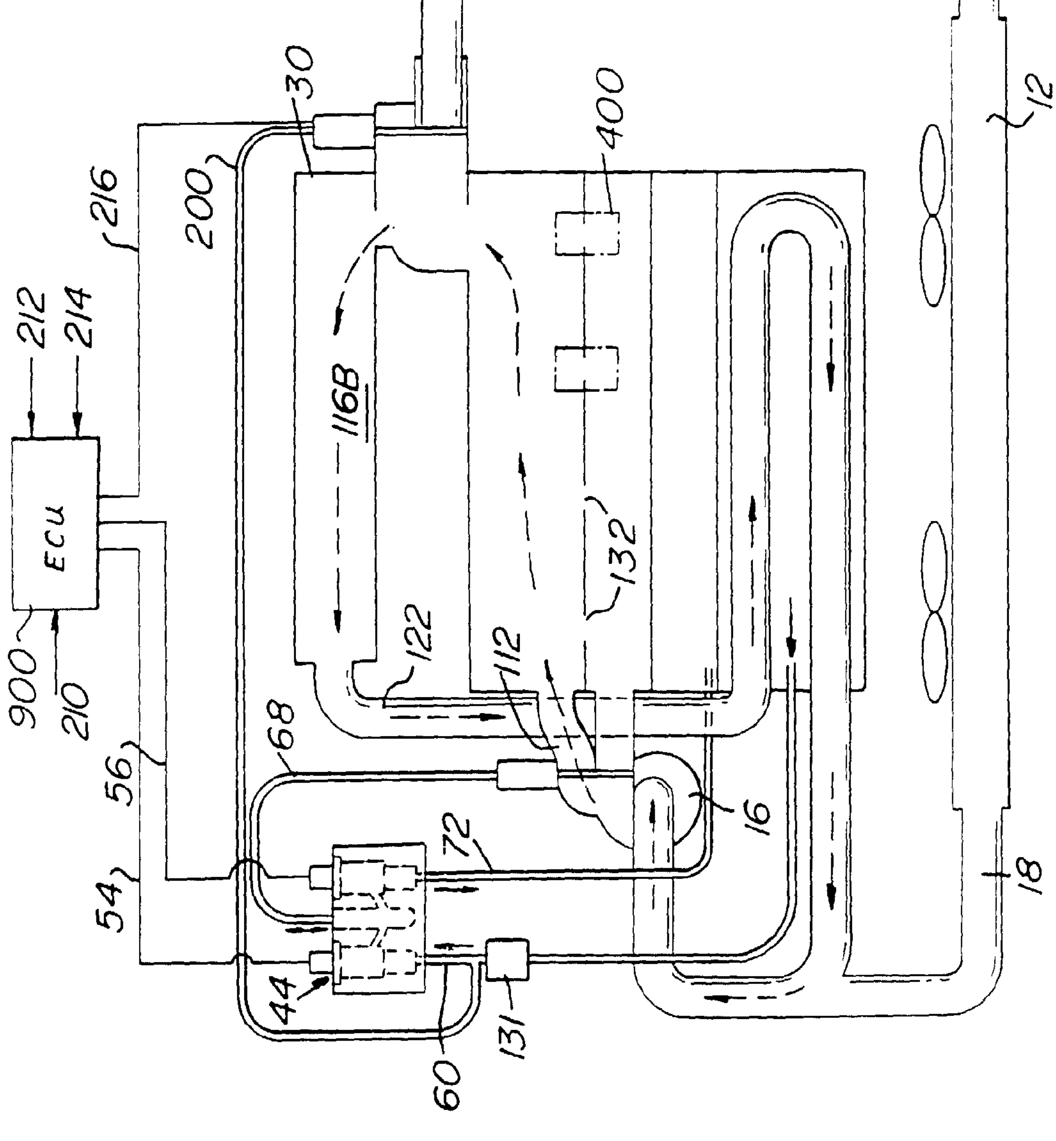

22
30
400
12
216
212
214
200
116B
ECU
122
132
112
900
210
68
16
56
72
54
44
60
131
18

FIG.6A

FIG.6B



22
30
400
12
216
200
212
214
116B
ECU
132
900
210
122
112
68
56
16
72
18
54
44
131
60

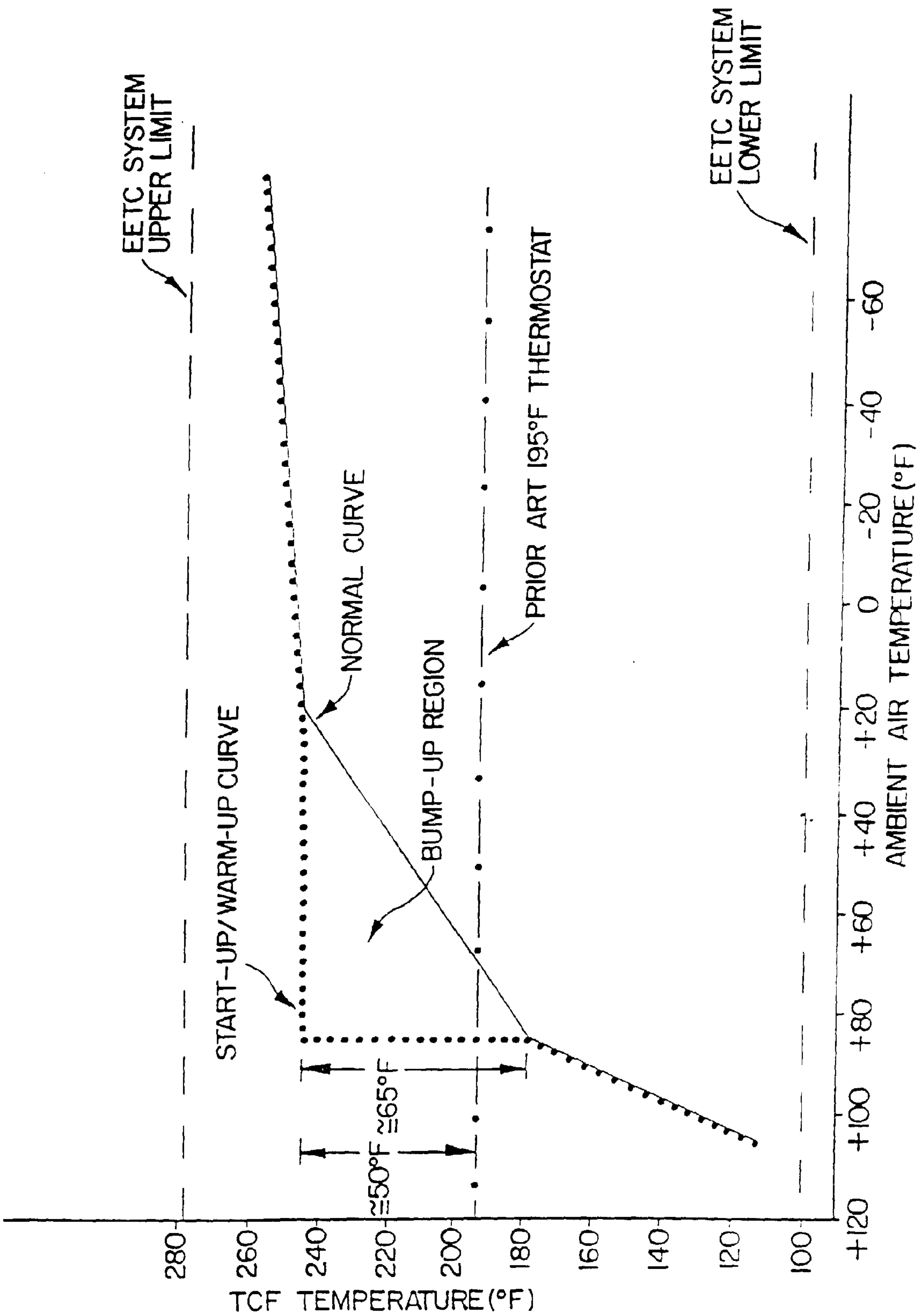

EETC SYSTEM UPPER LIMIT
EETC SYSTEM LOWER LIMIT
NORMAL CURVE
PRIOR ART 195°F THERMOSTAT
BUMP-UP REGION
START-UP/WARM-UP CURVE
≅50°F
≅65°F
TCF TEMPERATURE (°F)
280
260
240
220
200
180
160
140
120
100
AMBIENT AIR TEMPERATURE (°F)
+120
+100
+80
+60
+40
+20
0
-20
-40
-60

FIG. 7A

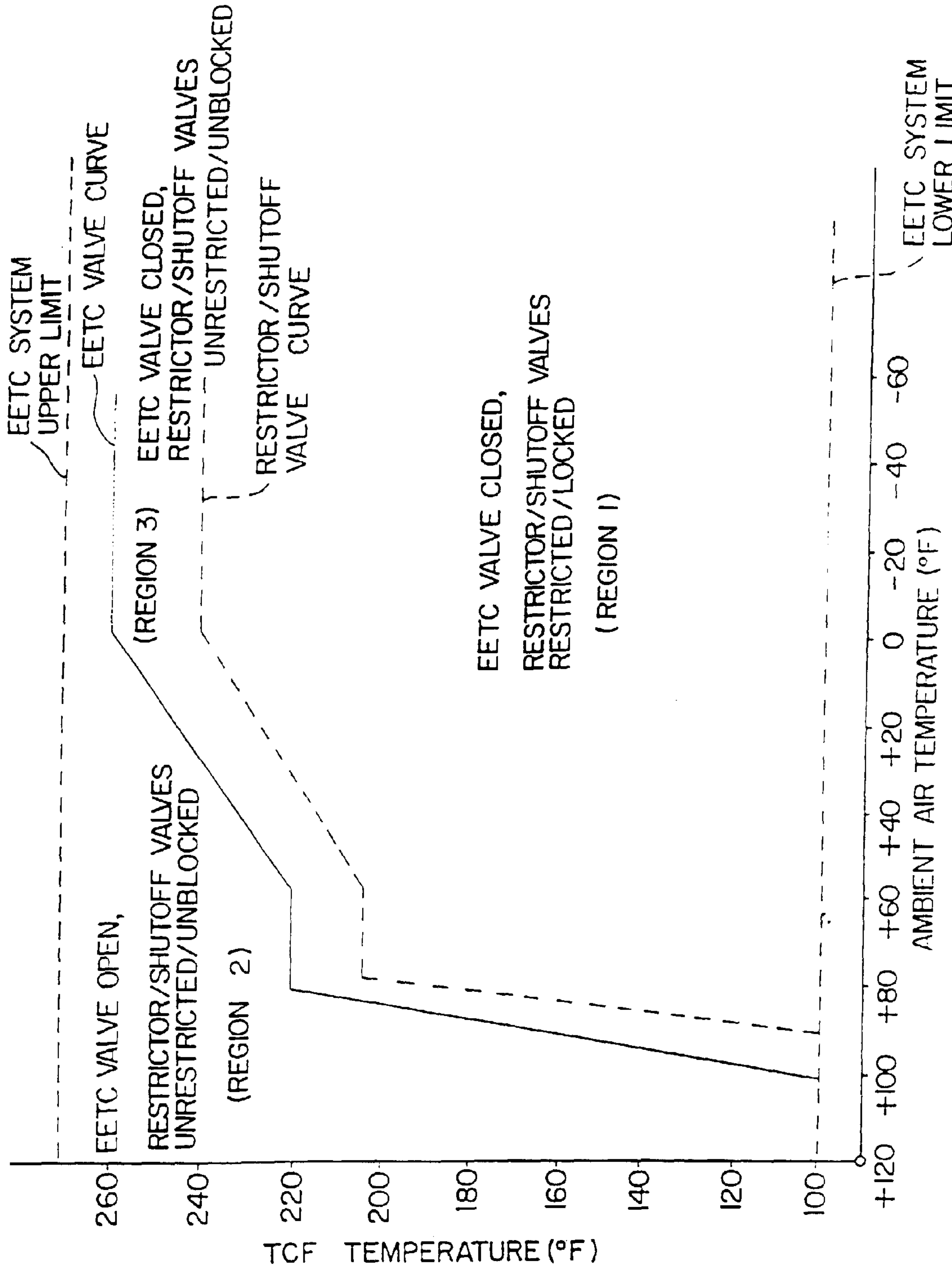
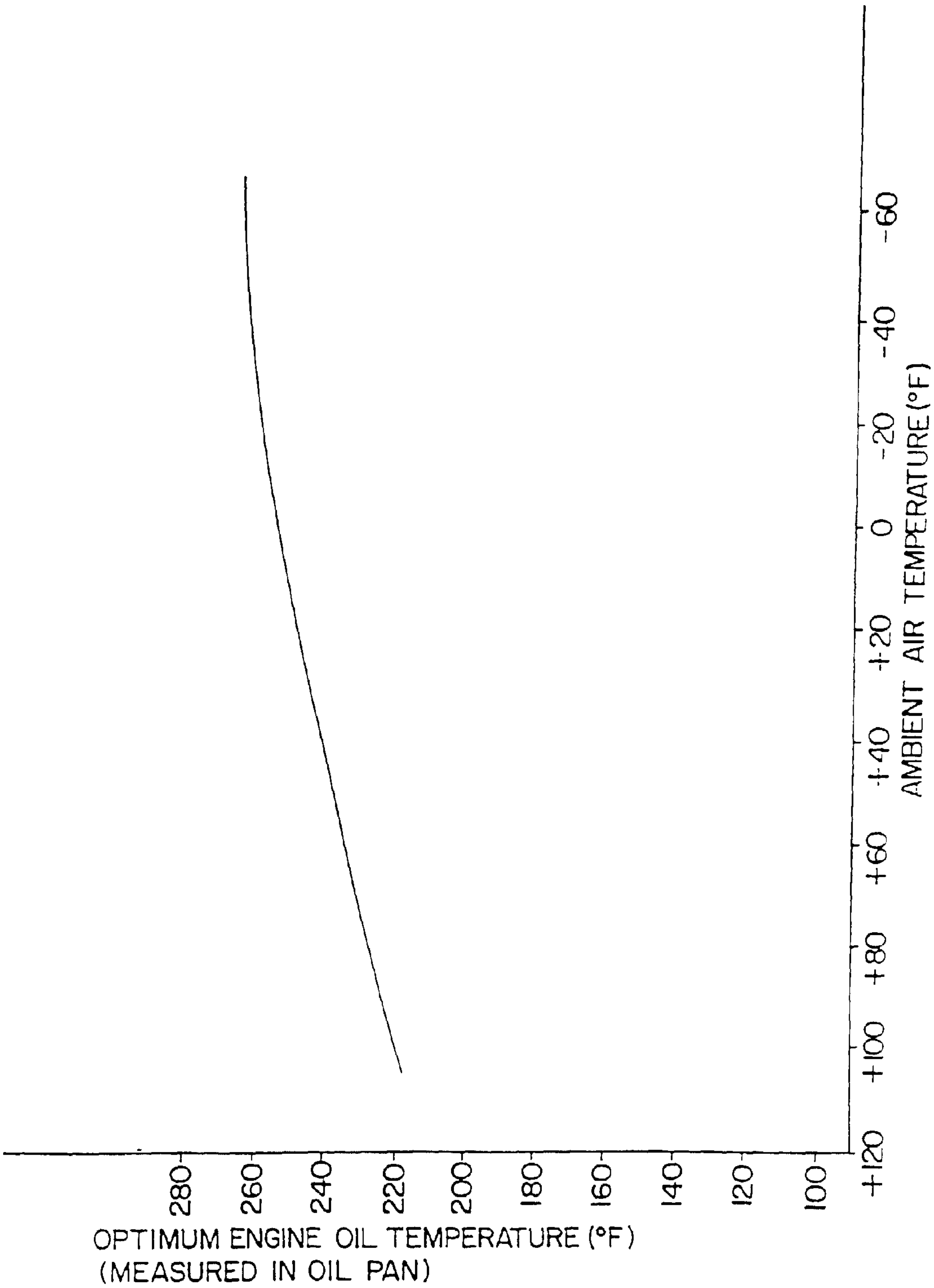

EETC SYSTEM UPPER LIMIT
EETC VALVE CURVE
EETC VALVE CLOSED, RESTRICTOR/SHUTOFF VALVES UNRESTRICTED/UNBLOCKED
(REGION 3)
RESTRICTOR/SHUTOFF VALVE CURVE
EETC VALVE CLOSED, RESTRICTOR/SHUTOFF VALVES RESTRICTED/LOCKED
(REGION 1)
EETC VALVE OPEN, RESTRICTOR/SHUTOFF VALVES UNRESTRICTED/UNBLOCKED
(REGION 2)
EETC SYSTEM LOWER LIMIT
TCF TEMPERATURE (°F)
260
240
220
200
180
160
140
120
100
+120
+100
+80
+60
+40
+20
0
-20
-40
-60
AMBIENT AIR TEMPERATURE (°F)

FIG. 7B



280
260
240
220
200
180
160
140
120
100
OPTIMUM ENGINE OIL TEMPERATURE (°F)
(MEASURED IN OIL PAN)
+120
+100
+80
+60
+40
+20
0
-20
-40
-60
AMBIENT AIR TEMPERATURE (°F)

FIG. 7C

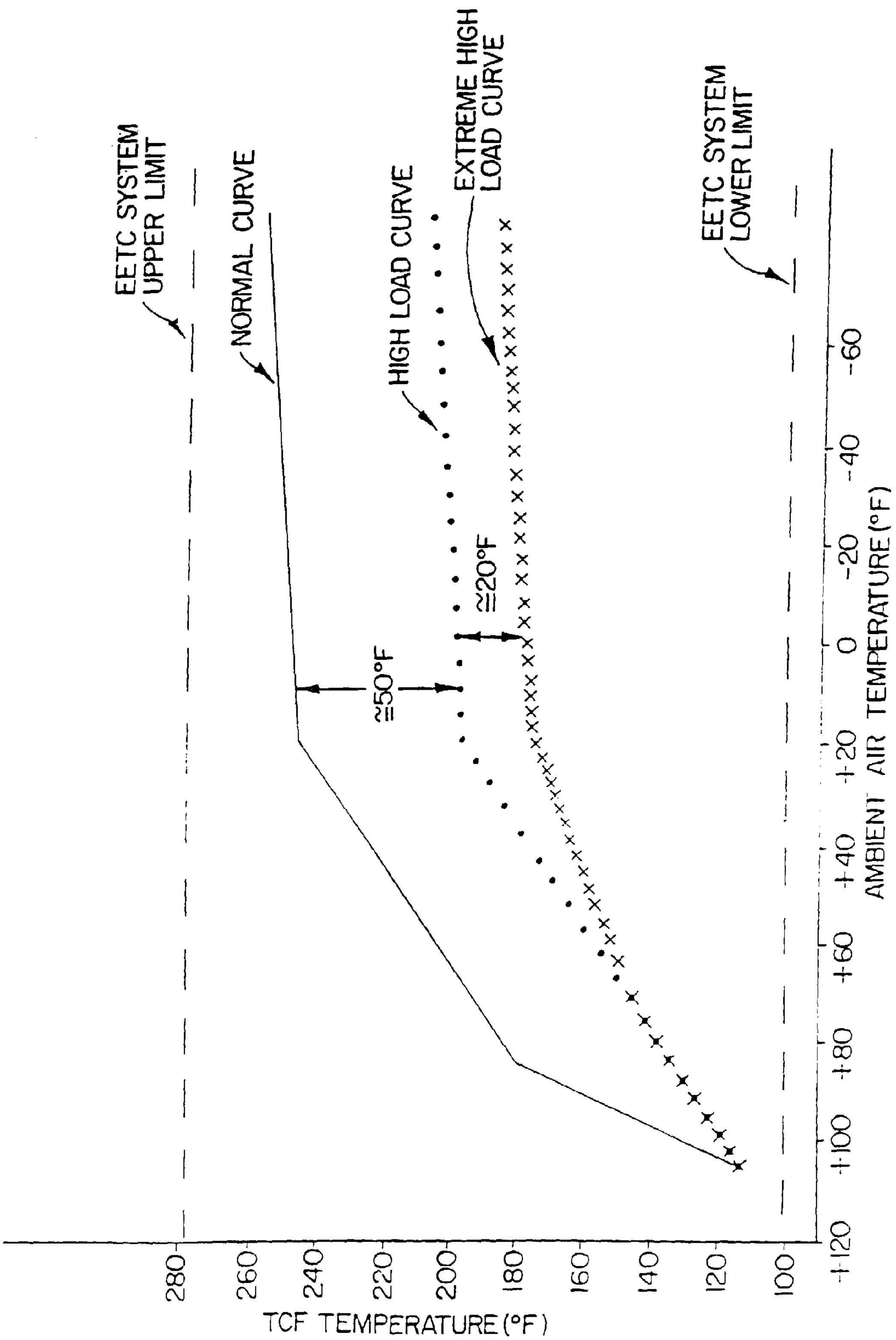

EETC SYSTEM UPPER LIMIT
NORMAL CURVE
HIGH LOAD CURVE
EXTREME HIGH LOAD CURVE
EETC SYSTEM LOWER LIMIT
≅50°F
≅20°F
280
260
240
220
200
180
160
140
120
100
TCF TEMPERATURE (°F)
+120
+100
+80
+60
+40
+20
0
-20
-40
-60
AMBIENT AIR TEMPERATURE (°F)

FIG. 7D

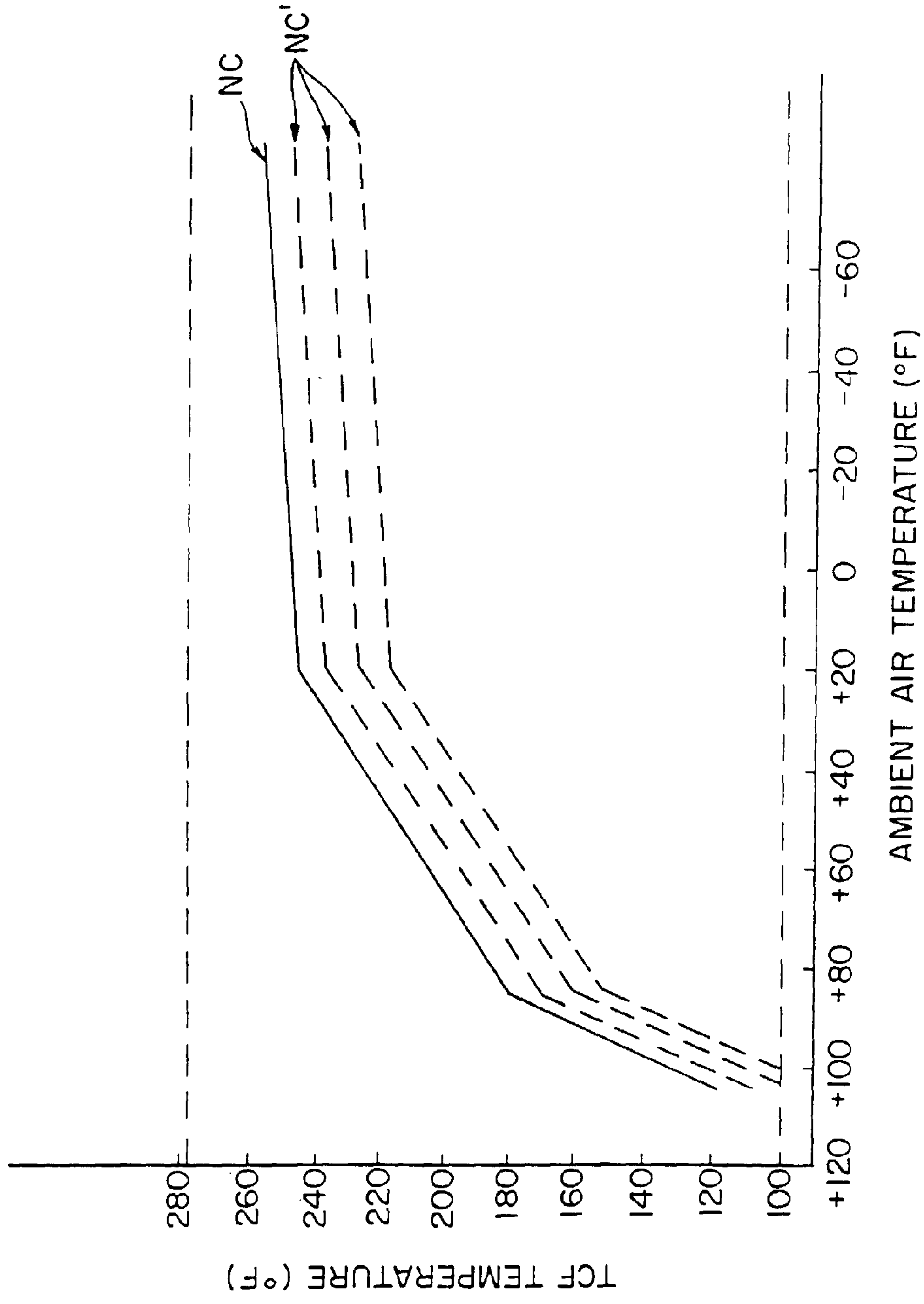

NC
NC'
TCF TEMPERATURE (°F)
280
260
240
220
200
180
160
140
120
100
+120
+100
+80
+60
+40
+20
0
-20
-40
-60
AMBIENT AIR TEMPERATURE (°F)

FIG. 7E

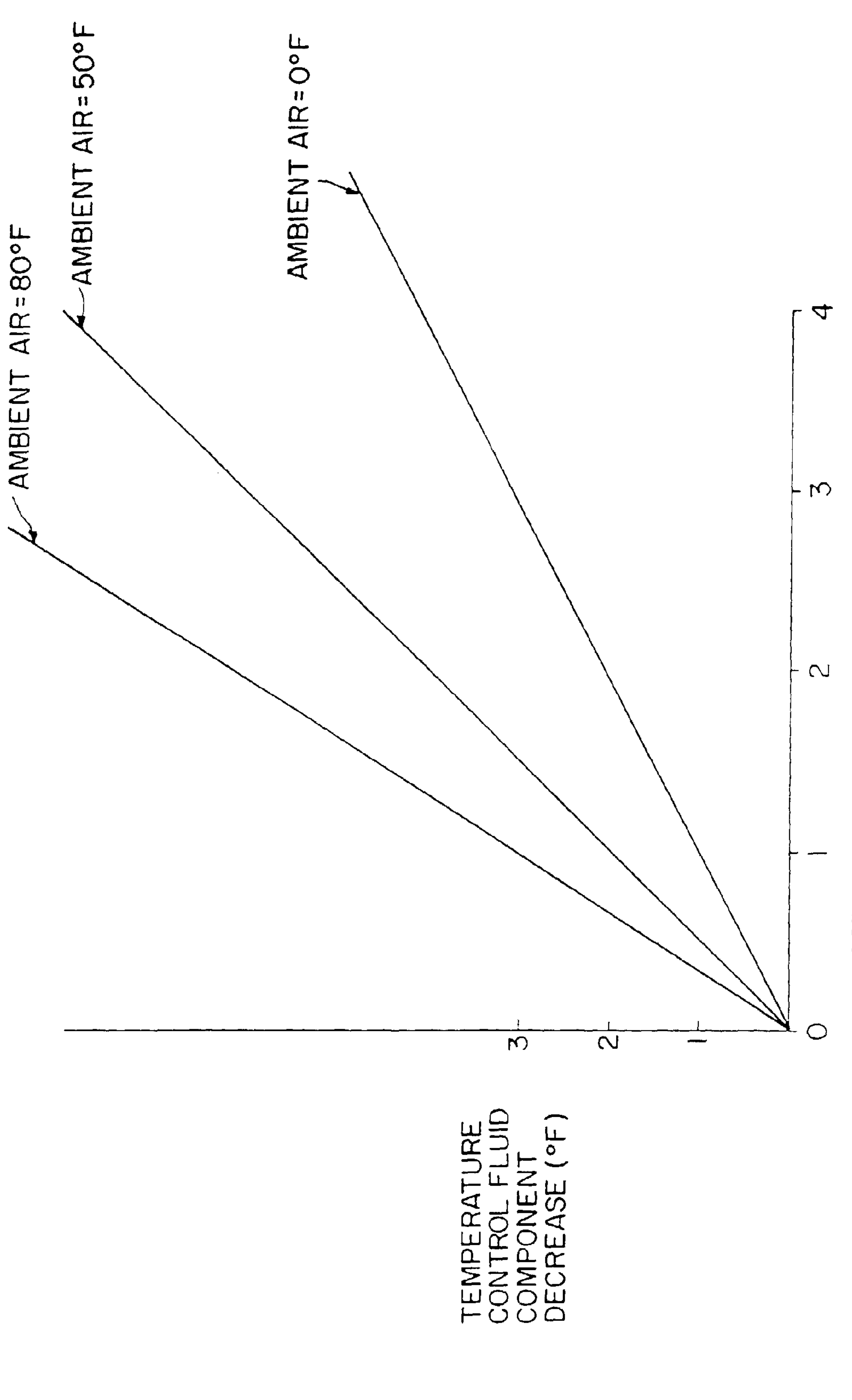

AMBIENT AIR = 80°F
AMBIENT AIR = 50°F
AMBIENT AIR = 0°F
TEMPERATURE CONTROL FLUID COMPONENT DECREASE (°F)
0
1
2
3
4
ACTUAL OIL TEMPERATURE INCREASE (°F)

FIG. 7F

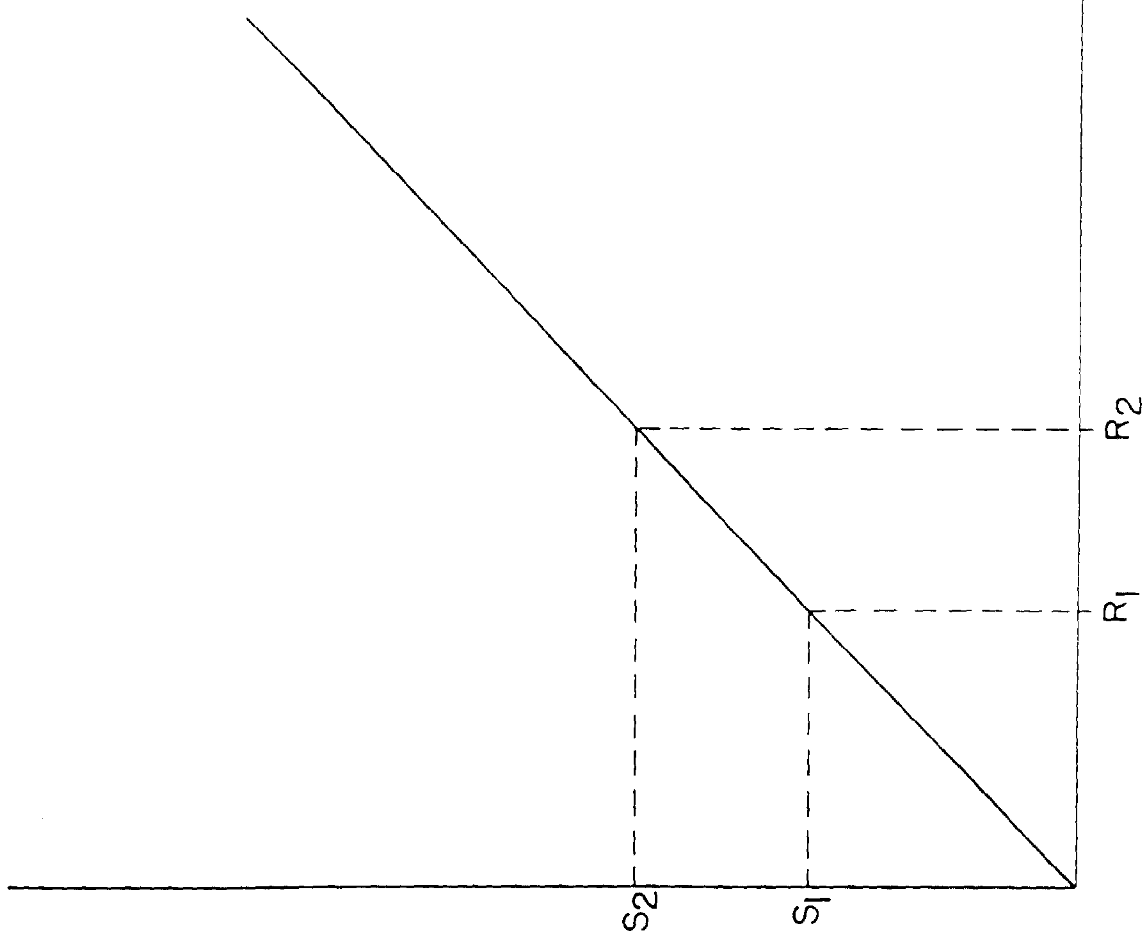


FIG. 7G

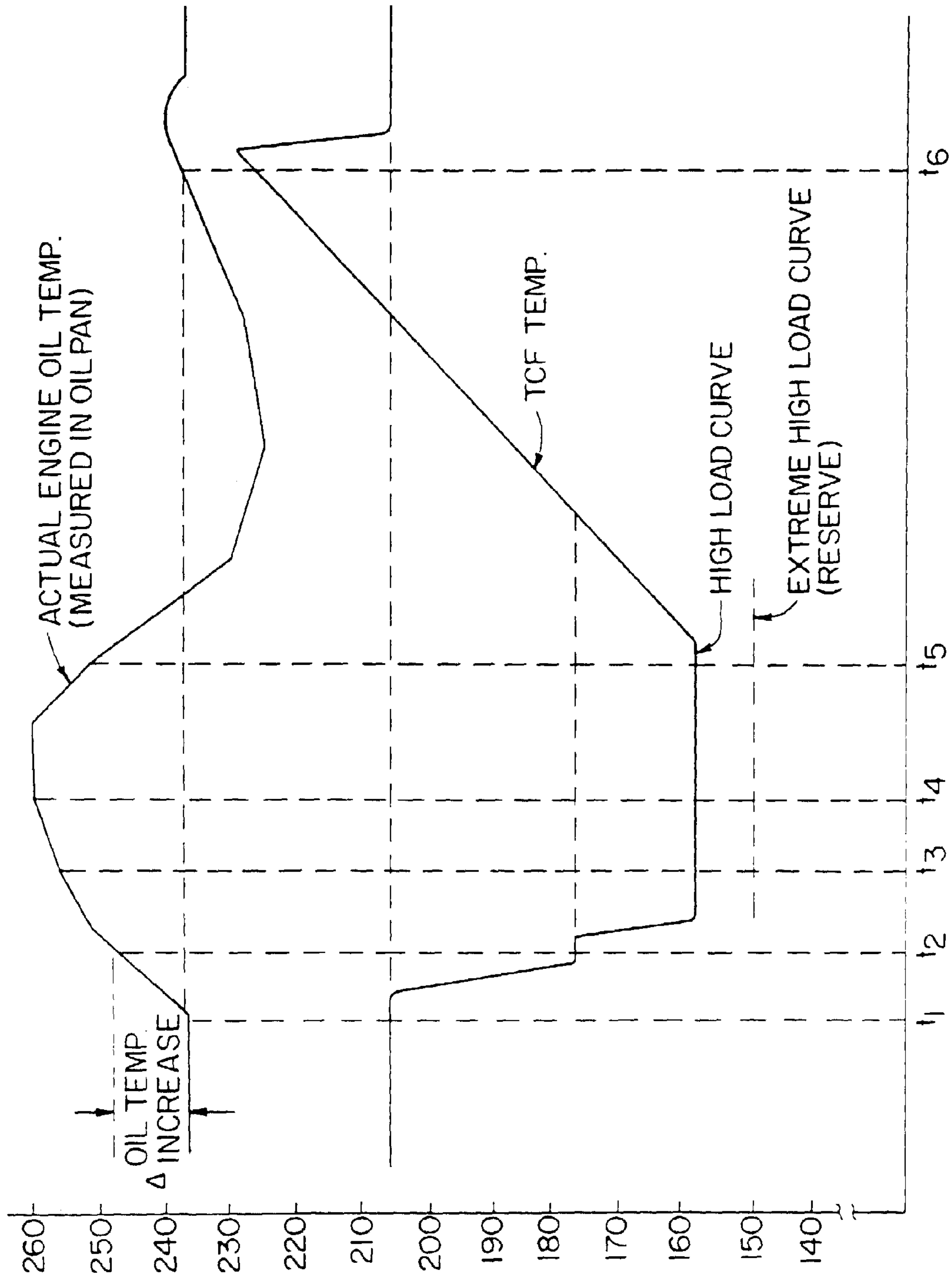

ACTUAL ENGINE OIL TEMP.
(MEASURED IN OIL PAN)
TCF TEMP.
HIGH LOAD CURVE
EXTREME HIGH LOAD CURVE
(RESERVE)
Δ OIL TEMP.
INCREASE
260
250
240
230
220
210
200
190
180
170
160
150
140
t_1
t_2
t_3
t_4
t_5
t_6

FIG. 7H

FIG. 9

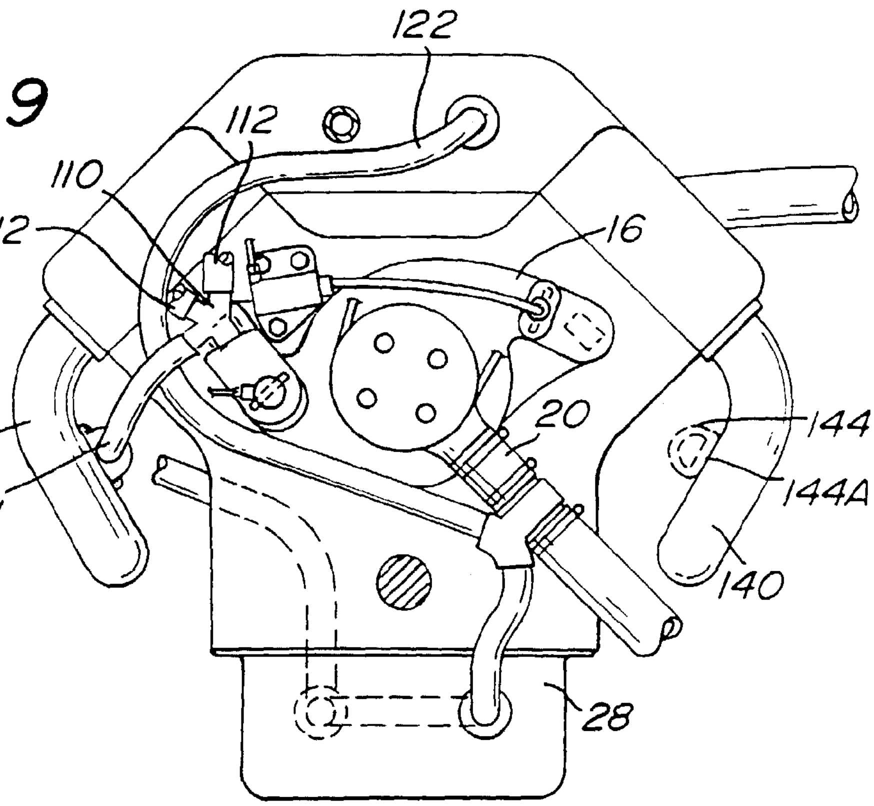

122
112
110
112
16
20
144
144A
140
141
140
28

FIG. 8

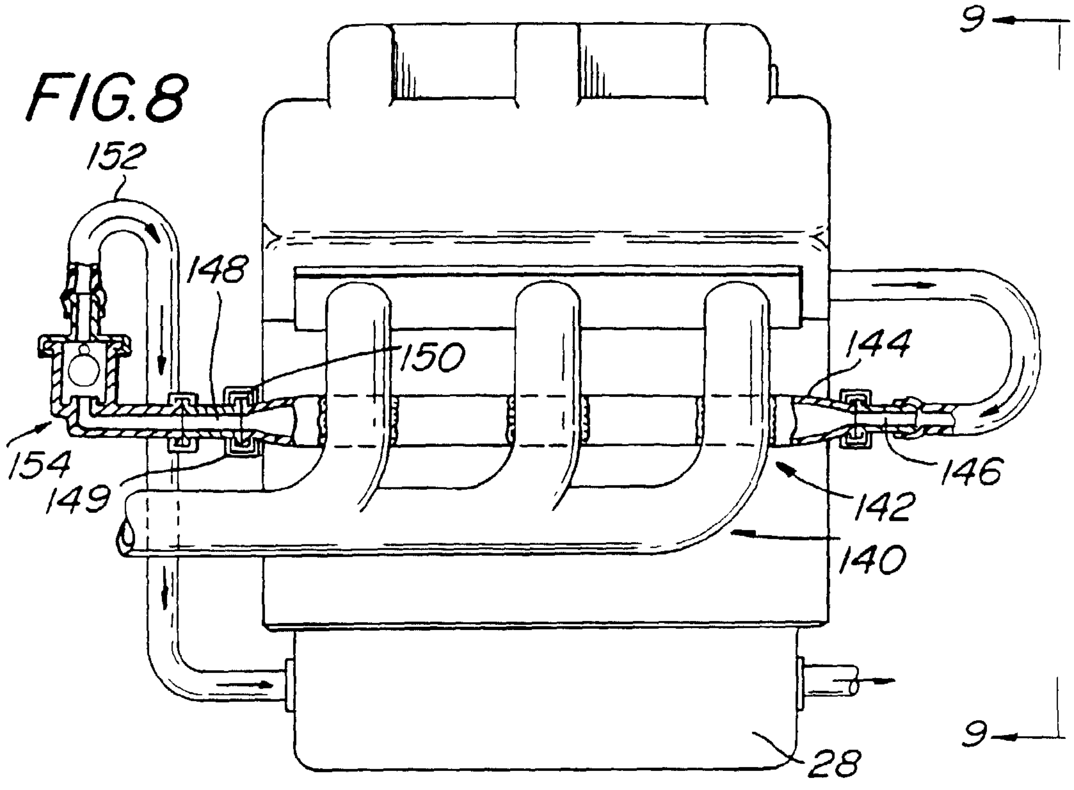

9
152
148
150
144
154
149
146
142
140
28
9

FIG.11

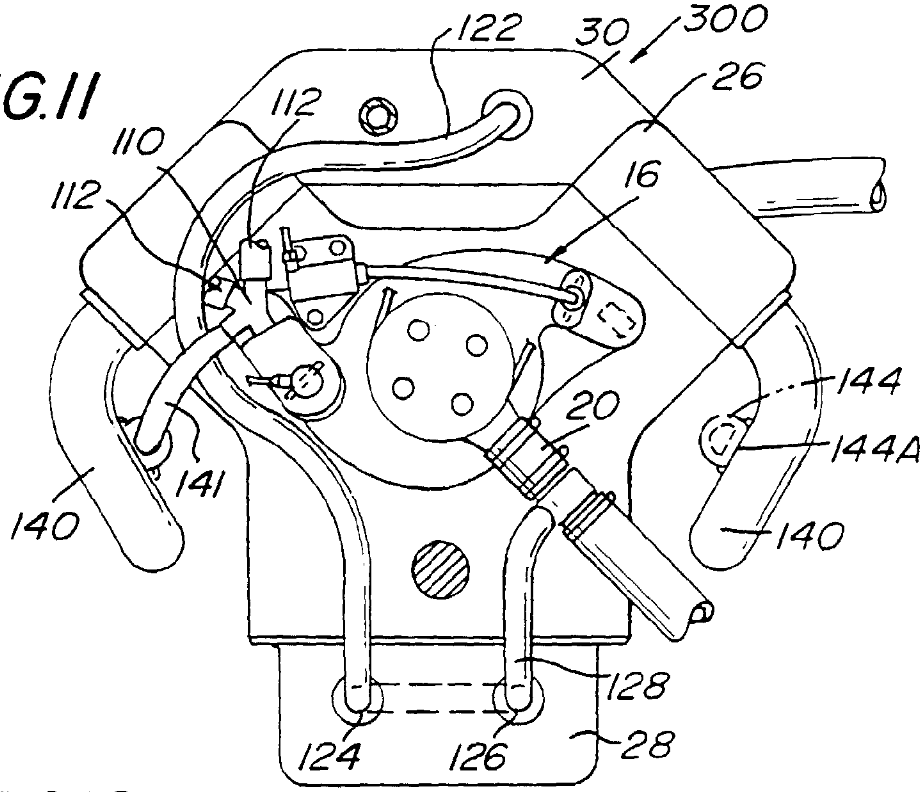
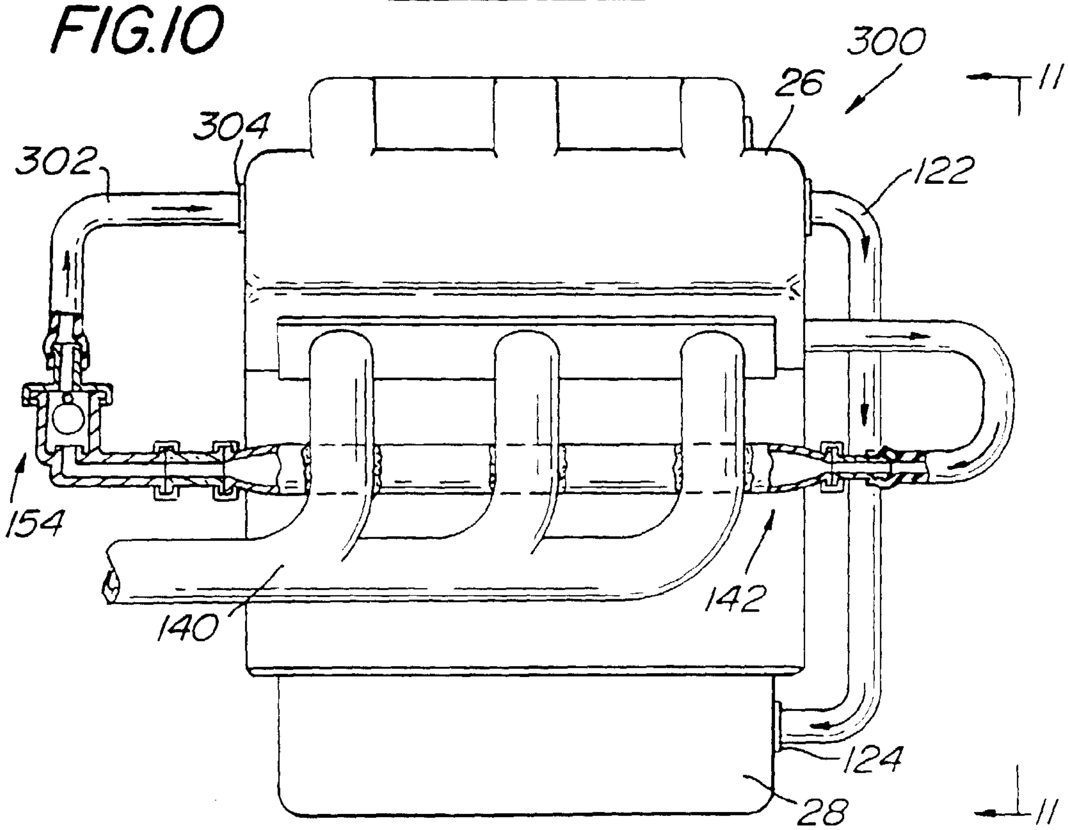

122
30
300
26
112
110
112
16
144
20
144A
141
140
140
128
124
126
28

FIG.10


300
26
11
304
302
122
154
142
140
124
28
11

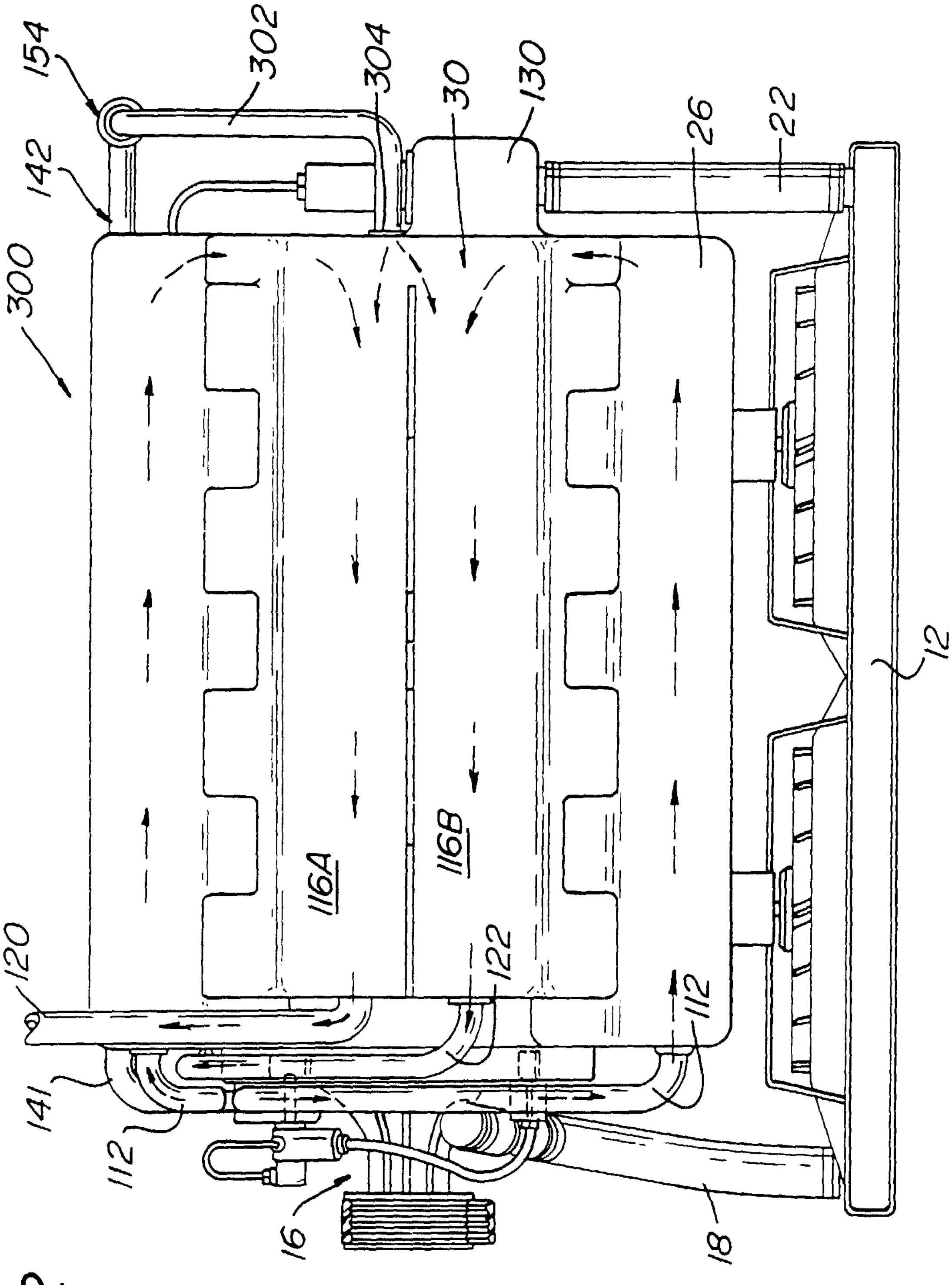
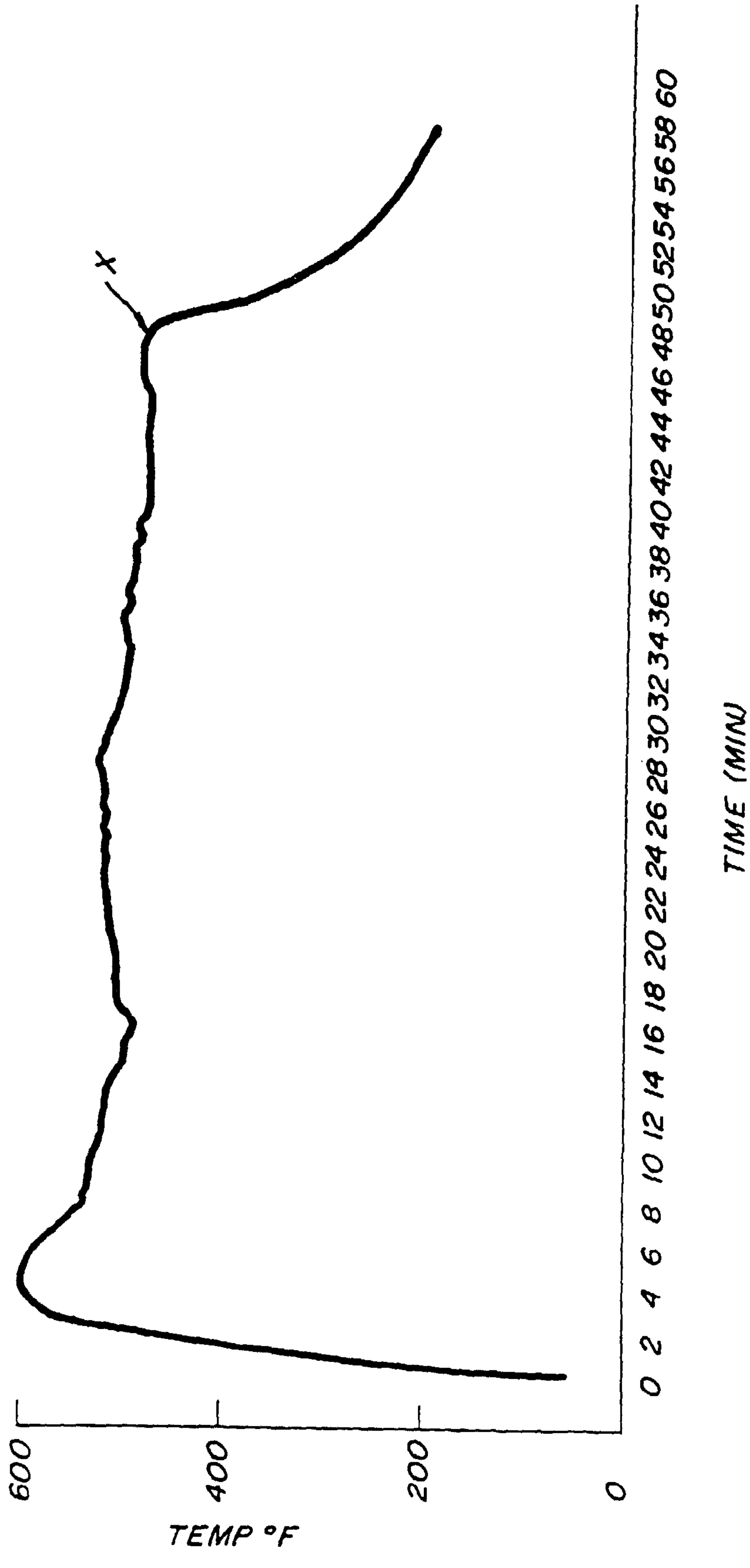

154
302
304
30
130
22
26
142
300
12
116A
116B
120
122
112
141
112
16
18

FIG.12

FIG.13


TEMP °F
0
200
400
600
TIME (MIN)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60
X

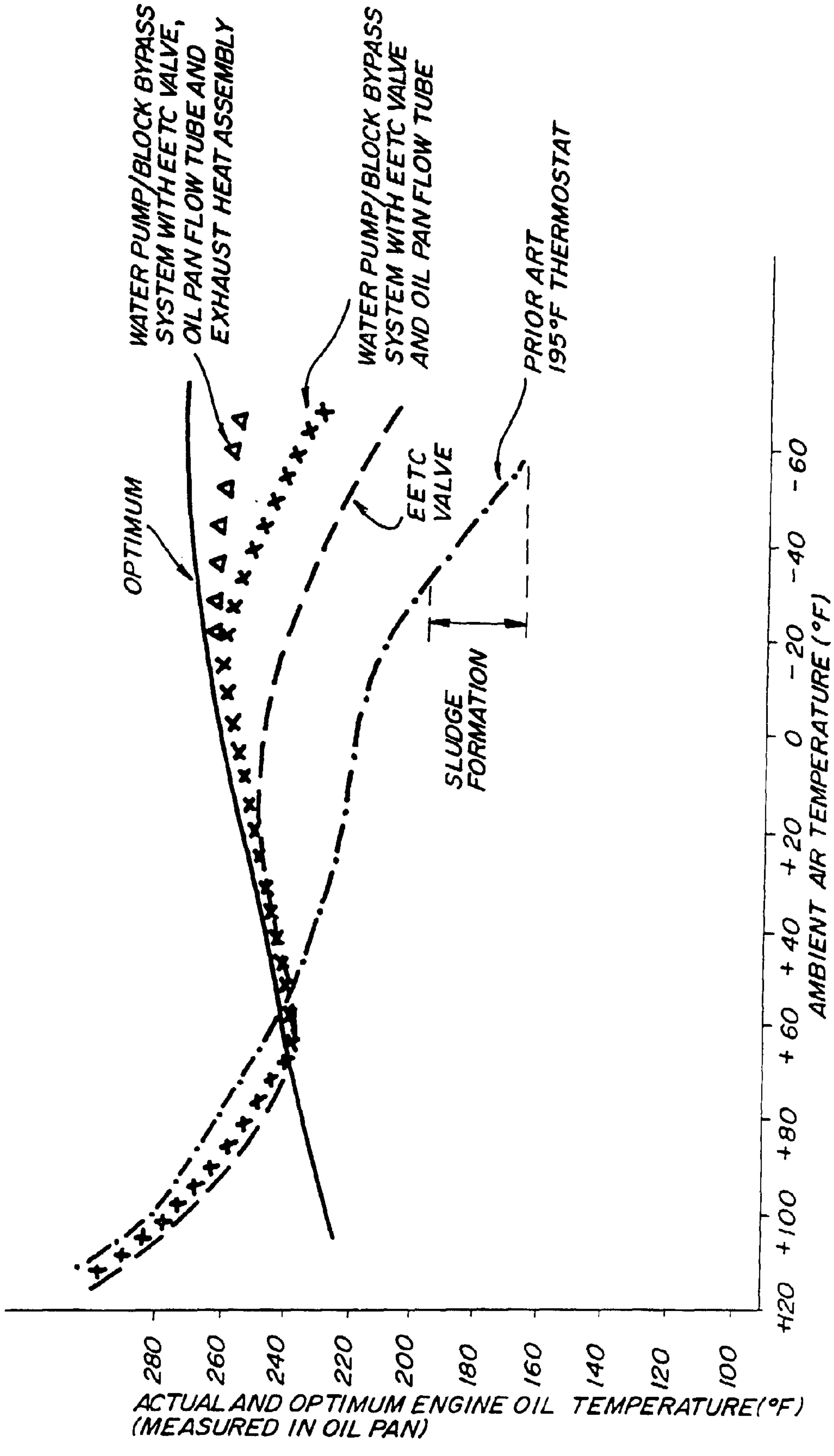

WATER PUMP/BLOCK BYPASS SYSTEM WITH EETC VALVE, OIL PAN FLOW TUBE AND EXHAUST HEAT ASSEMBLY
WATER PUMP/BLOCK BYPASS SYSTEM WITH EETC VALVE AND OIL PAN FLOW TUBE
PRIOR ART 195°F THERMOSTAT
OPTIMUM
EETC VALVE
SLUDGE FORMATION
+120 +100 +80 +60 +40 +20 0 −20 −40 −60
AMBIENT AIR TEMPERATURE (°F)
280 260 240 220 200 180 160 140 120 100
ACTUAL AND OPTIMUM ENGINE OIL TEMPERATURE (°F)
(MEASURED IN OIL PAN)

FIG. 14

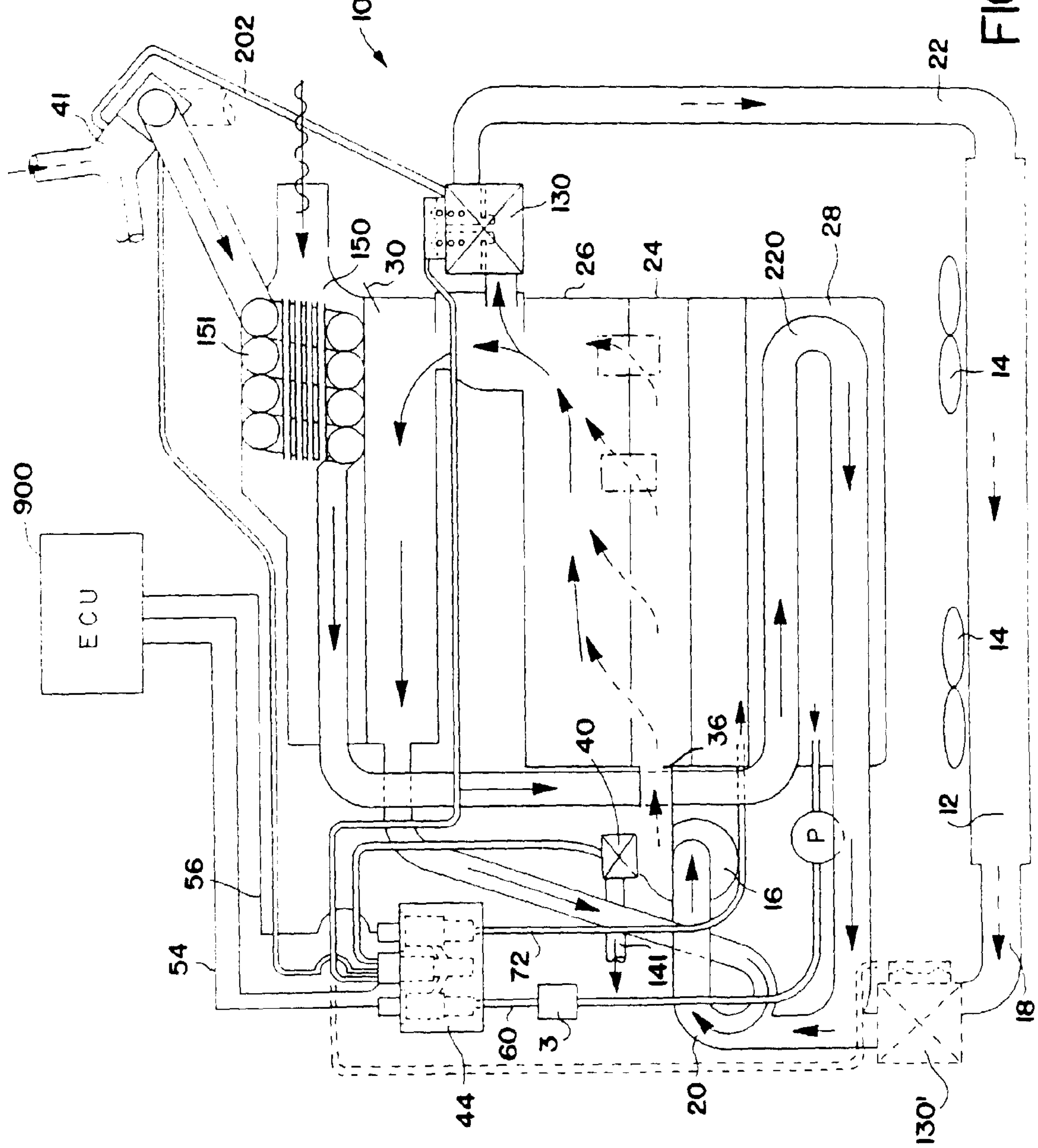

10
41
202
130
150
30
26
24
220
28
22
151
14
14
900
ECU
40
36
56
54
72
141
16
P
12
44
60
3
20
130'
18

FIG. 15

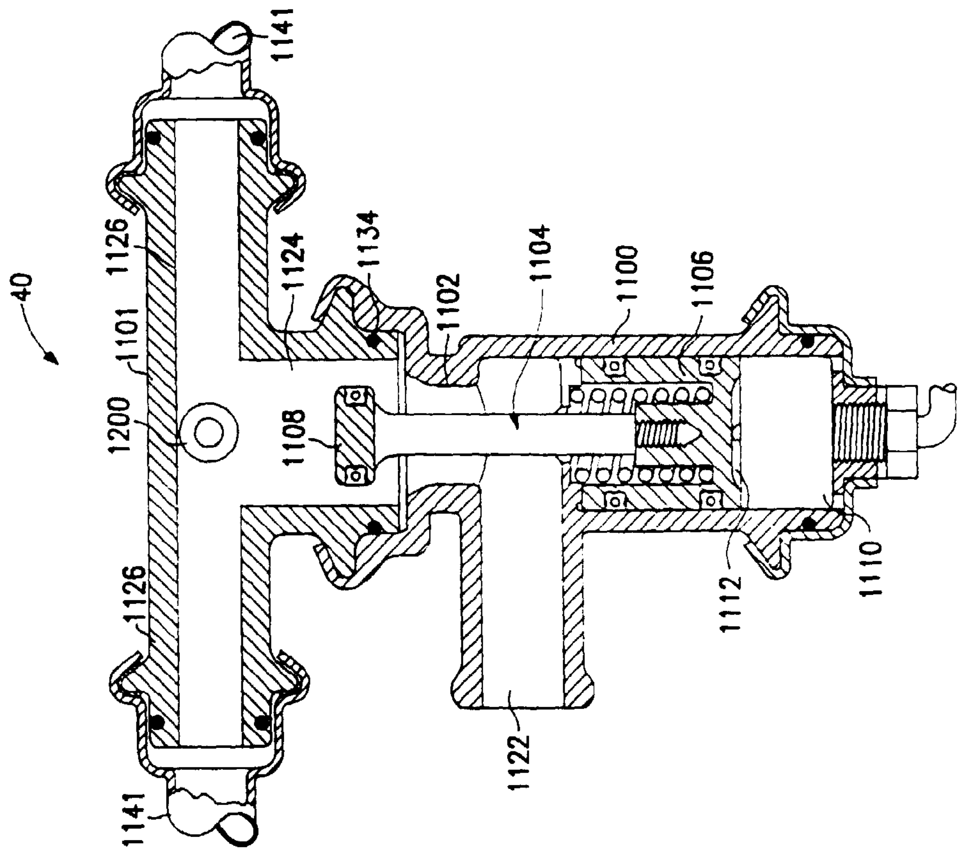


FIG. 16B

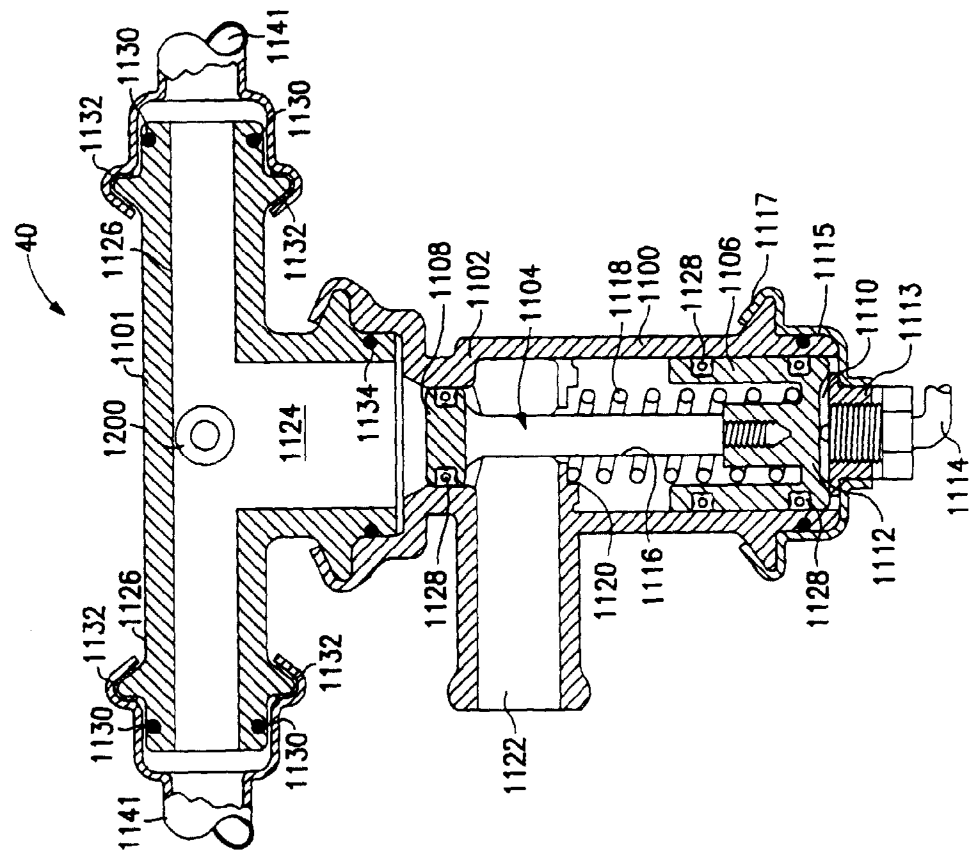


FIG. 16A

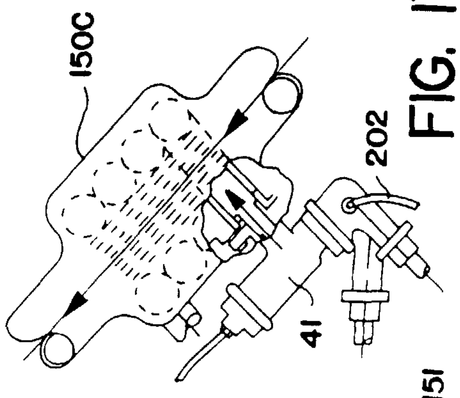


FIG. 17A

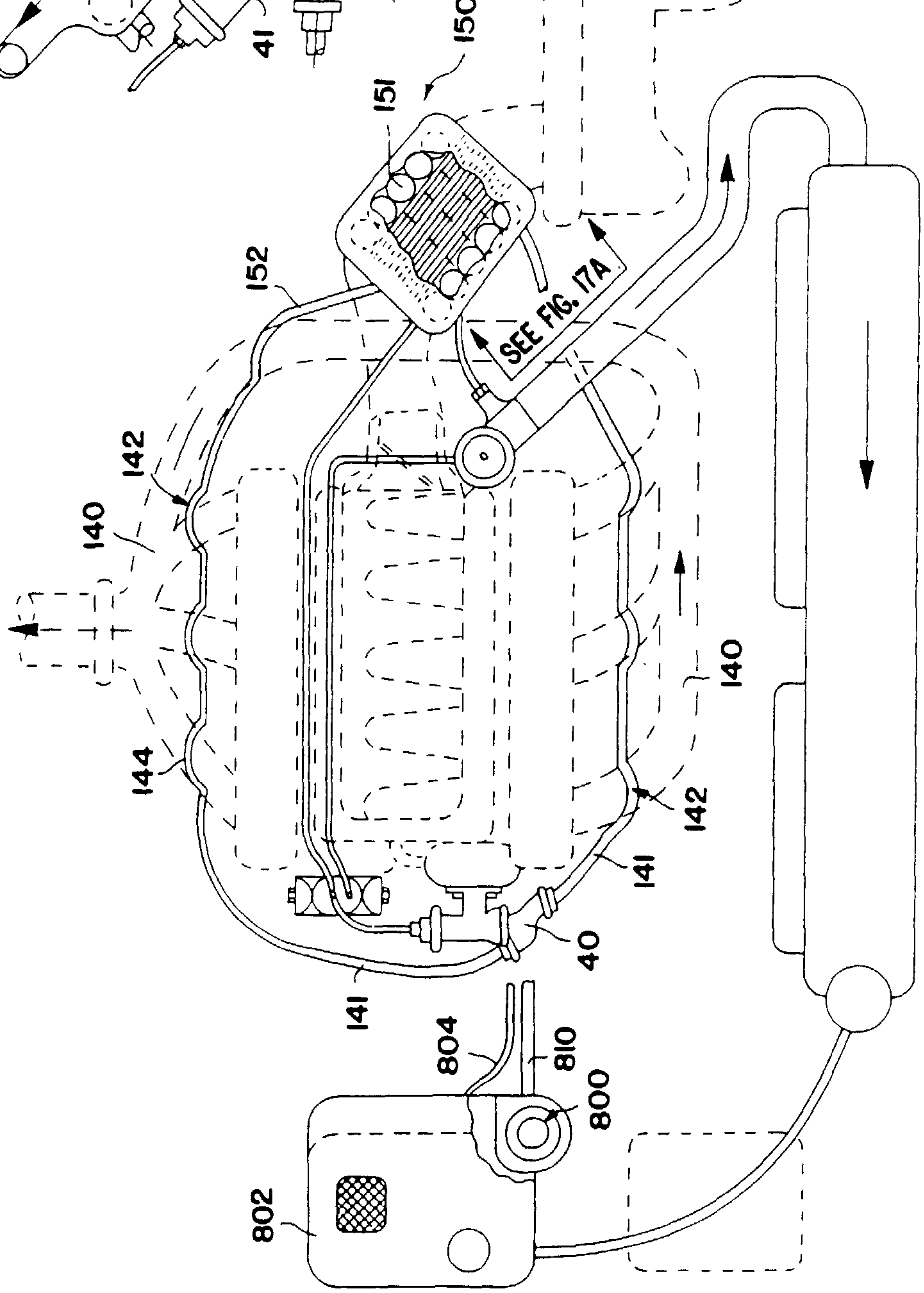


FIG. 17

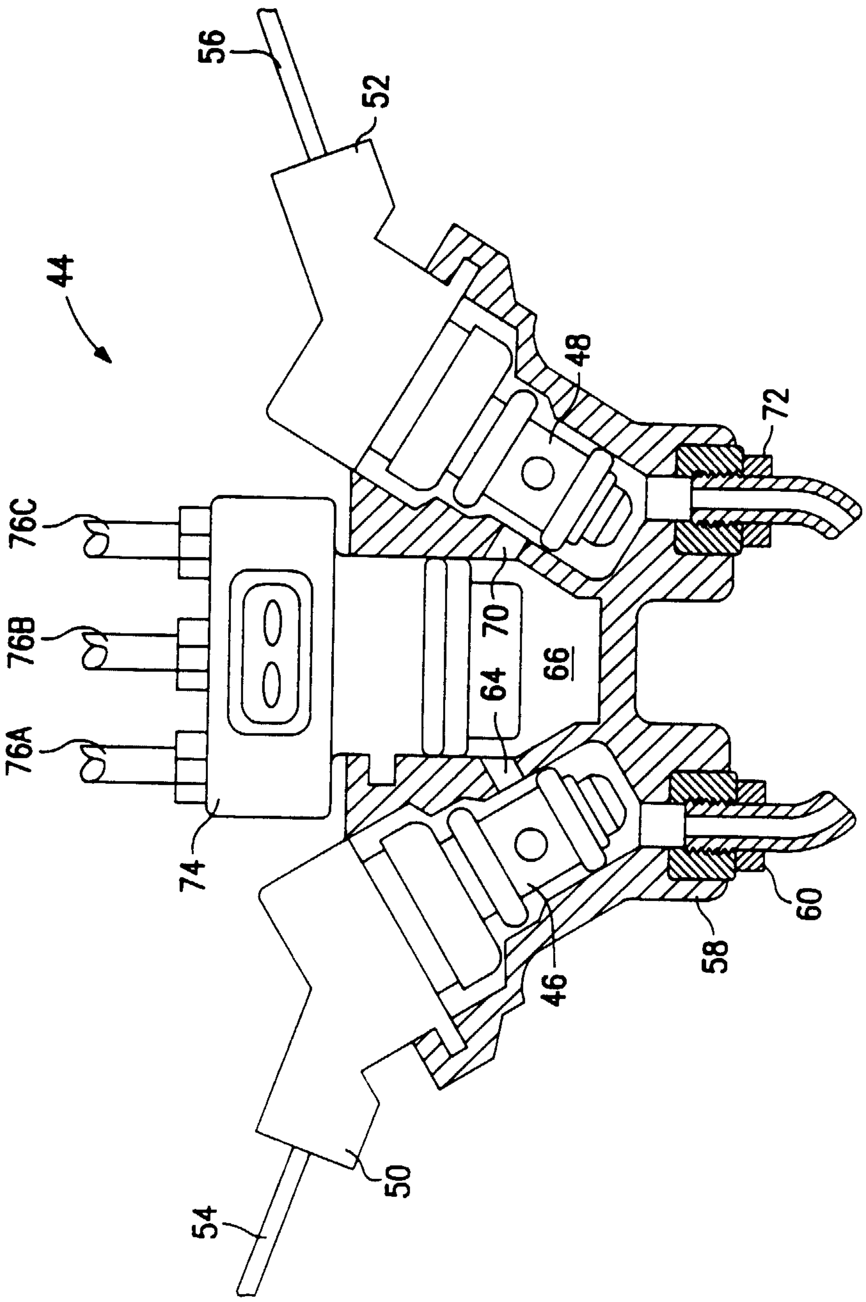


FIG. 18

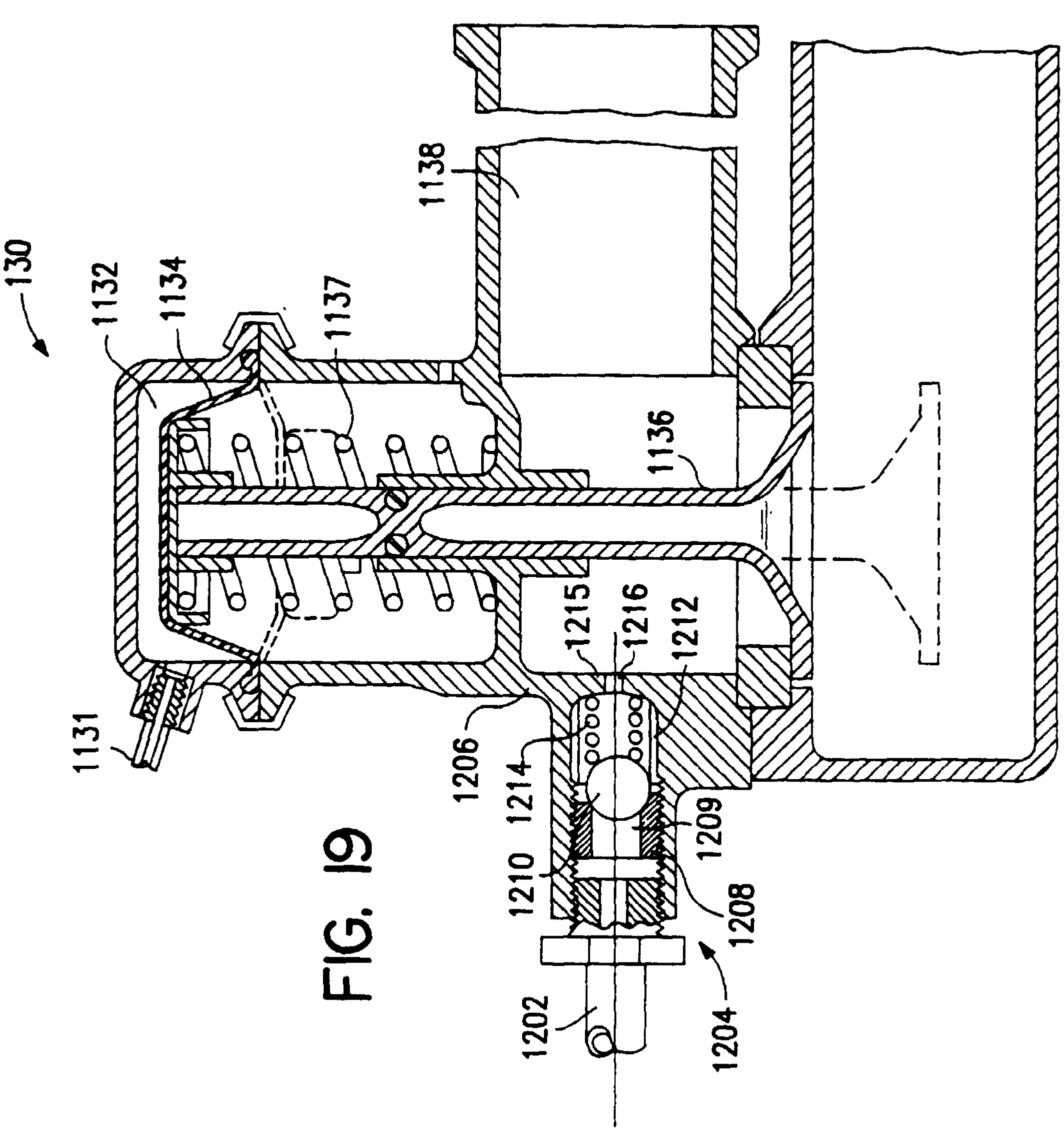

130
1132
1134
1137
1138
1136
1131
1206
1215
1216
1212
1214
1209
1210
1208
1202
1204

FIG. 19

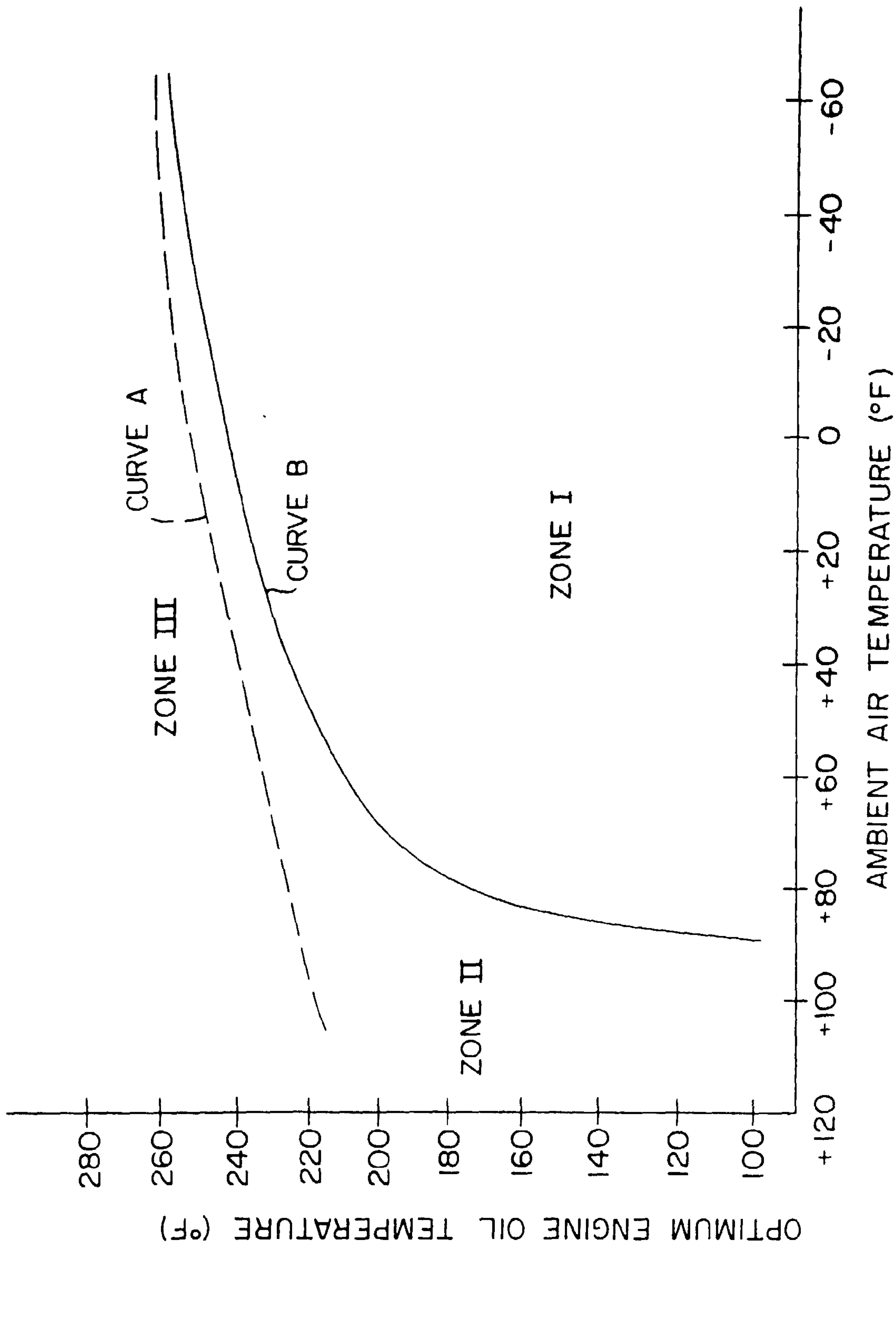

CURVE A
CURVE B
ZONE I
ZONE II
ZONE III
AMBIENT AIR TEMPERATURE (°F)
-60
-40
-20
0
+20
+40
+60
+80
+100
+120
OPTIMUM ENGINE OIL TEMPERATURE (°F)
280
260
240
220
200
180
160
140
120
100

FIG. 20

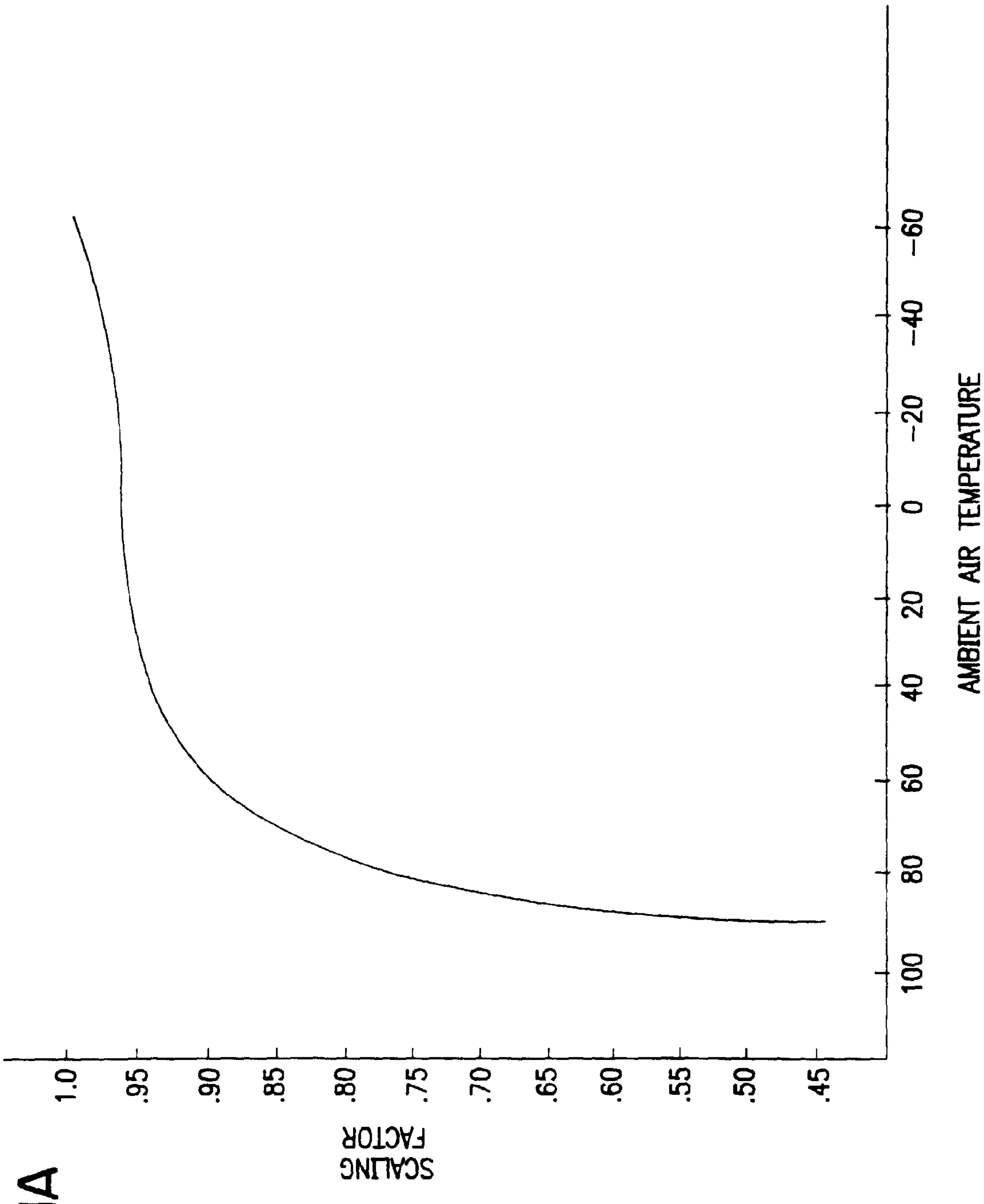

SCALING FACTOR
1.0
.95
.90
.85
.80
.75
.70
.65
.60
.55
.50
.45
100
80
60
40
20
0
-20
-40
-60
AMBIENT AIR TEMPERATURE

FIG. 21A

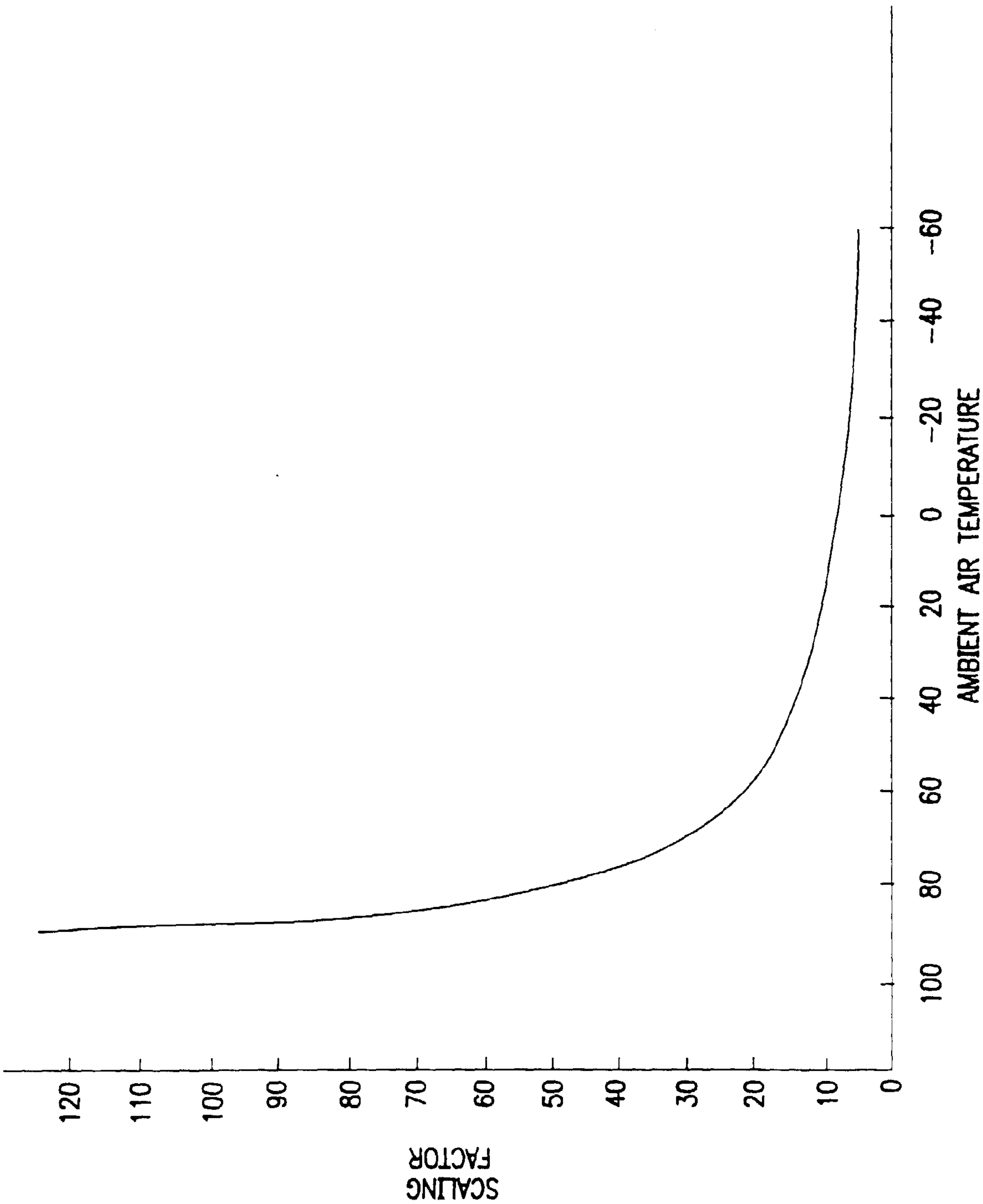

SCALING FACTOR
120
110
100
90
80
70
60
50
40
30
20
10
0
100
80
60
40
20
0
-20
-40
-60
AMBIENT AIR TEMPERATURE

FIG. 21B

FIG. 22A

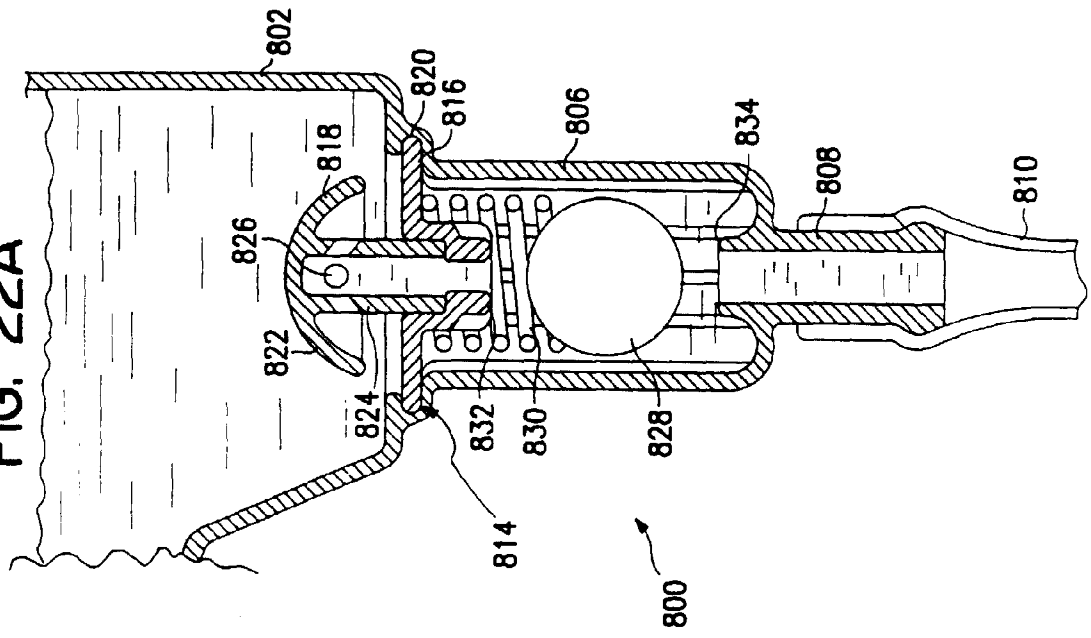


FIG. 22B

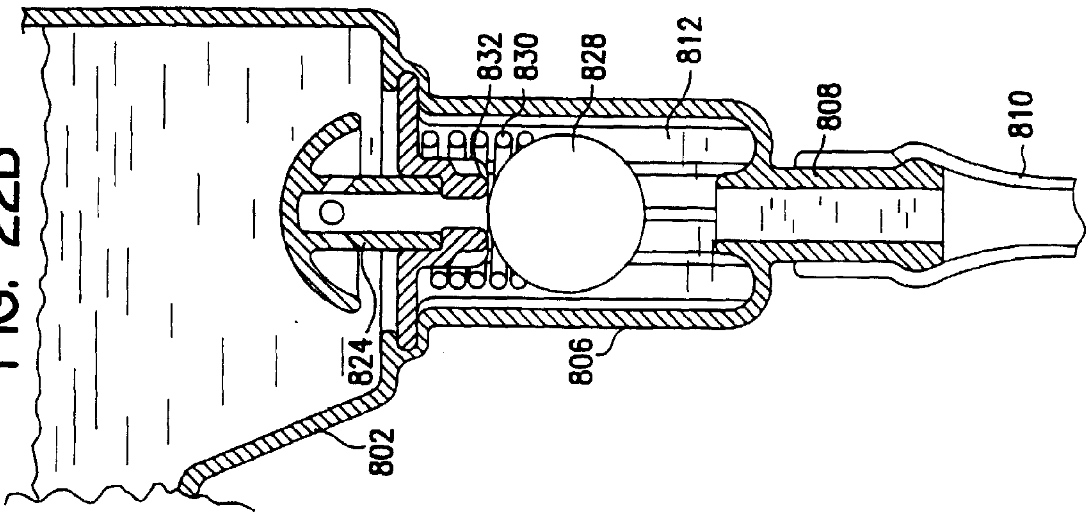


FIG. 22D

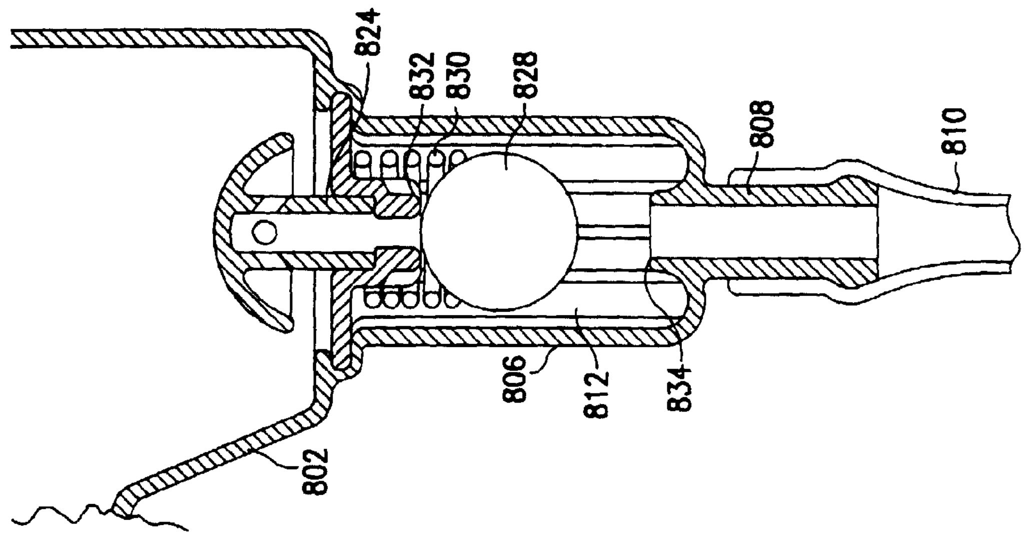
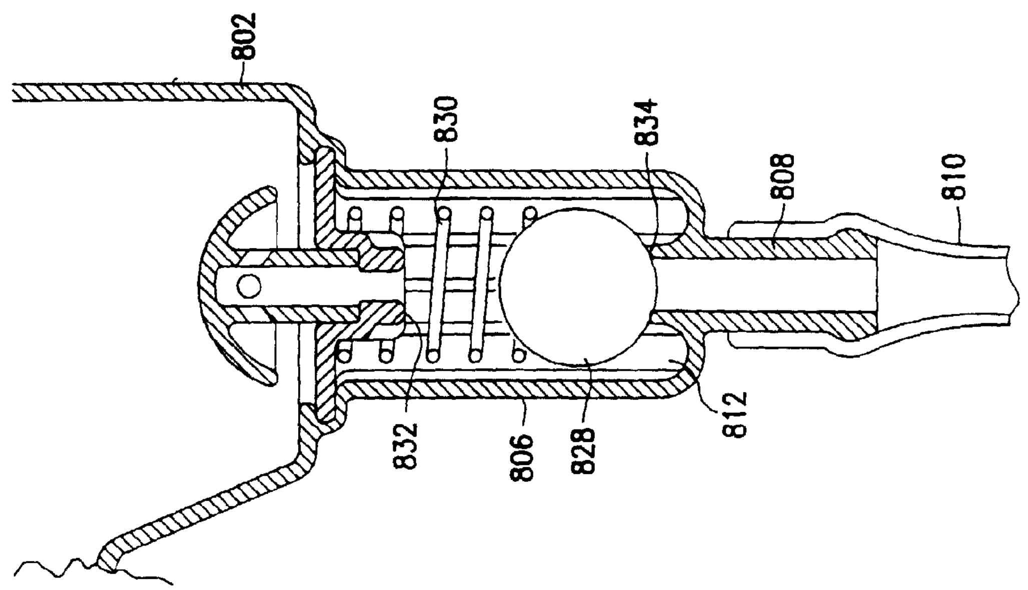


FIG. 22C



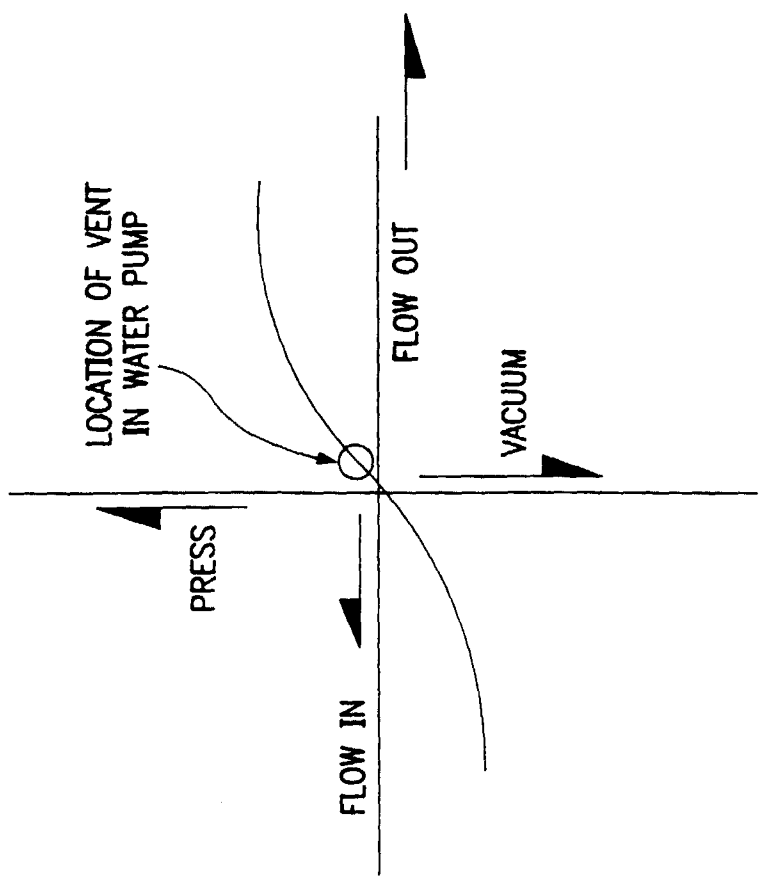

LOCATION OF VENT
IN WATER PUMP
FLOW OUT
VACUUM
PRESS
FLOW IN

FIG. 23

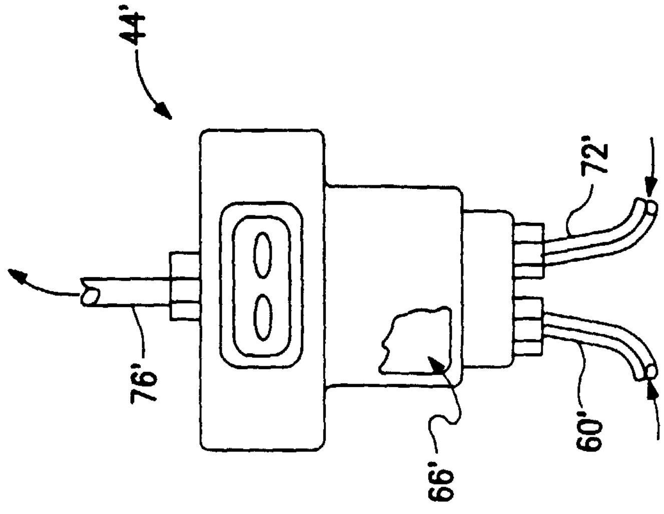

44'
76'
72'
66'
60'

FIG. 24