

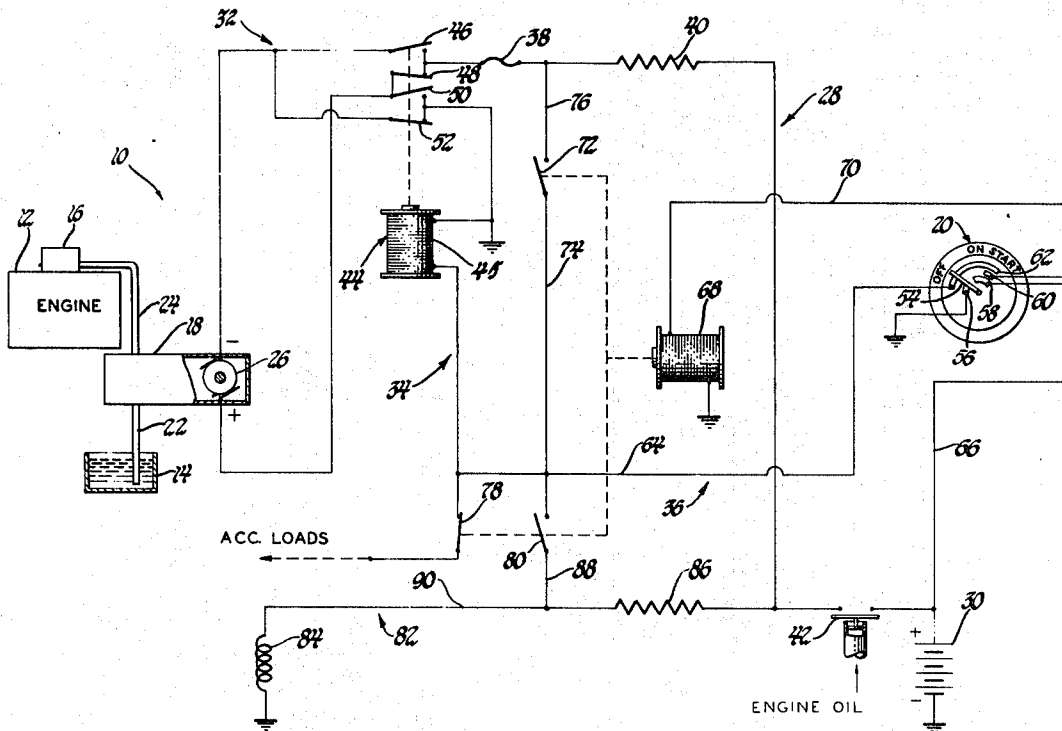
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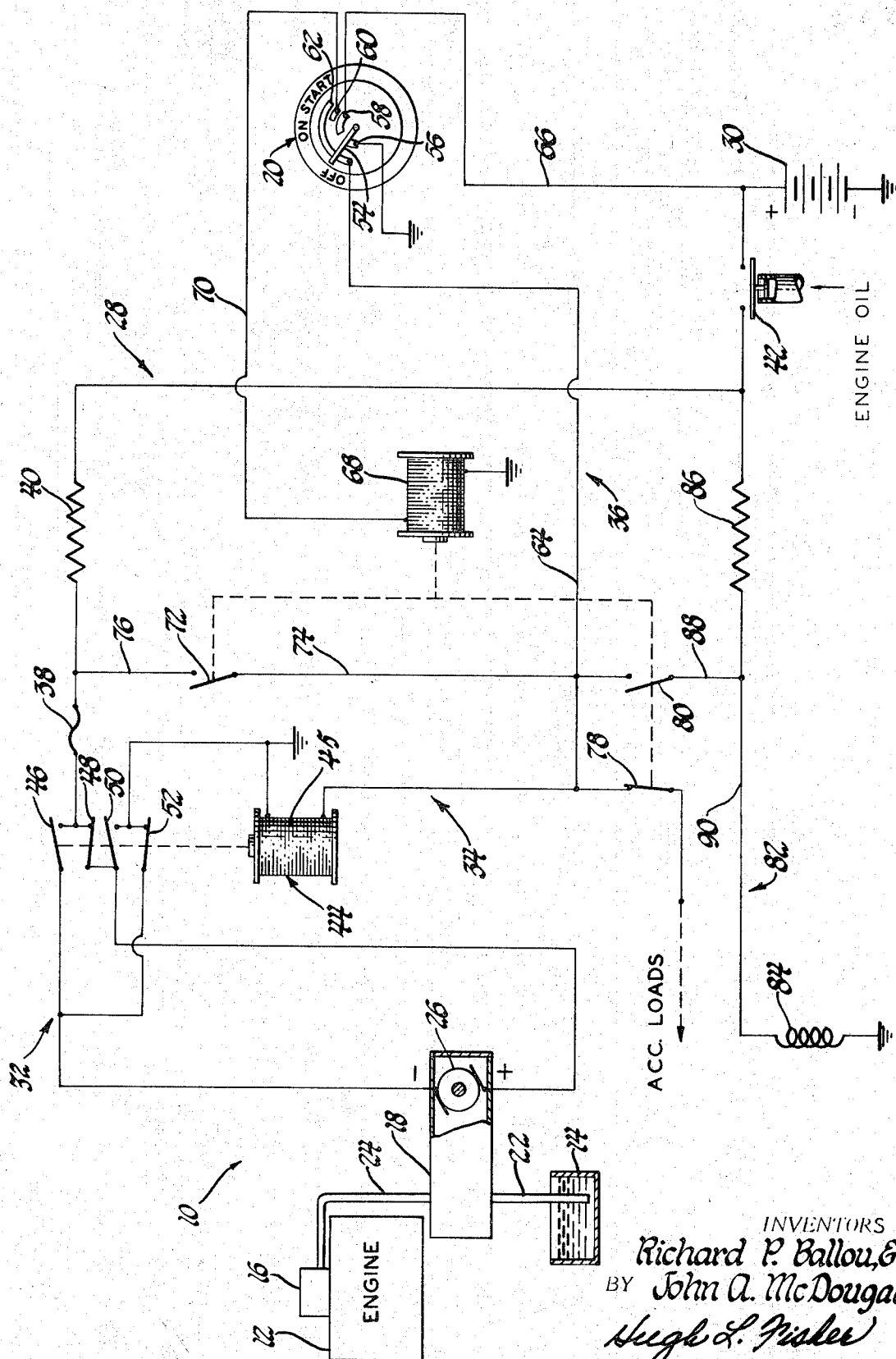
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[54] FUEL SUPPLY SYSTEM
13 Claims, 1 Drawing Fig.

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123/179; 417/10
[51] Int. Cl. F02m 59/42
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179; 417/10

ABSTRACT: A fuel supply system for transferring fuel between a reservoir and an engine. The apparatus incorporates a reversible electric fuel pump and a pump control circuit for controlling the transfer of fuel by the pump in accordance with the setting of a plural setting engine controller. The fuel pump transfers fuel to the engine to facilitate starting and operating the engine and withdraws fuel from the engine to stop the engine. A bypass network is provided for operating the pump and an ignition coil at increased voltages when starting the engine.





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FUEL SUPPLY SYSTEM

This invention relates to fuel supply systems and in particular to improvements in fuel supply systems for motor vehicles in which fuel is transferred between a fuel reservoir and an engine.

Fuel supply systems presently used in motor vehicles for supplying an engine with fuel from a fuel reservoir are unidirectional in operation as they utilize fuel pumps operable only to transfer fuel from the fuel reservoir to the engine. Since the primary purpose of fuel supply systems is to transfer fuel from the reservoir to the engine these prior systems perform satisfactorily when the engine is in operation. However, when the engine is stopped after a period of operation, these systems retain a significant quantity of fuel in proximity to the engine, which fuel is subject to evaporation loss due to heat from the engine while the engine cools.

It is therefore an object of this invention to provide a novel fuel supply system for an engine in which fuel is transferred from a reservoir to the engine when the engine is to be operated and from the engine to the reservoir when the engine is to be stopped, the engine being stopped by withdrawing its supply of fuel.

Another object of the invention is to provide an engine fuel supply system capable of providing an increased quantity of power to a fuel pump when starting the engine so as to drive the fuel pump faster and thereby increase the quantity of fuel being transferred by the pump to the engine when the engine is being started.

An additional object of this invention is to provide a fuel supply system for an engine that is particularly suited for combining with a vehicle ignition network so as to enhance the operation of the vehicle ignition network by providing an ignition coil with an increased voltage when starting the engine.

A further object of this invention is to provide a fuel supply system for an engine which is normally used to stop the engine by transferring fuel from the engine to a reservoir and which includes a provision for rapid engine restarting by not transferring fuel from the engine to the reservoir when the engine is stalled due to an overload condition.

The foregoing and other objects and advantages of the invention will become apparent from the following description and the accompanying drawing, in which is presented a schematic diagram of a fuel supply system incorporating the principles of the invention.

Referring now to the drawing, a fuel supply system 10 is provided to deliver fuel to an engine 12 from a fuel reservoir 14. In a typical application of this invention the engine 12 would be an internal combustion engine operable to power a motor vehicle and the reservoir 14 would be the vehicle's fuel tank.

In addition to the fuel reservoir 14 the fuel supply system 10 in the illustrated embodiment includes a carburetor 16 for mixing fuel with air and introducing the fuel-air mixture to the engine 12, the carburetor 16 being of a conventional design that has been modified in a fashion familiar to persons skilled in the art so as to permit the withdrawal of fuel therefrom, a reversible electric fuel pump 18 for transferring fuel between the reservoir 14 and the engine 12, a pump control circuit 28 for controlling the supply of electric energy to the pump 18, and a switch 20, e.g., an ignition switch, that is used as a plural setting engine controller. The pump 18 is operative in accordance with the setting of the switch 20. While any reversible electric fuel pump may be used for the pump 18, the pump described in Shultz et al. U.S. Pat. No. 3,418,991 is suggested as being of a suitable design for use in the fuel supply system 10 and can be, as will be understood by those versed in the art, made to rotate in either direction by reversing the armature connections.

The ignition switch 20 may be of any conventional design presently found in motor vehicles. In the illustrated embodiment it is of a type having OFF, ON, and START positions to obtain engine off, engine on, and engine starting conditions, respectively. When the engine 12 is to be operated the ignition

switch 20 is manually placed in the ON or START position, which positions enable the pump 18 to transfer fuel from the reservoir 14 through a pair of conduits 22 and 24 to the engine 12. When the engine 12 is to be stopped, the ignition switch 20 is placed in the OFF position, which position causes the pump 18 to withdraw fuel from the engine 12 by draining the carburetor 16 until the engine 12 is stopped due to a lack of fuel.

While the pump 18 and the ignition switch 20 shown in the illustrated embodiment are electric devices, persons skilled in the art will appreciate the reversible pumps and engine controllers of various other types may be used in place of these units. For example, the pump 18 may be replaced by a fluid driven pump and a plural setting engine controller utilizing fluid valves may be used in conjunction with such a pump in place of the ignition switch 20.

In the embodiment herein described the pump 18 includes a reversible D.C. motor 26 for driving the pump 18. The direction and rate of fuel transfer by the pump 18 are dependent upon the polarity and the magnitude of electric energy supplied to the motor 26. The pump control circuit 28 controls the supply of electric energy to the motor 26 in accordance with the ignition switch 20 position.

The pump control circuit 28 is powered by an electric power source, shown as a battery 30 in the drawing, and includes a pump energization network 32 for providing energization of the motor 26 by the battery 30, a direction control network 34 for controlling the motor 26 polarity in the pump energization network 32 so as to control the direction in which the pump 18 transfers fuel when the motor 26 is energized, and a bypass network 36 for providing the motor 26 with an increased quantity of electric energy when starting the engine 12. It should be noted at this point that the direction control network 34 does not itself provide energization of the motor 26 but merely controls the motor 26 polarity in the pump energization network 32 so as to control the direction in which the motor 26 drives the pump 18 when the motor 26 is energized by the pump energization network 32.

The pump energization network 32 includes the motor 26, a fuse 38 for protecting the circuits from excessive currents, a voltage limiting resistor 40 for reducing the voltage applied to the motor 26 by the battery 30 and for protecting the motor 26 from current surges produced by reversing the motor 26 polarity in the pump energization network 32 when the motor 26 is energized, and an engine responsive switch 42 for completing a current path from the battery 30 through the voltage limiting resistor 40 and the fuse 38 to the motor 26. For reasons which will be later explained. The motor 26 is energized through the voltage limiting resistor 40 only when the engine 12 is in operation. The engine responsive switch 42 is therefore selected to be of a type that is closed when the engine 12 is in operation and open when the engine 12 is stopped. As persons skilled in the art will appreciate, several parameters of the engine 12, such as oil pressure, engine coolant pressure, and engine speed may be used to close the engine responsive switch 42 when the engine 12 is in operation and open the engine responsive switch 42 when the engine 12 is stopped. In the illustrated embodiment the engine responsive switch 42 is shown to be of a type responsive to the engine 12 oil pressure.

The direction control network 34 includes a direction control relay 44 having a winding 45 and a plurality of contacts 46, 48, 50, and 52. Energization of the direction control relay 44 is controlled by the switch 20, which in the illustrated embodiment includes a wiper 54 and a plurality of terminals 56, 58, 60, and 62. The wiper 54 and the terminals 56, 58, 60, and 62 are of electrically conductive material, such as copper, and serve to complete various current paths through the switch 20.

The direction control relay 44 is deenergized by placing the switch 20 in the OFF position so as to connect the direction control relay 44 to ground through a lead 64, the terminal 62, the wiper 54, and the terminal 56. When the direction control relay 44 is deenergized the contacts 48 and 52 are closed so as to connect the motor 26 in the pump energization network 32

according to the polarity indicated in the drawing. The pump 18 can only transfer fuel from the engine 12 to the reservoir 14 when the motor 26 is connected in the pump energization network 32 according to this polarity.

The direction control relay 44 is energized by placing the ignition switch 20 in the ON or START position, which connects the direction control relay 44 to the battery 30 through the lead 64, the terminal 62, the wiper 54, the terminal 58, and a lead 66. When the direction control relay 44 is energized the contacts 48 and 52 are open and the contacts 46 and 50 are closed so as to connect the motor 26 in the pump energization network 32 according to a polarity opposite that shown in the drawing. Energizing the direction control relay 44 thus connects the motor 26 in the pump energization network 32 according to the polarity required for the pump 18 to transfer fuel from the reservoir 14 to the engine 12.

The bypass network 36 provides an increased voltage to the motor 26 when starting the engine 12 by completing a low impedance current path from the battery 30 to the fuse 38 so as to bypass the engine responsive switch 42 and the resistor 40. Virtually the entire battery 30 voltage is applied to the motor 26 when the voltage limiting resistor 40 is bypassed. By applying the entire battery 30 voltage to the motor 26 when starting the engine 12, the pump 18 is driven faster and transfers an increased quantity of fuel to the carburetor 16, reducing the time required for fuel to be introduced to the engine 12. This feature is especially useful after the engine 12 has been turned off by using the pump 18 to empty the carburetor 16 of fuel.

The bypass network 36 is actuated by placing the ignition switch 20 in the START position. Placing the ignition switch 20 in the START position energizes a starting relay 68 by completing a current path from the battery 30 through the lead 66, the terminal 58, the wiper 54, the terminal 60, a lead 70 and the starting relay 68. When the starting relay 68 is energized it closes a set of contacts 72 so as to complete the bypass network 36 from the battery 30 through the lead 66, the terminal 58, the wiper 54, the terminal 62, the lead 64, a lead 74, the contacts 72, and a lead 76 to the fuse 38. It is thus apparent that the motor 26 is provided with an increased voltage through the bypass network 36 when the engine 12 is being started.

The starting relay 68 may also be provided with sets of contacts 78 and 80 for combining the pump control circuit 28 with the various accessory devices presently found in motor vehicles and a conventional ignition network 82. When the starting relay 68 is energized by placing the ignition switch 20 in the START position the contacts 78 are opened and the contacts 80 are closed. Opening the contacts 78 relieves the battery 30 of excessive current drain when starting the engine 12 by opening the current paths to the various accessory devices in the vehicle while closing the contacts 80 provides for supplying the engine 12 with ignition energy when starting the engine 12, as will now be explained.

As in disclosed in the drawing, the ignition network 82 and the pump control circuit 28 may be combined by connecting the ignition network 82 in series with the switch 42 and the battery 30. The ignition network 82 is comprised of an ignition coil 84 for producing ignition pulses and a voltage dropping resistor 86 for limiting the voltage applied to the coil 84 through the engine responsive switch 42 to a level less than the battery 30 voltage. In a typical installation this voltage is approximately one-half the battery 30 voltage. Since the engine responsive switch 42 is closed by the engine 12 oil pressure, the coil 84 is only energized through the voltage dropping resistor 86 when the engine 12 is in operation. The coil 84 is energized by the bypass network 36 through the contacts 80 when starting the engine 12.

As was previously explained with regard to energization of the motor 26, placing the ignition switch 20 in the START position connects the lead 64 to the battery 30 through the ignition switch 20 and also energizes the starting relay 68. When the starting relay 68 is energized it closes the contacts 80 so as to connect the lead 64 to the coil 84 through a lead 88 and a

lead 90. Virtually the entire battery 30 voltage is thus applied to the coil 84 when starting the engine 12. The increased voltage applied to the coil 84 enables the coil 84 to provide an increased ignition pulse to the engine 12 so as to facilitate starting the engine 12.

The operation of the fuel supply system 10 will now be explained. When the engine 12 is stopped and the ignition switch 20 is in the OFF position the pump control circuit 28 is deenergized and the pump 18 is not transferring fuel. When it is desired to start the engine 12 the ignition switch 20 is placed in the START position so as to cause the battery 30 to energize the relays 44 and 68 through the lead 66, the terminal 58, the wiper 54, the terminals 60 and 62, and the leads 64 and 70, respectively.

When the direction control relay 44 is energized it closes the contacts 46 and 50 so as to connect the motor 26 in the pump energization network 32 according to the polarity needed for the pump 18 to transfer fuel from the reservoir 14 to the carburetor 16. When the starting relay 68 is energized it opens the contacts 78 so as to reduce the load placed on the battery 30 by the various accessory loads in the vehicle and closes the contacts 72 and 80 so as to permit energization of the motor 26 and the ignition coil 84 through the lead 64, which is at the battery 30 voltage. The pump 18 is thus driven so as to transfer fuel from the reservoir 14 to the carburetor 16 and the ignition coil 84 is made operative to supply ignition energy to the engine 12 while the engine 12 is being cranked in a conventional fashion, as by using a starting motor.

Once the engine 12 has been started the ignition switch 20 is placed in the ON position so as to deenergize the starting relay 68. Deenergizing the starting relay 68 causes it to close the contacts 78 so as to connect the various vehicle accessory devices to the battery 30 through the lead 64 and opens the contacts 72 and 80 so as to permit energization of the motor 26 and the coil 84 through the engine responsive switch 42 and the resistors 40 and 86, respectively.

As persons skilled in the art will appreciate, it is necessary that the contacts 72 and 80 remain closed at least until the engine responsive switch 42 closes so as to continue the energization of the motor 26 and the ignition coil 84 without interruption. To assure that energization of the motor 26 and the coil 84 is not interrupted, the starting relay 68 may be of a slow-release-type that does not drop out until a brief period has elapsed after it is deenergized. Since the engine responsive switch 42 closes very fast when the engine 12 is started, preventing the starting relay 68 from dropping out for approximately one second has been found to be sufficient to assure that the engine responsive switch 42 is closed before the contacts 72 and 80 are opened.

When the contacts 72 and 80 open, the resistors 40 and 86 reduce the voltages applied to the motor 26 and the ignition coil 84 to less than the battery 30 voltage. The motor 26 and the ignition coil 84 are therefore designed for operation at voltages less than the battery 30 voltage and use of the bypass network 36 when starting the engine 12 permits driving the motor 26 and the ignition coil 84 at voltages in excess of their design voltages so as to increase the transfer of fuel and ignition energy to the engine 12 when the engine 12 is being started. Because of the short time in which an increased voltage is applied to the motor 26 and the coil 84 when starting the engine 12, no damage to these units results from applying the increased voltages to them.

When it is desired to stop the engine 12 the ignition switch 20 is placed in the OFF position as shown in the drawing, deenergizing the direction control relay 44 by connecting it to ground through the lead 64, the terminal 62, the wiper 54, and the terminal 56. When the direction control relay 44 is deenergized it reverses the polarity of the motor 26 in the pump energization network 32, causing the pump 18 to transfer fuel from the engine 12 to the reservoir 14. Since the ignition network 82 continues to be energized by the battery 30 through the engine responsive switch 42 so long as the engine 12 is in operation, the engine 12 continues to operate

until it runs out of fuel. When the engine 12 stops it loses its oil pressure and opens the engine responsive switch 42. Opening the switch 42 deenergizes both the pump control circuit 28 and the ignition network 82.

The vehicle operator may restart the engine 12 simply by turning the ignition switch 20 to the START position as previously described.

Should the engine 12 oil pressure be lost due to stalling or some other reason prior to placing the ignition switch 20 in the OFF position, the engine responsive switch 42 will open as soon as the engine 12 oil pressure releases it. When the engine responsive switch 42 is opened it deenergizes the pump control circuit 28 and the motor 26 so as to stop the transfer of fuel and ignition energy to the engine 12. Since fuel is not withdrawn from the engine 12 by the pump 18 prior to the engine 12 stalling, the engine 12 may be immediately restarted after a stall without having to wait until the pump 18 has filled the carburetor 16 with fuel.

While many variations of this invention will be apparent to those skilled in the art it is understood that the invention is to be limited only by the following claims.

We claim:

1. In a fuel supply system for an engine, the combination of a plural setting engine controller, a fuel reservoir, a reversible fuel pump for transferring fuel between the engine and the reservoir, a power source for driving the pump, and pump control means operative to control the drive direction of the fuel pump by the power source in accordance with the setting of the engine controller so that when the engine is to be operated the pump supplies fuel to the engine and when the engine is to be stopped the pump withdraws fuel from the engine.

2. In a fuel supply system for an engine, the combination of a fuel reservoir, a reversible fuel pump for transferring fuel between the engine and the reservoir, a power source for driving the pump, a plural setting engine controller, and pump control means for controlling the supply of power from the power source to the pump, the pump control means including direction control means operative to control the drive direction of the fuel pump by the power source in accordance with the setting of the engine controller so that when the engine is to be operated the pump supplies fuel to the engine and when the engine is to be stopped the pump withdraws fuel from the engine.

3. In a fuel supply system for an engine, the combination of a plural setting engine controller, a fuel reservoir, a reversible fuel pump for transferring fuel between the engine and the reservoir, a power source for driving the pump, and pump control means for controlling the supply of power to the pump, the pump control means including direction control means operative to control the drive direction of the fuel pump by the power source in accordance with the setting of the engine controller so that when the engine is to be operated the pump supplies fuel to the engine and when the engine is to be stopped the pump withdraws fuel from the engine and bypass means also operative in accordance with the setting of the engine controller so as to increase the power supplied to the pump when the engine is to be started.

4. In a fuel supply system for an engine, the combination of a fuel reservoir, a reversible electric pump for transferring fuel between the reservoir and the engine, a power source for driving the pump, a plural setting engine controlling switch, and a pump control circuit for controlling the supply of power from the power source to the pump so as to drive the pump in accordance with the setting of the engine controlling switch so that when the engine is to be operated the pump supplies fuel to the engine and when the engine is to be stopped the pump withdraws fuel from the engine, the pump control circuit including a bypass network also operative in accordance with the setting of the engine controlling switch so as to increase the power supplied to the pump when the engine is to be started.

5. In a fuel supply system for an engine, the combination of a plural setting engine controlling switch including engine On, engine Off, and engine Starting settings, a fuel reservoir, a reversible electric pump for transferring fuel between the reservoir and the engine, a power source for driving the pump, and a pump control circuit for controlling the supply of power to the pump from the power source, the pump control circuit including a pump energization network for controlling the energization of the pump by the power source in accordance with the setting of the engine controlling switch and the engine operation so that when the engine controlling switch is in the engine Off or engine On position and the engine is in operation or when the engine controlling switch is in the engine Starting position the power source energizes the pump, and a direction control network operative in accordance with the setting of the engine controlling switch so that when the engine controlling switch is in the engine On or engine Starting position the pump may be energized by the power source for operation in a direction to supply fuel to the engine and when the engine controlling switch is in the engine Off position the pump may be energized by the power source for operation in a direction to withdraw fuel from the engine.

6. In a fuel supply system for an engine, the combination of a plural setting engine controlling switch including engine On, engine Off, and engine Starting settings, a fuel reservoir, a reversible electric pump for transferring fuel between the reservoir and the engine, a power source for driving the pump, and a pump control circuit for controlling the supply of power to the pump from the power source, the pump control circuit including a pump energization network for controlling the energization of the pump by the power source in accordance with the setting of the engine controlling switch and the engine operation so that when the engine controlling switch is in the engine Off or engine On position and the engine is in operation or when the engine controlling switch is in the engine Starting position the power source energizes the pump, and a direction control network operative in accordance with the setting of the engine controlling switch so that when the engine controlling switch is in the engine On or engine Starting position the pump may be energized by the power source for operation in a direction to supply fuel to the engine and when the engine controlling switch is in the engine Off position the pump may be energized by the power source for operation in a direction to withdraw fuel from the engine, and a bypass network also operative in accordance with the setting of the engine controlling switch so as to increase the power supplied to the pump when starting the engine.

7. In a fuel supply system for an engine, the combination of a plural setting engine controlling switch including engine On, engine Off, and engine Starting settings, a fuel reservoir, a reversible electric pump for transferring fuel between the reservoir and the engine, a power source for driving the pump, and a pump control circuit for controlling the supply of power to the pump from the power source, the pump control circuit including a pump energization network for controlling the energization of the pump by the power source in accordance with the setting of the engine controlling switch and the engine operation so that when the engine controlling switch is in the engine Off or engine On position and the engine is in operation or when the engine controlling switch is in the engine Starting position the power source energizes the pump, the pump energization network including a voltage limiting resistor and an engine responsive switch in series with the pump and the power source for supplying the pump with a reduced voltage from the power source when the engine is in operation, a direction control network for controlling the direction in which the pump transfers fuel in accordance with the setting of the engine controlling switch so that when the engine controlling switch is in the engine On or engine Starting position the pump may be energized by the power source for operation in a direction to supply fuel to the engine and when the engine controlling switch is in the engine Off position the pump may be energized by the power source for operation in a

direction to withdraw fuel from the engine, and a bypass network operative in accordance with the setting of the engine controlling switch so as to increase the power supplied to the pump when starting the engine by increasing the voltage applied to the pump.

8. In a fuel supply system for an engine, the combination of a plural setting engine controlling switch including engine On, engine off, and engine Starting settings, a fuel reservoir, a reversible electric pump for transferring fuel between the reservoir and the engine, a power source for driving the pump, and a pump control circuit for controlling the supply of power to the pump from the power source, the pump control circuit including a pump energization network for controlling the energization of the pump by the power source in accordance with the setting of the engine controlling switch and the engine operation so that when the engine controlling switch is in the engine Off or engine On position and the engine is in operation or when the engine controlling switch is in the engine Starting position the power source energizes the pump, the pump energization network including a voltage limiting resistor and an engine responsive switch in series with the pump and the power source for supplying the pump with a reduced voltage from the power source when the engine is in operation, a direction control network for controlling the direction in which the pump transfers fuel, the direction control network including a direction control relay in series with the engine controlling switch and the power source for controlling the polarity of the pump in the pump energization network in accordance with the setting of the engine controlling switch so that when the engine controlling switch is in the engine On or engine Starting position the pump may be energized by the power source for operation in a direction to supply fuel to the engine and when the engine controlling switch is in the engine Off position the pump may be energized by the power source for operation in a direction to withdraw fuel from the engine, and a bypass network for increasing the power supplied to the pump when starting the engine, the bypass network including a starting relay for closing a low resistance current path from the power source to the pump in accordance with the setting of the engine controlling switch so that when the engine controlling switch is in the engine Starting position the power supplied to the pump is increased by increasing the voltage applied to the pump.

9. In a fuel supply system for an engine, the combination of a fuel reservoir, a reversible fuel pump for transferring fuel between the reservoir and the engine, a power source for driving the pump, a plural setting engine controller, pump control means for controlling the supply of power to the pump, the pump control means including direction control means operative to control the drive direction of the fuel pump by the power source in accordance with the setting of the engine controller so that when the engine is to be operated the pump supplies fuel to the engine and when the engine is to be stopped the pump withdraws fuel from the engine, and ignition means for supplying ignition energy to the engine, the ignition means being energized by the power source, the pump control means also including bypass means operative in accordance with the setting of the controller so as to increase the power supplied to both the pump and to the ignition means when the engine is to be started.

10. In a fuel supply system for an engine, the combination of a fuel reservoir, a reversible electric pump for transferring fuel between the reservoir and the engine, a power source for driving the pump, a plural setting engine controlling switch, a pump control circuit for controlling the supply of power from the power source to the pump so as to drive the pump in accordance with the setting of the engine controlling switch so that when the engine is to be operated the pump supplies fuel to the engine and when the engine is to be stopped the pump withdraws fuel from the engine, and an ignition network for supplying ignition energy to the engine, the ignition network including an ignition pulse producing ignition coil energized by the power source, the pump control circuit including a

bypass network operative in accordance with the setting of the engine controlling switch so as to increase the power supplied to both the pump and to the ignition coil when the engine is to be started.

11. In a fuel supply system for an engine, the combination of a plural setting engine controlling switch including engine On, engine Off, and engine Starting settings, a fuel reservoir, a reversible electric pump for transferring fuel between the reservoir and the engine, a power source for driving the pump, a pump control circuit for controlling the supply of power to the pump from the power source, the pump control circuit including a pump energization network for controlling the energization of the pump by the power source in accordance with the setting of the engine controlling switch and the engine operation so that when the engine controlling switch is in the engine Off or engine On position and the engine is in operation or when the engine controlling switch is in the engine Starting position the power source energizes the pump, and a direction control network operative in accordance with the setting of the engine controlling switch so that when the engine controlling switch is in the engine On or engine Starting position the pump may be energized by the power source for operation in a direction to supply fuel to the engine and when the engine controlling switch is in the engine Off position the pump may be energized by the power source for operation in a direction to withdraw fuel from the engine, and an ignition network for supplying ignition energy to the engine, the ignition network including an ignition pulse producing ignition coil energized by the power source, the pump control circuit also including a bypass network operative in accordance with the setting of the engine controlling switch so as to increase the power supplied to both the pump and to the ignition coil when the engine is to be started.

12. In a fuel supply system for an engine, the combination of a plural setting engine controlling switch including engine On, engine Off, and engine Starting settings, a fuel reservoir, a reversible electric pump for transferring fuel between the reservoir, and the engine, a power source for driving the pump, a pump control circuit for controlling the supply of power to the pump from the power source, the pump control circuit including a pump energization network for controlling the energization of the pump by the power source in accordance with the setting of the engine controlling switch and the engine operation so that when the engine controlling switch is in the engine Off or engine On position and the engine is in operation or when the engine controlling switch is in the engine Starting position the power source energizes the pump, the pump energization network including a voltage limiting resistor and an engine responsive switch in series with the pump and the power source for supplying the pump with a reduced voltage from the power source when the engine is in operation, and a direction control network for controlling the direction in which the pump transfers fuel in accordance with the setting of the engine controlling switch so that when the engine controlling switch is in the engine On or engine Starting position the pump may be energized by the power source for operation in a direction to supply fuel to the engine and when the engine controlling switch is in the engine Off position the pump may be energized by the power source for operation in a direction to withdraw fuel from the engine, and an ignition network for supplying ignition energy to the engine in accordance with the setting of the engine controlling switch and the engine responsive switch so that when the engine controlling switch is in the engine Off or engine On position and the engine responsive switch is closed or when the engine controlling switch is in the engine Starting position the ignition network supplies ignition energy to the engine, the ignition network including an ignition pulse producing ignition coil energized by the power source, the pump control circuit also including a bypass network for increasing the power supplied to both the pump and to the ignition coil when starting the engine in accordance with the setting of the engine controlling switch so that when the engine controlling switch is in the en-

gine Starting position the power supplied both to the pump and to the ignition coil is increased by supplying an increased voltage both to the pump and to the ignition coil.

13. In a fuel supply system for an engine, the combination of a plural setting engine controlling switch including engine On, engine Off, and engine Starting settings, a fuel reservoir, a reversible electric pump for transferring fuel between the reservoir and the engine, a power source for driving the pump, a pump control circuit for controlling the supply of power to the pump from the power source, the pump control circuit including a pump energization network for controlling the energization of the pump by the power source in accordance with the setting of the engine controlling switch and the engine operation so that when the engine controlling switch is in the engine Off or engine On position and the engine is in operation or when the engine controlling switch is in the engine Starting position the power source energizes the pump, the pump energization network including a voltage limiting resistor and an engine responsive switch in series with the pump and the power source for supplying the pump with a reduced voltage from the power source when the engine is in operation, and a direction control network for controlling the direction in which the pump transfers fuel, the direction control network including a direction control relay in series with the engine controlling switch and the power source for con-

trolling the polarity of the pump in the pump energization network in accordance with the setting of the engine controlling switch so that when the engine controlling switch is in the engine On or engine Starting position the pump may be energized by the power source for operation in a direction to supply fuel to the engine and when the engine controlling switch is in the engine Off position the pump may be energized by the power source for operation in a direction to withdraw fuel from the engine, and an ignition network for supplying ignition energy to the engine, the ignition network including an ignition pulse producing ignition coil and a voltage dropping resistor in series with the engine responsive switch and the power source so as to supply the ignition coil with a reduced voltage from the power source, the pump control circuit also including a bypass network for increasing the power supplied to both the pump and to the ignition coil when starting the engine, the bypass network including a relay for closing low impedance current paths from the power source to both the pump and to the ignition coil in accordance with the setting of the engine controlling switch so that when the engine controlling switch is in the engine Starting position the power supplied both to the pump and to the ignition coil is increased by supplying an increased voltage both to the pump and to the ignition coil.

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