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[54] **FUEL PUMP SAFETY CIRCUITRY**
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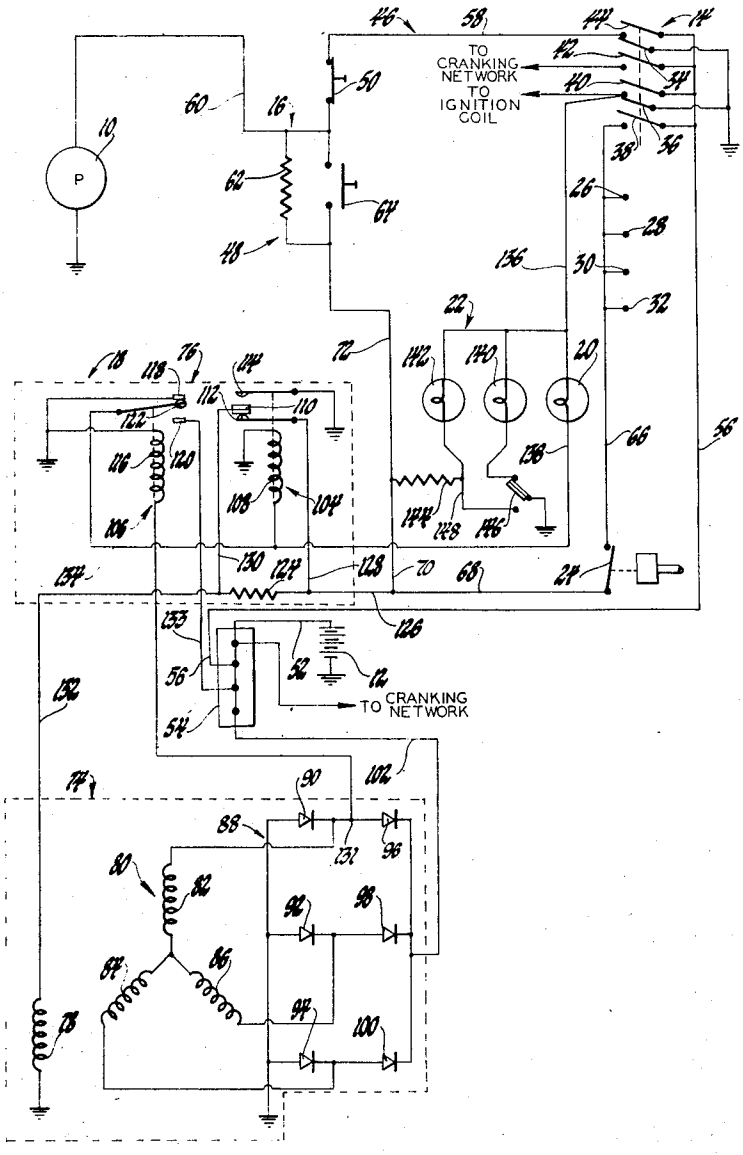
ABSTRACT: Vehicle circuitry having provisions for increasing the fuel transfer capability of a fuel pump when starting an engine, preventing the fuel pump from transferring fuel to the engine when the engine is flooded, operating the fuel pump at a plurality of speeds in accordance with the engine throttle setting, advising a vehicle operator that the engine oil pressure in the vehicle is insufficient to properly lubricate the engine by energizing a telltale network that is normally used to monitor various other conditions in the vehicle, stopping the engine by removing its supply of fuel when the engine loses oil pressure and permitting the vehicle operator to temporarily maintain the supply of fuel to the engine when the engine loses oil pressure by manipulating an ignition switch, checking the operativeness of the telltale network by completing current paths to ground through a plurality of telltales and a generator field winding when the engine is stopped and the ignition switch is in an engine on setting, and energizing a generator telltale when a rectifier in a rectifier network is inoperative and the ignition switch is in an engine off setting.



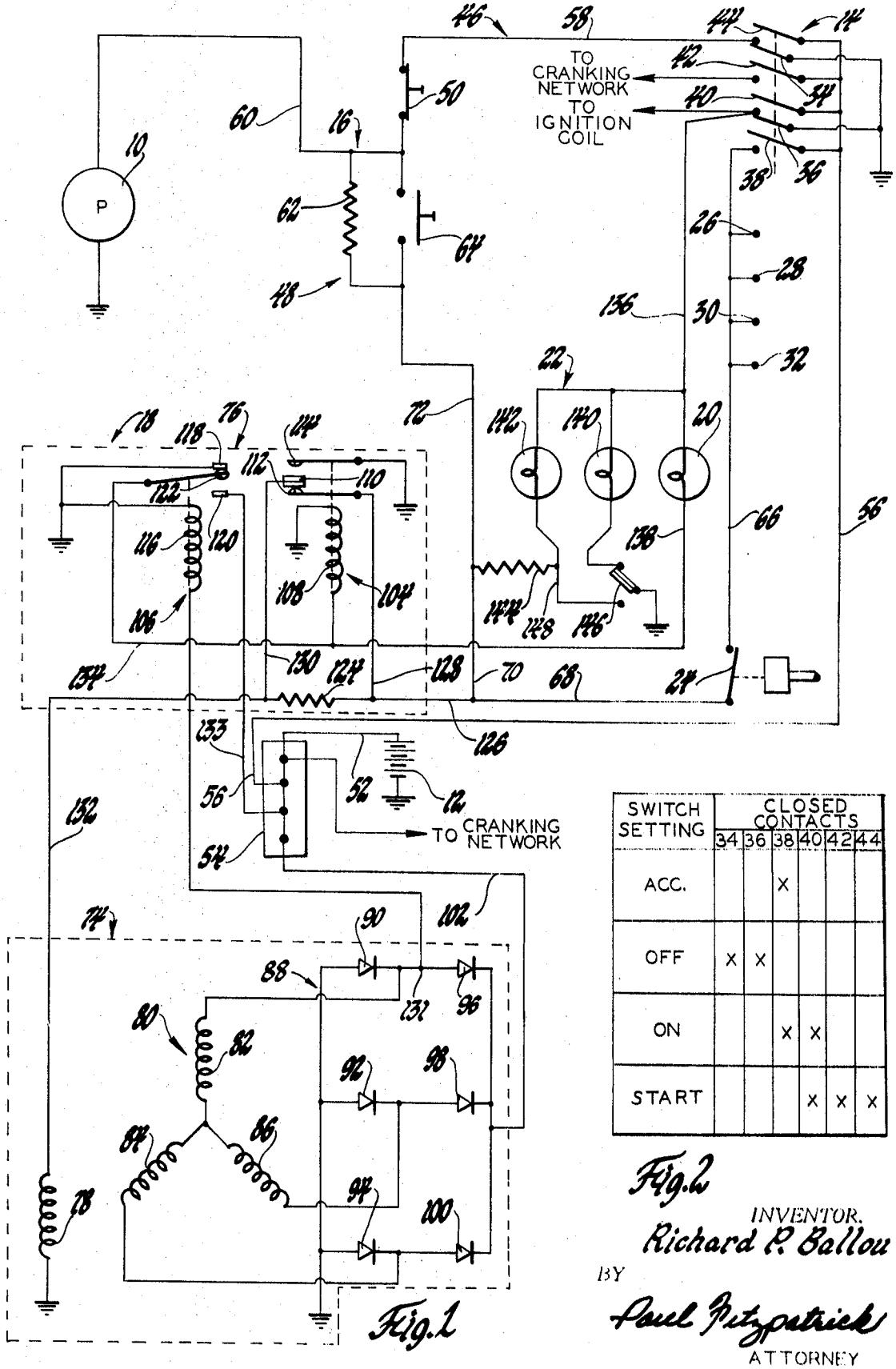


Fig. 1

SWITCH SETTING	CLOSED CONTACTS					
	34	36	38	40	42	44
ACC.			X			
OFF	X	X				
ON			X	X		
START				X	X	X

Fig. 2

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FUEL PUMP SAFETY CIRCUITRY

This invention relates to vehicle circuitry and in particular to circuitry for engine-driven vehicles.

Because the requirements of motor vehicles have undergone an evolutionary process in the last several years, due in part to many technological innovations, innumerable vehicle circuits have been developed to provide various desired features. The circuits in common use, however, have been designed primarily with a view to achieving a new result and have thus been combined with existing circuits to the detriment of overall efficiency. The subject circuitry is therefore directed both toward providing vehicle circuitry having new and different features by enhancing the operation of components presently used in vehicle circuits and toward improving the overall design of the vehicle circuitry.

It is therefore an object of this invention to provide motor vehicle circuitry having a provision for increasing the rate at which an electric fuel pump transfers fuel to an engine in accordance with the setting of the engine throttle so as to increase the fuel transfer capability of the fuel pump when the engine is to be operated at high speeds.

It is also an object of this invention to provide vehicle circuitry having a provision for discontinuing the operation of an electric fuel pump in accordance with the engine throttle setting when starting a flooded engine.

A further object of this invention is to provide vehicle circuitry having a provision for stopping an engine by discontinuing the supply of fuel to the engine when the engine oil pressure is insufficient to properly lubricate the engine and for permitting the vehicle operator to temporarily maintain the supply of fuel to the engine by manipulation of an ignition switch so as to temporarily continue the engine operation.

Another object of this invention is to provide vehicle circuitry having a provision for warning of a loss of oil pressure and impending stoppage of an engine by energizing a telltale network that is normally used to monitor various conditions in the vehicle other than the engine oil pressure.

It is an additional object of this invention to provide vehicle circuitry having a provision for checking the operation of a plurality of telltales that are normally used to monitor various conditions in the vehicle other than the operativeness of a generator by completing a current path to ground through the telltales and the field of the generator.

It is another object of this invention to provide vehicle circuitry having a provision for energization of a voltage regulator coil directly from the output of a generator so as to render the coil operation independent of accessory loads in the vehicle.

It is also an object of this invention to provide vehicle circuitry having a provision for energizing the field of an engine-driven generator through a switch responsive to oil pressure in the engine.

It is still another object of this invention to provide vehicle circuitry having a provision for checking the presence of a shorted positive diode in the rectifier of an AC generator by energizing a field relay in a voltage regulator assembly so as to complete a current path to ground through a generator operation telltale and an engine controlling switch that is placed in an engine off setting.

The foregoing and other objects and advantages of the invention will become apparent from the following description and from the accompanying drawings, in which FIG. 1 illustrates schematically a vehicle circuit incorporating the principles of the invention and FIG. 2 presents in table form the switching sequence of an ignition switch disclosed in FIG. 1.

As is seen in FIG. 1, the subject circuitry is comprised of an electric fuel pump 10 for transferring fuel from a fuel reservoir (not shown) to an engine (not shown), a power source, shown as a battery 12, for energizing the circuitry, an engine controlling switch 14 for controlling the energization of the circuitry by the battery 12, a pump energization network 16 for controlling the energization of the pump 10 by the battery 12 in accordance with the setting of the engine controlling switch 14, a generator network 18 for recharging the battery 12 when

the engine is in operation, a generator telltale 20 for indicating a malfunction in the generator network 18, a telltale network 22 for monitoring various conditions in the vehicle, and an engine responsive switch 24 for controlling the energization of the pump 10, the telltale network 22, and the generator network 18 in accordance with the engine operation.

While various conventional electric fuel pumps may be used as the pump 10, the pump described in U.S. Pat. No. 3,418,991 to Shultz et al. is suggested as being suitable for use as the pump 10.

FIG. 1 also discloses how the subject circuitry may be combined with various other circuitry in a vehicle. For example, a set of terminals 26, 28, 30 and 32 may be provided for energizing various accessory loads from the battery 12 through the engine controlling switch 14. As persons skilled in the art will appreciate, the engine controlling switch 14 may also be used to control the operation of a cranking network (not shown) for starting the engine and an ignition coil (not shown) for providing the engine with ignition energy.

The engine controlling switch 14 is an ignition switch which may be of any conventional design, only its function being of concern to this invention. In the illustrated embodiment the ignition switch 14 has four distinct settings. These settings are ACC, OFF, ON, and START for engine Off with accessories On, engine Off with accessories Off, engine On with accessories On, and engine Starting with accessories Off conditions, respectively.

The ignition switch 14 includes a set of grounded contacts 34 and 36 and a set of ungrounded contacts 38, 40, 42 and 44. The contacts 34, 36, 38, 40, 42 and 44 are closed in accordance with the various engine controlling switch 14 settings as shown in FIG. 2. For example, referring to FIG. 2, when the ignition switch 14 is in the START setting only the contacts 40, 42 and 44 are closed.

The pump energization network includes a starting branch 46 for energizing the pump 10 when starting the engine and an operating branch 48 for energizing the pump 10 when operating the engine. The starting branch 46 includes a normally closed switch 50 responsive to the engine throttle setting. Placing the ignition switch 14 in the START setting energizes the pump 10 from the battery 12 through a current path that includes a lead 52, a junction block 54, a lead 56, the contacts 44, a lead 58, the normally closed switch 50, a lead 60, and the pump 10. The normally closed switch 50 is adapted to be opened when the engine throttle is fully opened, as when set for maximum engine speed, thereby preventing the pump 10 from transferring fuel to the engine so as to facilitate starting the engine when the engine is flooded.

The operating branch 48 is energized in accordance with the setting of the ignition switch 14 and the position of the engine responsive switch 24 so as to energize the pump 10 when the ignition switch 14 is in the ON setting and the engine is in operation. While the engine responsive switch 24 may be responsive to several engine parameters, such as engine speed and engine coolant pressure, the engine responsive switch 24 in the illustrated embodiment is selected to be responsive to the engine oil pressure.

The operating branch 48 includes a voltage dropping resistor 62 and a normally open switch 64 that is responsive to the engine throttle setting. When the ignition switch 14 is in the ON setting and the engine operation has caused the oil pressure switch 24 to be closed a current path is completed from the battery 12 through the lead 52, the junction block 54, the lead 56, the contacts 38, a lead 66, the oil pressure switch 24, a lead 68, a lead 70, a lead 72, the resistor 62, the lead 60, and the pump 10.

When the engine is to be operated at high speeds it is desirable that the fuel transfer capability of the pump 10 be increased so as to facilitate providing the engine with an increased quantity of fuel. This is achieved in the operating branch 48 by closing the normally open switch 64 in response to the engine throttle setting. In operating the engine at low speeds the engine throttle setting is such that the normally

open switch 64 is open, causing the pump 10 to be energized through the voltage dropping resistor 62, which is on the order of a 5 ohm unit and which produces about a 4 voltage drop. When it is desired to operate the engine at high speeds the engine throttle setting is changed, closing the normally open switch 64 and bypassing the voltage dropping resistor 62 so as to increase the power supplied from the battery 12 to the pump 10 by applying virtually the entire battery 12 voltage, usually about 12 volts, to the pump 10. The fuel transfer capability of the pump 10 is thus increased merely by changing the engine throttle setting. As persons skilled in the art will appreciate, a variable resistor may be used in place of the normally open switch 64 to provide the pump 10 with several levels of energization dependent upon the engine throttle setting so as to more closely match the pump 10 energization to the fuel consumption needs of the engine. The operating branch 48 will continue energization of the pump 10 in accordance with the engine throttle setting so long as the oil pressure switch 24 and the contacts 38 are closed.

The generator network 18 includes an engine-driven generator 74 for converting mechanical energy supplied by the engine to electric energy and a voltage regulator assembly 76 for controlling the generator 74 output. While the generator 74 may be of any conventional design, the generator 74 shown in the illustrated embodiment is the well-known generator manufactured by the Delco-Remy Division of the General Motors Corporation. The Delcotron includes a field winding 78 and a Y-connected stator winding 80, comprised of individual windings 82, 84 and 86, that combine in a well-known way to develop a three-phase AC output. The Delcotron also includes a full wave bridge rectifier network 88, comprised of individual rectifiers 90, 92, 94, 96, 98 and 100, for changing this three-phase output to a DC output, which is used to recharge the battery 12. The generator 74 output is supplied to the battery 12 through a lead 102, the junction block 54, and the lead 52 so as to recharge the battery 12 when the engine is in operation.

The generator 74 output is dependent upon the energization of the field winding 78, which is controlled by the voltage regulator assembly 76. The voltage regulator assembly 76 includes a voltage regulator 104 and a field relay 106. The voltage regulator 104 includes a voltage regulator coil 108, a fixed contact 110 and a pair of movable contacts 112 and 114. The field relay 106 includes a relay winding 116, a pair of fixed contacts 118 and 120 and a movable contact 122. The voltage regulator assembly 76 also includes a current limiting resistor 124, the purpose of which will later become apparent.

The voltage regulator assembly 76 may be of several conventional designs. The voltage regulator assembly 76 in the illustrated embodiment is the unit manufactured by the Delco-Remy Division of the General Motors Corporation under Part No. 1119515. This unit has been modified for use in the illustrated embodiment by grounding the fixed contact 118 and by providing for electrical separation of the voltage sensitive coil 108 from the movable contact 112 in a manner familiar to persons skilled in the art.

The voltage regulator assembly 76 is powered by the battery 12 in accordance with the ignition switch 14 setting and the engine oil pressure so as to be connected to the battery 12 when the ignition switch 14 is in the ON setting and the engine operation has closed the oil pressure switch 24. The voltage regulator assembly 76 is energized through a current path from the battery 12 through the lead 52, the junction block 54, the lead 56, the contacts 38, the lead 66, the oil pressure switch 24, the lead 68, and a lead 126.

When the engine is in operation the voltage regulator assembly 76 is energized and the generator 74 is driven by the engine so as to produce an output from the stator winding 80 in accordance with the energization of the field winding 78. The field winding 78 is initially energized through a current path from the oil pressure switch 24 that includes the lead 68, the lead 126, a lead 128, the contacts 112 and 110, a lead 130, a lead 132, and the field winding 78. The battery 12 voltage is thus initially supplied to the field winding 78.

As the generator 74 output increases the field relay 106 is energized by the voltage produced at a junction 131 in the rectifier network 88, the junction 131 being the R terminal on the Delcotron. Energization of the field relay 106 causes the movable contact 122 to complete a circuit from the generator 74 through the lead 102, the junction block 54, a lead 133, the contacts 120 and 122, and a lead 134 to the voltage regulator coil 108. So long as the output voltage from the generator 74 that is applied to the voltage regulator coil 108 is below a certain predetermined level the voltage regulator coil 108 is unable to separate the contacts 110 and 112 and the field winding 78 continues to be energized through the current path previously described.

When the generator 74 output exceeds the predetermined level the voltage regulator coil 108 separates the movable contact 112 from the fixed contact 110, causing the field winding 78 to be energized through the current limiting resistor 124 that was previously bypassed by the current path through the contacts 110 and 112. The current limiting resistor 124, which has a resistance of approximately 10 ohms, serves to reduce the energization of the field winding 78 so as to reduce the generator 74 output. As the generator 74 output is reduced to a level slightly below the predetermined level the voltage regulator coil 108 releases the movable contact 112, closing the contacts 110 and 112 so as to increase the energization of the field winding 78 as was previously described. In practice, the contacts 110 and 112 are opened and closed several times a second so as to maintain precise control of the generator 74 output voltage.

In the event the generator 74 output voltage exceeds a second predetermined level the voltage regulator coil 108 energization is increased sufficiently to both separate the contacts 110 and 112 and close the contacts 110 and 114. Since the movable contact 114 is grounded, closing the contacts 110 and 114 grounds the field winding 78 so as to rapidly reduce the generator 74 output voltage. As the generator 74 output voltage falls below the second predetermined level the contacts 110 and 114 are separated so as to permit partial energization of the field winding 78 through the current limiting resistor 124 and the regulation of the generator 74 output continues in the fashion previously discussed.

It should be noted at this point that the provision for energizing the voltage regulator coil 108 from the junction block 54 through the contacts 120 and 122 rather than through the ignition switch 14 provides a very important, though subtle, advantageous feature in the operation of the voltage regulator assembly 76. Since the voltage regulator coil 108 is very sensitive to voltage variations, it should be isolated from loads which produce transients, such as the accessory loads energized from the lead 66. By connecting the voltage regulator coil 108 through a relatively direct route, i.e. with small lead wire and contact resistance, to the junction block 54 the voltage regulator coil 108 is effectively rendered independent of the various accessory loads.

The generator telltale 20 is provided for indicating a malfunction in the generator network 18. Placing the ignition switch 14 in the ON setting prior to starting the engine supplies the battery 12 voltage to the generator telltale 20 through a current path that includes the lead 52, the junction block 54, the lead 56, the contacts 40, and a lead 136. In addition, when the engine is not in operation the generator 74 is not producing a voltage at the junction 131 so the field relay 106 is deenergized and the contacts 118 and 122 are closed, grounding the generator telltale 20 through a lead 138, the lead 134, and the contacts 122 and 118. Since virtually the entire battery 12 voltage is thus placed across the generator telltale 20, the generator telltale 20 is energized when the ignition switch 14 is in the ON setting and the engine is not in operation, providing a check of the generator telltale 20 operativeness.

When the engine is in operation the generator 74 produces an output at the junction 131, energizing the field relay 106 so as to close the contacts 120 and 122. Closing the contacts 120 and 122 completes a current path from the generator 74 out-

put through the lead 102, the junction block 54, the lead 133, the contacts 120 and 122, the lead 134, and the lead 138 to the generator telltale 20. So long as the leads 136 and 138 are at nearly the same voltage the generator telltale 20 is extinguished. If the generator 74 stops producing an output when the ignition switch 14 is in the ON setting the contacts 118 and 122 will be closed, causing the generator telltale 20 to be energized and thereby warn of the malfunction.

The telltale network 22 includes a pair of telltales 140 and 142 and an isolating resistor 144. While the selection of the telltales 140 and 142 and the isolating resistor 144 is determined by the particular application, the telltales 140 and 142 are typically two candlepower units and the resistor 144 is a 10 ohm resistor. In the illustrated embodiment the telltale 140 is the well-known COLD telltale that is energized through a bimetal switch 146 when the engine is cold and the lead 136 is energized by the ignition switch 14 being in the ON setting. As the engine is heated the bimetal switch 146 will open the current path through the COLD telltale 10 and, at an increased temperature, the bimetal switch 146 will complete a current path through a lead 148, the telltale 142, and the lead 136 so as to energize the telltale 142, which is the well-known HOT telltale used to indicate that the engine is overheated, when the ignition switch 14 is in the ON setting and the engine is at the increased temperature.

The operativeness of the HOT telltale 142 is checked by placing the ignition switch 14 in the ON setting when the engine is stopped. Since the oil pressure switch 24 is open when the engine is stopped, placing the ignition switch 14 in the ON setting completes a current path from the battery 12 through the lead 52, the junction block 54, the lead 56, the contacts 40, the lead 136, the HOT telltale 142, the isolating resistor 144, the lead 70, the lead 126, the lead 128, the contacts 112 and 110, the lead 130, the lead 132, and the field winding 78. The HOT telltale 142 is thus energized so as to check its operativeness when the engine is stopped and the ignition switch 14 is in the ON setting. The HOT telltale 142 is extinguished when the engine operation closes the oil pressure switch 24 as the battery 12 voltage is then presented through the oil pressure switch 24 and the lead 68 to the lead 70, applying the same voltage to each side of the HOT telltale 142.

As persons skilled in the art will appreciate, the operativeness of various other telltales presently found in motor vehicles may be checked in a fashion similar to that used in checking the HOT telltale 142 operativeness. That is, by coupling them to the lead 70 through resistors analogous in operation to the isolating resistor 144. In the alternative, a diode may be substituted for the isolating resistor 144. A diode so substituted would have its anode connected to the lead 148 and its cathode connected to the lead 70 so as to permit energization of the HOT telltale 142 through the field winding 78, as was previously explained, and to prevent reverse leakage currents when the oil pressure switch 24 is closed.

The operation of the subject circuitry will now be explained. When the ignition switch 14 is in the OFF setting the circuitry in FIG. 1 is deenergized and the grounded contacts 34 and 36 on the ignition switch 14 are closed.

When the ignition switch 14 is placed in the ACC setting the contacts 38 are closed so as to energize the lead 66, from which a plurality of accessory loads may be energized through the terminals 26, 28, 30 and 32. Since the engine is not in operation, the oil pressure switch 24 remains open so as to preclude energization of other circuitry from the lead 66 while the ignition switch 14 is in the ACC setting.

When the ignition switch 14 is placed in the ON setting prior to starting the engine the contacts 38 and 40 are closed so as to supply power to the various accessories connected to the lead 66 and to check the operativeness of the generator telltale 20 and the telltale network 22. Closure of the contacts 40 energizes the lead 136 through a current path from the battery 12 that includes the lead 52, the junction block 54, the lead 56, the contacts 40, and the lead 136. Since the engine is inoperative the generator 74 is not producing an output and the field relay 106 is thus deenergized, leaving the contacts 118 and 122 closed so as to enable the generator telltale 20 to be energized from the lead 136 through a current path that includes the lead 138, the lead 134 and the contacts 122 and 118.

The HOT telltale 142 is also energized from the lead 136 but through a current path that includes the isolating resistor 144, the lead 70, the lead 126, the lead 128, the contacts 112 and 110, the lead 130, the lead 132, and the field winding 78. Of course, if other telltales in the telltale network 22 were connected to the lead 70 in a similar fashion to the connection of the HOT telltale 142, the operativeness of these telltales would be checked simultaneously with the checking of the HOT telltale 142.

Since the COLD telltale 140 is energized from the lead 136 through the bimetal switch 146 when the engine is cold, no additional provision needs to be made for checking its operativeness.

Placing the ignition switch 14 in the START setting closes the contacts 42 so as to energize the cranking network and opens the contacts 38 so as to relieve the battery 12 of the accessory loads connected to the lead 66 when the cranking network is starting the engine. The contacts 40 remain closed when the ignition switch 14 is placed in the START setting so as to permit continued checking of the generator telltale 20 and the telltale network 22 operativeness when starting the engine. In addition, placing the ignition switch 14 in the START setting closes the contacts 44 so as to energize the starting branch 46 and the pump 10, thereby transferring fuel to the engine when starting the engine. Since the starting branch 46 provides a low impedance current path from the battery 12 to the pump 10 it supplies virtually the entire battery 12 voltage to the pump 10, providing it with an increased fuel transfer capability when starting the engine. In addition, a transmission interlock switch (not shown), with which persons skilled in the art are familiar, may be used to prevent cranking of the engine by the cranking network until the pump 10 has supplied the engine with sufficient fuel for starting. For example, when the well-known vehicle transmission is engaged the cranking network is disengaged, but the starting branch 46 is unaffected. The battery 12 is thus protected from an excessive current drain by the cranking network while the pump 10 transfers sufficient fuel to the engine for starting, after which the transmission is disengaged and the engine started.

In the event the engine becomes flooded prior to its being started the supply of fuel to the engine may be discontinued by setting the engine throttle for maximum engine speed so as to open the normally closed switch 50 and deenergize the pump 10. This may be done in vehicles employing the well-known accelerator pedal simply by fully depressing the accelerator pedal. Setting the engine throttle for maximum engine speed thus facilitates starting a flooded engine since the engine can be cranked by the cranking network while the fuel supply to the engine is discontinued.

When the engine has been started the ignition switch 14 is returned to the ON setting, opening the contacts 44 so as to deenergize the starting branch 46 and closing the contacts 38 so as to energize the operating branch 48 upon closure of the oil pressure switch 24. Energization of the pump 10 is continued without interruption as the oil pressure switch 24 is closed almost immediately upon starting the engine. The pump 10 is energized by the operating branch 48 in accordance with the engine throttle setting so that when the engine throttle is set for low engine speeds the switch 64 is opened and the pump 10 is energized through the resistor 62 and when the engine throttle is set for high engine speeds the switch 64 is closed and the pump 10 is energized through the switch 64. The switch 64 in the illustrated embodiment thus provides for operating the pump 10 at two levels of fuel transfer capability, though it is recognized that use of a variable resistance in place of the switch 64 would provide for operating the pump 10 at several additional levels of fuel transfer capability.

Upon closure of the oil pressure switch 24 the field winding 78 is energized through the voltage regulator assembly 76 so as to enable the generator 74 to produce an output. When the generator 74 is producing an output the voltage at the junction 131 energizes the field relay 106, which closes the contacts 120 and 122 so as to complete a current path from the generator 74 output through the lead 102, the junction block 54, the lead 133, the contacts 120 and 122, the lead 134, and the lead 138 to the generator telltale 20. The generator telltale 20 is thus extinguished since the leads 136 and 138 are at nearly the same voltage.

Closure of the oil pressure switch 24 also extinguishes the HOT telltale 142 by supplying a voltage to the lead 70 that is nearly the same voltage as is on the lead 136, as was previously explained. Of course, the COLD telltale 140 will remain energized so long as the bimetal switch 146 completes a current path from the energized lead 136 through the COLD telltale 140 to ground.

In the event the engine oil pressure falls to a level insufficient to properly lubricate the engine while the engine is in operation, the oil pressure switch 24 will open, deenergizing the field winding 78 and permitting the energization of the generator telltale 20 and the telltale network 22. When the field winding 78 is deenergized the generator 74 no longer produces an output and the field relay 106 is deenergized so as to apply ground potential to the generator telltale 20 through the contacts 118 and 122, the lead 134, and the lead 138. Since the lead 136 is energized, the generator telltale 20 is also energized.

In addition, opening the oil pressure switch 24 permits energization of the HOT telltale 142 through the lead 148, the isolating resistor 144, the lead 70, the lead 126, the lead 128, the contacts 112 and 110, the lead 130, the lead 132, and the field winding 78. Other telltales connected in parallel with the HOT telltale would be energized in a similar fashion.

Several, or even all, of the telltales in the vehicle may thus be energized simultaneously to indicate that the engine oil pressure is insufficient to properly lubricate the engine. It is therefore unnecessary to have a separate telltale to monitor the engine oil pressure, which is the present familiar practice. Furthermore, since the pump 10 is energized through the oil pressure switch 24 when the ignition switch 14 is in the ON setting, the simultaneous energization of several telltales in the vehicle serve to indicate that the pump 10 is deenergized and that the engine will soon stop due to a lack of fuel, the time required to stop the engine depending upon the present rate of fuel consumption by the engine and the amount of fuel available to the engine.

While it is desirable that the engine be stopped soon after the oil pressure switch 24 is opened to prevent harming the engine by operation of the engine when the engine oil pressure is insufficient to properly lubricate the engine, there are certain circumstances under which the vehicle operator may wish to temporarily continue the engine operation. He may do so by placing the ignition switch 14 in the START setting so as to energize the pump 10 through the starting branch 46 as was previously explained thereby maintaining the supply of fuel to the engine. (Since the transmission is engaged while the vehicle is being driven, the cranking network will not be energized at this time.) By having the ignition switch 14 spring biased to prevent its remaining in the START setting, as is customarily the case, the vehicle operator must either continuously or intermittently hold the ignition switch 14 in the START setting to provide sufficient fuel to the engine to prevent its stoppage. The engine will thus be kept in operation so long as the vehicle operator is willing to take affirmative action to prevent its stopping. The engine will stop when he permits it to run out of fuel by changing the ignition switch 14 setting to other than the START SETTING.

When it is desired to stop the engine after normal operation the ignition switch 14 is placed in the OFF setting, which closes the contacts 34 and 36 so as to ground the circuitry shown in FIG. 1.

Some additional features are provided by the subject circuitry that have not previously been discussed. Among these are use of the generator telltale 20 to check the rectifier network 88 operativeness and a means of making a vehicle employ subject circuitry less subject to theft.

The generator telltale 20 is energized when a positive rectifier 96, 98, or 100 in the rectifier network 88 is shorted and the ignition switch 14 is in the OFF setting as shorting one of the rectifiers 96, 98, or 100 will energize the field relay 106 so as to complete a current path through the generator telltale 20 and the grounded contacts 36. For example, if the rectifier 98 is shorted a current path is completed from the battery 12 through the lead 52, junction block 54, the lead 102, the rectifier 98 the winding 86, the winding 82, the junction 131 and the relay winding 116, energizing the relay winding 116 so as to close the contacts 120 and 122. Closure of the contacts 120 and 122 completes a current path from the battery 12 through the lead 52, the junction block 54, the lead 133, the contacts 120 and 122, the lead 134, the lead 138, the generator telltale 20, the lead 136, and the grounded contacts 36. The generator telltale 20 is thus energized whenever one of the positive rectifiers 96, 98, or 100 in the rectifier network 88 is shorted and the ignition switch 14 is in the OFF setting.

The presence of a shorted negative rectifier 90, 92, or 94 in the rectifier network 88 causes the generator telltale 20 to become energized when the generator 74 is being driven by the engine as a shorted negative rectifier in the rectifier network 88 precludes the voltage at the junction 131 from energizing the relay winding 116. The relay winding 116 is thus deenergized, closing the contacts 118 and 122 so as to energize the generator telltale 20 by the battery 12 through a current path that includes the lead 52, the junction block 54, the lead 56, the contacts 40, the lead 136, the generator telltale 20, the lead 138, the lead 134, and the contacts 122 and 118. For example, when the negative rectifier 90 is shorted the junction 131 is connected to ground so as to deenergize the relay winding 116 and permit energization of the generator telltale 20 through the current path just described, but in the case of a shorted negative rectifier 92 or 94 the junction 131 is not grounded. The generator telltale 20 will thus remain deenergized so long as the generator 74 output maintains the relay winding 116 energized. However, once the engine has been stopped and restarted a shorted negative rectifier 92 or 94 will prevent the generator 74 from producing its normal output. The voltage at the junction 131 is thus prevented from building up sufficiently to energize the relay winding 116 and the generator telltale 20 will be energized when the ignition switch 14 is in the ON setting as was previously explained. It can be seen from the foregoing that shorting one of the negative rectifiers 90, 92 or 94 in the rectifier network 88 before the engine is started will be indicated when the engine is in operation and the shorting of the rectifier 90 can be detected even if it occurs while the engine is in operation.

A vehicle employing the subject circuitry may be made less subject to theft than vehicles employing conventional circuitry as the grounded contact 34 in the subject circuitry grounds the pump 10 when the ignition switch 14 is in the OFF setting. While a vehicle which employs an electric fuel pump is inherently more difficult to steal because of the additional electric circuit that must be "jumpered," the grounded contact 34 provides an additional measure of security as the extremely reliable circuitry in the pump energization network 16 and the pump 10 may be positioned in a very inaccessible location. The inaccessibility of these elements is an additional deterrent to "jumpering" and as such the vehicle is made more theftproof.

While the foregoing description has been keyed to the illustrated embodiment, it is to be understood that other embodiments may be used to practice the present invention and that the present invention is to be limited only by the following claims.

I claim:

1. Circuitry for a motor vehicle having a throttle controlled engine and a reservoir for fuel, the circuitry comprising, in combination, an electric fuel pump for transferring fuel between the reservoir and the engine; a power source for energizing the pump; and a pump energization network for controlling the energization of the pump by the power source in accordance with the engine operation, the pump energization network including an operating branch for energizing the pump from the power source when the engine is in operation, the operating branch including a resistor in series with the pump and the power source for reducing the power supplied to the pump by the power source so as to establish a low fuel transfer capability of the pump when the engine throttle is set to operate the engine at low speeds and a switch responsive to the engine throttle setting for increasing the power supplied to the pump by the power source by completing a low impedance current path from the power source to the pump so as to increase the fuel transfer capability of the pump when the engine throttle is set to operate the engine at high speeds.

2. Circuitry for a motor vehicle having a throttle controlled engine and a reservoir for fuel, the circuitry comprising, in combination, an electric fuel pump for transferring fuel between the reservoir and the engine; a power source for energizing the pump; a pump energization network for controlling the energization of the pump by the power source in accordance with the engine operation, the pump energization network including an operating branch for energizing the pump from the power source when the engine is in operation, the operating branch including a resistor in series with the pump and the power source for reducing the power supplied to the pump by the power source so as to establish a low fuel transfer capability of the pump when the engine throttle is set to operate the engine at low speeds and a switch responsive to the engine throttle setting for increasing the power supplied to the pump by the power source by completing a low impedance current path from the power source to the pump so as to increase the fuel transfer capability of the pump when the engine throttle is set to operate the engine at high speeds; and an engine responsive switch for controlling the energization of the operating branch and the pump by the power source in accordance with the engine operation so as to energize the operating branch and the pump when the engine is in operation.

3. Circuitry for a motor vehicle having a throttle controlled engine and a reservoir for fuel, the circuitry comprising, in combination, an electric fuel pump for transferring fuel between the reservoir and the engine; a power source for energizing the pump; a plural setting engine controlling switch including an engine On setting; and a pump energization network for controlling the energization of the pump by the power source in accordance with the engine operation and the setting of the engine controlling switch, the pump energization network including an operating branch for energizing the pump from the power source when the engine controlling switch is in the engine On setting and the engine is in operation, the operating branch including a resistor in series with the pump and the power source for reducing the power supplied to the pump by the power source so as to establish a low fuel capability of the pump when the engine throttle is set to operate the engine at low speeds and a switch responsive to the engine throttle setting for increasing the power supplied to the pump by the power source by completing a low impedance current path from the power source to the pump so as to increase the fuel transfer capability of the pump when the engine throttle is set to operate the engine at high speeds.

4. Circuitry for a motor vehicle having a throttle controlled engine and a reservoir for fuel, the circuitry comprising, in combination, an electric fuel pump for transferring fuel between the reservoir and the engine; a power source for energizing the pump; a plural setting engine controlling switch including an engine On setting; a pump energization network for controlling the energization of the pump by the power source in accordance with the engine operation and the setting of the engine controlling switch, the pump energization network including an operating branch for energizing the pump from the power source when the engine controlling switch is in the engine On setting and the engine is in operation, the operating branch including a resistor in series with the pump and the power source for reducing the power supplied to the pump by the power source so as to establish a low fuel transfer capability of the pump when the engine throttle is set to operate the engine at low speeds and a switch responsive to the engine throttle setting for increasing the power supplied to the pump by completing a low impedance current path from the power source to the pump so as to increase the fuel transfer capability of the pump when the engine throttle is set to operate the engine at high speeds; and an engine responsive switch for controlling the energization of the operating branch in accordance with the engine operation so as to energize the operating branch and the pump when the engine is in operation and the engine controlling switch is in the engine On setting.

5. Circuitry for a motor vehicle having a throttle controlled engine and a reservoir for fuel, the circuitry comprising, in combination, an electric fuel pump for transferring fuel between the reservoir and the engine; a power source for energizing the pump; and a pump energization network for controlling the energization of the pump by the power source, the pump energization network including a starting branch for energizing the pump from the power source when the engine is being started, the starting branch including a switch responsive to the engine throttle setting for preventing energization of the starting branch and the pump when the engine is being started and the engine throttle is set to operate the engine at maximum speed so as to facilitate starting the engine by preventing the pump from transferring fuel to the engine when the engine is flooded.

6. Circuitry for a motor vehicle having a throttle controlled engine and a reservoir for fuel, the circuitry comprising, in combination, an electric fuel pump for transferring fuel between the reservoir and the engine; a power source for energizing the pump; a plural setting engine controlling switch including an engine Starting setting; and 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, the pump energization network including a starting branch for energizing the pump from the power source when the engine controlling switch is in the engine Starting setting, the starting branch including a switch responsive to the engine throttle setting for preventing energization of the pump when the engine controlling switch is in the engine Starting setting and the engine throttle is set to operate the engine at maximum speed so as to facilitate starting the engine by preventing the pump from transferring fuel to the engine when the engine is flooded.

7. Circuitry for a motor vehicle having a throttle controlled engine and a reservoir for fuel, the circuitry comprising, in combination, an electric fuel pump for transferring fuel between the reservoir and the engine; a power source for energizing the pump; a plural setting engine controlling switch including engine On and engine Starting settings; and 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, the pump energization network including a starting branch for energizing the pump from the power source when the engine controlling switch is in the engine Starting setting, the starting branch including a first switch responsive to the engine throttle setting for preventing energization of the pump when the engine controlling switch is in the engine Starting setting and the engine throttle is set to operate the engine at maximum speed so as to facilitate starting the engine by preventing the pump from transferring fuel to the engine when the engine is flooded, and an operating branch for energizing the pump from the power source when the engine controlling switch is in the engine On setting, the operating branch including a resistor in series with the pump

and the power source for reducing the power supplied to the pump by the power source so as to establish a low fuel transfer capability of the pump when the engine throttle is set to operate the engine at low speeds and a second switch responsive to the engine throttle setting for increasing the power supplied to the pump by completing a low impedance current path from the power source to the pump so as to increase the fuel transfer capability of the pump when the engine throttle is set to operate the engine at high speeds.

8. Circuitry for a motor vehicle having an engine and a reservoir for fuel, the circuitry comprising, in combination, an electric fuel pump for transferring fuel between the reservoir and the engine; a power source for energizing the pump; a plural setting engine controlling switch including engine On and engine Starting settings; 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, the pump energization network including a starting branch for energizing the pump from the power source when the engine controlling switch is in the engine Starting setting and an operating branch for energizing the pump from the power source when the engine controlling switch is in the engine On setting and the engine is in operation; and an engine responsive switch responsive to the engine oil pressure for controlling the energization of the operating branch in accordance with the engine oil pressure so as to deenergize the operating branch and the pump when the engine oil pressure is insufficient to properly lubricate the engine and the engine controlling switch is in the engine On setting.

9. Circuitry for a motor vehicle having a throttle controlled engine and a reservoir for fuel, the circuitry comprising, in combination, an electric fuel pump for transferring fuel between the reservoir and the engine; a power source for energizing the pump; a plural setting engine controlling switch including engine On and engine Starting settings; 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, the pump energization network including a starting branch for energizing the pump from the power source when the engine controlling switch is in the engine Starting setting, the starting branch including a first switch responsive to the engine throttle setting for preventing energization of the pump when the engine controlling switch is in the engine Starting setting and the engine throttle is set to operate the engine at maximum speed so as to facilitate starting the engine by preventing the pump from transferring fuel to the engine when the engine is flooded, and an operating branch for energizing the pump from the power source when the engine controlling switch is in the engine On setting, the operating branch including a resistor in series with the pump and the power source for reducing the power supplied to the pump by the power source so as to establish a low fuel transfer capability of the pump when the engine throttle is set to operate the engine at low speeds and a second switch responsive to the engine throttle setting for increasing the power supplied to the pump by completing a low impedance current path from the power source to the pump so as to increase the fuel transfer capability of the pump when the engine throttle is set to operate the engine at high speeds; and an engine responsive switch responsive to the engine oil pressure for controlling the energization of the operating branch in accordance with the engine oil pressure so as to deenergize the operating branch and the pump when the engine oil pressure is insufficient to properly lubricate the engine and the engine controlling switch is in the engine On setting.

10. Circuitry for a motor vehicle having an engine and a reservoir for fuel, the circuitry comprising, in combination, supplied electric fuel pump for transferring fuel between the reservoir and the engine; a power source for energizing the pump; a plural setting engine controlling switch including engine On and engine Starting settings; 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, the pump energization network including a starting branch for energizing the pump from the power source when the engine controlling switch is in the engine Starting setting and an operating branch for energizing the pump from the power source when the engine controlling switch is in the engine On setting and the engine is in operation; a telltale network energized by the power source for monitoring at least one condition in the vehicle; and an engine responsive switch responsive to the engine oil pressure for controlling the energization of the operating branch and the telltale network so as to permit energization of the telltale network and to preclude energization of the operating branch when the engine oil pressure is insufficient to properly lubricate the engine and the engine controlling switch is in the engine On setting, the energization of the telltale network thereby indicating both that the engine oil pressure is insufficient to properly lubricate the engine and that the engine will soon stop due to a lack of fuel caused by deenergization of the pump unless the pump energization is maintained by placing the engine controlling switch in the engine Starting setting so as to energize the pump through the starting branch.

11. Circuitry for a motor vehicle having an engine and a reservoir for fuel, the circuitry comprising, in combination, an electric fuel pump for transferring fuel between the reservoir and the engine; a power source for energizing the pump; a plural setting engine controlling switch, the engine controlling switch including an engine Off setting and a grounded contact; 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, the pump energization network being connected to ground by the grounded contact when the engine controlling switch is in the engine Off setting so as to preclude operation of the pump until the engine controlling switch setting is changed to a setting other than the engine Off setting.

12. Circuitry for a motor vehicle comprising, in combination, a power source; an engine driven generator for recharging the power source, the generator including a field winding energized by the power source for controlling the generator output; a voltage regulator assembly for regulating the generator output by controlling the energization of the field winding by the power source in accordance with the generator output; and an engine responsive switch for controlling the supply of power to the voltage regulator assembly from the power source in accordance with the engine operation so as to preclude energization of the field winding when the engine is inoperative.

13. Circuitry for a motor vehicle comprising, in combination, a power source; an engine driven generator for recharging the power source, the generator including a field winding energized by the power source for controlling the generator output; a voltage regulator assembly for regulating the generator output by controlling the energization of the field winding by the power source in accordance with the generator output; a telltale network energized by the power source for monitoring at least one condition in the vehicle other than the generator operation; and an engine responsive switch both for controlling the supply of power from the power source to the voltage regulator assembly so as to energize the field winding in accordance with the engine operation, the engine responsive switch precluding energization of the field winding when the engine is inoperative, and also for controlling the energization of the telltale network so as to permit energization of the telltale network through the field winding when the engine is inoperative and to preclude energization of the telltale network through the field winding when the engine is operative, the energization of the telltale network when the engine is inoperative providing a check of the telltale network operativeness.

14. Circuitry for a motor vehicle comprising, in combination, a power source; an engine driven generator for recharging the power source, the generator including a field winding

energized by the power source for controlling the generator output; a voltage regulator assembly for regulating the generator output by controlling the energization of the field winding by the power source, the voltage regulator assembly including a voltage regulator for sensing the generator output and for controlling the energization of the field winding in accordance with the generator output; and an engine responsive switch for controlling the supply of power to the voltage regulator assembly from the power source in accordance with the engine operation so as to preclude energization of the field winding when the engine is inoperative.

15. Circuitry for a motor vehicle comprising, in combination, a power source; an engine driven generator for recharging the power source, the generator including a field winding energized by the power source for controlling the generator output; a voltage regulator assembly for regulating the generator output by controlling the energization of the field winding by the power source, the voltage regulator assembly including a voltage regulator for sensing the generator output and for controlling the energization of the field winding in accordance with the generator output and a field relay for sensing the presence of a generator output and for supplying the generator output to the voltage regulator when the generator is producing an output; a telltale network energized by the power source for monitoring at least one condition in the vehicle other than the generator operation; and an engine responsive switch both for controlling the supply of power from the power source to the voltage regulator assembly so as to energize the field winding in accordance with the engine operation, the engine responsive switch precluding energization of the field winding when the engine is inoperative, and also for controlling the energization of the telltale network so as to permit energization of the telltale network through the field winding when the engine is inoperative and to preclude energization of the telltale network through the field winding when the engine is operative, the energization of the telltale network when the engine is inoperative providing a check of the telltale network operativeness.

16. Circuitry for a motor vehicle comprising, in combination, a power source; an engine driven generator for recharging the power source, the generator including a field winding energized by the power source for controlling the generator output, a voltage regulator assembly for regulating the generator output by controlling the energization of the field winding by the power source in accordance with the generator output; a telltale network energized by the power source for monitoring at least one condition in the vehicle other than the generator operation; and an engine responsive switch responsive to the engine oil pressure both for controlling the supply of power from the power source to the voltage regulator assembly so as to energize the field winding in accordance with the engine operation, the engine responsive switch precluding energization of the field winding when the engine oil pressure is insufficient to properly lubricate the engine, and also for controlling the energization of the telltale network so as to permit energization of the telltale network through the field winding when the engine oil pressure is insufficient to properly lubricate the engine and to preclude energization of the telltale network through the field winding when the engine oil pressure is sufficient to properly lubricate the engine, the energization of the telltale network when the engine is not in operation providing a check of the telltale network operativeness and the energization of the telltale network when the engine is in operation providing an indication that the engine oil pressure is insufficient to properly lubricate the engine.

17. Circuitry for an engine driven motor vehicle comprising, in combination, a power source; a plural setting engine controlling switch including engine On, engine Off, and engine Starting settings, the engine controlling switch also including a grounded contact; an engine driven AC generator for recharging the power source, the generator including a field winding energized by the power source for controlling the generator output and a rectifier network for rectifying the generator output so as to facilitate recharging the power source, the rectifier network including positive rectifiers; a voltage regulator assembly for regulating the generator output by controlling the energization of the field winding by the power source, the voltage regulator assembly including a voltage regulator for sensing the generator output and for controlling the energization of the field winding in accordance with the generator output and a field relay for sensing the presence of a generator output and for supplying the generator output to the voltage regulator when the generator is producing an output, the field relay being energized by the generator output when the generator is producing an output and by the power source when a positive rectifier in the rectifier network is short circuited and the generator is not producing an output; and a generator telltale energized by the power source in accordance with the energization of the field relay and the setting of the engine controlling switch, the generator telltale being energized when the field relay is deenergized and the engine controlling switch is in the engine On or engine Starting setting so as to provide an indication that the generator is inoperative, the generator telltale also being energized through the grounded contact when the field relay is energized by the power source through a shorted positive rectifier and the engine controlling switch is in the engine Off setting so as to provide an indication of the rectifier network operativeness.

18. Circuitry for a motor vehicle having an engine and a reservoir for fuel, the circuitry comprising, in combination, an electric fuel pump for transferring fuel between the reservoir and the engine; a power source for energizing the pump; a plural setting engine controlling switch including engine On and engine Starting settings; a pump energization network for controlling the energization of the pump by the power source in accordance with the engine operation and the setting of the engine controlling switch, the pump energization network including a starting branch for energizing the pump from the power source when the engine controlling switch is in the engine Starting setting and an operating branch for energizing the pump from the power source when the engine controlling switch is in the engine On setting and the engine is in operation; an engine driven generator for recharging the power source, the generator including a field winding energized by the power source for controlling the generator output; a voltage regulator assembly for regulating the generator output by controlling the energization of the field winding by the power source in accordance with the generator output; a telltale network energized by the power source for monitoring at least one condition in the vehicle other than the generator operation; and an engine responsive switch responsive to the engine oil pressure for controlling the energization of the operating branch in accordance with the engine oil pressure so as to deenergize the operating branch and the pump when the engine oil pressure is insufficient to properly lubricate the engine and the engine controlling switch is in the engine On setting, for controlling the supply of power from the power source to the voltage regulator assembly so as to energize the field winding in accordance with the engine operation, the engine responsive switch permitting energization of the field winding when the engine oil pressure is sufficient to properly lubricate the engine and precluding energization of the field winding when the engine oil pressure is insufficient to properly lubricate the engine, and for controlling the energization of the telltale network so as to permit energization of the telltale network through the field winding when the engine oil pressure is insufficient to properly lubricate the engine and to preclude energization of the telltale network through the field winding when the engine oil pressure is sufficient to properly lubricate the engine, the energization of the telltale network when the engine is not in operation providing a check of the telltale network operativeness and the energization of the telltale network when the engine is in operation providing an indication that the engine oil pressure is insufficient to properly lubricate the engine and that the engine will soon stop due to a lack of fuel caused by deenergization of the pump unless the

pump energization is maintained by placing the engine controlling switch in the engine Starting setting so as to energize the pump through the starting branch.

19. Circuitry for a motor vehicle having an engine and a reservoir for fuel, the circuitry comprising, in combination, an electric fuel pump for transferring fuel between the reservoir and the engine; a power source for energizing the pump; a plural setting engine controlling switch including engine On, engine Off, and engine Starting settings, the engine controlling switch also including a grounded contact; a pump energization network for controlling the energization of the pump by the power source in accordance with the engine operation and the setting of the engine controlling switch, the pump energization network being connected to ground by the grounded contact when the engine controlling switch is in the engine Off setting so as to preclude operation of the pump until the engine controlling switch setting is changed to a setting other than the engine Off setting, the pump energization network including a starting branch for energizing the pump from the power source when the engine controlling switch is in the engine Starting setting and an operating branch for energizing the pump from the power source when the engine controlling switch is in the engine On setting and the engine is in operation; an engine driven AC generator for recharging the power source, the generator including a field winding energized by the power source for controlling the generator output and a rectifier network for rectifying the generator output so as to facilitate recharging the power source, the rectifier network including positive rectifiers; a voltage regulator assembly for sensing the generator output and for regulating the generator output by controlling the energization of the field winding by the power source in accordance with the generator output; a generator telltale energized by the power source in accordance with the generator output and the setting of the engine controlling switch, the generator telltale being energized when the engine controlling switch is in the engine On or engine Starting setting and the voltage regulator assembly senses that the generator is not producing an output so as to provide an indication that the generator is inoperative and being energized through the grounded contact when the power source supplies power to the voltage regulator assembly through a shorted positive rectifier and the engine controlling switch is in the engine Off setting so as to provide an indication of the rectifier network operativeness; a telltale network energized by the power source for monitoring at least one condition in the vehicle other than the generator operation; and an engine responsive switch responsive to the engine oil pressure for controlling the energization of the operating branch in accordance with the engine oil pressure so as to deenergize the operating branch and the pump when the engine oil pressure is insufficient to properly lubricate the engine and the engine controlling switch is in the engine On setting, for controlling the supply of power from the power source to the voltage regulator assembly so as to energize the field winding in accordance with the engine operation, the engine responsive switch permitting energization of the field winding when the engine oil pressure is sufficient to properly lubricate the engine and precluding energization of the field winding when the engine oil pressure is insufficient to properly lubricate the engine, and for controlling the energization of the telltale network so as to permit energization of the telltale network through the field winding when the engine oil pressure is insufficient to properly lubricate the engine and to preclude energization of the telltale network through the field winding when the engine oil pressure is sufficient to properly lubricate the engine, the energization of the telltale network when the engine is not in operation providing a check of the telltale network operativeness and the energization of the telltale network when the engine is in operation providing an indication that the engine oil pressure is insufficient to properly lubricate the engine and that the engine will soon stop due to a lack of fuel caused by deenergization of the pump unless the pump energization is maintained by placing the engine controlling switch in the engine Starting setting so as to energize the pump through the starting branch.

20. Circuitry for a motor vehicle having a throttle controlled engine and a reservoir for fuel, the circuitry comprising, in combination, an electric fuel pump for transferring fuel between the reservoir and the engine; a power source for energizing the pump; a plural setting engine controlling switch including engine On, engine Off, and engine Starting settings, the engine controlling switch also including a grounded contact; a pump energization network for controlling the energization of the pump by the power source in accordance with the engine operation and the setting of the engine controlling switch, the pump energization network being connected to ground by the grounded contact when the engine controlling switch is in the engine Off setting so as to preclude operation of the pump until the engine controlling switch setting is changed to a setting other than the engine Off setting, the pump energization network including a starting branch for energizing the pump from the power source when the engine controlling switch is in the engine Starting setting, the starting branch including a first switch responsive to the engine throttle setting for preventing energization of the pump when the engine controlling switch is in the engine Starting setting and the engine throttle is set to operate the engine source maximum speed so as to facilitate starting the engine by preventing the pump from transferring fuel to the engine when the engine is flooded, and an operating branch for energizing the pump from the power source when the engine controlling switch is in the engine On setting and the engine is in operation, the operating branch including a resistor in series with the pump and the power source for reducing the power supplied to the pump by the power source so as to establish a low fuel transfer capability of the pump when the engine throttle is set to operate the engine at low speeds and a second switch responsive to the engine throttle setting for increasing the power supplied to the pump by completing a low impedance current path from the power source to the pump so as to increase the fuel transfer capability of the pump when the engine throttle is set to operate the engine at high speeds; an engine driven AC generator for recharging the power source, the generator including a field winding energized by the power source for controlling the generator output and a rectifier network for rectifying the generator output so as to facilitate recharging the power source, the rectifier network including positive rectifiers; a voltage regulator assembly for regulating the generator output by controlling the energization of the field winding by the power source, the voltage regulator assembly including a voltage regulator for sensing the generator output and for controlling the energization of the field winding in accordance with the generator output and a field relay for sensing the presence of a generator output and for supplying the generator output to the voltage regulator when the generator is producing an output, the field relay being energized by the generator output when the generator is producing an output and by the power source when a positive rectifier in the rectifier network is short circuited and the generator is not producing an output; a generator telltale energized by the power source in accordance with the energization of the field relay and the setting of the engine controlling switch, the generator telltale being energized when the field relay is deenergized and the engine controlling switch is in the engine On or engine Starting setting so as to provide an indication that the generator is inoperative, the generator telltale also being energized through the grounded contact when the field relay is energized by the power source through a shorted positive rectifier and the engine controlling switch is in the engine Off setting so as to provide an indication of the rectifier network operativeness; a telltale network energized by the power source for monitoring at least one condition in the vehicle other than the generator operation; and an engine responsive switch responsive to the engine oil pressure for controlling the energization of the operating branch in accordance with the engine oil pressure so as to deenergize the operating branch

and the pump when the engine oil pressure is insufficient to properly lubricate the engine and the engine controlling switch is in the engine On setting, for controlling the supply of power from the power source to the voltage regulator assembly so as to energize the field winding in accordance with the engine operation, the engine responsive switch permitting energization of the field winding when the engine oil pressure is sufficient to properly lubricate the engine and precluding energization of the field winding when the engine oil pressure is insufficient to properly lubricate the engine, and for controlling the energization of the telltale network so as to permit energization of the telltale network through the field winding when the engine oil pressure is insufficient to properly lubricate the engine and to preclude energization of the telltale network through the field winding when the engine oil pressure is sufficient to properly lubricate the engine, the energization of the telltale network when the engine is not in operation providing a check of the telltale network operativeness and the energization of the telltale network when the engine is in operation providing an indication that the engine oil pressure is insufficient to properly lubricate the engine and that the engine will soon stop due to a lack of fuel caused by deenergization of the pump unless the pump energization is maintained by placing the engine controlling switch in the engine Starting setting so as to energize the pump through the starting branch.

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,587,545 Dated September 7, 1971

Inventor(s) Richard P. Ballou

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the Specification, Column 3, line 27 "generator" should read -- delcotron --. Column 5, line 19 "10" should read -- 140 --. Column 9, line 61, after "fuel" insert -- transfer --. Column 11, line 70, delete "supplied" and insert -- an --. Column 16, line 25, delete "source" and insert -- at --.

Signed and sealed this 8th day of February 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents