

Feb. 22, 1966

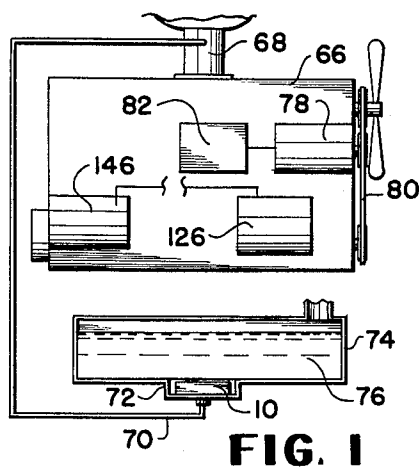
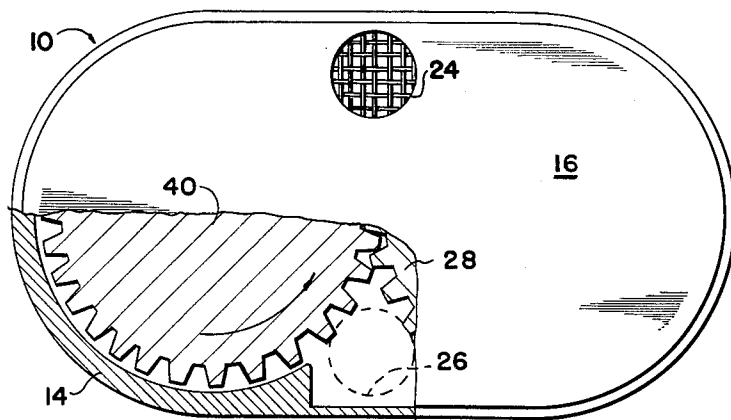
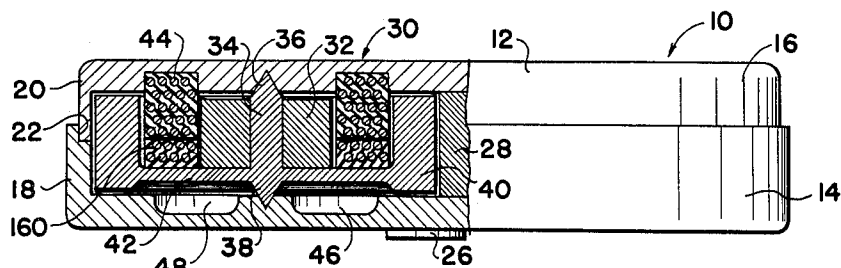
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3,236,221

FUEL SUPPLY CONTROL SYSTEM

Filed Nov. 12, 1963

2 Sheets-Sheet 1



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**Feb. 22, 1966**

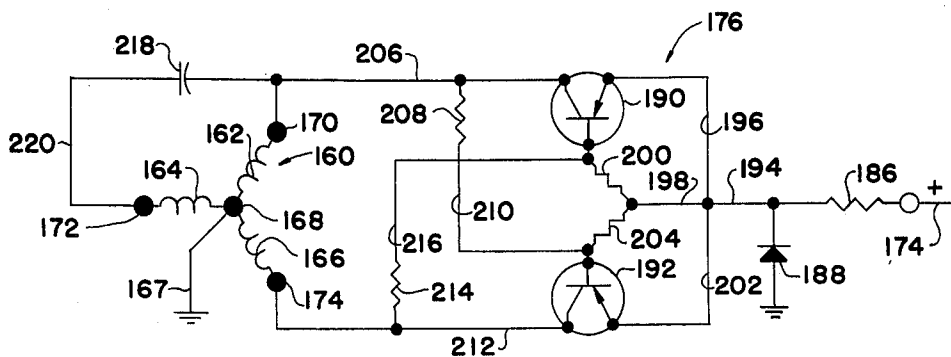
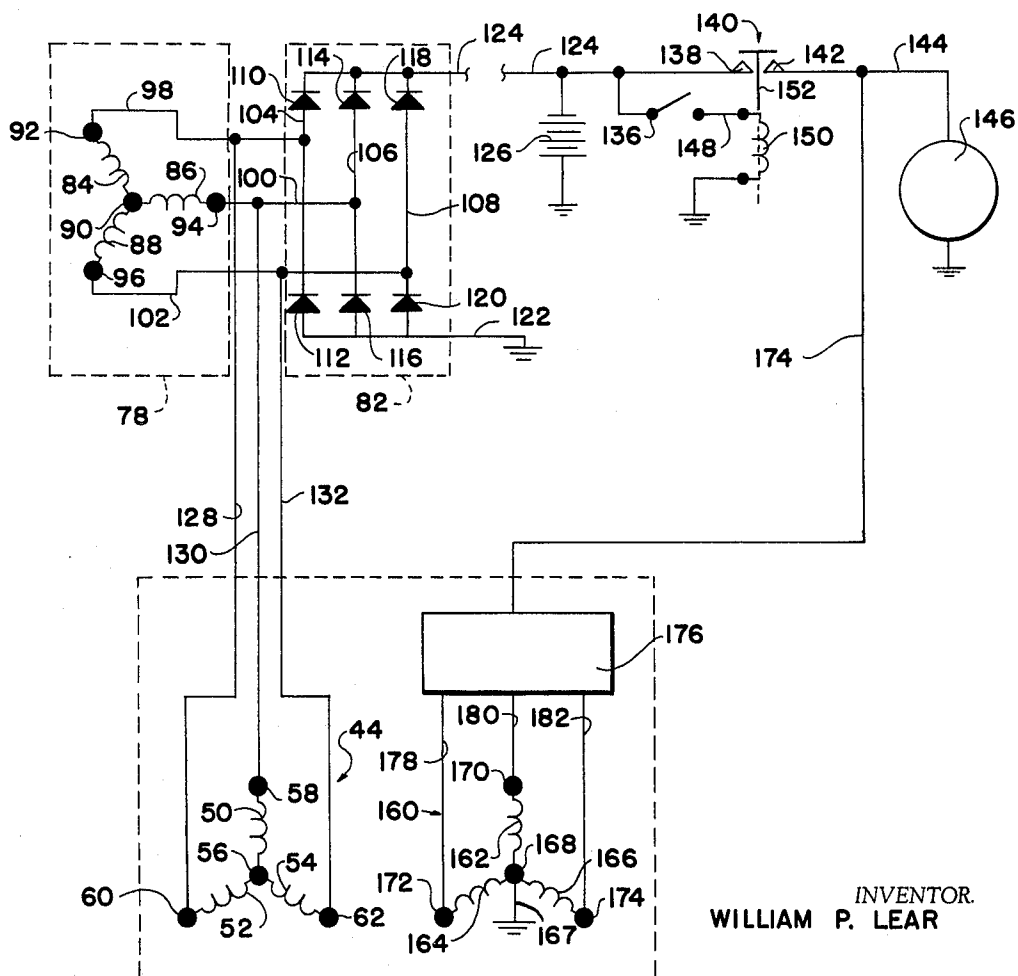
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## FUEL SUPPLY CONTROL SYSTEM

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2 Sheets-Sheet 2



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## FUEL SUPPLY CONTROL SYSTEM

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This invention relates to pump means and in a more specific aspect to electrical powering of motor means for pumps or other apparatus. In another aspect the invention relates to electrically powered pump means for fuel or other fluids wherein the fluid being pumped is utilized to cool the windings of the motor means and in addition to lubricate the bearings of the motor. In a still more specific aspect the invention relates to electrically powered fuel pump means for supplying fuel to a combustion engine wherein the pump is powered from electrical means associated with the engine and functions to supply an amount of fuel to the engine which is a function of the desired speed of the vehicle. In another aspect the invention relates to new fuel supply means for an engine or the like wherein the fuel supply means is shut off automatically when the engine stops to thereby eliminate fire hazards and dangers caused by continuous operation of fuel pump subsequent to stopping of the engine. In another aspect the invention relates to new fuel supply means including an electrically powered fuel pump wherein the pump is normally operated from an A.C. voltage source and wherein a D.C. voltage source and oscillator can be utilized for initial operation of the pump.

Many pump means and means for obtaining electrical energy to pump means are known to the art including pump means for supplying fuel to an engine. In typical pump means of the prior art the pump is normally operated independently from operation of the engine and the pump can continue operation even though the engine stops as a result of lack of fuel, disabling of the engine, or as the result of an accident. This contributes to a fire hazard since fuel is pumped to a hot engine and not utilized in the engine and such is a particularly serious disadvantage where the engine is used to propel a vehicle such as an automobile or the like. In addition, a typical prior art pump motor is lubricated by conventional oils or other lubricants and where the pump means is not satisfactorily lubricated there is a chance that the fuel pump can become overheated from friction in operation which can contribute to pump failure and possibly a fire at the fuel pump. In addition, typical fuel pumps for automobile engines and the like are normally located remotely from the fuel tank and must create sufficient vacuum to draw the fuel from the tank to the pump and thereafter force the fuel to the engine and large pumps are frequently required to produce sufficient vacuum to draw the fuel from the tank. It is much easier for a pump to operate where minimum vacuum or drawing of fuel is required. In addition, the conventional D.C. powered fuel pumps for automobiles and the like normally operate at substantially constant speed without regard to engine speed and other means are required for regulation of the amount of fuel required for the engine.

In accordance with the present invention new powering means and fuel supply means are provided which overcome many of the disadvantages of the prior art and provide new power means and fuel supply means having improved performance and reliability. The power means of the invention includes an A.C. motor having a rotor with a stator winding adjacent the rotor and the winding of the motor is connectible to a source of A.C. voltage for normal operation of the motor. In addition, the motor preferably has an auxiliary winding and an oscillator is connected to the auxiliary winding and is con-

2

nectible to a source of D.C. voltage with the oscillator being operable to provide an A.C. voltage to the auxiliary winding of the motor for operation thereof.

In another aspect the invention relates to means for pumping a fluid which includes a fluid pump which is positionable in the fluid to be pumped and which has a housing mounting a driven element and an A.C. motor or power means which is operatively connected to the driven element, the motor having a winding connectible to an A.C. source for operation of the motor and additionally having an auxiliary winding connectible to an oscillator which in turn is connectible to a source of D.C. voltage for initial operation of the motor during starting conditions. In a preferred embodiment of the invention the pump means is constructed and adapted so that fuel or other fluids being pumped are received within the housing of the pump means and provide lubrication for the moving parts of the pump means and power means therefor and additionally the fuel provides cooling for the windings of the electric motor powering the pump means and results in buoying of the part to relieve the bearings of weight and thereby contribute to long life of the moving parts.

Accordingly, it is an object of the invention to provide new powering means.

Another object of the invention is to provide new electrical powered pump means adapted to be operated from either A.C. or D.C. voltage sources.

Another object of the invention is to provide new means for obtaining electrical power to a motor for a pump or the like.

Still a further object of the invention is to provide new pump means wherein the fluid being pumped is utilized to cool the windings of a motor associated with the pump and wherein the fluid being pumped can also be used to lubricate the bearings of the pump motor.

A still further object of the invention is to provide new pump means having electric powering means therewith wherein the pump means is adapted to be submerged in the fluid being pumped and wherein the fluid is utilized to provide buoyancy for the moving parts of the pump means including the motor associated therewith to thereby relieve the bearings of weight and result in longer life.

A still further object of the invention is to provide new fuel supply means for an engine or the like wherein the fuel pump of the fuel supply means is automatically stopped when the engine stops.

Another object of the invention is to provide new fuel supply means wherein the speed of the fuel pump is substantially directly proportional to the speed of the engine.

A still further object of the invention is to provide new fuel supply means including fuel pump means wherein fire danger or hazard from operation of the pump is substantially eliminated.

Various other objects, advantages and features of the invention will become apparent to those skilled in the art from the following description taken in connection with the accompanying drawings, in which:

FIG. 1 is a view illustrating a preferred specific embodiment of a fuel supply means of the invention.

FIG. 2 is a top plan view, partially broken away, illustrating a preferred specific embodiment of the power means of the invention.

FIG. 3 is a side view, partially in elevation and partially in cross section, of the power means of FIG. 2.

FIG. 4 is a schematic diagram of a preferred specific embodiment of the electrical means for obtaining electrical power to the motor for pumps or the like shown in FIGS. 2 and 3.

FIG. 5 is a schematic diagram illustrating an oscillator usable with the electrical powering means of FIG. 4.

The following is a discussion and description of preferred specific embodiments of the new powering means and fuel supply means of the invention, such being made with reference to the drawings whereon the same reference numerals are used to indicate the same or similar parts and/or structure. It is to be understood that such discussion and description is not to unduly limit the scope of the invention.

Referring now to the drawings in detail, an electrically powered pump is shown generally at 10 in FIGS. 2 and 3 and includes a hollow housing shown generally at 12 which preferably is elongated and includes a lower housing portion 14 and an upper housing portion 16, the housing portions 14 and 16 having projecting side walls 18 and 20, respectively, which are connected together in any suitable manner, such as by the formation of a ledge or the like 22 on the side wall 18 which receives the lower edge portion of the wall 20 of the upper housing portion 16. A fluid inlet opening is provided and can be located in the upper portion 16 of the housing 12. Preferably, the inlet is provided with a screen or the like as shown at 24 in FIG. 2 to prevent entry of solid matter into the pump housing, which might impair pump operation or clog fuel lines. A fluid outlet 26 is also provided at any suitable location in the housing 12 and can be connected to a fuel line or the like as described hereinafter.

The pump 10 has a driven element or means 28 positioned in one end portion of the housing 12 which is adapted to receive a fluid and discharge same from the pump housing. The driven element 28 can be a portion of a vane pump, centrifugal pump, gear pump or other suitable structure for moving fluids.

Powering means are provided for the pump 10 and desirably includes a motor shown generally at 30. The motor 30 is preferably a multiphase induction motor and is located in the end portion of the housing 12 opposite from the driven element 28. The motor 30 includes an annular rotor 32 mounted on a shaft 34 and preferably the shaft 34 has tapered conical or needle-shaped end portions 36 and 38 which are matingly received in recesses in the housing portions 16 and 14, respectively, to rotatably mount the shaft 34 and rotor 32 within the housing. An annular gear 40 can be provided and operatively connected to shaft 34 by a web-like portion or member 42 to cause rotation of the gear 40 during rotation of shaft 34 and rotor 32. Gear 40 is engageable with the driven element 28 of the pump so that operation of the motor drives the driven element. An annular stator winding 44 is mounted in housing portion 16 and is positioned around and is in close proximity to the rotor 32 and the stator winding is desirably positioned between the rotor 32 and the gear 40.

Preferably, the housing 12 is constructed and adapted to receive fuel through screen 24 at the inlet of the housing with portions of the housing being shaped to form recesses or hollows as illustrated at 46 and 48 in FIG. 3 so that fuel can be received in and substantially fill the hollow portions 46 and 48 around the motor to thereby provide buoyancy for the rotatable portions of the motor, such as the rotor 32, shaft 34 and gear 40 and thus reduce the weight and load on the conical tapered end portions 36 and 38 of the shaft 34. In a similar manner recesses can be provided around the driven elements of the pump. The presence of fuel or other fluids in and around the motor provides lubrication to the bearing portions of the shaft 34 and further serves to cool the motor windings 44. Thus, additional lubricant required with many prior art motor or power means is eliminated and the motor continually runs at a cool temperature. In addition, since the load on the bearing portions 36 and 38 of shaft 34 is substantially reduced longer life is obtained and less maintenance is required.

When the pump 10 of the invention is utilized for pumping fuel or other combustible materials a multiphase induction motor is preferably provided. The windings of

such a motor are diagrammatically illustrated in FIGS. 4 and 5 of the drawings and include three windings 50, 52 and 54, each of which are connected in one end to a common terminal 56 and have the other end thereof connected to terminals 58, 60 and 62, respectively. By using an induction motor there are no brushes or contacts to cause electrical sparking which might otherwise cause a fire or explosion hazard and by the elimination of sparking the pump means can be mounted within the fuel tank and safely receive fuel in the hollows or recesses 46 and 48.

The fuel pump means 10 is shown in FIG. 1 as part of fuel supply means for supplying fuel to conventional engine means 66 which can have a carburetor or the like 68 associated therewith for mixing of fuel and an oxygen containing fluid. The outlet of the pump means 10 is connected to one end of a fuel line 70 which has the other end thereof connected to the carburetor or the like 68. The fuel pump 10 is preferably mounted in a sump 72 of a fuel tank 74 so that substantially all of the fuel 76 contained within the tank 74 can be transmitted by the pump 10 to the engine 66. In addition, by mounting the pump 10 in the sump 72 the pump will be continuously supplied with fuel, the bearings of the motor 30 will be lubricated and the motor will be cooled as long as there is any fuel within the tank 76.

Generator means 78 for electrical powering of accessories can be provided and operatively connected to the engine 66, such being particularly desirable when the engine is used to power an automobile, truck, etc. The generator means 78 is connected by belt means 80 to the drive shaft of the engine 66 for operation during operation of the engine. Many of the automobiles now being produced utilize alternators as the means for generating electrical energy and the A.C. voltage generated by the alternator is converted by rectifier means to a D.C. voltage for battery charging operations, powering of accessories and for other uses. A bridge type rectifier is shown generally at 82 and is connected to the alternator 78 in any suitable manner. For example, FIG. 4 of the drawings illustrates the alternator as having three coils or windings 84, 86 and 88 each of which are connected in one end to a common terminal 90 and are connected in the other end portions to contacts or terminals 92, 94 and 96, respectively. The terminals 92, 94 and 96 are connected to one end of conductors 98, 100 and 102, respectively, and the conductors 98, 100 and 102 are connected to conductors 104, 106 and 108 of the diode bridge 82. The diode bridge 82 includes diodes 110 and 112 connected to the conductor 104, diodes 114 and 116 connected to conductor 106 and diodes 118 and 120 connected to conductor 108. Diodes 112, 116 and 120 are connected to conductor 122 which is grounded as shown. The diodes 110, 114 and 118 are connected to a conductor 124 which in turn is connected to the battery 126 and/or to accessories for the automobile, truck or the like. The winding 44 of the A.C. motor 30 of the pump 10 is connected to the output of alternator 78 between the alternator and the bridge 82 in any suitable manner, such as by the use of conductor 128 connected to conductor 98 and to terminal 60 of the motor, by a conductor 130 connected to the conductor 100 and to the terminal 58 of the motor, and by a conductor 132 connected to conductor 102 and to terminal 62 of the motor. Thus, the A.C. voltage generated by the alternator 78 is provided directly to the windings 44 of the motor 30 while a portion of the voltage generated is also supplied to the battery 126 and accessories from the bridge 82.

During operation of engine 66 the motor 30 of the pump means 10 receives electrical energy from conductors 128, 130 and 132 connected to the alternator 78 and operation of the motor 30 drives the driven element 28 of the pump means 10 to provide fuel through the fuel line or conduit 70 to carburetor or the like 68 and from there to the engine 66 for operation of the engine. When

the engine 66 is stopped either intentionally or as a result of an accident or when the fuel tank 74 is empty, electrical energy is no longer supplied to the pump 10 from the alternator and the pump stops so that fuel will not be supplied to the engine and cause fire. The alternator generates a rotating electrical voltage which is governed by the speed of the engine, and the speed of the fuel pump which is powered by a multiphase induction motor is directly proportional to the speed of the alternator. For this reason the fuel pump supplies an amount of fuel to the engine which is a function of the speed of the engine. This is in direct contrast to conventional D.C. powered fuel pumps which operate at a constant speed almost regardless of the engine speed.

The engine 66 can be started in the usual and conventional manner and a portion of FIG. 4 illustrates a conventional engine starting circuit. The battery 126 connected to conductor 124 provides D.C. voltage to one terminal of an ignition switch 136 and to a terminal 138 of a starter switch shown generally at 140. The other terminal 142 of switch 140 is connected to a conductor 144 which in turn is connected to the starter motor 146 which is operatively connected to the engine 66 in any suitable manner. Motor 146 is also grounded as shown.

Ignition switch 136 is also connected by conductor 148 to a solenoid coil or the like 150 and switch member 152 associated with the coil 150 has a portion thereof engageable with the contacts 138 and 142 of switch 140. When the ignition switch 136 is closed D.C. voltage from battery 126 is provided through conductor 124, switch 136 and conductor 148 to the coil 150 to cause retraction of the member 152 to thereby close switch 140 and complete the circuit across terminals 138 and 142 which in turn provides electrical energy through conductor 144 to starter motor 146 for cranking of the engine 66. As soon as the engine begins to turn over as result of operation of the motor 146 the alternator 78 begins to generate some electrical energy and such is provided through conductors 128, 130 and 132 to the motor 30 of the pump means 10 for operation of the pump so that fuel is pumped to the engine 66 and the engine can be started. While the amount of electrical energy generated by alternator 78 during cranking of the engine is relatively small, a great deal of fuel is not needed at this stage of operation of the engine and the pump means operates satisfactorily for starting purposes.

If desired, a separate source of A.C. voltage can be supplied to the motor 30 of the pump 10 during cranking of the engine 66. A circuit for this purpose is illustrated in FIG. 4 where an auxiliary stator winding is shown generally at 160 and includes three coils or windings 162, 164 and 166 each of which are connected in one end to a common terminal 168 and connected in the other end to separate contacts or terminals 170, 172 and 174. Terminal 168 is grounded by conductor 167. The auxiliary winding 160 is positioned in the housing 12 of the pump 10 and located concentrically with the rotor 32 of the motor 30 and the winding 160 can be positioned at one end of the winding 44 as illustrated in FIG. 3.

Preferably, the electrical energy supplied to the winding 160 is provided from the automobile battery 126 and for this purpose a conductor 174 is provided and is connected in one end portion to conductor 144 so that D.C. voltage from the battery 126 is supplied to conductor 174 when the switch 136 is closed to thereby close switch 140 and provide electrical energy to conductor 144 and the starting motor 146.

The D.C. voltage from the battery must be changed to an A.C. voltage for operation of the A.C. motor 30 and for this purpose an oscillator and phasing capacitor or multiphase oscillator is provided and such is shown generally at 176 in FIGS. 4 and 5 of the drawings and is connected to the other end portion of the conductor 174 and to conductors 178, 180 and 182 which are connected to the auxiliary stator winding 160. The A.C. oscillator and

phasing capacitor or multiphase oscillator 176 functions to provide a rotating electrical voltage to the auxiliary stator 160 and the provision of the oscillator permits use of a smaller pump of less expensive design, such as a centrifugal type pump rather than a gear pump or a sliding vane impeller pump. As soon as the engine 66 starts the switch 140 is opened and starting motor 146 and the multiphase oscillator 176 are taken out of the circuit and the motor 30 operates from the energy received directly from alternator 78 in the manner explained hereinbefore.

The oscillator 176 can be of any suitable and common construction. A typical multiphase oscillator capable of generating a rotating A.C. voltage is illustrated at 176 in FIG. 5 of the drawings. In the oscillator of FIG. 5 direct current is received from the battery from conductor 174 which is connected to one end of a resistor 186. The other end of the resistor is connected to a diode 188 and the resistor and diode together comprise a spike filter to keep voltage transients on the vehicles D.C. bus from damaging the transistors 190 and 192. The spike filter is connected by conductors 194 and 196 to one terminal of the transistor 190 and by conductor 198 and resistor 200 to another terminal of the transistor. Likewise conductor 202 connects the filter to one terminal of transistor 192 and conductor 198 and resistor 204 connect the filter to another terminal of the transistor 192. The third terminal of transistor 190 is connected by conductor 206 to one end of a resistor 208 and to terminal 170 of the auxiliary winding 160 and the other end of resistor 208 is connected by conductor 210 to the other end of resistor 204 and to one of the terminals of the transistor 192. In a similar manner the third terminal of transistor 192 is connected by conductor 212 to one end of a resistor 214 and to terminal 174 of the auxiliary winding 160 and the other side of resistor 214 is connected by conductor 216 to the base terminal of transistor 190 and to the resistor 200. A capacitor 218 is provided and one side or terminal thereof is connected to conductor 206 and the other side thereof is connected by conductor 220 to the terminal 172 of the auxiliary winding 160.

The transistors 190 and 192 operate in connection with the auxiliary stator windings of the pump motor to form a simple square wave oscillator and the capacitor 218 provides a phase shift in the voltage applied to the third leg of the auxiliary stator winding and in operation the apparatus of FIG. 5 affects a phase shift which causes affective voltage rotation. The rotating voltage provided by the apparatus of FIG. 5 permits operation of the motor 30 and of the pump 10 during cranking of the starting engine or motor 146 for engine 66 to thereby provide fuel through fuel line 70 to the carburetor 68 into the engine.

As will be seen from the foregoing description of the invention new means for providing electrical energy to motor means have been provided and such is especially usable for operation of an engine 66 wherein alternating current is generated during operation of the engine for supplying A.C. energy to the pump motor which in turn provides fuel to the engine, such resulting in a fuel supply system which immediately ceases operation when the engine 66 stops thereby providing inherent safety factors not ordinarily present with prior art devices, particularly in fuel supply systems for automobiles or the like. The fuel supply means of the invention utilizes any common pump structure in connection with the electric motor means and in addition the electrical powering means permits immersion of the fuel pump in the fuel tank and the pump is not required to develop a large amount of vacuum as in many prior art fuel supply systems wherein the fuel pump is remotely located from the fuel tank. Thus, smaller pump structures can be utilized. In addition, the motor 30 of the pump structure operates more efficiently and cooler as a result of presence of fuel in and around the moving parts of the motor which serves

to cool the windings and additionally substantially floats the rotating parts to reduce wear on the bearing surfaces. The bearing surfaces are lubricated by the fuel and there is less wear on the bearing surfaces and since lubrication is always present during operation of the motor there is no likelihood of overheating at the bearing surfaces which might result in fire or failure of the pump. Furthermore, pump speed is directly proportional to the speed of the engine since the alternator is operated directly from the engine and the fuel pump powered directly therefrom and preferably utilizes a multiphase induction motor, such being dissimilar from prior art systems operated from D.C. powered fuel pumps which operate a constant speed.

While the invention has been described in connection with preferred specific embodiments thereof, it will be understood by those skilled in the art that this description is intended to illustrate and not to limit the scope of the invention which is defined by the claims.

I claim:

1. In a fuel supply system for an internal combustion engine having a fuel tank and a pump for delivering fuel therefrom to the engine: an alternating current motor operatively coupled to the pump, said motor containing two sets of windings each independently capable of operating the motor; and alternator driven by the engine, the A.C. output of said alternator being operably connected to one of said motor winding sets; an electronic A.C. generator circuit energized by a source of D.C. potential for providing A.C. power; and a starter motor circuit including a starting switch for energizing said starter motor circuit and said generator circuit for selectively energizing the other of said motor winding sets; whereby the pump is motivated by said motor to deliver fuel to the engine while the engine is in operation, and at an independent rate upon the engine start-up period while said starting switch is closed.

2. In a fuel supply system for an internal combustion engine having a fuel tank and a pump for delivering fuel therefrom to the engine: an alternating current motor operatively coupled to the pump for driving it to supply fuel to the engine, said motor containing two sets of stator winding each capable of operating the motor; an alternator driven by the engine for producing A.C. voltage proportional to engine speed, the A.C. output of said alternator being operably connected to one of said motor winding sets; an electronic A.C. generator circuit energized by a source of D.C. potential for providing A.C. power; and a starter motor circuit including a starting switch for energizing said starter motor circuit and said generator circuit for selectively energizing the other of said motor winding sets; whereby the pump is motivated by said motor to deliver fuel to the engine at a rate substantially proportional to the engine speed, and at a predetermined rate upon the engine start-up period while said starting switch is closed.

3. In a fuel supply system for an internal combustion

engine having a fuel tank and a pump for delivering fuel therefrom to the engine: a multi-phase alternating current motor operatively coupled to the pump for driving it to supply fuel to the engine, said motor containing two sets of multi-phase stator windings each independently capable of operating the motor; a multi-phase alternator driven by the engine, the A.C. output of said alternator being operably connected to one of said motor winding sets; an electronic multi-phase A.C. generator circuit energized by a source of D.C. potential for providing multi-phase A.C. power; and a starter motor circuit including a starting switch for energizing said starter motor circuit and said generator circuit for selectively energizing the other of said motor winding sets; whereby the pump is motivated by said motor to deliver fuel to the engine while the engine is in operation, and at an independent rate upon the engine start-up period while said starting switch is closed.

4. In a fuel supply system for an internal combustion engine having a fuel tank and a pump for delivering fuel therefrom to the engine: a multi-phase alternating current motor operatively coupled to the pump for driving it to supply fuel to the engine, said motor containing two sets of multi-phase stator windings each capable of operating the motor; a multi-phase alternator driven by the engine for producing multi-phase A.C. voltage proportional to engine speed, the A.C. output of said alternator being operably connected to one of said motor winding sets; an electronic multi-phase A.C. generator circuit energized by a source of D.C. potential for providing multi-phase A.C. power; and a starter motor circuit including a starting switch for energizing said starter motor circuit and said generator circuit for selectively energizing the other of said motor winding sets; whereby the pump is motivated by said motor to deliver fuel to the engine at a rate normally substantially proportional to the engine speed, and at a predetermined rate upon the engine start-up period while said starting switch is closed.

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