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(54) PORTABLE TRANSFER PUMP

(71) We, FACET ENTERPRISES, INC., a corporation organised and existing under the laws of the State of Delaware U.S.A. and having an office at 7030 South Yale, Suite 800, Tulsa, Oklahoma 74136, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:-

The need to transfer fluid from one place to another at home, as well as at remote locations such as a camp site, on a boat, and on a farm, and even in some industrial premises, is a common occurrence and often causes problems. Often it is inconvenient to dump or bail liquid from one container to another and a small pump could do the job much more efficiently and expediently. However, most of these occasions are not sufficiently repetitive to justify the costs of building a pump into a particular device with which the need may arise. Therefore, a small portable electrical fluid pump would be most useful for a wide variety of applications, and to be practical the pump must be sufficiently small that it can be transported and stored with ease and must be readily able to be connected to a convenient source of electrical power. One source of electrical power that is usually available, even at remote locations, is a battery such as that of an automobile, truck, tractor, or other vehicle, a boat, or even an aircraft. These vehicles or craft often have a cigarette lighter or other outlet which provides convenient access to the vehicle's source of electrical power, and a D.C. electromechanical fluid pump having an electrical connector which could be plugged into the cigarette lighter or another electrical power outlet of the vehicle or craft would fill many existing needs. Examples of portable fluid pumps are disclosed in United States Patent Specifications Nos. 3,629,674 and 3,381,616 and this invention relates to an improved, more reliable portable electrical fluid transfer pump.

According to the invention, a portable fluid transfer pump comprises a cylindrical guide member having a guide portion and a contiguous neck portion at one end of the guide portion and forming an outlet port, an inlet member having one end received in the end of the guide portion remote from the outlet port and having a neck portion which extends away from the guide member and which is similar to the neck portion forming the outlet port, the inlet member also having a fluid passageway extending through it concentric with its neck portion and forming an inlet port, a solenoid coil which is disposed concentrically around the guide portion and which generates a magnetic field in response to a current flow therethrough, a detection coil magnetically linked to the solenoid coil so that it generates a first signal in response to the solenoid coil generating an increasing magnetic field and generates a second signal in response to a decreasing magnetic field, a blocking oscillator including an electronic switching device for controlling the current flow through the solenoid coil, and hence the magnetic field generated thereby, between maximum and minimum values in response to the first and second signals generated by the detection coil, a piston member which is disposed in the guide portion and which is movable therein against a resilient bias in response to a magnetic field of predetermined magnitude generated by the solenoid coil whereby the piston member reciprocates as the magnetic field is increased and decreased, valve means which is disposed in the guide member and which co-operates with the piston member so that fluid is pumped unidirectionally from the inlet port to the outlet port when the piston member is reciprocated, and an external housing surrounding the guide member, the inlet member, the solenoid coil, and the detection coil, the housing comprising a first part having an aperture through which the outlet port projects, a second part having an aperture through which the inlet port projects, and means for locking the first and second parts together, the arrangement being such that when the first and second parts of the housing are locked together they serve to retain the inlet member in the end of the guide member.

Preferably the pump includes an electrical cord which has at least two electrical leads for connecting an electrical power supply to the pump and which has at one of its ends one of the leads connected to one end of the solenoid coil and another of the leads connected to the blocking oscillator, the leads being connected at the other end of the cord to an electrical connector which is arranged to fit in an electrical outlet of an electrical power source, such as that provided by a vehicle battery.

Preferably the electronic switching device of the blocking oscillator is a solid state switch, preferably a silicon Darlington amplifier. The silicon Darlington amplifier is less costly and more compact than equivalent germanium type solid state switching devices. Furthermore, it provides high gain and permits the use of a higher base resistance, which gives the blocking oscillator an operating temperature range of from -55°C to +90°C without temperature compensation. The silicon Darlington amplifier also can endure higher temperatures and, therefore, minimizes the heat sink requirements permitting an even more compact pump assembly.

An example of a preferred embodiment of the portable fluid transfer pump in accordance with the invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 is a perspective schematic view of the pump;
Figure 2 is a cross sectional view of the pump; and
Figure 3 is a circuit diagram of the blocking oscillator which forms part of the pump.

The portable fluid transfer pump illustrated in Figure 1 comprises an electromagnetic pump 10 having an electrical cord 12 connected at one end to the electrical input of the pump 10, and at the other end to an electrical connector 14 adapted to fit into the cigarette lighter socket of a motor vehicle. An electrical switch 16 controlling the supply of electrical power to the pump may be disposed on the cord 12 between the electromagnetic pump 10 and the connector 14, or may be mounted on the body of the pump 10 as illustrated in Figure 2. The pump 10 has an inlet 18 to which is connected a fluid conduit, such as a rubber hose, 20 which connects the pump with the source of fluid (not shown) to be pumped. The pump also has an outlet 22 to which is connected a second fluid conduiit, such as a rubber hose, 24 which conducts the pumped fluid to a desired repository (not shown). For example, the fluid transfer pump may be used to pump petrol from a storage vessel, which may be the petrol tank of a vehicle, to the petrol tank of an internal combustion engine powering a chain saw, or vice versa. The pump also includes a hanger 26 which permits the pump to be suspended from any convenient support while in operation, and which may also be used for storing the pump.

The details of the electromagnetic pump 10 are illustrated in Figure 2. The external housing of the pump comprises a body 28 and a cover 30, the upper portion of the body 28 having a recessed circumferential land 32 generally mating with the inner surface 34 of the cover 30. A series of dogs 36 disposed at predetermined locations about the periphery of the land 32 engage a series of detents 38 in the cover 30 and secure the cover 30 to the body 28. Guide supports 40 and 42 are disposed inside the body 28 and the cover 30, respectively, and support a generally cylindrical guide 44. The upper end of the cylindrical guide 44 has a neck portion 46 which forms the outlet 22 shown in Figure 1, the neck portion 46 protruding through an aperture 48 in the cover 30. The end of the neck portion 46 is formed as a truncated cone shaped portion 50, the base of which is slightly larger than the remainder of the neck portion 46. The tapered end of the truncated cone portion 50 facilitates the attachment of the rubber tube 24, and the larger base engages the inner wall of the rubber tube causing it to expand, thereby forming a fluid tight seal. Disposed in the cylindrical guide 44 is a magnetically permeable hollow piston member 52 which is free to move in a reciprocating manner within the cylindrical guide 44. Valve members 54 and 56 are provided so that, in operation, a unidirectional fluid flow through the guide 44 and the hollow piston 52 from the inlet 18 to the outlet 22 is obtained when the piston is reciprocated.

At the lower end of the cylindrical guide 44 there is an inlet member 58 having a neck portion 60 protruding through an aperture 62 in the body 28. The neck portion 60 forms the inlet 18 shown in Figure 1 and at its end has a truncated cone section 64 similar to that of the outlet 22 as described above. A seal, shown as an 0-ring 66, forms a fluid seal between the inlet member 58 and the cylindrical guide 44. A first resilient member, shown as a spring 68, is disposed between the inlet member 58 and the piston member 52 and biases the piston member towards the outlet 22. A second resilient member, shown as a spring 70, is disposed between the piston member 52 and the shoulder 72 formed in the cylindrical guide 44 at the base of the neck portion 46. The spring 70 cushions the upward thrust of the piston member 52 under the action of the spring 68 at the end of the piston's stroke.

Disposed on a spool 74, which surrounds the guide 44 and which is confined between flanges 76 and 68 of the guide support members 40 and 42 respectively, are a solenoid coil 80 and a detection coil 82. Electrical power is received by the pump via a two-wire electrical cord 12 which enters through an aperture (not shown) in the body 28. One of the wires of the cord 12 is connected directly to a printed circuit board 84 containing a blocking oscillator circuit which is described later with reference to Figure 3. The other wire of the cord 12 is also connected to the printed circuit board 84, but through a switch 86 which controls the on-off operation of the pump. As previously mentioned, the switch 86 may be omitted from the pump body and located in the cord 12.

The operation of the pump is as follows. With no electrical power applied, the piston member 52 rests in the uppermost position as shown, under the biasing action of the spring 68. With the connector 14 plugged into the power supply of a vehicle battery, closure of the switch 86 applies electrical power to the solenoid coil 80 and the blocking oscillator of the circuit board 84 which initiates an initial current flow in the solenoid coil 80. The solenoid coil 80 generates a magnetic field in response to the current flow, and the detection coil 82, in response, generates a signal initiating the operational cycle of the blocking oscillator which thereby increases the current flow in the solenoid coil. The current flow in the solenoid coil 80 rapidly increases until the generated magnetic field is sufficient to move the piston member 52 against the biasing force of the spring 68. As the piston member 52 moves against the force of the spring 68, the valve 54 opens and the valve 56 closes and the fluid trapped between the two valves is displaced into the hollow portion of the piston member 52 as the piston 52 moves towards the valve 56. Saturation of the current flow in the solenoid coil 80 terminates the signal induced in the detection coil 82, which in turn terminates the current flow in the solenoid coil 80. The magnetic field generated by the solenoid coil collapses and is no longer capable of holding the piston member 52 against the biasing force of the spring 68. The piston member 52 therefore moves back towards the outlet 22 under the force of the spring 68, and the valve member 54 closes so that the fluid displaced into the hollow portion of the piston is carried with the piston member 52 towards the outlet. The valve 56 opens and fluid from the source is drawn up through inlet 18 into the space between the valves 54 and 56. When the magnetic field has completely collapsed and the piston has returned to its rest position, the pump is in its initial state and the operating cycle just described is repeated.

The details of the blocking oscillator disposed on the circuit board 84 are shown in Figure 3. Terminals 88 and 90 represent the contacts of the connector 14 at the end of the electrical cord 12 represented by twin leads 92 and 94. The terminals 88 and 90 connect the circuit to a source of electrical power illustrated as a battery 96. The lead 92 is connected to the input end of the solenoid coil 80 and the cathode of a diode 102 through the switch 86, and the lead 94 is connected to the collectors of silicon transistors 98 and 100. The transistors 98 and 100 are connected to form the familiar pnp Darlington pair amplifier. The emitter of the transistor 98 is the emitter terminal of the Darlington amplifier, and the base of the transistor 100 is the base terminal. The emitter of the amplifier is connected to the output end of the solenoid coil 80 and to one end of the detection coil 82. The other end of the detection coil 82 is connected to the anode of the diode 102 through parallel connected resistances 104 and 106, and is also connected to the base of the transistor 100 through series connected resistances 108 and 112. The junction between the resistances 108 and 112 is connected to the collectors of the transistors 98 and 100 and to the lead 94 through a resistance 110.

The operation of the blocking oscillator is as follows. When the switch 86 is closed, a start current flows through the solenoid coil 80, the detection coil 82, resistances 108 and 110, and the lead 94 to the terminal 90. Resistances 108 and 110 form a voltage divider applying a potential to the base of the transistor 100 which is less than the potential at the emitter, thereby biasing the transistor 100 causing it to conduct. Conduction of the transistor 100 forward biases the transistor 98 causing it to conduct also. The conduction of the transistors 98 and 100 increases the current flow through the solenoid coil 80, which thereby generates an expanding magnetic field which induces a current to flow in the detection coil which is counter to the "start current" flow. The induced current forward biases the base of the transistor 100, still further increasing the conductance of the transistors 98 and 100. This process continues and rapidly both transistors become saturated (fully conductive). In the meantime, the magnetic field generated by the solenoid coil 80 has become sufficient to attract the piston member 52 against the biasing force of the spring 68. When the transistors 98 and 100 start to saturate, the magentic field generated by the solenoid coil 80 expands at a slower rate and the signal induced in the detection coil 82 decreases. A decrease in the signal induced in the detection coil 82 decreases the current which forward biases the base of the transistors 98 and 100. This process continues until the base current of the transistor 100 is terminated, turning off the transistor 98 and the current flow through the solenoid coil 80. Termination of the current flow in the solenoid coil 80 causes the magnetic field to collapse, i.e. contract, thereby inducing a signal in the detection coil 82 which is in the reverse direction of the signal induced by the expanding magnetic field. This signal reverse biases the transistor

100, and holds the transistors 98 and 100 in the off (nonconductive) state until the magnetic field has completely collapsed After the magnetic field has collapsed, the signal induced in the detection coil 82 reverse biasing the transistor 100 in the "off" state is terminated, and the "start current" will again flow through the solenoid coil 80, the detection coil 82 and the resistances 108 and 110 to forward bias the transistor 100 and reinitate the cycle.

The circuit comprising the resistances 104 and 106 and the diode 102 provides a controlled dissipation of the current in the solenoid and detection coils when the transistors 98 and 100 are in the "off state" and the magnetic field is collapsing.

The high gain Darlington amplifier comprising the transistors 98 and 100 permits the use of smaller control signals, permitting an increase in the value of the base resistance 110. This increases the stability of the oscillator over a wider range of temperatures, and increases the life of the oscillator since the current induced by the collapsing magnetic field will preferentially flow through the dissipation circuit comprising the resistances 104 and 106 and the diode 102. The silicon Darlington amplifier is also more compact than equivalent germanium devices and can endure higher temperatures, eliminating the requirement for an elaborate heat sink to dissipate the heat generated.

Typical values for the components of the circuit illustrated in Figure 3 are as follows:

Diode 102	2 amperes, 200 volts
Resistance 104	180 ohms, 1/2 watts
Resistance 106	180 ohms, 1/2 watts
Resistance 108	10 ohms, 1/4 watts
Resistance 110	2000 ohms, 1/4 watts
Resistance 112	130 ohms, 1/4 watts

Having described the preferred embodiment with reference to the drawings, it is not intended that the invention be limited to the specific embodiment shown. One skilled in the art could alter the pump or circuit configuration without departing from the scope of the invention as defined in the following claims.

WHAT WE CLAIM IS:-

1. A portable fluid transfer pump comprising a cylindrical guide member having a guide portion and a contiguous neck portion at one end of the guide portion and forming an outlet port, an inlet member having one end received in the end of the guide portion remote from the outlet port and having a neck portion which extends away from the guide member and which is similar to the neck portion forming the outlet port, the inlet member also having a fluid passageway extending through it concentric with its neck portion and forming an inlet port, a solenoid coil which is disposed concentrically around the guide portion and which generates a magnetic field in response to a current flow therethrough, a detection coil magnetically linked to the solenoid coil so that it generates a first signal in response to the solenoid coil generating an increasing magnetic field and generates a second signal in response to a decreasing magnetic field, a blocking oscillator including an electronic switching device for controlling the current flow through the solenoid coil, and hence the magnetic field generated thereby, between maximum and minimum values in response to the first and second signals generated by the detection coil, a piston member which is disposed in the guide portion and which is movable therein against a resilient bias in response to a magnetic field of predetermined magnitude generated by the solenoid coil whereby the piston member reciprocates as the magnetic field is increased and decreased, valve means which is disposed in the guide member and which co-operates with the piston member so that fluid is pumped unidirectionally from the inlet port to the outlet port when the piston member is reciprocated, and an external housing surrounding the guide member, the inlet member, the solenoid coil, and the detection coil, the housing comprising a first part having an aperture through which the outlet port projects, a second part having an aperture through which the inlet port projects, and means for locking the first and second parts together, the arrangement being such that when the first and second parts of the housing are locked together they serve to retain the inlet member in the end of the guide member.

2. A portable pump according to claim 1, including an electrical cord which has at least two electrical leads for connecting an electrical power supply to the pump and which has at one of its ends one of the leads connected to one end of the solenoid coil and another of the leads connected to the blocking oscillator, the leads being connected at the other end of the

cord to an electrical connector which is arranged to fit in an electrical outlet of an electrical power source.

3. A portable pump according to claim 2, in which the electronic switching device is a solid state switch having an emitter terminal connected to the end of the solenoid coil opposite that which is connected to one of the electrical leads and also to one end of the detection coil, a collector terminal connected to the other electrical lead, and a base, and the blocking oscillator also comprises first and second resistances connected in series between the other end of the detection coil and the collector terminal and forming, in combination with the solenoid coil and the detection coil, a voltage divider between the two electrical leads, a third resistance having one end connected to the junction between the first and second resistances and its other end connected to the base terminal of the solid state switch, and a series connected resistance and diode connected between the said other end of the detection coil and the said one end of the solenoid coil for dissipating in a controlled manner the currend induced in the solenoid and detection coils by a rapidly decreasing magnetic field, the arrangement being such that the first signal induced in the detection coil forward biases the base terminal of the solid state switch to increase the current flow through the solenoid coil, and the second signal reverse biases the base terminal of the solid stage switch to decrease the current flow through the solenoid coil.

4. A portable pump according to claim 3, in which the solid state switch is a silicon Darlington amplifier.

5. A portable pump according to claim 3 or claim 4, in which the resistance of the serially connected resistance and diode comprises a fourth resistor connected in parallel with a fifth resistor between the said other end of the detection coil and the diode.

6. A portable pump according to any one of claims 2 to 5, in which the blocking oscillator is disposed in an internal chamber of the pump isolated from the fluid flow through the pump.

7. A portable pump according to any one of claims 2 to 6, in which the pump includes a switch for controlling the flow of electrical power from the electrical connector to the solenoid coil.

8. A portable pump according to claim 7, in which the switch is located in the electrical cord.

9. A portable pump according to any one of claims 2 to 8, in which the connector is arranged to fit into a cigarette lighter socket of a motor vehicle.

10. A portable pump according to any one of the preceding claims, in which the pump includes a hanger for suspending the pump from a convenient support.

11. A portable fluid transfer pump comprising a housing having coaxially disposed apertures, a cylindrical guide member disposed in the housing coaxial with the apertures and having a contiguous neck section at one end forming an outlet port which projects through one of the apertures, an inlet member which is received in the end of the guide member remote from the outlet port and which has a fluid passageway extending therethrough coaxial with the guide member, the inlet member having a neck section which projects through the other of the apertures to form an inlet port and which is similar to the neck section forming the outlet port, the portions of the housing adjacent the apertures abutting the shoulders of the guide member and the inlet member formed by their sections, a cylindrical armature which is slidably disposed in the guide member and which has a central bore forming a valve retainer, first valve means which is fixed in the valve retainer so as to permit unidirectional fluid flow through the cylindrical armature towards the outlet port and which has a portion projecting from the armature and forming a spring retainer, second valve means disposed adjacent the inlet member so as to permit a unidirectional fluid flow through the passageway in a direction towards the outlet port, a compression spring disposed between the armature and the second valve means for biassing the armature towards the outlet port, one end of the spring being located around the spring retainer and the other end of the spring holding the second valve means against the inlet member, a solenoid coil which is disposed in the housing coaxially around the outside of the guide member and which generates a magnetic field in response to a current flow through the coil to move the armature against the bias of the spring whereby the armature reciprocates to pump fluid from the inlet port to the outlet port as the magnetic field generated by the solenoid coil increases and decreases a detection coil disposed in the housing and magnetically linked to the solenoid coil so that it generates a first induced signal in response to the solenoid coil generating an increasing magnetic field and generates a second signal in response to a decreasing magnetic field, the detection coil having one end connected to the output end of the solenoid coil, and control means for controlling the current flow through the solenoid coil, and hence the magnetic field generated thereby, between maximum and minimum values in response to the first and second signals generated by the detection coil, the control means comprising serially connected resistance means and a diode connected between the input end of the solenoid coil and the other end of the detection coil for dissipating in a controlled manner the current induced in the solenoid and detection coils

by a decreasing magnetic field, a silicon Darlington amplifier having an emitter terminal, a collector, and a base, the emitter terminal being connected to the output end of the solenoid coil, serially connected first and second resistances which are connected between the said other end of the detection coil and the collector of the Darlington amplifier and which, in series with the solenoid and detection coils, form a voltage divider, and a third resistance connected between the base of the Darlington amplifier and the junction between the first and second resistances, the pump also comprising an electrical cord having at least two leads of which one lead is connected to the input end of the solenoid coil, and a second lead is connected to the collector of the Darlington amplifier, and a connector disposed at the opposite end of the cord from the pump housing for connecting the two leads to an electrical outlet of an electrical power source.

12. A portable pump according to claim 11, including means attached to the housing for suspending the pump from a support.

13. A portable pump according to claim 11 or claim 12 including a switch mounted in the housing for controlling the supply of electrical power to the input end of the solenoid coil.

14. A portable pump according to claim 11 or claim 12, in which the electrical cord includes a switch for controlling the flow of electrical power through the electrical cord.

15. A portable pump according to any one of claims 11 to 14, in which the connector is arranged to be received in the cigarette lighter socket of an engine powered vehicle.

16. A portable pump according to claim 1, substantially as described with reference to the accompanying drawings.

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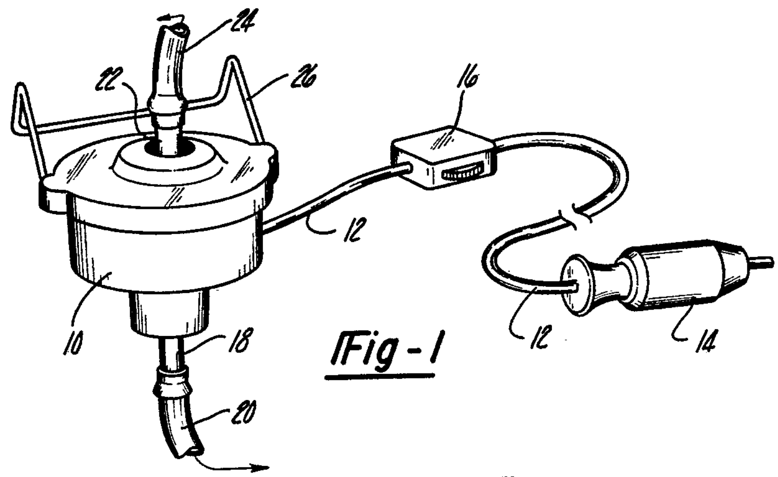
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Fig-1

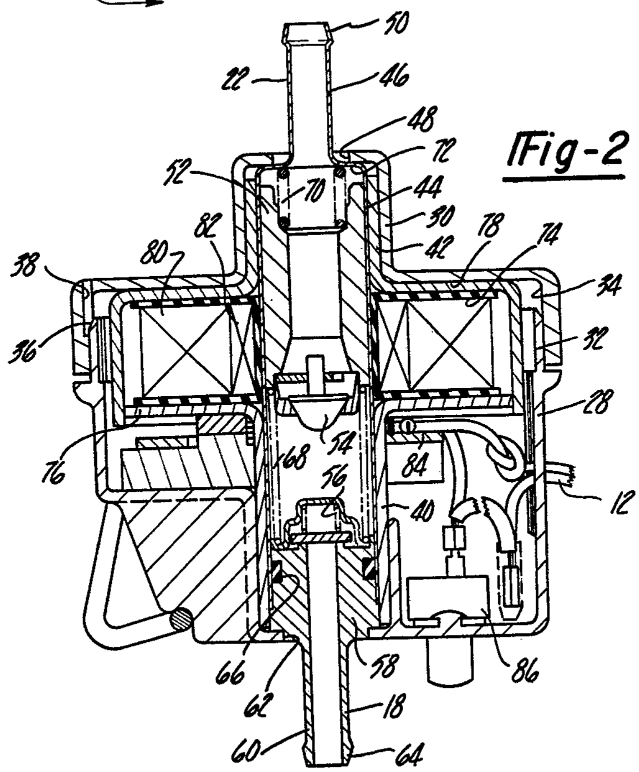
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Fig-2

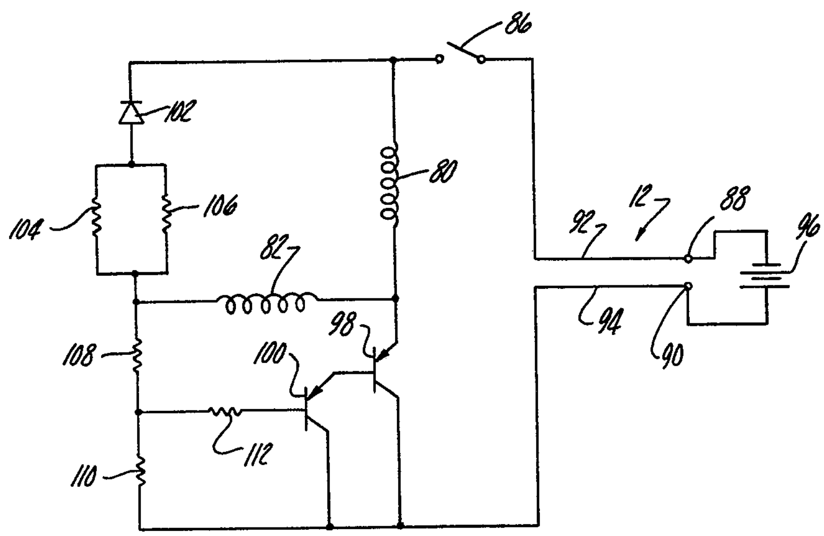

Fig-3