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(19)

(54) APPARATUS FOR INDICATING THE ENGINE SYSTEM STARTABILITY OF A VEHICLE BATTERY

(71) We LUCAS INDUSTRIES LIMITED, a British Company of Great King Street, Birmingham B19 2XF, 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:-

This invention relates to apparatus for indicating the condition of a vehicle battery in regard to its ability to start the engine system.

There exist many types of vehicle in which a battery is used both for starting the engine of the vehicle and also for operating various other electrical and electronic equipment. In many cases it is necessary to operate the electrical or electronic equipment when the vehicle engine is not running and in these circumstances, particularly in a cold climate, the battery may become discharged to a point where it is unable to restart the engine. It is an object of the invention to provide an indicating apparatus for indicating when the battery charge is becoming too low for starting the engine system having regard to the engine, engine oil and battery temperatures and additional mechanical loading e.g. generators, compressors.

Apparatus in accordance with the invention comprises an electronic circuit including means sensitive to the battery voltage, means sensitive to at least one other battery parameter, and means sensitive to the engine temperature, said circuit providing a warning indication when the battery voltage is less than a level determined as a function of the engine temperature and said other battery parameter.

Preferably said other battery parameter is the internal resistance of the battery which may be measured in a manner which is known *per se* by applying an a.c. signal from a constant current a.c. source to the battery terminals and measuring the alternating voltage across the battery.

In this case the electronic circuit may include a first function generator supplied with a first signal corresponding to the engine temperature and producing a signal corresponding to the starting voltage, i.e. the voltage required to be applied to the engine starter motor to start the engine system at that temperature, a second function generator supplied with said engine temperature signal and producing a second signal corresponding to the starting current, i.e. the current required to be applied to the engine starter motor to start the engine system at that temperature, a multiplier to which said second signal and a signal corresponding to the battery internal resistance are applied so as to produce a third signal corresponding to the voltage drop across the internal resistance of the battery if the starting current is caused to flow through the battery and means for comparing the actual battery voltage with the sum of said first and third signals.

The term "engine system" used herein means an engine of a specific type, having a specific load and lubricated by a specific type of oil.

In the accompanying drawings, Figure 1 is a block diagram of an example of the apparatus and Figure 2 is a circuit diagram of a function generator of which the example of the apparatus contains two.

Referring firstly to Figure 1 the battery 10 is the battery of a vehicle electrical system which includes an electric engine starter motor 11 and one or more electrical equipment loads 12 which may be operated even when the vehicle engine is not running.

In principle, the apparatus operates by detecting the engine temperature and the internal resistance of the battery. For any given engine temperature it is possible for the designer to predict what voltage and current the motor 11 will require to turn

over a given engine using a given type of oil. Thus a temperature sensor 13 associated with a temperature signal conditioning circuit 14 provides a temperature -dependent signal which is applied to two function generator circuits 15 and 16 respectively generating signals corresponding to the required current and voltage respectively.

An arrangement, known per se, is employed for generating a further signal dependent on the internal resistance of the battery 10. This arrangement is well known and one embodiment includes a constant current a.c. generator 16 driven by the battery with its a.c. output generator 16 driven by the battery with its a.c. output coupled to the battery via d.c. blocking means e.g. a capacitor 17. An a.c. detector circuit 18 is connected across the battery to detect the a.c. voltage produced by passing the constant a.c. signal through the battery and provides a d.c. output linearly related to the internal resistance of the battery. This d.c. output and the output from the function generator 15 are applied to an analogue multiplier 19. The circuits are arranged so that the signals from the function generator 16 and the multiplier 19 are both of opposite polarity to the vehicle battery and these signals are applied via resistors 20 and 21 to the inverting input terminal of an operational amplifier 22. A further signal conditioning circuit 24 in the form of a passive low pass filter stage is connected to the battery 10 to provide an indication of the voltage thereacross. The output of the circuit 24 is applied via resistor 23 to the inverting input terminal of the amplifier 22.

The amplifier 22 is connected as a summing amplifier with its non-inverting input terminal grounded and with a feedback path from its output terminal to its inverting input terminal consisting of a resistor 25, a variable resistor 26 and a current meter 27 in series. The output terminal of the amplifier 22 may also be connected to a level detector/warning lamp array 28.

When the battery is fully charged the positive signal applied to the amplifier 22 via the resistor 23 will exceed the sum of the negative signals from the resistors 20, 21 so that the output of the amplifier 22 will be fully negative. As the battery 10 discharges, or the temperature falls, the point will be reached where the output of the amplifier 22 starts to rise and the meter 27 may be marked with a band to show that the charge of the battery is becoming insufficient to start the engine system. Finally the battery voltage will fall below that required for starting and the output of the amplifier 22 will then become positive.

The level detector/warning lamp array 28, can thus be arranged to cause one lamp to be lit when the battery voltage is safely high, a second to be lit when it is becoming insufficient to start the engine system and a third to be lit when it has fallen too low.

Turning now to Figure 2, the function generator shown includes three operational amplifiers 30, 31 and 32, each connected as an inverting amplifier. The gain of each amplifier is set by its feedback circuit which in each case consists of a resistor R and a variable resistor VR in series. The inverting input terminals of the amplifiers 30, 31, 32 are connected to the output terminal of the temperature signal conditioning circuit 14 via respective resistors R_1, R'_1 and R''_1 and to a reference voltage source V_{REF} by respective resistors R_2, R'_2 and R''_2. The variable resistors VR are set to give amplifier 30 the greatest gain and amplifier 32 the least gain and the signal R_{EF} is of negative polarity. The output terminals of the three amplifiers are connected by diodes D forming a "highest wins" gate to a common output terminal.

The circuit described enables the output signal from the function generator to be set to match within a few percent the temperature/voltage or current characteristic of the starting motor/engine/lubricant system with which it is used.

The voltage V_{REF} is generated by a regulated power supply circuit 33 of the d.c.-a.c.-d.c. type akso providing ±15V supplies for the operational amplifiers 22, 30, 31 and 32.

WHAT WE CLAIM IS

1. Apparatus for indicating the condition of a vehicle battery in regard to its ability to start the engine system of the vehicle, comprising an electronic circuit including means sensitive to the battery voltage, means sensitive to at least one other battery parameter, and means sensitive to the engine temperature, said circuit providing a warning indication when the battery voltage is less than a level determined as a function of the engine temperature and said other battery parameter.

2. Apparatus as claimed in claim 1 in which said other battery parameter is the internal resistance of the battery.

3. Apparatus as claimed in claim 2 in which said means sensitive to the battery internal resistance comprises a constant current a.c. source connected to apply an a.c. signal to the battery terminals and means for measuring the magnitude of the alternating voltage across the battery.

4. Apparatus as claimed in claim 2 in which the electronic circuit includes a first function generator supplied with a first signal corresponding to the engine temperature and producing a signal corresponding to the starting voltage i.e.. the voltage required to be applied to the engine starter motor to start the engine system at that

temperature, a multiplier to which said supplied with said engine temperature signal and producing a second signal corresponding to the starting current, i.e. the current required to be applied to the engine starter motor to start the engine system at that temperature, a multiplied to which said second signal and a signal corresponding to the battery internal resistance are applied so as to produce a third signal corresponding to the voltage drop across the internal resistance of the battery if the starting current is caused to flow through the battery and means for comparing the actual battery voltage with the sum of said first and third signals.

5. Apparatus for indicating the condition of a vehicle battery in regard to its ability to start the engine system of the vehicle substantially as hereinbefore described with reference to the accompanying drawings.

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1575407 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

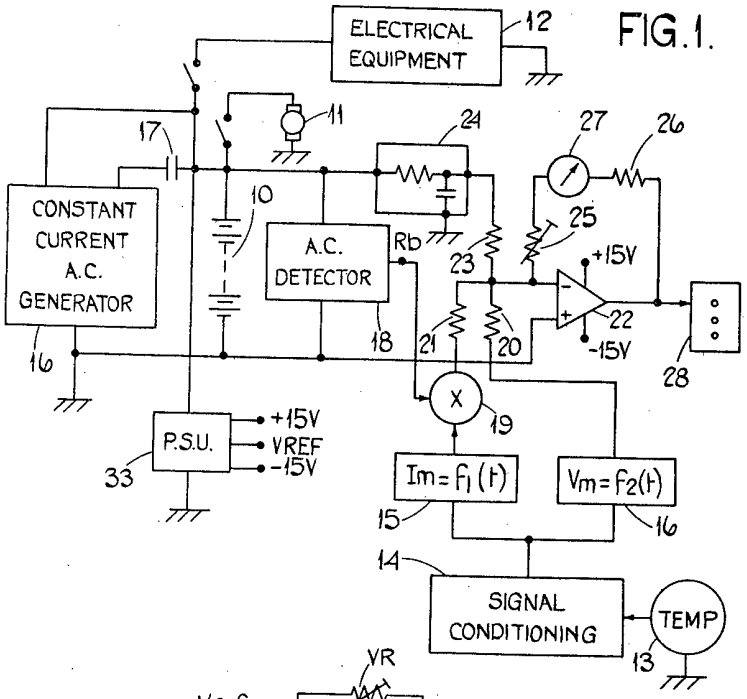

FIG.1.

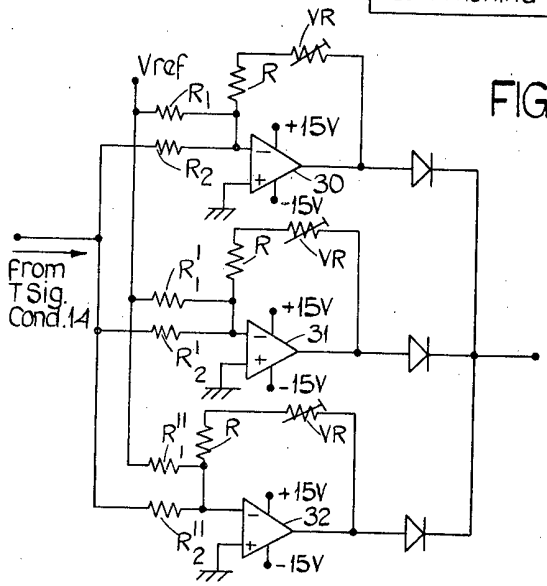

FIG.2.