# United States Patent [19]

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[54] **LIGHTING CIRCUIT SYSTEM**


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[52] **U.S. Cl.** ...................... **315/79**, 240/7.6, 315/79, 322/78, 323/76

[51] **Int. Cl.** ............................................ **B60q 1/26**

[58] **Field of Search** ............................ 240/7.6, 8.1; 315/77, 78, 79, 82; 322/78, 79; 323/76, 79



[56] **References Cited**

UNITED STATES PATENTS

2,509,662 5/1950 Wisman ............................ 322/78

3,092,767 6/1963 Schilling ............................ 323/76



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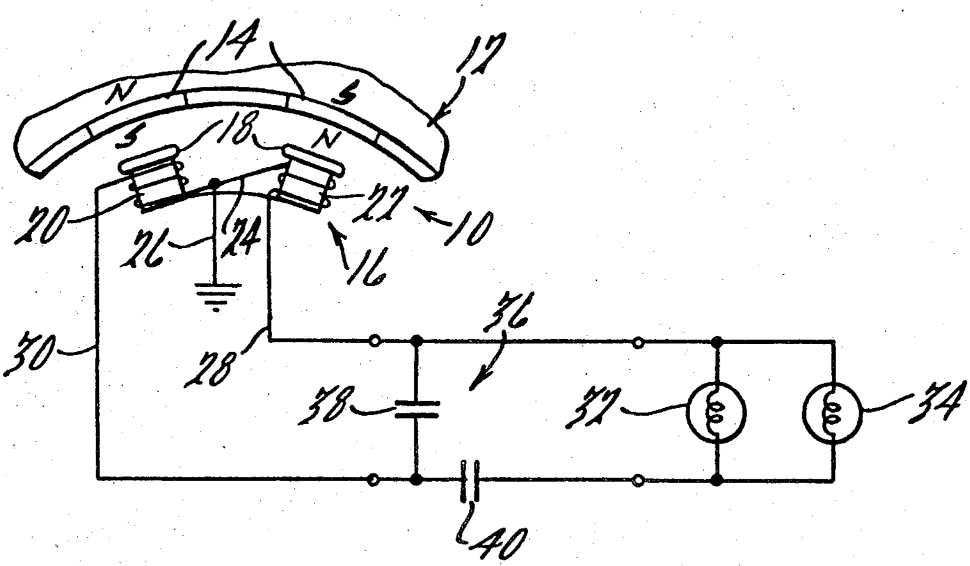
[57] **ABSTRACT**


An electrical system for regulating the output potential to a lighting circuit for a vehicle from an existing electrical generating device driven by the engine of the vehicle whereby the potential to the lights will be sufficient to provide adequate lighting over the usable speed range of the engine.


**11 Claims, 4 Drawing Figures**



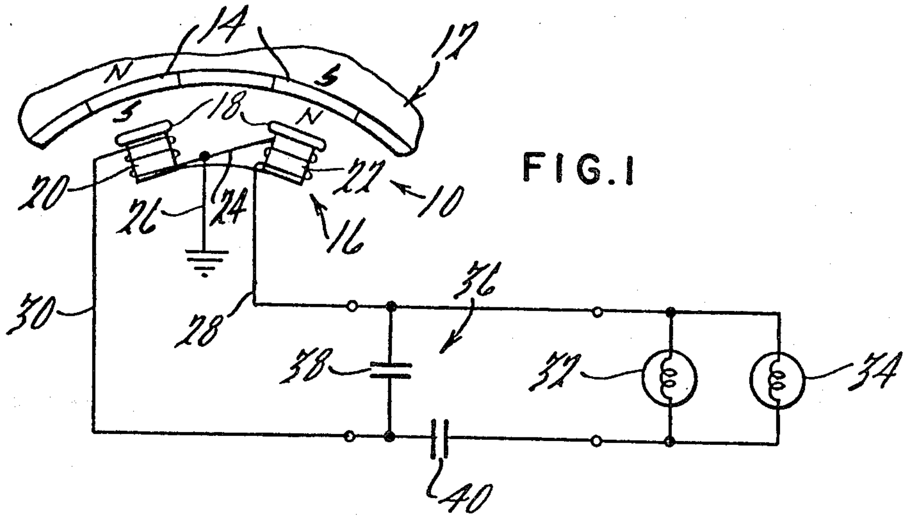



FIG.1

FIG.2

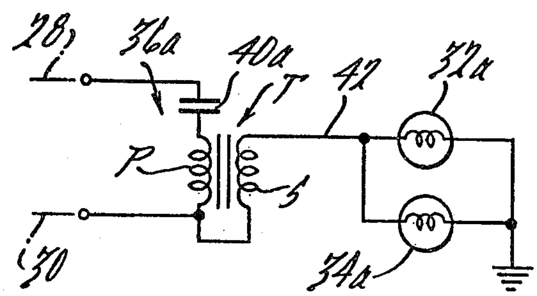
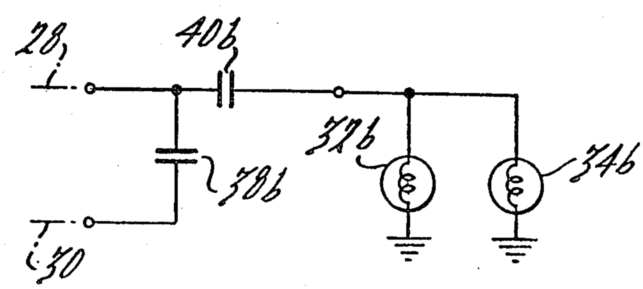



FIG.3



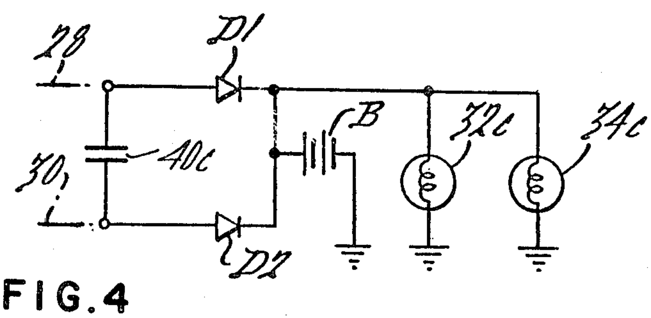




FIG.4

# LIGHTING CIRCUIT SYSTEM

## SUMMARY - BACKGROUND OF THE INVENTION

The present invention relates to an electrical system for regulating the potential to a vehicle lighting circuit.

Vehicles such as snowmobiles have their lights energized by a generating device such as a magneto which also provides electrical energy for the ignition system of the vehicle engine. The output of the generating device, however, varies with engine speed and where there is no battery in the system, at low engine speeds, such as idle, the lights may dim considerably. This can be especially troublesome if the vehicle is being driven and while it is moving at a fair rate of speed the operator permits the vehicle to coast by releasing the accelerator pedal. In this condition the vehicle may still be moving rapidly but the vehicle operator's visibility will be substantially reduced since the lights will dim. Another problem occurs in multiple lighting systems if one light burns out. With some generating devices this reduction in load will result in a substantial increase in potential at high speeds to a magnitude sufficient to overload and burn out the remaining light or lights. In the present invention a simple circuit system is provided which can be readily connected to the existing leads from the generating device and which regulates the output potential such that the potential at the low speed end is boosted to substantially improve the lighting at low engine speeds and the potential is regulated such that at high engine speeds the potential applied to a remaining light or lights will not be excessive to burn out such light or lights in the event one light does burn out.

Therefore, it is an object of the present invention to provide an electrical system for use with the lighting windings of a generating device whereby the potential to the lights will be regulated.

It is another object to provide an electrical system for use with the lighting winding of a generating device for boosting the potential at low speeds such as idle to improve the lighting at such low speeds.

It is another object to provide an electrical system for use with the lighting winding of a generating device whereby the potential at high speeds will be regulated to prevent burn out of the remaining light or lights in the event one light burns out.

The present invention utilizes a specially tuned resonant circuit to provide the improved lighting function. Therefore it is another object to provide a resonant system in combination with the lighting windings of a generating device for regulating the potential of the lighting winding.

The system of the present invention is also useful where a battery is in the system and is used to regulate the charging potential to the battery such as to provide sufficient potential at low engine speeds and also provides regulation to the lights in the event the battery is removed from the circuit and the vehicle is operated solely via the potential from the generating device; in this event the system of the present invention will provide a regulated potential to the lights boosting the low speed end and preventing burn out at the high speed end.

Therefore it is another object of the present invention to provide an electrical system for use with a lighting circuit including a battery and battery charge circuit whereby a regulated potential is provided for charging the battery and, in the event the battery is removed, a regulated potential is provided for lighting the lights.



Other objects, features, and advantages of the present invention will become apparent from the subsequent description and the appended claims, taken in conjunction with the accompanying drawing in which:

FIG. 1 is a schematic diagram of the lighting winding of an electrical generating device and an associated lighting circuit and an electrical circuit embodying features of the present invention;

FIG. 2 is a schematic diagram of a modified form of electrical circuit;

FIG. 3 is a different form of electrical circuit including features of the present invention; and

FIG. 4 is a modified form of system for use with a battery charging circuit and lighting circuit.

Looking now to FIG. 1 a permanent magnet electrical generating device is partially shown and is indicated by the numeral **10.** The operating device **10** has a rotor **12** adapted to be driven by the engine of a vehicle such as a snowmobile, and includes a plurality of circumferentially spaced permanent magnets **14** of alternating polarity. The magnets are preferably made of a ceramic material such as barium ferrite. A stator **16** includes a plurality of radially extending, circumferentially spaced poles **18.** On two of the poles are wound lighting windings **20** and **22** which are electrically connected in series aiding relationship via a conductor **24** which is grounded via ground **26** whereby the windings **20** and **22** define a grounded center tapped winding. Output conductors **28** and **30** are connected to opposite sides of windings **20** and **22.** A pair of lights **32** and **34** are connected in parallel. In a conventional circuit one side of the lights **32, 34** is connected to ground and the other side is connected to one of the conductors **28** or **30** whereby the lights **32, 34** are connected across only one of the windings **20, 22** to ground. With such a lighting circuit, however, the lights **32, 34** will be dimly lit at low speeds such as idle and at high speeds, if one of the lights **32, 34** is burned out, the other of the lights may be burned out because of the excessive voltage generated. These problems are connected by the circuit of FIG. **1.** In FIG. **1,** the lights **32, 34** are ungrounded and are connected in parallel to a resonant circuit **36** which is connected to conductors **28** and **30.**

The resonant circuit **36** includes a capacitor **38** connected between conductors **28** and **30** and hence across the windings **20, 22**; another capacitor **40** is connected between conductor **30** and one side of lights **32, 34.** Note that in some existing generating device constructions the center tap lead is difficult to get at and only the leads such as leads **28** and **30** are readily accessible; therefore the circuit of FIG. **1** provides a simple circuit connection for such generating devices.

An engine driving the rotor **12** will vary in speeds, over the speed range, from around 1,000 r.p.m. (at idle) to around 10,000 r.p.m. (at wide open throttle). The voltage output from the generator **10** will vary generally as a straight line with speed. In conventional systems, while adequate voltage is generated at normal engine running speeds (i.e. 5,000 r.p.m.) to properly energize the lights, the voltage at slower speeds, such as, at or near idle speeds, will be too low to adequately energize the lights and will be unnecessarily high at maximum speeds resulting in premature light burn out. In this regard it should be noted that the variations in voltage have a substantial effect on light output since for an incandescent lamp the light output in lumens varies generally as the square of the applied voltage.

The capacitor **40** is selected to boost the low speed voltage output while the capacitor **38** tends to regulate or lower the high speed voltage output. The capacitor **40** can be considered to be in series resonance with the windings **20** and **22** and in series with the parallely connected lights **32, 34**; the capacitance **38** can also be considered to be in series resonance with the windings **20** and **22** while it is in parallel with lights **32, 34**. For an engine having a speed range of from around 1,000 r.p.m. to around 10,000 r.p.m., the capacitor **40** is selected to have a magnitude where its capacitive reactance equals the inductive reactance of windings **20** and **22** at an engine speed of around 2,000 r.p.m. This point of resonance is selected taking into consideration the resistive impedance of the series circuit as provided mainly by the resistance of the lights **32, 34**. The resistance of the circuit will lower the Q of the series resonant circuit and will also result in a generally flat response over a substantially wide speed range. By selecting the point of resonance, considering the Q of the circuit as affected by the resistive impedance, to be proximate to the idle speed of the engine, the voltage output at idle will be substantially raised to a magnitude providing adequate light energization.

The effect, however, of the series resonance as provided by capacitor **40** will be quite minimal at higher engine speeds i.e. 5,000 r.p.m. and above. The magnitude of the capacitor **38** is selected to be in resonance with the windings **20** and **22** at around 5,000 r.p.m.; this resonant circuit, however, while boosting the voltage of resonance will, at higher engine speeds result in an increase in circulating current flowing from windings **20** and **22** to capacitor **38** which in turn will result in an increase in the back m.m.f.; this will provide a regulating effect by reducing the voltage generated by windings **20** and **22**. Note that the capacitor **38** has a magnitude whereby it has little effect over the low speed range but is effective at higher speeds. In one preferred form the magnitude of capacitor **40** was approximately 120 times the magnitude of capacitor **38**. In this same form of circuit where not capacitors **38** and **40** were used the output voltage for one generator was 6.9 volts at 1,200 r.p.m. and 15.5 volts at 7,750 r.p.m. When the capacitors **38** and **40** were used the output voltage for the same generator was 11.9 volts at 1,200 r.p.m. and 11.6 volts at 7,750 r.p.m.

The embodiments of FIGS. **2 – 4** are modifications of the circuit of FIG. **1** for use with the generator **10**. In these embodiments only the structure different from that of FIG. **1** has been shown and similar components serving similar functions are given the same numerical designation with the addition of a letter postscript.

The embodiment of FIG. **2** shows a modified form of lighting circuit in which the lights **32*a*** and **34*a*** are connected in parallel and have one end grounded. The lights are normally grounded at one end in existing installations and with the circuit of FIG. **1** the lights **32** and **34** are ungrounded. In FIG. **2** capacitor **40*a*** is a part of a series resonant circuit **36*a*** and is connected in series with windings **20** and **22** of generator **10** via conductors **28** and **30**. The capacitor **40*a*** is connected in series with the primary P of a transformer with the series circuit of capacitor **40*a*** and primary P being connected in series with windings **20** and **22**. A secondary winding S of transformer T is connected to the ungrounded side of lights **32*a*** and **34*a*** via conductor **42**. The magnitude of capacitor **40*a*** is selected to be in resonance with the inductance of transformer T, via primary P, and windings **20** and **22** whereby the voltage output to lights **32*a*** and **34*a*** is boosted at the low end to substantially improve the lighting at low engine speeds such as engine idle.

The system of FIG. **3** is similar to that of FIG. **1** except that the lights **32*b*** and **34*b*** are maintained with one end at ground. The capacitor **38*b*** provides a parallel resonant circuit with both windings **20** and **22** while capacitor **40*b*** provides a series resonant circuit only with winding **22** (since the lights **32*b*** and **34*b*** in the series resonant circuit are connected to ground at one end.) As with the embodiment of FIG. **1** the series and parallel resonant circuits act to increase the voltage at the low speed end (idle) and regulate or reduce the voltage at the high speed end.

FIG. **4** shows another circuit in which the lights can be maintained grounded. Thus lights **32*c*** and **34*c*** are connected in parallel and have one side grounded. The opposite side of lights **32*c*** and **34*c*** is connected to the positive side of a battery B which has its opposite side grounded. Battery B is charged by d-c current from the alternator **10** via diodes D1 and D2 which are connected to conductors **28** and **30**, respectively. Note that the lights **32*c*** and **34*c*** are energized by battery B as well as generator **10**. The battery B acts as a stabilizing or regulating element relative to the generator **10** and in this regard acts to protect lights **32*c*** and **34*c*** from burn out by preventing the generated output voltage from becoming excessively high at high engine speeds. However, in the event the battery is removed for replacement and the engine is still used then the lights **32*c*** and **34*c*** could not be protected. Capacitor **38*c*** is connected across conductors **28** and **30** and hence is connected in parallel with the windings **20** and **22**. The capacitor **40*c*** is selected with parameters similar to capacitors **40** and **40*b*** and is in resonance with windings **20** and **22** at lower engine speeds. This will act to boost the voltage applied to battery B for charging at lower engine speeds and since capacitor **40*c*** does parallel the windings **20** and **22** it will, at higher engine speeds, act as a shunt; the shunt current will tend to shut down the alternator **10** and hence limit the voltage to the lights **32*c*** and **34*c*** at higher engine speeds; in this way, in the event the engine is used with the battery B out of the circuit, the circuit of capacitor **38*c*** will prevent the voltage to the lights **32*c*** and **34*c*** from becoming excessive and burning these lights out.

While it will be apparent that the preferred embodiments of the invention disclosed are well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the invention.

What is claimed is:

**1.** In a lighting circuit for a vehicle having a generator driven by an engine with the speed of the engine varying the speed of the generator and hence the output voltage of the generator, a regulating circuit comprising: conductor means electrically connecting lights of the vehicle to generating windings of the generator with the generator windings normally providing a low voltage to the lights over a low generator speed range whereby the illumination from the lights is not at a desirable level, resonant circuit means externally connected to the generating windings of the generator including a first capacitor electrically connected in a series circuit with the lights and the generator windings and having a magnitude selected relative to the inductance of the remainder of the circuit including the windings to provide resonance at a preselected low generator speed range for boosting the voltage to the lights over said preselected low generator speed range whereby adequate illumination will be obtained over substantially the entire speed range of the generator including said preselected low generator speed range, and a second capacitor electrically connected in a parallel circuit with the generator windings and having a magnitude selected relative to the inductance of the remainder of the circuit including the windings for providing resonance at an intermediate generator speed and for providing a recirculating current at generator speeds higher than said intermediate generator speed whereby the voltage from the windings will be reduced at such higher speeds.

2. The circuit of claim 1 for a generator having an operating range of from around 1,000 to around 10,000 r.p.m. and with said first capacitor providing resonance at around 2,000 r.p.m., said second capacitor providing resonance at around 5,000 r.p.m.

3. The circuit of claim 2 with said second capacitor having a magnitude for providing a recirculating current at generator speeds higher than said intermediate engine speed whereby the potential from the windings will be reduced at such higher speeds.

4. The circuit of claim 1 with the windings being center tapped to ground and with said conductor means connecting said first capacitor and the lights in an ungrounded circuit across the windings.

5. The circuit of claim 1 with the windings being center tapped to ground and with said resonant circuit means including transformer means for coupling to the lights, said conductor means connecting said first capacitor in an ungrounded circuit to said transformer means and across the windings and connecting the lights to said transformer means in a grounded circuit.

6. The circuit of claim 1 with the windings being center tapped and with said conductor means connecting the lights to said resonant circuit means in a grounded circuit.

7. The circuit of claim 1 with the windings being center tapped to ground, said resonance circuit means including a transformer having primary and secondary windings, said conductor means connecting said first capacitor in series with said primary and across the windings in an ungrounded circuit, said conductor means connecting said secondary to the lights in a grounded circuit.

8. The circuit of claim 1 with the windings being center tapped to ground, said conductor means connecting said second capacitor across the windings in an ungrounded circuit, said circuit means connecting said first capacitor to the lights in a grounded circuit.

9. The circuit of claim 1 with the windings being center tapped to ground, said conductor means connecting said first capacitor across the windings in an ungrounded circuit, said conductor means comprising a pair of diodes connected to opposite sides of said first capacitor, said conductor means connecting said diodes to the lights and connecting the lights to ground, a battery, said conductor means connecting said battery across the lights.

10. The circuit of claim 1 with said first capacitor having a magnitude relative to the inductance of the remainder of the circuit and the resistance of the circuit including the resistance of the lights to define a resonant circuit having a relatively low Q whereby the voltage over said preselected low speed range will be generally uniform.

11. For a generator in which the output voltage of the generator varies with the speed of the generator, a regulating circuit comprising: resonant circuit means externally connected to the generating windings of the generator including a first capacitor electrically connected in a series circuit with the generator windings and having a magnitude selected relative to the inductance of the remainder of the circuit including the generator windings for boosting the output voltage of the generator at a predetermined low generator speed, and a second capacitor electrically connected in a parallel circuit with the generator windings and having a magnitude selected relative to the inductance of the remainder of the circuit including the generator windings for reducing the output voltage of the generator at generator speeds higher than said low generator speed whereby the output voltage of said generator is controlled over an extended generator speed range.

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