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Design and Construction of a Torch powered by Shaking

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ABSTRACT

The main aim of this project is to design and construct a touch powered by shaking. A renewable energy flashlight comprises a housing and a barrel located within the housing. A wire coils wraps around the barrel, between the barrel and the housing. A magnet oscillates within the barrel when the touch light is shaken, generating an alternating current in the coil. Two spring at either end of the barrel causes the magnet to recoil when the magnet strikes the springs. An electronics assembly within the housing includes a capacitor for storing charge, a rectifier connected to the capacitor, and means for conducting current flowing in the coil to the rectifier, to charge the capacitor. A LED is connected to the capacitor by means of a switch, and lights up when the switch is turned on. This torch will be mostly needed in the rural area where there is scarcity of Electricity and because its cheap for them to purchase.

General Terms

Renewable energy flashlight, Electronic assembly.

Keywords

Flashlight, Permanent magnet, Coil, LED, Capacitor.

1. INTRODUCTION

Flashlights are extremely useful as portable lighting devices. However, several features of convectional flashlights limit their usefulness. Flashlights are commonly needed in emergencies, such as when the owner's electricity goes out. But there is no guarantee that when the emergency occurs, the flashlight will work. Currently, most flashlights use batteries, which rely on chemical reactions and therefore limited useful life, as well as limited storage life. So, even if the flashlights was put in a drawer with fresh batteries, it may not work three years later when it is needed. Batteries can also cause corrosion due to leakage, rendering the flashlight unusable, even with fresh batteries. Further, most flashlights use incandescent lamps, which are prone to filament damage from shock, such as from being dropped. Incandescent lamps also burn out.

A second concern with the conventional flashlight is how wasteful they are, both in the environmental sense and in financial sense. Batteries are rapidly becoming hazard to our environment due to their current methods of disposal. Also, they are expensive, and have to be replaced frequently. A need remains in the art for renewable energy flashlight that always works, even after being dropped or left in the car for years, without requiring batteries or incandescent lamps.

The renewable energy flashlight utilizes a permanent magnet, which oscillates through a coil of wire by shaking the flashlight to generate electricity for charging a capacitor to power a Light Emitting Diode (LED).

2. PERMANENT MAGNETS

2.1 Types of Permanent Magnet

(1) Carbon Steel
(2) Alnico
(3) Ceramic magnets such as Indox, Arnox, Vectolite, Ferroxdure.
(4) Rare-earth magnets such as Recoma
(5) Neodymium

2.2 Strength of Permanent Magnets

For "hard" materials such as Alnico, the energy required to demagnetize it is about 50,000 J/m3 . It is precisely this high energy which distinguishes permanent magnets from other magnetic materials. Materials used in the manufacture of permanent magnets should have a high Br (residual flux density) and a large Hc (coercive force) so that the required demagnetizing energy is as great as possible. Permanent magnets have high demagnetizing energy. Saturation flux density for most magnetic materials is 2T.

The inherent opposition to change in domain orientation is called hysteresis. Hysteresis enables us to create permanent magnets. Modern permanent magnets produce very strong magneto motive forces so that they are often smaller than electromagnets of equal length. Because no energy iss required to sustain the magnetic field, permanent magnets enable us to manufacture devices having high efficiency and relatively small dimensions.

2.3 Energy Stored in Permanent Magnets

$W = \frac{1}{2}U\Phi$ (magnetic energy in the air gap)
$\Phi = BA$ (flux in the air gap)
$U = HL$ (difference of magnetic potential across the air gap)
$W = \frac{BHAL}{2}$
$W = \frac{1}{2}(BH)V$
$V = \frac{(2W)}{(BH)}$ (volume of magnet)
V should be as small as possible. The strength of a permanent depends exclusively on the amount of energy it can store in its external magnetic field[1].

2.4 Principles of Operation of Permanent Magnets

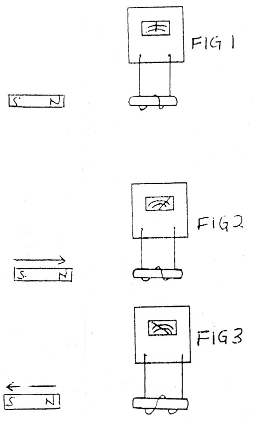

Fig. 1. This is example of the image in a column.

As the magnet approaches the field that it creates at the location of the coil becomes stronger and stronger, and it is this changing magnetic field that produces the current. When the magnet moves away from the coil, current is also produced but in the reverse direction. Now the field becomes weaker as the magnet moves away and once again it is the changing field that generates the current.

A current would be created in fig. if the magnet were held stationary and the coil moved, because the magnetic field at the coil would be changing as the coil approached or receded from the magnet. Only the relative motion between the magnet and the coil is needed to generate current; it does not matter which moves.

The current in the coil is called induced current, because it is brought about by the changing magnetic field. Since the source of emf is always needed to produce current, the coil itself behaves as if it were a source of emf. This *emf* is known as induced *emf*. Thus, a changing magnetic field induces an emf in the coil, and the emf leads to an induced current.

Emotional emf, E = blu when b, l, u are perpendicular
b – flux density
l – length of coil
u – speed

Faraday's Law of electromagnetic induction states that emf, E induced in a coil of N loops is

$$E = -n(\Phi - \Phi_0)/(t - t_0)$$

$$E = -N\Delta\Phi/\Delta t$$

$\Delta\Phi$ – change in magnetic flux through one loop
Δt – time interval during which the change occurs.

2.5 Calculating the Length of Coil

Using an LED rating of 5V or 3V.

$$V_R = 3V$$

$$I_{Fmax} = 30mA$$

$$V_F = 2V$$

Using the equation,

$$R = \frac{V_S - V_F}{I_F}$$

Taking $V_S = 5V$

$$R = \frac{5 - 2}{30 \times 10^{-3}}$$

$$= 100\Omega$$

A 100Ω resistor is connected in series with the diode.

$$E = blu$$

With the help of a flux gauge b can be calculated knowing the volume of magnet[2][3].

$$L = \frac{E}{bu}$$

$$N_{turns} = \frac{L}{\text{Circumference of the barrel}}$$

$$N_{turns} = \frac{L}{\prod D}$$

3. METHODOLOGY

Figs. 4a and 4b show the operation of reed switch 26 in detail. Fig. 4a shows reed switch 26 in the open position, and Fig. 4b shows reed switch 26 in the closed position. Switch activating magnet 30 is captivated by slide 28, which is retained by switch retainer 32. Switch activating magnet 30, switch slide 28 and switch retainer 32 are inserted into a pocket in housing 10 adjacent to reed switch 26. Reed switch 26 will be off when switch activating magnet 30 is directly over it. In this position it is effectively immune to the magnetic field of the charging magnet 12. Red switch 26 will turn on when switch activating magnet 30 is moved approximately 0.1 inch from the off position.

Alternatively, switch activating magnet 30 may also be placed so that in its first position, it a is sufficient away from reed switch 26 for reed switch 26 to be off, and in its second position, it is even further from reed switch 26 so that reed switch 26 turns back on.

Fig. 6a shows a voltage waveform across a wire coil 18. The waveform is sinusoidal, with gaps between the sine waves when the magnet is away from coil 18. The amplitude and the frequency of the sine wave will vary depending upon the speed at which charging magnet 12 passes through the coil 18.

Fig. 6b shows the voltage across capacitor 22 (due to the rectified current provided by rectifier 20). The underlying voltage of capacitor 22 rises with time as flashlight 100 is shaken.

Fig. 6c shows the voltage across capacitor 22 after flashlight 100 has been shaken sufficiently to charge up capacitor 22. At this point capacitor protection Zener diode 27 and current limiting resistor 25 bleed voltage from capacitor 22, preventing overcharging of capacitor 22.

Fig. 7 is a cutaway side view depicting a second preferred embodiment 200 of the flashlight, which utilizes rebound magnets 17 rather than springs 16 in the ends of barrel 14 and oriented to repel charging magnet 12. Rebound magnets 17 are installed in both ends of the barrel 14, and oriented to repel charging magnet 12. Thus the south end of one rebound magnet 17 faces the south end of charging magnet 12, and the

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north end of the other rebound magnet 17 faces the north end of the charging magnet. Each rebound magnet 17 opposes the travel of the charging magnet 12 as it approaches that magnet 17, and causes it to repel back towards the center of barrel 14.

Rebound magnets 17 are preferably neodymium disk magnets. Rubber bumpers 15 are attached to the ends of charging magnet 12 (or alternatively to the inner ends of rebound magnets 17) to prevent sharp impact between the rebound magnets and the charging magnet, if the flashlight is shaken vigorously or dropped. Rubber bumpers 15 are typically domed shaped or semispherical, and may attached with pressure sensitive adhesive on the flat side of the bumper.

what is claimed is:

(1) A renewable energy flashlight comprising: An elongated housing forming an opening at one end;
A barrel assembly located within the housing including;
A hollow elongated barrel disposed within the housing,
A wire coil wrapped around the barrel and disposed between the barrel and the housing,
A charging magnet disposed within the barrel and sized to freely oscillate within the barrel when the barrel is shaken.
Two rebound magnets attached within the barrel and at either end of the barrel to cause the magnet to recoil when the charging magnet strikes the rebound magnets.
Wherein the charging magnet oscillates within the barrel when the barrel is shaken, whereby the charging magnet passes back and forth through the wire coil and causes current to flow within the coil; and
An electronics assembly located within the housing, said electronics assembly including: a capacitor for storing charge, a rectifier connected to the capacitor; means for conducting current flowing in the wire to the rectifier, whereby the rectifier rectifies the current, said rectifier providing rectified current to the capacitor, whereby the capacitor is charged, a light emitting diode (LED) located near the housing opening, and switch means of selectively connecting the charged capacitor to the LED, whereby the LED selectively lights up.

(2) The flashlight of claim 1, further including an LED protecting diode connected between the LED and the capacitor, for protecting the LED form high voltage surges.

(3) The flashlight of claim 2, further including a resistor and a capacitor protecting diode connected between the LED and capacitor, for protecting the capacitor form sustained overvoltage conditions.

(4) The flashlight of claim 3, wherein the LED protecting diode and the capacitor protecting diode are Zener diodes or voltage regulators.

(5) The flashlight of claim 1, wherein the switch comprises a reed switch located within the housing, and a selectively moveable switch magnet located external to the housing for activating the reed switch.

(6) The flashlight of claim 1, wherein the charging magnet is a neodymium or alnico magnet.

(7) The flashlight of claim 6, wherein the coil is formed of magnetic wire.

(8) The flashlight of claim 7, wherein the housing and the barrel are formed of plastic.

(9) The flashlight of claim 8, wherein the rebound magnets are neodymium or alnico magnets.

(10) The flashlight of claim 1, further including a lens affixed within the housing opening adjacent to the LED, for focusing light from the LED.

(11) The flashlight of claim 10, further including means for hermetically sealing the housing and the lens.

(12) The flashlight of claim 11, wherein the housing and the lens form a hermetically sealed compartment containing the electronics assembly and the barrel assembly, whereby the flashlight is explosion proof.

(13) The flashlight of claim 10, wherein the lens is located less than its focal distance away from the LED, whereby the light from the LED forms an expanding beam.

(14) The flashlight from claim 10, further including an LED protecting diode connected between the LED and the capacitor, for protecting the LED from high voltage surges.

(15) The flashlight of claim 14, further including a resistor and a capacitor protecting diode connected between the LED and the capacitor, for protecting the capacitor from sustained overvoltage conditions.

(16) The flashlight of claim 15, wherein the LED protecting diode and the capacitor protecting diode are Zener diodes or voltage regulators.

(17) The flashlight of claim 10, wherein the switch comprises a reed switch located within the housing, and a selectively movable switch magnet located external to the housing for activating the reed switch.

(18) The flashlight of claim 10, wherein the charging magnet is a neodymium or alnico magnet.

(19) The flashlight of claim 18, wherein the coil is formed of magnet wire.

(20) The flashlight of claim 19, wherein the housing and the barrel are formed of plastic.

(21) The flashlight of claim 20, wherein the rebound magnets are neodymium or alnico magnets.

4. SUMMARY

It is an object to provide renewable energy flashlight that always works, even after being dropped or left in the car for years, without requiring batteries or incandescent lamps. The renewable energy torchlight utilizes a magnet, which oscillates through a coil of wire by shaking the torchlight, to generate electricity for charging a capacitor to power a light emitting diode. The renewable energy flashlight comprises of an elongated housing forming an opening at one end, a barrel assembly located within the housing which includes a hollow elongated barrel disposed within the housing, a wire coil wrapped around the barrel and disposed between the barrel and the housing. A magnet disposed within the barrel and sized to freely oscillate within the barrel when the barrel is shaken; two springs attached within the barrel and at either end of the barrel to cause the magnet to recoil when the magnet strikes the springs, wherein the magnet oscillates within the barrel when the barrel is shaken, whereby the magnet oscillates back and forth through the wire coil and causes current to flow in the coil.

The flashlight also includes an electronic assembly located within the housing, including a capacitor for storing charge, a rectifier connected to a capacitor, means for conducting current flowing in the wire coil to the rectifier, which rectifies the current and provides a rectified current to the capacitor, a light emitting diode (LED) located near the housing opening, and a switch means for selectively connecting the charged capacitor to the LED, whereby the Led is selectively lights up. As a feature the flashlight includes an LED protecting diode connected between the LED and the capacitor, for protecting the LED from high voltage surges. A resistor and a capacitor protecting diode connected to between the LED and the capacitor. It protects the capacitor from sustained overvoltage conditions. The LED protecting diode and the capacitor protecting diode are Zener

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diodes or voltage regulators.

The switch comprises a reed switch located within the housing, and a selectively movable magnet located external to the housing for activating the reed switch. Generally, the charging the magnet and the switch magnet are neodymium magnets. The wire coil is formed of magnet wire, and the housing and the barrel are of plastic. The springs are formed of stainless steel.The flashlight also includes a lens affixed within the housing opening adjacent to the LED, for focusing light from the LED. The lens and the housing are hermetically sealed. This forms a hermetically sealed compartment containing the electronics assembly and the barrel assembly, making the flashlight explosion proof. In general, the lens is located less than its focal distance away from the LED, whereby the light form the LED forms an expanding beam.

Reference

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[2] Hughes & McKenzie Smith (1995). Electrical Technology, Electrical Materials. Pp. 137

[3] Paul Horowitz & Winifred Hill (1980, 1989). The Art of electronics, Cambridge University Press. UG / TK 7815 HOR. Pp 45,361.

Appendix

FIG. 4a

FIG. 4b

FIG. 4c

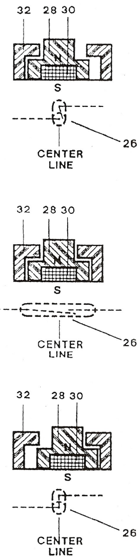


FIG. 3

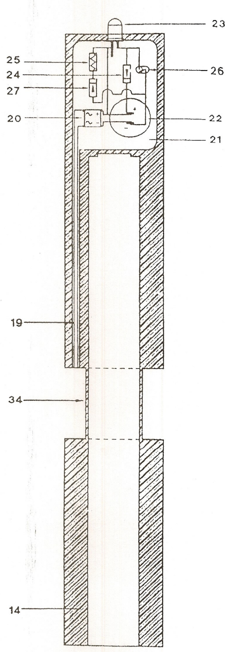
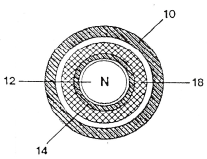


FIG. 2



SECTION A-A

FIG. 1

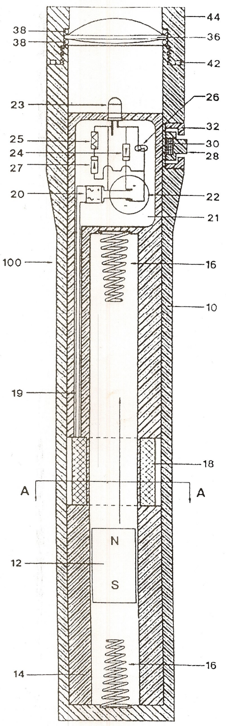


FIG. 7

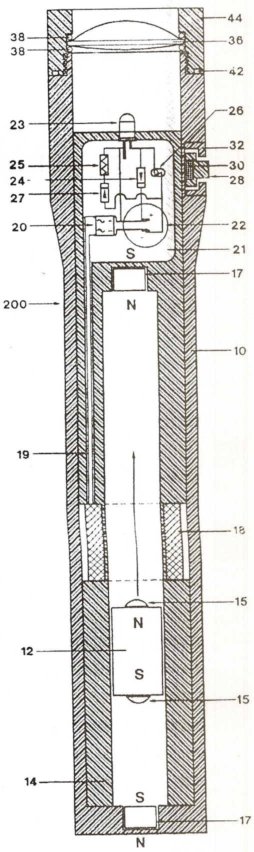


FIG. 5

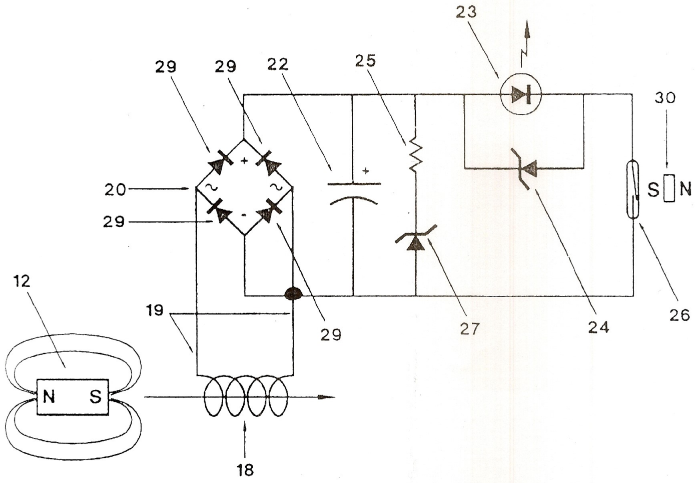


FIG. 6a

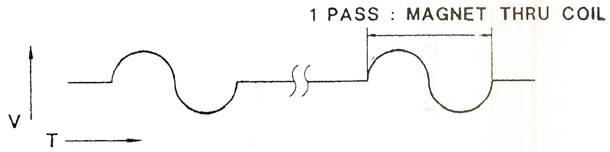


FIG. 6b

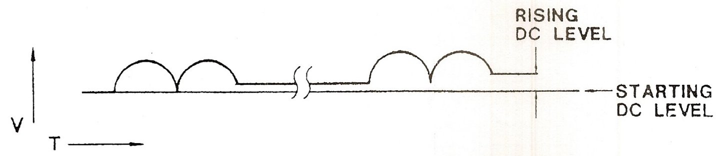


FIG. 6c