Harvesting Energy from Thunderstorm - A New Source of Renewable Energy - Review

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ABSTRACT: Energy crisis is a major problem now-a-days. With the exponential growth of population and technology, the necessity of much more energy requirement becomes a serious issue. Therefore the need for alternative sources of energy comes to the field. Nature offers us a lot of alternatives and among them, one such feasible choice underused by mankind is the power of a thunderstorm. This paper proposes the strategy of harvesting the new source of renewable energy from a thunderstorm.

KEYWORDS: Energy crisis, renewable energy, thunder-electricity

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1. INTRODUCTION

In order to solve the power crisis of today's modern world, there is an urgent requirement of renewable energy source. In that case harvesting energy from thunderstorms can be a solution to the problem. Since the late 1980s, attempts are being made to store and use the enormous amount of energy of a lightning. A single lightning bolt contains approximately 5 billion joules of energy sufficient to light family unit for a month. Thunderstorms contain an atom bomb's energy. This energy is already been utilized to generate hydrogen from water [1]. According to previous researches Tesla Coil can be used to generate high voltage by using mock lightning produced by mock generator in order to harvest lightning energy [2]. But lightning has always been considered as hazardous and very difficult to control. To overcome this problem, we can use lasers to produce hot and dense plasma to observe the laser pulse trail and prevent forming of long plasma channels to control and guide strikes of lightning [3].

2. THEORY

2.1. Lightning

Lightning could be defined as a gigantic spark of electricity within the atmosphere between clouds, the air and the ground [1, 3]. Sudden electrostatic discharge which occurs generally during a thunderstorm is known as Lightning. The flash is referred as the atmospheric charged regions which temporarily equalize through the discharge. If a lightning flash involves an object on the ground it can be referred as strike. Through lightning light is created in form of black body radiation, electron flow creates very hot plasma and sound in form of thunder. When lightning occurs at great distance, it may not be heard but can be seen. The process of creation of lightning is a very complicated process. Both the theories of precipitation and convection tend to elucidate the electrical behavior among the clouds. Lightning primarily occurs when warm air and cold air are mixed together resulting in atmospheric disturbances. It may also occur in natural disasters such as wild land fire, typhoons, and explosions due to volcanoes.

2.2. Types of Lightning

Primarily lightning are of three types: within a cloud itself (intra cloud or IC); from one cloud to another cloud (CC) and lastly between a cloud and the ground (CG).

2.3. Frequency of Lightning

Lightning occurs 40-50 times a second (approx.) around the world, which results in nearly 1.4 billion flashes each year. A lightning flash's frequency, distribution, power and other physical properties are affected by many factors in a particular region of the world [1]. As majority of humans are terrestrial, CG lightning is studied the most among the three types of lightning.

3. LIGHTNING ROD

The principle of lightning rod was first developed by Benjamin Franklin in 1749 and further improvements towards a reliable system around 1760.It is a metal rod (usually copper) that usually protects a structure from the damage of lightning by intercepting the flashes and guiding the currents to the ground and earthing them[5]. As the lightning tries to strike the highest object in the vicinity, the lightning rods are generally placed at the structure's tip and along its ridges; low-impedance cables are used to ground them. The soil is the ground in the case of a building; whereas water is used on a ship. A lightning rod and its associated grounding conductors provide protection by diverting current passage through non - conducting parts of the structure, enabling it to follow the least resistance path and to pass through the rod and its cables without causing any harm. The high resistance of the non - conductive materials results

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them to be heated by the passage of electrical current, resulting in fire and other kind of damages [11]. On structures of height less than 24 meters (around 80 feet),cone of protection is being provided by a lightning rod having ground radius nearly equal to its vertical height above the ground. On taller structures, the area of protection is spread about 24 to 28 meters from the base of the structure.

4. LIGHTNING POWER GENERATION SYSTEM

4.1. Using Parallel Capacitors

Huge amount of electricity is possessed by the lightning sources. The method or process has been designed for human use for the first time using this renewable lightning energy source. Lightning is a regular phenomenon result in injuries and unavoidable casualties during rainy and stormy times. In a neighborhood at the top of skyscraping buildings, towering trees and antenna mounting edifice, a large number of lightning arresters could be fit. A connection should be made with every lightning arrester to a transducer which is placed at a central location using quite thick conducting wires made of copper or any alloy. The lightning arresters grab flashes of current alternating (AC) in nature blended with adequate amount of Direct Current (DC), as a result a large amount of electricity flows through the conductive feeder wire and related circuit[4].The electrical energy collected by lightning arresters is flown through the rectifying circuit in order to convert completely into Direct Current, then this Direct Current electrical voltages are flown into the set of capacitors kept in parallel fashion as shown in the fig1 by C_1, C_2, C_3, with a comparatively high capacitive range that is typically used in high voltage or parallel battery charges. This loaded condenser or battery thus acts as a DC voltage source and is supplied as electric power or voltage source to the load or the battery.

4.2. Using Transducer

Another method of acquiring electricity from light source is accomplished by a circuit consisting transducers i.e. conversion of electrical energy to the energy forms such as mechanical or thermal energy etc., then this converted energy i.e. thermal or mechanical energy is transformed into electrical power. Used to store lightning electrical power, the transducer converts this enormous amount of electrical energy either to thermal energy through appropriate alloy or metallic plates, for example. NiCr alloy, thermocouple, etc. or to mechanical energy using the rotary motors, accelerometers, etc. In Fig. 2, I is the total current received from the light source after rectification as DC subdivided into three or more current quantities such as I_1, I_2 and I_3 etc. in order to supply three or more than three transducer plates to convert the currents into thermal or mechanical energy or any other form of energy [4]. Then, as shown in Fig.2, these thermal or mechanical or altered quantities of energy are further transformed to electricity by an appropriate transducer. Lastly, the electrical output derived from the light source is used.

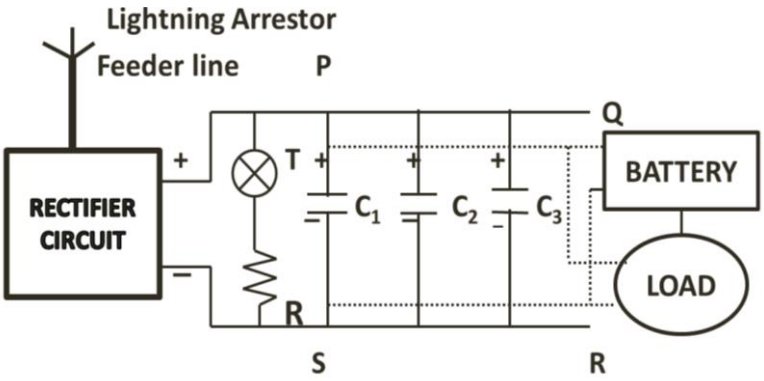

Fig.1. Circuit Diagram for Storage of Lightning Power using Capacitors connected inparallel fashion and Supplying to Load or Battery

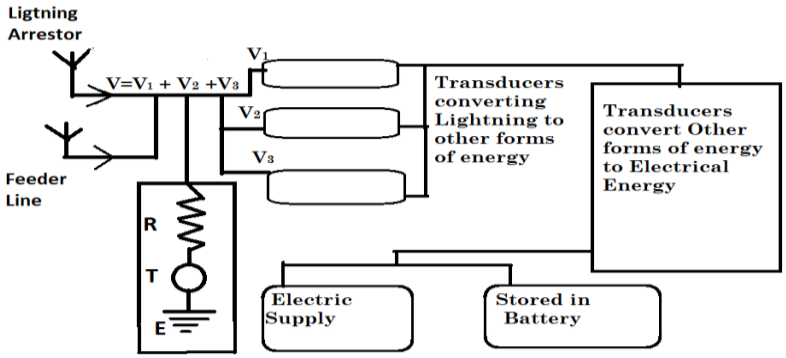

Fig.2. Block Diagram of Generation of Electricity from Charged Cloud or Lightning Source using Parallel Plate Transducers

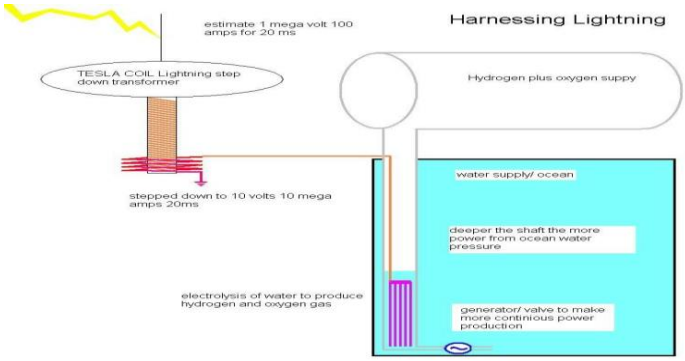

Fig.3 Harnessing lightning through Tesla Coil

4.3. Further Improvements

The capacitors connected in the PQRS panel as it is shown in Fig 1 or transducer circuit in Fig 2 for the transformation of electrical energy to thermal or mechanical or another energy form are fully filled or converted after arrestation of one light source, and not fully discharged or transformed in the other form in very short span of time (the rate of discharge rely upon our specification).Hence the rectifying circuit is linked to another set of completely discharged capacitors or activated transducer circuit for continuous picking up of lightning source by that same circuit. As a result the same lightning plant being used safely for multiple numbers of lightnings in that region [4]. The high - voltage commercial electrical power supply line can be used after detaching from commercial generators, especially during rainy and stormy times when the lightning is well predicted, for the use of feeder wire with a specified distance in order to fetch the lightning source to the lightning plant situated at a central location.

5. LASER CONTROLLED LIGHTNING

5.1. Ultrashort Laser-Triggered Lightning

Ultrashort pulse lasers have emerged as serious candidates for laser - triggered lightning achievement. They can generate long as well as continuous plasma channels with a modest amount of energy through multiphoton ionization for their very high peak intensity. Such channels could be used during thunderstorms in order to trigger and guide a positive upward leader from a ground rod. This leader could then connect with a negative leader coming down from a cloud, "catching" the lightning bolt while forming [7].

5.2. Triggering neodymium or CO_2 Lasers

Also producing long laser spark using neodymium or CO_2 lasers with energies up to several KJs and typical pulse duration of 50 ns, could highly favor air ionization creating a temperature of 4000 K. But it also has a limitation of creating opaque plasma channels and deviating geometrical focus [7, 11, 12].

5.3. Effect of Triggering Femtosecond Lasers

In order to overcome these limitations *Teramobile* introduced ultrashort lasers shorter than nanosecond. *Teramobile* fired femtosecond terawatt laser independently and to thunderstorm where investigated to be found. A frequency duplicated YAG pulse of moderate energy would also be proposed to improve the ability of these femtosecond filaments to trigger high voltage discharges as well as sequences of ultrashort pulses at 800 nm to improve plasma life. Their results also suggest that in a strong positive electrical field, a small fraction of the plasma filaments initiated electrical events. When laser is fired it is found that more electrical events are observed in thunder clouds. In order to implement and optimize search enhanced laser schemes in a field campaign, it is necessary to evaluate the influence of each parameter investigated. A key element for search field operation will be the sensitive detection system with adequate spatial and temporal resolution. Laser effect as a function of each experimental parameter should be monitored. As a result it would help us to control and optimize lightning [6].

6. PAST EXAMPLES

In 2007 Alternate Energy Holding Inc. (AEHI) reportedly able to lit up a 60 watt bulb for about 20 minutes using the power of lightning. Also using Tesla coil circuit hydrogen can be extracted from water electrolysis where is source of high voltage is lightning [1,5].

7. CONCLUSION

Harnessing thunder energy into electrical energy will change the world of renewable energy sources. Along with pre proposed plans of utilizing lightning energy if we get the access to control lightning with the help of lasers, it will be easier to harvest lightning energy.

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