

Development and Power Measurement of Bicycle Power Generator

Jia-Hroung Wu¹, Min-Shin Lee², Hung-Hsun Li³ and Wei-Hsin Wang³

¹Associate Professor, Hsiuping University of Science and Technology, Taichung City, Taiwan, R.O.C.

²Lecturer, Hsiuping University of Science and Technology, Taichung City, Taiwan, R.O.C.

³Postgraduate, Hsiuping University of Science and Technology, Taichung City, Taiwan, R.O.C.

Abstract: *The purpose of this paper is development of bicycle power generation mechanism. Generally, bicycle power generator must provide function of lighting and warning at night. And let 3C products can be charged, can conform to the needs of modern life. The current bicycle power generator utilizes the friction between generation mechanism and wheel to drive the circular generator. The rider spends more effort in order to achieve the purpose of power generation. Therefore, the innovation of this paper provides battery-free and frictionless power generation mechanism. It is an innovation which is taking into account the convenience of modern life, comfort and green thinking.*

The frictionless bicycle power generation mechanism is rotated relatively by the stator of coil and rotor of magnets each other. Utilize Fleming's right-hand rule, the coil cutting magnetic field lines will be generated power generation. This is a very practical and frictionless rotation wheel of power generation.

This paper known that the bicycle speed exceeds 21 km/hr, then the maximum charging voltage is all more than 3V when charge 140 seconds in the three capacitors of 6600, 9400 and 12700(μ F). The maximum charging voltage is more than 3V, then can drive 3 volt LED lights to light. And the results obtained by the experimental, the power generation mechanism suitable for the impedance of 400 to 500 ohms, the bicycle power generation mechanism can obtain a large instantaneous power about 0.03 watts to 0.058 watts under this load.

Keywords: *bicycle power generation mechanism, coil, magnetic, frictionless, Fleming's right-hand rule.*

1. Introduction

1.1. Research of the Motivation

The scheme of a lot of alternative energy source was produced by the questions. For example, wind-power electricity generation, hydroelectric generation and solar energy electricity generation...etc. But the energy is obtained by the development of larger and more cost generator. Although the larger generator can provides much more energy, but can't provide conveniently energy for people in the outdoor. People only obtain electric energy at the place of export electric energy equipment. But the speech for the person of needing energy is badly, this is a quite troublesome question.

Therefore, if the generator structure can be minimized to let people obtain conveniently energy, then people will live happily in daily life.

1.2. Purpose of Research

Modern people often ride bicycle, it provides people good activity of sport or recreation. So, many research and inventor thinking change the rotation energy of trampling bicycle into the electric energy. However, utilize the patent database of the Republic of China to search the relevant patent of "the bicycle power generator". Most bicycle generators are invented by rotation generator to generate electricity [1] [2]. The iron is twined by coil, it will be generated power by cutting magnet lines when magnet was rotated. But the power generation

mechanism is very complicated. It wears and tears very easy. Because the structure transmits energy loss, so the kind of power generation mechanism efficiency and life time is very low.

In order to improve above-mentioned shortcomings, this paper utilizes “Structure of a voice coil assemble “【3】, “Structure of vibration sheet generator “【4】 and “Method of generating electricity using external vibration force “【5】 patents of the Republic of China regard as development blueprint of the bicycle power generators. According to above, has already developed “Bicycle power generation mechanism “【6】 and “Bicycle power generation mechanism “【7】 patents of the Republic of China. This paper target is development of “Bicycle power generation mechanism “【7】. The structure of sheet planar coil will install at rear wheel shelf. The pair of magnet structure will install at spokes of wheel. The bicycle power generators are moved relatively frictionless by sheet planar coil and pair of magnet structure each other to generate electric power. It will be generated electric power by the coil cutting magnetic field lines. This is called Fleming's right-hand rule. Bicycle power generator connects circuit, LED, and the bridge rectification circuit. The electric power can be light, storage energy, record the relevant voltage signal and provides electric power for 3C portable products. Then, it will reduce the use of batteries and household power, and achieve energy-saving purposes. The purpose of research wants to charge more than 3 volts to capacitor, and achieves to drive purpose of 3 volts LED light. According to relation of maximum instantaneous power vs. impedance with different rotation speed, understand the efficiency of bicycle power generator.

2. Method of Research

2.1. Structure of the Generator

The development of bicycle power generation mechanism and circuit has already been finished testing and manufacturing. And can be a testing producing in a small amount. First, sheet planar coil was manufactured. Secondly, install the sheet planar coil to rear wheel shelf. Finally, put the pair of magnet on the spokes of wheel. Utilize Fleming's right-hand rule, it will be generated electric power by the coil cutting magnetic field lines.

The structure of sheet planar coil was combined rapidly by copper coil and sheet structure, as showing in Fig. 2-1. The pair of magnet structure was combined rapidly by opposite magnetic pole, as showing in Fig. 2-2.

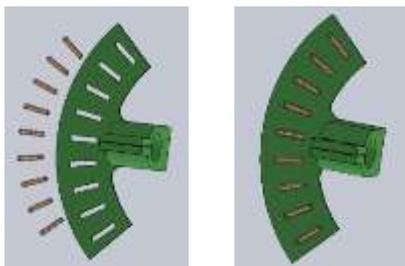


Fig. 2-1 Exploded and combined schematic figure of copper coil and sheet structure

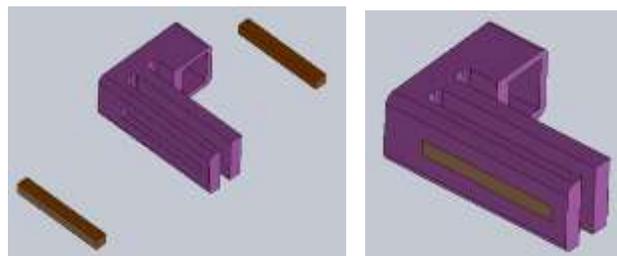


Fig. 2-2 Exploded and combined schematic figure of magnets and a pair of magnet structure

According to Fig. 2-3, very parts of bicycle power generation mechanism assemble separately on the bicycle. The pair of magnet structure will install at spokes of wheel. The structure of sheet planar coil will install at rear wheel shelf. The bicycle power generation mechanism assembles wholly by every part, as showing in Fig. 2-3.

Bicycle power generator connects the circuit. It provides lighting and warning of lamp at night. Or bicycle power generator connects the bridge rectification circuit, as showing in Fig. 2-4. Let the electric power storage, and provides electric power for 3C portable products.

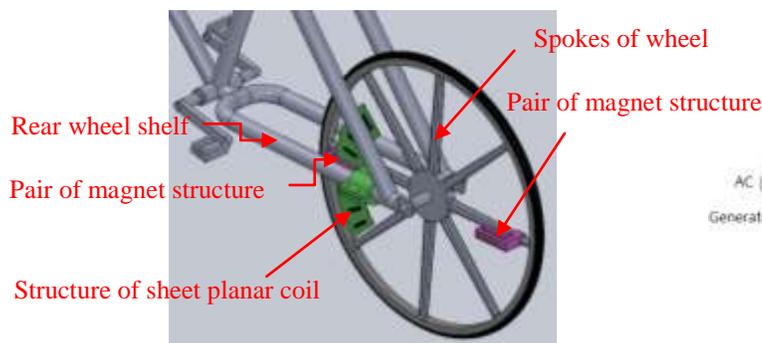


Fig. 2-3 Combined schematic figure of bicycle power generation mechanism

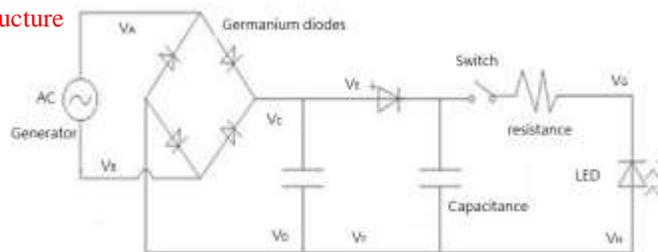


Fig. 2-4 Schematic figure of the bridge rectification circuit

2.2. Manufacturing of Power Generator

Sheet planar coil was manufactured by coil which twines 250 circles for electric power experiment, as showing in Fig. 2-5. Put the sheet planar coil into structure of sheet planar coil which is manufactured by 3D printer (as showing in Fig. 2-6). The coil head and coil end welds with the soldering tin. Sheet planar coil was stick and fixed in structure of sheet planar coil by sticky tape, as showing in Fig. 2-7.



Fig. 2-5 Coil

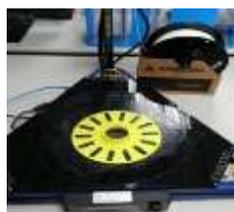


Fig. 2-6 3D printer



Fig. 2-7 Sheet planar coil



Fig. 2-8 Bicycle power generator



This paper utilize characteristic which are moved relatively by sheet planar coil and pair of magnet structure each other to generate electric power. It will be generated electric power by the coil cutting magnetic field lines. Sheet planar coil and pair of magnet structure install actually to the relative position of the bicycle, as showing in Fig. 2-8. Bicycle power generator connects circuit, LED, and the bridge rectification circuit, then the electric power will can be light, storage energy, record the relevant voltage signal and provides electric power for 3C portable products.

3. Result of Experiment

This paper records separately charge voltages vs. time in the 1.4、 1.6、 2.0 rounds per second (r.p.s.) which are rotated by pedals. That is 3.2, 3.6 and 4.5r.p.s. which are rotated by rear wheel, may be about 22, 24 and 31 km/hr for 0.3m wheel radius. The alternating current (AC) passes the bridge rectification circuit to transform alternating current (AC) to direct current (DC) in the experiment which uses 6600 μ F capacitor to charge. And the NI USB-6009 DAQ data acquisition card records charge voltages between positive and negative pole about 140 seconds. The relation chart of voltages vs. time for all experiments is as follows:

- The experiment uses 6600 μ F, 9400 μ F and 12700 μ F capacitor to charge about 140 seconds. The relation chart of voltages vs. time is showing in Fig. 3-1., Fig. 3-2. and Fig.3-3. respectively;
- The experiments regard resistance as impedance to measure signals from 100 to 1000 ohms increases 100 ohms each time. The experiments records separately charge voltages vs. time in the 1.4、 1.6、 2.0 rounds per second (r.p.s.) which are rotated by pedals when one pair of magnet structure is used. That is 3.2, 3.6 and 4.5r.p.s. which are rotated by rear wheel, may be about 22, 24 and 31 km/hr for 0.3m wheel radius. For example, the experiment records charge voltages vs. time at 1.4r.p.s. which are rotated by pedals when one pair of magnet structure is used with resistance 100 Ω , as showing in Fig. 3-4.

The experiment gets maximum value form the absolute maximum positive and negative voltages in the Fig. 3-4. Substitute the absolute maximum voltage $V_{\max} = 1.3V$ into the power equation to calculate power. Then obtains $P_{\max} = \frac{V_{\max}^2}{R} = \frac{1.3^2}{100} = 0.0169W$. Finally, the experiments measure signals from 100 ohms to 1000 ohms increases 100 ohms each time with different rotation speed by pedals when one pair of magnet structure is used, then calculate power for every experiment, as showing in Fig. 3-5.

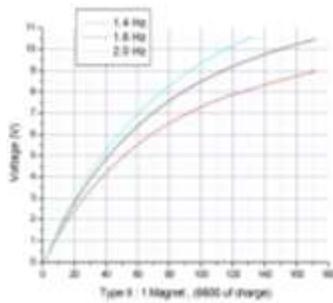


Fig. 3-1 Figure of voltages vs. time (6600 μ F)

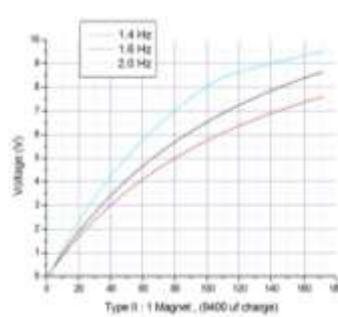


Fig. 3-2 Figure of voltages vs. time (9400 μ F)

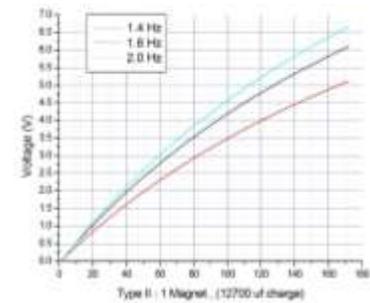
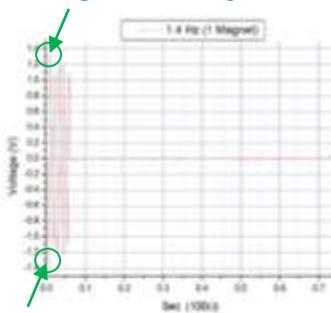


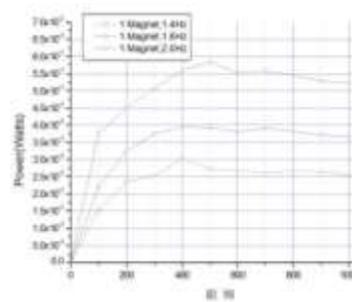
Fig. 3-3 Figure of voltages vs. time (12700 μ F)

Maximum positive voltage



Maximum negative voltage

Fig. 3-4 Figure of voltages vs. time with resistance 100 Ω Fig. 3-5 Figure of maximum instantaneous power vs. impedance with different rotation speed



4. Results and Discussion

4.1. Results

According to Fig. 3-1, Fig. 3-2 and Fig. 3-3, this paper records separately charge voltages vs. time in the 1.4, 1.6, 2.0 rounds per second (r.p.s.) which are rotated by pedals. That is 3.2, 3.6 and 4.5r.p.s. which are rotated by rear wheel, may be about 22, 24 and 31 km/hr for 0.3m wheel radius.. And the experiment uses separately 6600 μ F, 9400 μ F and 12700 μ F capacitor to charge about 140 seconds, as showing in Table 4-1.

According to Table 4-1, the maximum charge voltages exceed 3Volts with different rotation speed and all capacitor about 140 seconds charging. Accord with and charge more than 3 volts to capacitor, and achieves to drive purpose of 3 volts LED light.

According to Fig. 3-5, the experiment has maximum instantaneous power under between 400 to 500 ohms with different rotation speed, as showing in Table 4-2.

Table 4-1 Capacitor vs. maximum charge voltages with different pedals rotation speed

Capacitor (r.p.s.) Rotation speed	6600 μ F Voltage(V)	9400 μ F Voltage (V)	12700 μ F Voltage (V)
1.4	8.3	6.9	4.5
1.6	9.8	7.9	5.3
2.0	10.6	9.1	5.8

Table 4-2 Impedance vs. maximum instantaneous power with different pedals rotation speed

Rotation speed (r.p.s.)	Resistance (Ω)	Maximum instantaneous power (W)
1.4	500	0.03
1.6	400	0.039
2.0	400	0.058

It can be known that the impedance of bicycle power generator selects suitably between 400 to 500 ohms.

4.2. Discussion

The bicycle power generation mechanisms possess innovating in manufacturing and assembling process. Not only the innovative patent possess simple and easy characteristic, but also it is used extensively by other power generation market.

In addition, they vibrated relatively by sheet planar coil and pair of magnet structures each other in this innovation patent, and the bicycle power generation mechanism is a frictionless device. So, not only it wears and tears very low, but also it is very few damage. This research utilizes the advantage method and procedure of manufacturing, the vibrating sheet generators can offer the electric power whenever and wherever. It can be break-through the restriction that 3C products must use portable electric power.

The process of research can increase the voltage through some increasing the parameter of power generation. For example, more number of coils, the higher magnetic field, more pairs of magnet and the faster bicycle speed, can let the bicycle power generator increase the voltage. But the bicycle power generation mechanism want make greater generating efficiency, the influence of maximum instantaneous power vs. impedance is not obvious with different rotation speed.

According to results, if popularize this achievement to all bicycles which can install the bicycle power generation mechanism. Then, it will reduce the use of batteries and household power in the world.

5. Acknowledgements

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6. References

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