An Examination of Handicrafts Using Clean Energy for Schoolchildren

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Abstract

Recently, there have been many proposals and countermeasures for the purpose of the global environmental protection. Solar cell, windmill and fuel cell using clean energies are actively applied to home generation of electricity instead of using fossil fuel. However, teaching materials that are easy to understand regarding the use of clean energies are not generally used in elementary schools. Handicrafts and experiments using clean energies are especially required at early time of schoolchildren. This paper proposes handicrafts using solar cell, windmill and fuel cell suitable to address schoolchildren's needs. This paper deals with solar cells operated chain tower and merry-go-round, and wind power operated propeller type and signboard type windmills and Ferris wheel powered by a fuel cell.

Keywords

schoolchildren, handicraft, solar cell, windmill, fuel cell, clean energy, metallic alloys for hydrogen storage, global environmental protection

1. INTRODUCTION

Recently, global warming caused by burning of fossil fuel have been attributed to abnormal weather in the world. In order to address this global challenge there have been various activities in almost every society. Solar cell, windmill and fuel cell using clean energies are actively applied to home generation of electricity and electric vehicle instead of using fossil fuel. However, teaching materials that are easy to understand regarding the use of clean energies are not generally used in elementary schools. Handicrafts and experiments using clean energies are especially required at early time of schoolchildren from a viewpoint of ecology.

For making handicrafts, following points are specially considered.

(1) That schoolchildren came up with various ideas of using clean energies.
(2) That they show their originality.
(3) That handicrafts can be easily repaired by themselves using inexpensive materials.
(4) That they do not use electric handicrafts kit such as semiconductor devices as they do not understand it's operating principles.

This paper proposes original handicrafts using solar cell, wind power and fuel cell suitable to address schoolchildren's needs. There are chain tower and merry-go-round operating solar cell, windmills of signboard type and propeller type operating wind power, and Ferris wheel operating a fuel cell.

2. HANDICRAFTS USING SOLAR CELL

We are receives the blessings of solar rays in life since olden times. Solar chain tower and solar-merry-go-round as handicrafts using solar cell are described as follows.

2.1 Solar chain tower

General view of solar chain tower using solar cell is shown in Figure 1. Firstly, solar cell (1) generates the voltage and current by applying the solar rays to its surface. Rated voltage and current of solar cell are 2V, 0.25A (0.5W). The size of solar cell is 62mm x 83mm. Generating voltage is applied to DC motor (2). DC motor is M25E-4 with rated voltage of 3V made by MITSUMI. Pulley I (4) is installed to the shaft of DC motor, and they are connected to pulley II (3) installed to the modified PET bottle (5) by rubber band (7). Chain (6) is installed in the blades of the modified PET bottle. Therefore, the blades of the modified PET bottle as a solar chain tower are rotated by DC motor driven by a solar cell. As reduction ratio between pulley I and pulley II is 1/6, solar chain tower is rotated at a slow speed. Operation of solar chain tower is investigated by adjusting the

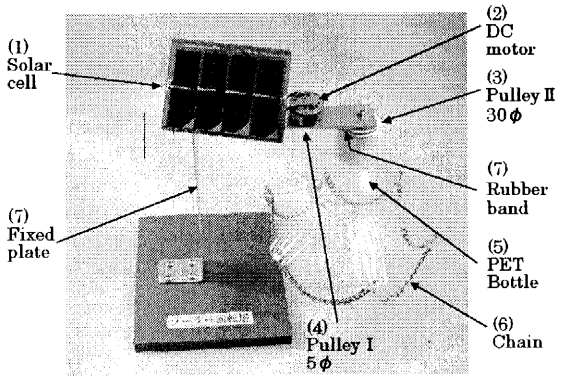

Fig. 1 General view of solar chain tower

intensity of illumination of reflector lamp with 100W. As a result, rotation of solar chain tower is started when solar cell generates about 75mW (1.7V x 44mA) at intensity of illumination with 5500 lx. Solar chain tower is rotated a high speed when solar cell generated 87mW (1.9V x 46mA) at intensity of illumination with 10000 lx.

2.2 Solar-merry-go-round

General view of solar-merry-go-round using solar cell is shown in Figure 2. The solar-merry-go-round is mounted on a 120ϕ x 8 t circular acrylic plate. The Components of solar-merry-go-round using solar cell is shown in Figure 3. Rated voltage and current of solar cell are 2V, 0.5A (1W). The size of solar cell with the outward appearance of an octagon is 122mm x 122mm, and light-intercepting area of solar cell is a diameter of 100ϕ. (+) of generating voltage (2) by applying the solar rays to surface of solar cell (1) is applied to (+) pole (16) by a conducting wire inside the rotating prop (3), and (-) of generating voltage (2) is applied to rotating prop (3) and fixed plate (6) as the (-) pole of DC motor (8). The (+) pole (16) is touched to leaf spring (9) as the (+) pole of DC motor. The size of rotating prop made of a circular aluminum cylinder is 13ϕx 190mm. The size of fixed aluminum plate (6) is 100mm x 50mm x 2t. DC motor can use both FC-280SA and RF-370C made by MABUCHI MOTOR. Pulley I (10) is installed in the shaft of DC motor, and they are connected to pulley II (11) installed in the rotating prop by a rubber band (12). As reduction ratio between pulley I and pulley II is about 1/3, solar-merry-go-round is smoothly rotated at a slow speed. 8 x 100mm aluminum chains are suspended from the gem clips installed in the octagonal solar cell.

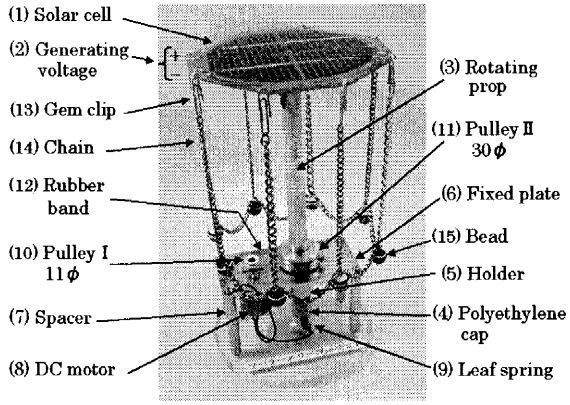

Fig. 2 General view of solar-merry-go-round

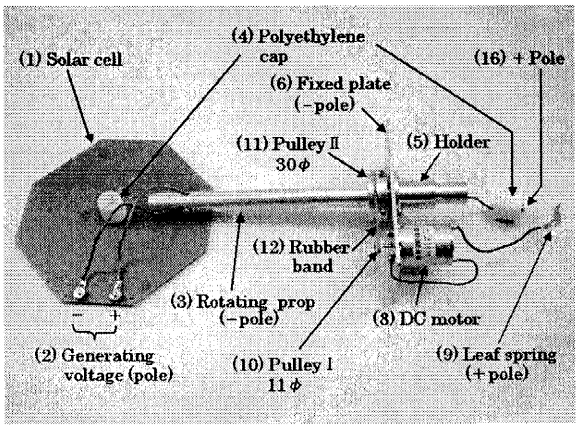

Fig. 3 Components of solar-merry-go-round

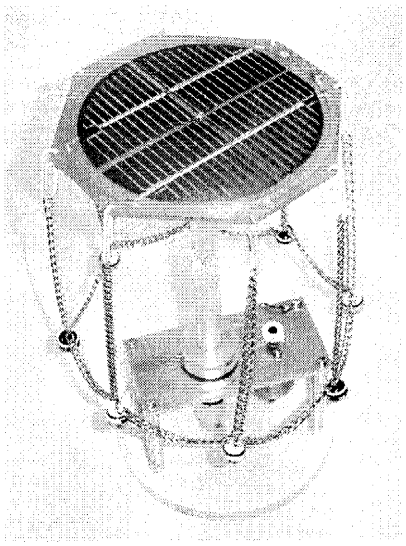

Fig. 4 A view of rotating the slowly of solar-merry-go-round

Operation of solar-merry-go-round is investigated by adjusting the intensity of illumination of reflector lamp with 100W. Therefore, rotation of the solar-merry-go-round is started when solar cell is generated about 78mW (1.35V x 58mA) at intensity of illumination with 3500 lx. A view of slowly rotating of solar-merry-go-round is shown in Figure 4. The solar-merry-go-round is rotated faster when solar cell is generates about 114mW (1.75V x 65mA) at intensity of illumination with 9700 lx. The rotational speed of solar-merry-go-round by applying solar rays on a very fine weather is very fast compared to using illumination of reflector lamp.

3. HANDICRAFTS USING WIND POWER

We have used wind power in life as windmill since olden times. Windmills of signboard type and propeller type as handicrafts using wind power are described as follows.

3.1 Windmill of signboard type

General view of windmill with signboard type is shown in Figure 5. Size of four pieces of cardboard used as blades (2) is 90mm x 120mm, and four pieces of blades are installed in a quadratic prism (1) with the size of 8mm x 8mm x 140mm using a double-sided tape. For

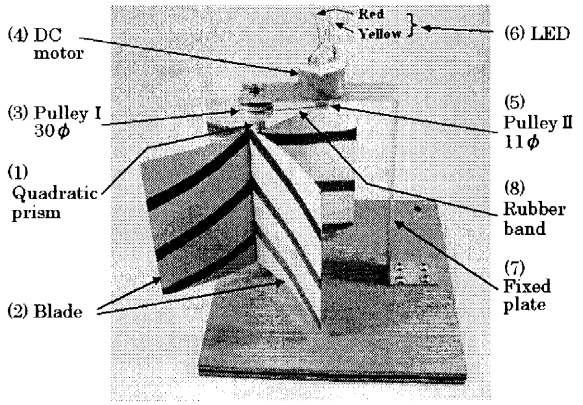

Fig. 5 General view of windmill with signboard type

DC motor (4) both RF-500TB by MABUCHI MOTOR and MHT-5RF2T by Matsushita can be used. Pulley I (3) is installed in the quadratic prism, and there are connected to pulley II (5) installed in the shaft of DC motor by a rubber band (8). Reduction ratio between pulley I and pulley II is about 3. DC motor functions as a generator when the shaft of motor is rotated by four blades. Two red and yellow LED (6) are soldered on two poles of DC motor in order to monitor generating electric power. Yellow LED is turn on when the blades are moved clockwise and in the same way, red LED is turn on when the blades are moved counterclockwise.

Generating characteristics of windmill with signboard type is investigated by applying the wind power from a blower. As a result, generating electric power of windmill with signboard type is started with 8.3mW (1.65V x 5mA) when wind velocity is 3.5m/s, there is a power generation of 72mW (1.8V x 40mA) at wind velocity of 4.5m/s.

3.2 Windmill of propeller type

General view of windmill with propeller type is shown in Figure 6. Propeller (1) with a diameter of 250mm as blade of windmill is cut to the curved surface with 1-2mm in thickness using a cypress board with size of 250mm x 30mm x 5t. For DC motor (2) FC-280SA made by MABUCHI MOTOR is used. DC motor is operated as generator by rotating the propeller. Rotating the propeller helps DC motor to function as a generator. LED (3) mounted on the DC motor is turn on when electric power is generated by rotating the propeller. Tail unit (4) is used to turn the direction of blowing wind.

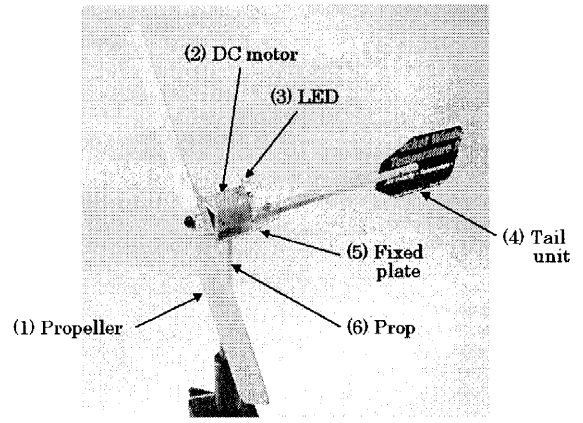

Fig. 6 General view of windmill with propeller type

Characteristics of generating electric power by windmill propeller type are shown in Figure 7. Measurement of characteristics is made by adjusting the wind power of blower with rated electric power of 30W at AC100V. As a result, generation of electric power P_0 (E_0 x I_0) started at 68mW (1.95V x 35mA) when wind velocity was about 6m/s. power generation was 110mW (2.03V x 54mA) at wind velocity of 7.3m/s. Rotational speed of propeller at wind velocity of 7.3m/s was about 2600rpm. A handy type SM-18 made by Speedtech was used for the measurement of wind velocity.

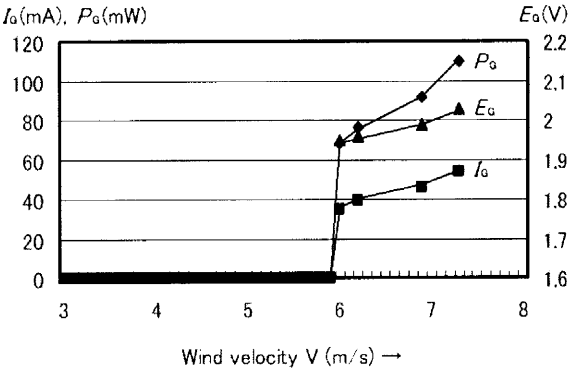

Fig. 7 Characteristics of generating electric power for windmill with propeller type

4. HANDICRAFTS USING FUEL CELL

Fuel cell is used as drive source of electric vehicle [Yamaguchi et al., 2005]. Ferris wheel as handicrafts using fuel cell are described as follows.

4.1 Ferris wheel using fuel cell

General view of Ferris wheel using fuel cell is shown in Figure 8. Size of Ferris wheel (4) with eight gondolas (5) is a diameter of 200φ. Generating voltage based on fuel cell is applied to DC motor (1) through speed controller (6). A series-type regulator with transistor is used for speed control. A DC motor RF-500TB is used for operating at low voltage. Pulley I (2) is installed in the shaft of the DC motor, and they are connected to pulley II (3) installed in the shaft of Ferris wheel by a rubber band (8). Reduction ratio between pulley I and pulley II is 1/20. Ferris wheel using fuel cell is smoothly rotated at a slow speed of about 9.2rpm when supplying elec-

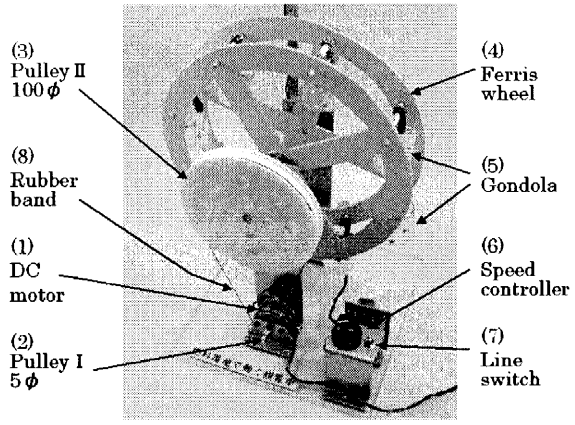

Fig. 8 General view of Ferris wheel using fuel cell

tric power is 0.495W (5.5V x 90mA) by setting to 0.07MPa the pressure of H_2 gas.

General view of fuel cell system used for Ferris wheel is shown in Figure 9. Fuel cell (1) PFC0505.N made by DAIDO METAL is used. Outline of the fuel cell is shown in Table 1. The method of sending O_2 in air into the fuel cell is carried out by natural aspiration. Gas pressure of H2 sent to fuel cell is adjusted to 0.01-0.07MPa as indication of pressure gauge (4) using a regulator (3). Fluoric resin tube (5) connecting the fuel cell and regulator is removable very easily. Metallic alloys for hydrogen storage MHSC-70L (2) filled-up to capacity of 70NL with a

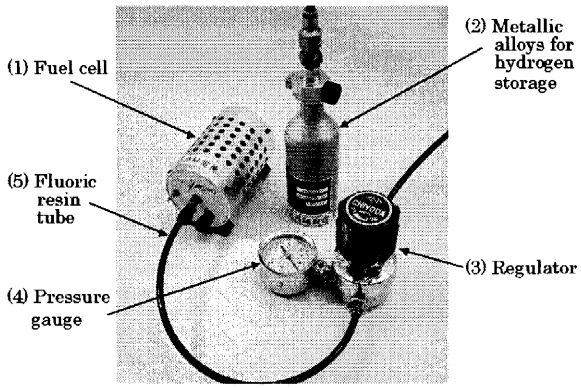

Fig. 9 General view of fuel cell system

Table 1 Outline of used fuel cell

Type	PFC0505.N
Rated voltage and current	DC 5V, 1A
Rated power	5W
Open circuit voltage	6.5V
Rated pressure of hydrogen	0.07MPa
Environmental temperature	0~45 ℃
Size	70φ ×80 mm
Weight	470g

Table 2 Outline of metallic alloys for hydrogen storage

Type	MHSC-70L
Quantity of storage for hydrogen	70NL
Common pressure of hydrogen	0~0.99 MPa
Environmental temperature	0~45 ℃
Size	50φ ×165 mm
Weight	900g

pressure of 1MPa is used made by Japan Steel Works, LTD. Outline of the metallic alloys for hydrogen storage which is compact and light-weight is shown in Table 2.

5. A VIEW OF SCHOOLCHILDREN MAKING HANDICRAFTS

Handicrafts class using clean energies is opened in August during the summer vacation for 120 schoolchildren every year at our university. This picture (Figure 9) shows the broken solar-merry-go-round being repaired by the teacher.

Fig. 9 A view of handicrafts for solar-merry-go-round

6. CONCLUSION

This paper proposes original handicrafts using solar cell, wind power and fuel cell suitable to address schoolchildren's needs. The handicrafts contain chain tower and merry-go-round powered by solar cell, signboard type and propeller type windmills operated by wind power and Ferris wheel powered by fuel cell.

As a result, it has obtained the following.

(1) Solar chain tower, windmills of signboard type and propeller type handicrafts are made easily.

(2) As handicrafts of solar-merry-go-round and Ferris wheel using fuel cell are complicated, method of handicrafts must be investigated further.

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