

Article

## Devices to generate clean and renewable energy from honey bee hives

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Received 21 April 2019; Accepted 28 May 2019; Published 1 September 2019



### Abstract

There is a need for finding new, clean and cheap energy sources. Honey bees, on the other side, provide the agricultural sector with essential pollination service to crops. One hive contains thousands of bees, and hundreds of hives can be kept in one place (i.e. apiary). This study, for the first time, describes designs for the possibility of producing electricity from honey bee hives utilizing the kinetic energy of bees. The generated energy is expected to be clean and cheap, and without any negative impacts on the bees. The produced energy can be increased using large number of hives and can be stored. This study provides a new trend to produce energy from insects.

**Keywords** colonies; moving; power; physics.

**Arthropods**  
ISSN 2224-4255  
URL: <http://www.iaees.org/publications/journals/arthropods/online-version.asp>  
RSS: <http://www.iaees.org/publications/journals/arthropods/rss.xml>  
E-mail: [arthropods@iaees.org](mailto:arthropods@iaees.org)  
Editor-in-Chief: WenJun Zhang  
Publisher: International Academy of Ecology and Environmental Sciences

### 1 Introduction

Honey bees, *Apis mellifera* L., are used widely in the agricultural sector to increase the production from plants, especially that honey bees are the major pollinator to many plants (Morse and Calderone, 2000). Also, keeping honey bees provide beekeepers and farmers with additional source of income (Chazovachii et al., 2013; Qaiser et al., 2013) by marketing valuable bee products including honey and other colony products. Beside these benefits, scientists have used honey bees to other purposes including the detection of plant diseases, detection of TNT and drugs using proboscis extension reflex (PER) test (Abou-Shaara, 2018). Also, honey bees are used to monitor the environmental contamination with pesticides or heavy metals (Balayiannis and Balayiannis, 2008; Conti and Botrè, 2001; Zhelyazkova, 2012; Abou-Shaara and Abuzeid, 2018; Faghani and Rahimian, 2018; Zhang, 2018). On the other hand, some rural areas in the world still suffer from lacking of cheap and continuous electricity sources. Thus, searching for a method to generate clean and cheap electricity from farm animals is important. Using animal power in agriculture is common and well known, including the use of draught animal power to generate electricity (Paras et al., 2016). One of the most common small animals at rural areas is honey bees which are kept in hives. Developing methods that can lead to generate energy from

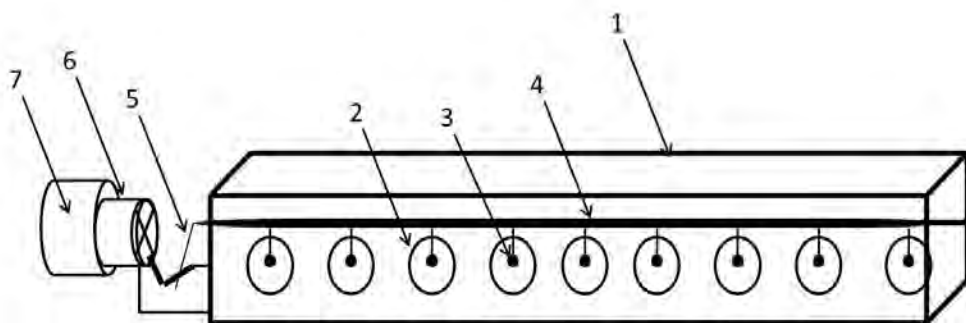
bee hives could be considered as a good trend to obtain cheap, clean and continuous energy.

There are no previous trails to generate electricity from honey bees. Only, electricity can be used to produce bee venom from honey bee colonies. The collection of bee venom depends on the exposure of honey bee workers to electrical shocks (Benton et al., 1963). This method does not yield any electricity production from the bees. The bodies of honey bees hold electrical charges (Erickson, 1982; Corbet et al., 1982). But it is not possible to gather electricity directly from the bodies of the bees. Alternatively, it is possible to utilize the kinetic energy of honey bees to produce electricity. Typically, thousands of bees are existed in each hive (Southwick and Heldmaier, 1987). Such large number of bees is continuously moving either to do activities inside the hives or outside it. The tasks of the bees are distributed according to age; the younger bees less than 21 days do activities inside the hive while the older ones do foraging activities (Abou-Shaara, 2014). Thus, utilizing the kinetic energy of honey bees either inside or outside the hive is possible to produce electricity. Therefore, this paper describes designs to produce electricity from honey bee colonies utilizing the activities of the bees without any negative impacts on the bees.

## 2 Devices

### 2.1 External device

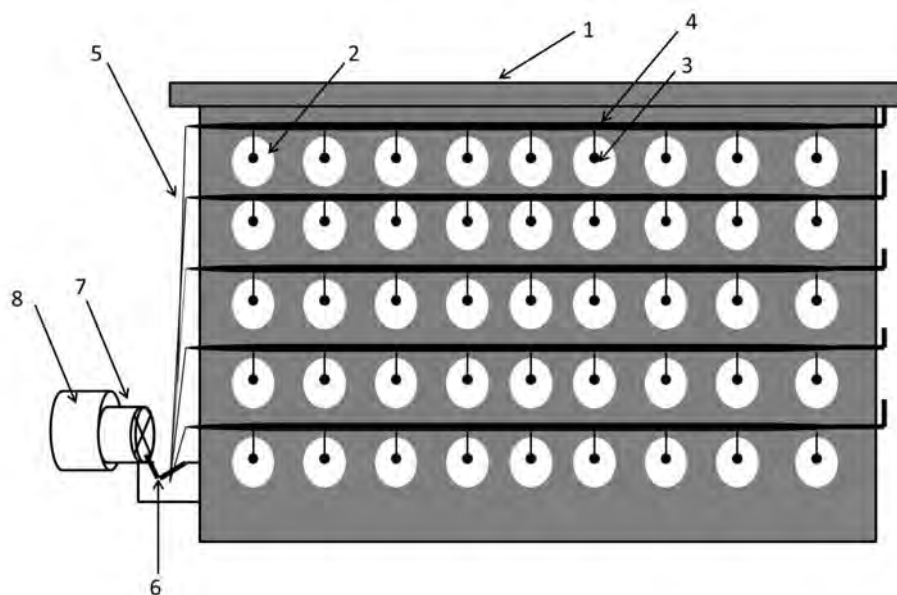
Electricity can be generated using device that can be fixed in front of the hives. The forager bees, in this case, are utilized to generate electricity by using their kinetic energy. The forager bees are typically old bees that perform tasks outside the hives to collect nectar, pollen, water or other materials (Abou-Shaara, 2014). During the movements of the forager bees from outside to inside the hives or vice versa they will pass through the device (Fig. 1) and hence electricity can be generated and stored in batteries until use. The bees will push small balls and these balls are connected to a movable tube, and this tube is connected to a small dynamo to generate electricity.



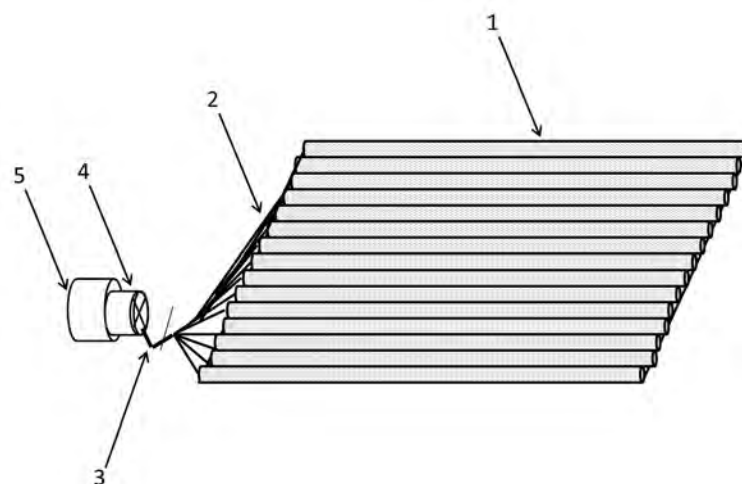
**Fig. 1** Parts of the external device working outside the hives. This device is a box (1) with dimensions (5x5x40 cm, HxLxW), this box is placed in front of the hive and contains holes (2) with a diameter of 7 mm per each, the bees can pass from these holes to push a small transparent ball (3) moving the tube (4), and then the arm (5) push the fan (6) to generate electricity from the dynamo (7). This dynamo can be used to charge batteries, and these batteries can be further used to operate various devices.

### 2.2 Internal device

The second device can produce electricity utilizing the kinetic energy of bees inside the hives. The device (Fig. 2) resembles normal wooden frame. This device contains small balls that can be pushed by bees during their normal movements inside the hives. Similarly to the previous device, bees can push small balls which are connected to a movable tube which is connected to a small dynamo to generate electricity.



**Fig. 2** Parts of the internal device working inside the hives. This device contains the carrier frame (1) (with dimensions of 25x 42 cm Lx W) which contains holes (2) with diameter of 7 mm, and the bees can pass through these holes to push small balls (3), hence moving the horizontal tube (4), and moving part (5) which connects to an arm (6) to move the fan (7) to generate electricity by the dynamo (8). This dynamo can be used to charge batteries, and these batteries can be further used to operate various devices.

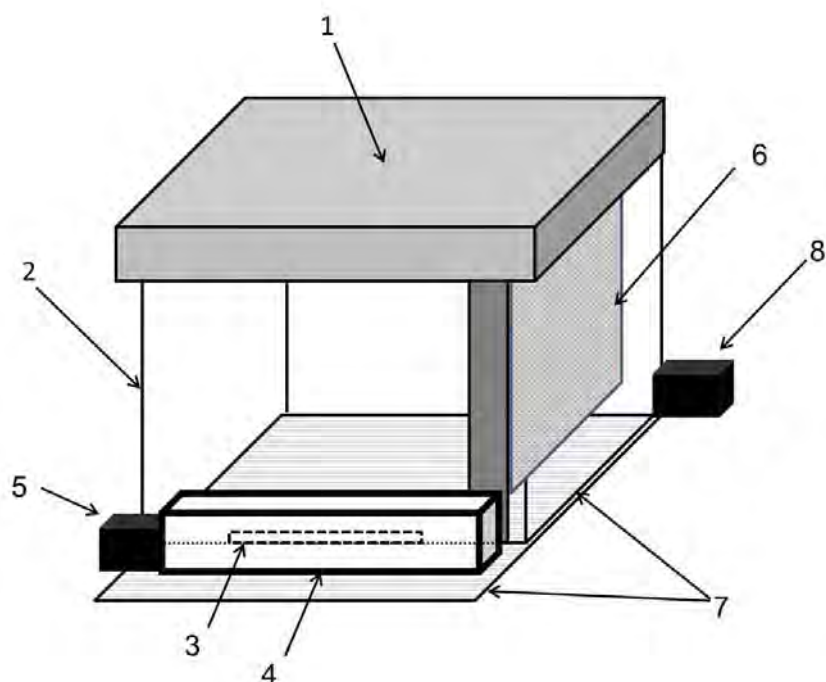


**Fig. 3** Parts of the device which working inside and outside the hives at the same time; this device consists of a board (25x55 cm, WxL) to be fixed under the hive box, and this board contains many of small tubes arranged close to each other (1), these tubes have rough surfaces to be easily moved by bees during their movements, and when these tubes move, the part (2) and the arm (3) are also moved to move the fan (4) to generate electricity by the dynamo (5).

### 2.3 Third device

This device can be used to generate electricity from inside and outside the hives at the same time. This device (Fig. 3) depends on using moving tubes with rough surfaces to be moved by bees during their movements, and these tubes are connected to a dynamo to generate electricity. The generated electricity can be stored using batteries until use. The position of fixing these devices in relation to the hive body is shown in Fig. 4. It is expected that the energy from these devices is about 12 volt per minute. The daily energy of the internal and third devices is expected to be more than the external device. This because the external device depends on

forager bees only, and foraging activity of honey bees occurs only during the daytime, while the activities of bees inside the hive occur day and night.



**Fig. 4** The positions of the devices in relation to the hive. The hive consists of upper cover (1), a box (2) and hive entrance (3). The external device (4) is placed in front of the entrance (3) to utilize the movements of the forager bees when entering or leaving the hive, while the fan and the dynamo (5) are placed beside the device. The internal device (6) is placed inside the hive beside the hive frames to utilize the movements of the bees inside the hive to generate electricity, while the fan and the dynamo (8) is placed outside the hive. The third device (7) is placed under the hive box while the fan and the dynamo (8) are placed outside the hive. The third device utilizes the movements of the bees inside and outside the hives because this device covers the hive bottom and the front part of the hive.

### 3 Conclusion

Devices that can be used to generate electricity from honey bee hives are designed. The amount of electricity can be increased using large number of hives. These devices are not expected to cause harmful impacts on the colonies or even to hinder the normal activities. These devices are expected to help beekeepers, to obtain enough energy to operate devices used during beekeeping work, especially at isolated regions. Also, farmers at poor or isolated areas have an additional option to obtain electricity by using these devices. This study opens a door for a future development of devices to generate electricity from insects.

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