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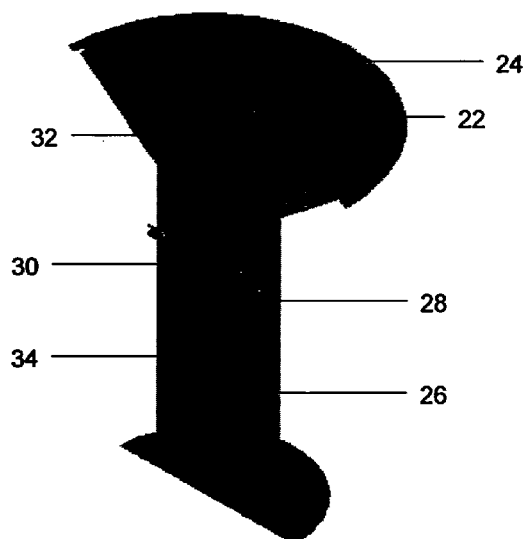
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(54) Title: PIEZOELECTRIC BASED ENERGY HARVESTER

Fig. 2



(57) Abstract: The present invention provides an piezoelectric based energy harvester apparatus [20] consisting of a specially designed mechanical structure, hollow cylindrical structure [30] with a piezoelectric cantilever bridge [34] within its chamber, that upon exposure to the collected rain water incoming from the roof structure [24] into the post [26], will move or vibrate due to buoyant force of the strategically trapped rain water. With the structure built-in mechanical cantilevers bridge [34] that has piezoelectric properties, the vibration of the cylindrical structure [30] is followed by the generation of micro energy. Therefore, besides serving its traditional purpose for protection, post/pillar can also be used to produce energy which can power up low power electronic devices such as for precision agriculture application. This apparatus can also act as an alternative energy harvester during raining season where no sunlight is available.



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PIEZOELECTRIC BASED ENERGY HARVESTER

The present invention relates to a piezoelectric based energy harvester for micro-energy harvesting via the use of rain water.

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BACKGROUND ART

At present, there is a pressing need for green and renewable energy sources. Various apparatus has been invented for energy harvesting from natural resources such as sunlight, wind, rain, tides and geothermal heat, which is naturally abundance. These energy harvesters power up devices that are used in applications such as agriculture, infrastructure, bridges, building, open field logistics, shipping and airport. They are very useful in cases when electric power from national electric grid is far away from grid connection.

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Piezoelectric based energy harvester apparatus contains material which produces voltage of micro energy in response to applied mechanical strain. The resulting mechanical strain could be from the movement of infrastructures in response to impact by falling raindrops, wind energy or water movement.

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There are several types of piezoelectric based energy harvester apparatus for micro energy harvesting. Presently, there are apparatus for pyroelectric and piezoelectric power generation where in this invention; a roof system for a building is adapted to harness the pyroelectric and piezoelectric effects. This roof is provided with covering structures adapted with piezoelectric materials which are capable to convert mechanical energy from falling rain into electric energy by compression or deformation of the piezoelectric material. The roof is also adapted with a pyroelectric system that generates electric power from temperature changes.

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Another prior art listed the conversion of ocean wave using piezoelectric material members where a float is mechanically coupled to a piezoelectric material member on the ocean water. In response to the up and down movement of the float caused by the passing waves, the piezoelectric member will undergo alternate straining and destaining which causes the member to generate electricity. The output impedance of the float is

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matched to the input impedance of the member for increasing energy transfer from the float to the member.

5 The present invention is made in view of the prior art described above where electricity is generated from natural resources such as rain water and ocean waves via piezoelectric material. In the prior art of roof apparatus, no rain water was collected which renders the apparatus being useful only during rainfall condition. The roof apparatus also did not use buoyant forces and use the falling rain drop pressure only. As for the prior art of ocean wave apparatus, this apparatus uses the buoyant force of the
10 floats and is only useful at areas nearby seas.

SUMMARY OF INVENTION

15 The present invention proposes a piezoelectric based energy harvester apparatus where rainwater is collected and micro energy is harvested using a closed condition dynamic fluid pressure which uses buoyant force, falling raindrops and not fully dependant on the weather and location conditions. The piezoelectric based floating energy harvester is placed inside a post/pillar infrastructure where it is capable of generating electrical energy through mechanical vibration derived from the falling rain drops and the buoyant
20 force of the strategically trapped rain water. This way, besides serving its traditional purpose for protection, building/post/pillar can also be used to produce energy which can power up low power electronic devices such as devices for precision agriculture application. This apparatus can also act as an alternative energy harvester during raining season where no sunlight is available.

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BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a drawing of a side view of closed dynamic condition of the dynamic fluid pressure piezoelectric based energy harvester apparatus.

30 Fig. 2 is a perspective cut away drawing of the piezoelectric based energy harvester apparatus.

Fig. 3 is a cross-sectional drawing of the piezoelectric cantilever bridge attached inside the hollow chamber.

Fig. 4 is a cross-sectional drawing of the restrains attached inside the energy harvester apparatus structure.

DESCRIPTION OF EMBODIMENTS

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Hereinafter, the present invention is described in detail.

The invention involves a piezoelectric based energy harvester apparatus [20] where rainwater [21] is collected within the closed condition dynamic fluid pressure apparatus and micro energy harnessed via the piezoelectric based floating energy harvester placed inside the post/pillar infrastructure through mechanical vibration derived from the falling ran drops and the buoyant force of the strategically trapped rain water.

The piezoelectric based energy harvester apparatus [20] is a closed condition dynamic filled pressure apparatus as shown in Fig. 1. Small rainwater inlets [22] on the top roof surface [24] of the harvester allow entry of the rain water. The size of the inlet [22] holes stop debris and large particles from entering the rainwater storage area. Rain water through these inlets [22] are redirected and stored at the bottom of the post [26]. Rain water outlets [28] are positioned strategically, on the top area of the post, to drain the flooded water from the post [26]. The outlets [28] are placed strategically to confirm two conditions. Firstly, the overflow rain water is drained away of the post [26] and secondly, to avoid a hollow cylindrical structure [30] from being completely submerged in water. A cone structure [23] is coupled above the post [26] and below the roof surface [24].

The cut away view of the piezoelectric based energy harvester apparatus [20] is shown in Fig. 2. Rain drops falling into the inlets [22] are redirected and stored inside the post [26] structure. The stored rainwater inside the post [26] generates a buoyant force at the bottom surface of the hollow cylindrical structure [30]. This buoyant force will be in upward direction which will lift the hollow cylindrical structure [30].

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The buoyancy upward force keeps things floating while the earth's gravity force pushes things downward. The net upward buoyancy force is equal to the magnitude of the weight of fluid displaced by the body. This force enables the object to float or become lighter. When the buoyant force at the bottom surface of the hollow cylindrical structure

[30] is greater than the gravity, the hollow cylindrical structure [30] submerged in the trapped rain water will feel an upward buoyant force. The difference between the gravitational force and buoyant force on the hollow cylindrical structure [30] creates vibration.

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The roof surface [24] of the piezoelectric based energy harvester apparatus [20] is designed to allow upward and downward movement during rain. The roof surface [24] is connected to the top surface of the hollow cylindrical structure [30] through a flexible thin pole [32]. In floating state the rain drops on the roof surface [24] will create additional downward force which is also in opposite direction of the buoyant force. This exerts opposite forces and creates additional vibration in the hollow cylindrical structure [30].

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The piezoelectric cantilever bridge [34] attached inside the chamber of the hollow cylindrical structure [30] will then vibrate and produce enough magnitude of deflection in the uniform cantilever beams. Fig. 3 shows cross section of the chamber within hollow cylindrical structure [30] where inside it, piezoelectric cantilever beams with flexible uniform width are attached to a thin rod to form the cantilever bridge [34]. To limit the maximum upward and downward movement of hollow cylindrical structure [30], post restrains [36] are attached at the inner surface of the post and chamber restrains [38] are attached in the outer surface of the hollow cylindrical structure [30] as shown in Fig. 4. An additional roof surface [25] is coupled at a distance below the roof surface [24] so that rain water does not interfere with the movement of the chamber.

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Accordingly, the invention disclosed an piezoelectric based energy harvester apparatus [20] consisting of a specially designed mechanical structure, hollow cylindrical structure [30] with a piezoelectric cantilever bridge [34] within its chamber, that upon exposure to the collected rain water incoming from the roof surface [24] into the post [26], will move or vibrate due to buoyant force. With the structure built-in mechanical cantilevers bridge [34] that has piezoelectric properties, the vibration of the cylindrical structure [30] is followed by the generation of micro energy which could be tap to power up low power electronic devices.

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CLAIMS

1. A piezoelectric based energy harvester [20] comprising:

a post [26];

a roof surface [24] with rain inlet [22]; and

a chamber [30] with piezoelectric cantilever bridge [34];

characterized in that,

a pole [32] extends from the roof [24] within the post [26] towards the chamber [30].

2. A harvester according to Claim 1, further comprising a cone structure [23] coupled above the post [26] and below the roof surface [24].

3. A harvester according to Claim 1, further comprising an additional roof surface [25] coupled at a distance below the roof surface [24].

4. A harvester according to Claim 1, wherein the roof structure [24] has a plurality of inlets [22] with sizes which allows entry of rain water into the post [26] but stop debris and large particles from entering the post [26].

5. A harvester according to Claim 1, wherein the post [26] has outlets [28] above the pole restrainer which allows overflow rain water to drain away and avoid the hollow cylindrical structure [30] from being completely submerged in water.

6. A harvester according to Claim 1, wherein the chamber [30] is cylindrically shaped.

7. An apparatus according to Claim 1, wherein the pole [32] connecting the top of hollow cylindrical structure [30] to the roof surface is flexible allowing a floating state of the roof structure [24] with upward and downward movement during rain.

8. A harvester according to Claim 1, wherein the cantilever bridge [34] is formed with flexible uniform width of piezoelectric cantilever beams attached to a thin rod.

9. An apparatus according to Claim 1, wherein the chamber has chamber restrain [38] and the post has post restrains [36] at two different height to limit the movement and vibration of chamber.

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Fig. 1

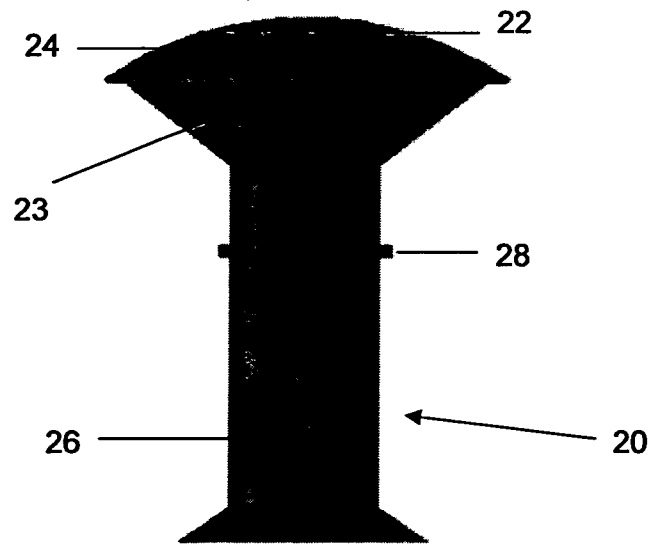


Fig. 2

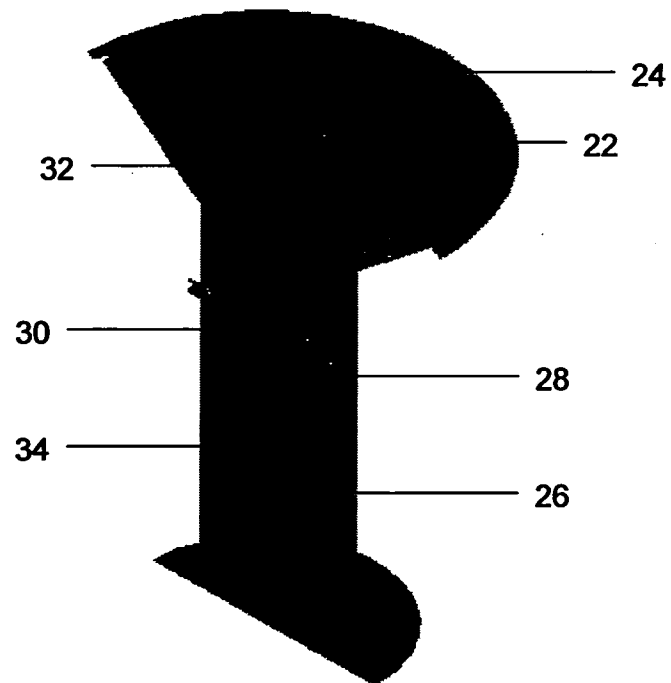


Fig. 3

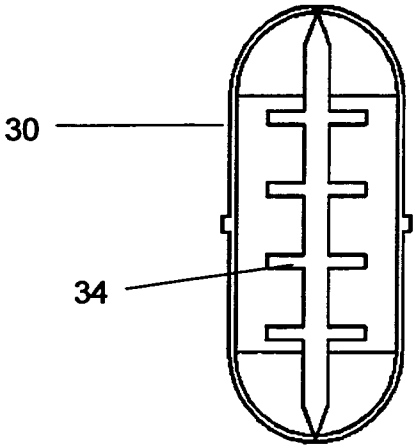
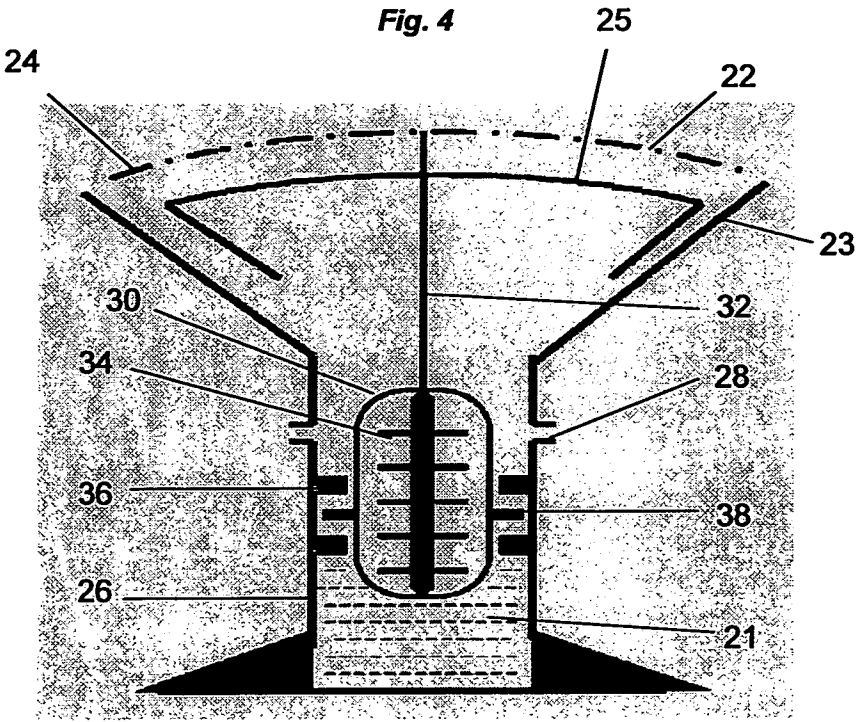


Fig. 4



INTERNATIONAL SEARCH REPORT

International application No.

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A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI and TXTE (full text database) searched with keywords: piezoelectric, energy harvesting, rain, chamber, buoyant, cantilever, post, vibration and like terms.

Google Scholar searched with similar keywords as above plus: "piezoelectric cantilever bridge", "rain water tank", etc.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5552657 A (EPSTEIN et al.) 03 September 1996 See whole document.	
A	KR 20100006313 A (YANG YOON SEOK [KR]) 19 January 2010. English abstract retrieved from EPODOC database. See English abstract.	
L, A	ROMAIN-GUIGON et al., "Rain Power: Harvesting Energy from the Sky", PHYsOrg.com, 22 January 2008, (retrieved on 01 August 2011). Retrieved from the Internet <URL: www.physorg.com/pdf120216714.pdf > See whole document.	



Further documents are listed in the continuation of Box C



See patent family annex

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/MY2011/000063

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member			
US	5552657	AU	49856/96	WO	9626364
KR	20100006313	NONE			
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.					
END OF ANNEX					