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(54) **Title:** A SYSTEM FOR RAILWAY ELECTRIFICATION USING RENEWABLE ENERGY

(57) **Abstract:** The present invention envisages a system (100) for railway electrification having a grid (60) acting as a main power source and an auxiliary power source configured to feed the grid (60). The auxiliary power source comprises a plurality of wind turbines (30) sequentially arranged vertically at a pre-determined distance along each side of railway track (20). Each of the wind turbines (30) is adapted to convert energy of slipstreams generated by a moving locomotive (10) passing on the railway track (20) into electrical power. At least one solar panel (36) mounted on an operative top of each of the wind turbines (30) to generate electrical power. Further, an electrical unit (40) is coupled to the wind turbines (30) and the solar panels (36). The electrical unit (40) facilitates unidirectional transmission of the electrical power from the auxiliary power source to the grid (60).

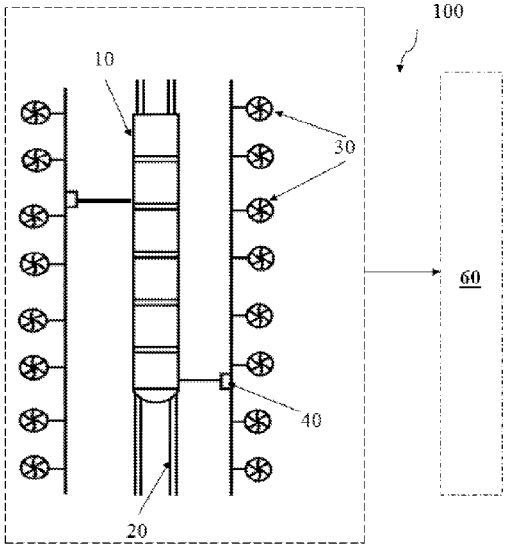


FIGURE 1

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A SYSTEM FOR RAILWAY ELECTRIFICATION USING RENEWABLE ENERGY

FIELD

The present disclosure relates to the field of railway electrification. Particularly, the present disclosure relates to railway electrification using renewable energy.

DEFINITIONS OF TERMS USED IN THE SPECIFICATION

As used in the present disclosure, the following terms are generally intended to have the meaning as set forth below, except to the extent that the context in which they are used indicate otherwise.

The expression "Usable Form" used hereinafter in the specification refers to, but not limited to, a form of energy/power either A.C or D.C which is transformed according to the requirement. The transformation from one form to another is performed using capacitor, step-down transformer, step-up transformer, etc.

These definitions are in addition to those expressed in the art.

BACKGROUND

The background information herein below relates to the present disclosure but is not necessarily prior art.

Railway electrification system supplies electric power to railway trains without requiring a prime mover or fuel supply on-board. Electric power is generated remotely at large generating stations or sometimes at generating stations dedicated for exclusively railways, and is supplied to the railway locomotives through distribution networks which also include switches and transformers.

Conventionally, the electrical power is supplied to locomotives from distantly located generators through electrical power lines. These lines are vulnerable to snags. Also, the efficiency of long distance transmission is low due to heavy transmission losses. Further, a large amount of the electrical power for supplying to railways is generated using conventional energy sources such as thermal or hydroelectric power produced with the help of non-renewable energy sources. However, large amount of usage of the non-renewable energy sources has gradually lead to rapid depletion of the non-renewable energy sources and

various environmental challenges. Hence, it is desirable to complement the rapidly depleting non-renewable energy sources by renewable and non-conventional energy sources such as solar energy, nuclear energy or wind energy for driving railway locomotives.

There is therefore required a system for railway electrification which is environment friendly and requires minimal transmission losses.

OBJECT

Some of the objects of the present disclosure, which at least one embodiment herein satisfies, are as follows:

A primary object of the present invention is to provide a system for railway electrification system using renewable energy.

An object of the present invention is to provide a system for power generation using air flow created by motion of railway locomotives.

Another object of the present invention is to provide a system that has minimal power transmission losses.

Yet another object of the present invention is to provide a system that can be easily incorporated in current railway electrification systems.

Still another object of the present invention is to provide a system that is cost effective.

Yet another object of the present invention is to provide a system that is environment-friendly.

Other objects and advantages of the present disclosure will be more apparent from the following description, which is not intended to limit the scope of the present disclosure.

SUMMARY

The present disclosure envisages a system for railway electrification having a grid acting as a main power source and an auxiliary power source configured to feed the grid. The auxiliary power source comprises a plurality of cylindrical wind turbines, at least one solar panel, and an electrical unit.

The plurality of wind turbines is sequentially arranged vertically at a pre-determined distance along each side of railway track. Each of the wind turbines is adapted to convert energy of slipstreams generated by a moving locomotive passing on the railway track into electrical power. The at least one solar panel is mounted on an operative top of each of the wind turbines. The solar panel is configured to generate electrical power. The electrical unit is coupled to the wind turbines and the solar panels to receive electrical power from the wind turbines and the solar panels. The electrical unit is further configured to facilitate unidirectional transmission of the electrical power to the grid.

In an embodiment, the electrical unit includes a coupling arrangement configured to provide electrical isolation between the auxiliary power source and the grid, and further configured to ensure unidirectional flow of electrical power from the auxiliary power source to grid.

In another embodiment, the electrical unit is configured to condition said electrical power generated by each of the plurality of wind turbines and the solar panels to a usable form.

In yet another embodiment, the electrical unit is configured to condition the generated electrical power by performing power conversion, power amplification, and impedance matching.

In still another embodiment, each of the wind turbines comprises a rotor and a generator configured to convert rotational energy of the wind turbine to the electrical power.

In an embodiment, the plurality of wind turbines is configured to rotate both in clockwise and anti-clockwise directions.

In another embodiment, the system includes a control unit configured to facilitate alteration of height of each of the wind turbines with respect to the ground, wherein the alteration is based on a set of pre-determined factors.

In yet another embodiment, the set of predetermined factors is selected from the group consisting of speed, consistency, and direction of the slipstream.

In still further embodiment, the plurality of wind turbines is selected from the group consisting of a small helical wind turbine, a vertical axis wind turbine, a Counter-rotating wind turbine, a Giromill wind turbine, a Savonius wind turbine, a Darrieus wind turbine, and a Gorlov wind turbine.

BRIEF DESCRIPTION ACCOMPANYING DRAWING

A system for railway electrification using renewable energy, of the present disclosure will now be described with the help of the accompanying drawing, in which:

Figure 1 illustrates a schematic view of the system coupled to a railway locomotive and a grid, in accordance with an embodiment of the present disclosure.

Figure 2 illustrates an isometric view of a wind turbine of the system of Figure 1, coupled with a solar panel;

Figure 3 illustrates an isometric view of the wind turbine of the system of Figure 2; and

Figure 4 illustrates an isometric view of the system of Figure 1, for railway electrification.

LIST OF REFERENCE NUMERALS

100	-	System
10	-	Locomotive
20	-	Railway Track
30	-	Wind Turbines
31	-	Base plate
32	-	Rods
33	-	Rotor blades
34	-	Rotor shaft
35	-	Mounting frame
36	-	Solar panel
40	-	Electrical Unit
60	-	Grid

DETAILED DESCRIPTION

Embodiments, of the present disclosure, will now be described with reference to the accompanying drawing.

Embodiments are provided so as to thoroughly and fully convey the scope of the present disclosure to the person skilled in the art. Numerous details are set forth, relating to specific components, and methods, to provide a complete understanding of embodiments of the present disclosure. It will be apparent to the person skilled in the art that the details provided in the embodiments should not be construed to limit the scope of the present disclosure. In some embodiments, well-known processes, well-known apparatus structures, and well-known techniques are not described in detail.

The terminology used, in the present disclosure, is only for the purpose of explaining a particular embodiment and such terminology shall not be considered to limit the scope of the present disclosure. As used in the present disclosure, the forms "a," "an," and "the" may be intended to include the plural forms as well, unless the context clearly suggests otherwise. The terms "comprises," "comprising," “including,” and “having,” are open ended transitional phrases and therefore specify the presence of stated features, integers, steps, operations, elements, modules, units and/or components, but do not forbid the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. The particular order of steps disclosed in the method and process of the present disclosure is not to be construed as necessarily requiring their performance as described or illustrated. It is also to be understood that additional or alternative steps may be employed.

When an element is referred to as being "mounted on," “engaged to,” "connected to," or "coupled to" another element, it may be directly on, engaged, connected or coupled to the other element. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed elements.

A preferred embodiment of a system (100) of the present disclosure for railway electrification using renewable energy will now be described in detail with reference to the Figures 1-4. The preferred embodiment does not limit the scope and ambit of the disclosure.

The system (100) is configured to utilize the maximum amount of slipstreams generated by the moving locomotive (10). The present system (100) is configured to generate a continuous electrical power, thereby providing a more efficient system.

Figure 1 describes a system (100) for railway electrification having a grid (60) acting as a main power source, and a plurality of wind turbines (30) acting as an auxiliary power source configured to feed electrical power to the grid (60). The auxiliary power source comprises a plurality of cylindrical wind turbines (30), at least one solar panel (36) mounted on said turbines (30) and an electrical unit (40).

The wind turbines (30) are sequentially arranged vertically at predetermined distance along each side of the railway track (20) (as shown in figures 1 and 4). Each wind turbines (30) is adapted to convert the energy of the slipstream generated by the moving locomotive (10) on the railway track (20) into electrical power.

Each wind turbine (30) is enclosed in a frame comprising a base plate (31), and a plurality of rods (32) extending from the periphery of the base plate (31). The wind turbine (30) comprises a rotor and a generator (not specifically shown in figures). The rotor, having a plurality of rotor blades (33) and rotor shaft (34), is attached vertically to the base plate (31). The rotor blades (33) are configured to rotate in the wake of the slipstream of the moving locomotive (10) and spin the generator in order to generate electric power.

In an embodiment, the wind turbine (30) is selected from the group consisting of a small helical wind turbine, a vertical axis wind turbine (VAWT), a Counter-rotating wind turbine, a Giromill wind turbine, a Savonius wind turbine, a Darrieus wind turbine, and a Gorlov wind turbine.

In another embodiment, vertical axis wind turbines (VAWT) are preferable for tapping the potential energy of the slipstream for generating the electrical energy due to their compact design. Since the area available for tapping wind power between two locomotives (10) running on parallel track (20) has a narrow width, VAWTs are a preferred choice for maximum utilization of the wind's potential. The axis of the VAWT is generally perpendicular to the streamlines of the wind and is generally perpendicular to the ground.

In an exemplary embodiment, the wind turbines (30) are installed in the space available between two adjacent tracks (20) in order to facilitate capture of the high pressure slipstreams generated by the movement of two locomotives (10) crossing each other by the wind turbines (30). In an embodiment, the rotor blades (33) of the wind turbines (30) are configured to rotate in both clockwise and anticlockwise direction in accordance with the direction of

movement of the locomotive (10) to utilize the pressure of the slipstream in a more effective way.

The frame further includes a mounting frame (35) extending from an operative top of the plurality of rods (32) (as shown in figure 2). The mounting frame (35) facilitates mounting of the solar panel (36) on the wind turbine (30). In an embodiment, each solar panel (36) is provided with a solar tracking mechanism (not shown in figures) configured to track the position of the sun, and accordingly align the solar panel (36) such that the solar panel (36) is perpendicular to the impinging rays of the sun. The solar panel (36) is connected to the generator which converts the solar power captured by the sun to produce electric power.

Further, the wind turbines (30) and the solar panels (36) are coupled with the electrical unit (40) via a transmission cable (not shown in figures). The electric power generated by the wind turbines (30) and the solar panels (36) is received by the electrical unit (40) which then feeds the electric power to the grid (60). In an embodiment, the electrical unit (40) is configured to facilitate unidirectional transmission of the electrical power to the grid (60).

In an embodiment, the electrical unit (40) includes a coupling arrangement configured to provide electrical isolation between said auxiliary power source and said grid (60), and further configured to ensure unidirectional flow of electrical power from said auxiliary power source to said grid (60). In another embodiment, the coupling arrangement includes an isolation transformer or a directional coupler. In another embodiment, the coupling arrangement further includes a step-up transformer to increase the low-voltage output of the generator to higher distribution voltage level, and other necessary electrical components, known in the art, to provide a near continuous source of power to the grid (60). In still another embodiment, in addition to the transformer, the coupling arrangement includes a supply line, a contactor, a grounding, capacitors, an impedance matching circuit, an ac-to-dc convertor, and a dc-to-ac motor convertor.

In an embodiment, the auxiliary power source acts as a loop that is configured to collect the electrical power from the wind turbines (30) and supply the electrical power back into the railway electrification system to provide operating power for auxiliary components of the locomotive (10).

In an exemplary embodiment, the system (100) is configured to utilize the movement of wind in two phases, one in real-time passing of the locomotive (10) across the plurality of wind

turbines (30), and second wherein the locomotive (10) has already moved past the wind turbines (30). In the latter case, the wind turbine (30) includes flywheels (not shown in figures) configured to store rotational energy, which can be used to rotate the rotor blades (33) when the pressure of the slipstream is not sufficient.

The system (100) further includes a control unit (not shown in figures) configured to alter the height of each wind turbine (30) with respect to the ground based on a set of predetermined factors. In an embodiment, the set of predetermined factors is selected from the group of speed, consistency, and direction of the slipstream. In another embodiment, the dimensions of the rotor blades (33) of the wind turbines (30) are optimized for maximum power generation with minimum drag imparted on motion of the locomotive (10), thereby ensuring maximum efficiency of the system (100).

Since the wind turbines (30) are positioned at predetermined distance from each other, the energy of the slip streams is effectively utilized to generate maximum electrical energy without hindering the energy generation of the other wind turbines (30) positioned nearby. Further, the wind turbines (30) are installed at a predetermined distance from the railway track (20), thereby allowing sufficient clearance from the windows and exits of the moving locomotive (10). This clearance is sufficient to avoid any contact with passengers travelling in the locomotive compartments. The predetermined distance mainly depends on factors such as, vibration generated by the moving locomotive (10), speed of the wind generated by the locomotive (10), effective area in which the generated wind is sufficient to rotate the wind turbines (30).

The foregoing description of the embodiments has been provided for purposes of illustration and not intended to limit the scope of the present disclosure. Individual components of a particular embodiment are generally not limited to that particular embodiment, but, are interchangeable. Such variations are not to be regarded as a departure from the present disclosure, and all such modifications are considered to be within the scope of the present disclosure.

In addition, any disclosure of components contained within other components or separate from other components should be considered exemplary because multiple other architectures may potentially be implemented to achieve the same functionality, including incorporating all, most, and/or some elements as part of one or more unitary structures and/or separate structures.

TECHNICAL ADVANCEMENTS

The present disclosure described herein above has several technical advantages including, but not limited to, the realization of a system for railway electrification, that:

- can be easily incorporated in current railway electrification systems;
- is economical; and
- is environment-friendly.

The foregoing disclosure has been described with reference to the accompanying embodiments which do not limit the scope and ambit of the disclosure. The description provided is purely by way of example and illustration.

The embodiments herein and the various features and advantageous details thereof are explained with reference to the non-limiting embodiments in the following description. Descriptions of well-known components and processing techniques are omitted so as to not unnecessarily obscure the embodiments herein. The examples used herein are intended merely to facilitate an understanding of ways in which the embodiments herein can be practiced and to further enable those of skill in the art to practice the embodiments herein. Accordingly, the examples should not be construed as limiting the scope of the embodiments herein.

The foregoing description of the specific embodiments so fully reveal the general nature of the embodiments herein that others can, by applying current knowledge, readily modify and/or adapt for various applications such specific embodiments without departing from the generic concept, and, therefore, such adaptations and modifications should and are intended to be comprehended within the meaning and range of equivalents of the disclosed embodiments. It is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation. Therefore, while the embodiments herein have been described in terms of preferred embodiments, those skilled in the art will recognize that the embodiments herein can be practiced with modification within the spirit and scope of the embodiments as described herein.

Throughout this specification the word “comprise”, or variations such as “comprises” or “comprising”, will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

The use of the expression "at least" or "at least one" suggests the use of one or more elements or ingredients or quantities, as the use may be in the embodiment of the disclosure to achieve one or more of the desired objects or results.

Any discussion of documents, acts, materials, devices, articles or the like that has been included in this specification is solely for the purpose of providing a context for the disclosure. It is not to be taken as an admission that any or all of these matters form a part of the prior art base or were common general knowledge in the field relevant to the disclosure as it existed anywhere before the priority date of this application.

The numerical values mentioned for the various physical parameters, dimensions or quantities are only approximations and it is envisaged that the values higher/lower than the numerical values assigned to the parameters, dimensions or quantities fall within the scope of the disclosure, unless there is a statement in the specification specific to the contrary.

While considerable emphasis has been placed herein on the components and component parts of the preferred embodiments, it will be appreciated that many embodiments can be made and that many changes can be made in the preferred embodiments without departing from the principles of the disclosure. These and other changes in the preferred embodiment as well as other embodiments of the disclosure will be apparent to those skilled in the art from the disclosure herein, whereby it is to be distinctly understood that the foregoing descriptive matter is to be interpreted merely as illustrative of the disclosure and not as a limitation.

CLAIMS:

1. A system (100) for railway electrification having a grid (60) acting as a main power source and an auxiliary power source configured to feed said grid (60), said auxiliary power source comprising:

    - a plurality of wind turbines (30) sequentially arranged vertically at a pre-determined distance along each side of railway track (20), each of said wind turbines (30) is adapted to convert energy of slipstreams generated by a moving locomotive (10) passing on said railway track (20) into electrical power; and

    - at least one solar panel (36) mounted on an operative top of each of said wind turbines (30), said solar panel (36) configured to generate electrical power; and

    - an electrical unit (40) coupled to said wind turbines (30) and said solar panels (36) to receive electrical power from said wind turbines (30) and said solar panel (36), and further configured to facilitate unidirectional transmission of said electrical power to said grid (60).

2. The system (100) as claimed in claim 1, wherein said electrical unit (40) includes a coupling arrangement configured to provide electrical isolation between said auxiliary power source and said grid (60), and further configured to ensure unidirectional flow of electrical power from said auxiliary power source to said grid (60).

3. The system (100) as claimed in claim 1, wherein said electrical unit (40) is configured to condition said electrical power generated by each of said plurality of wind turbines (30) and said solar panels (36) to a usable form.

4. The system (100) as claimed in claim 3, wherein said electrical unit (40) is configured to condition the generated electrical power by performing power conversion, power amplification, and impedance matching.

5. The system (100) as claimed in claim 1, wherein each of said wind turbines (30) comprises a rotor and a generator configured to convert rotational energy of said wind turbine to said electrical power.

6. The system (100) as claimed in claim 1, wherein said plurality of wind turbines (30) is configured to rotate both in clockwise and anti-clockwise directions.

7. The system (100) as claimed in claim 1, wherein said system (100) includes a control unit configured to facilitate alteration of the height of each of said wind turbines (30) with respect to the ground, wherein said alteration is based on a set of pre-determined factors.

8. The system (100) as claimed in claim 7, wherein said set of predetermined factors is selected from the group consisting of speed, consistency, and direction of slipstream.

9. The system (100) as claimed in claim 1, wherein said plurality of wind turbines (30) is selected from the group consisting of a small helical wind turbine, a vertical axis wind turbine, a Counter-rotating wind turbine, a Giromill wind turbine, a Savonius wind turbine, a Darrieus wind turbine, and a Gorlov wind turbine.

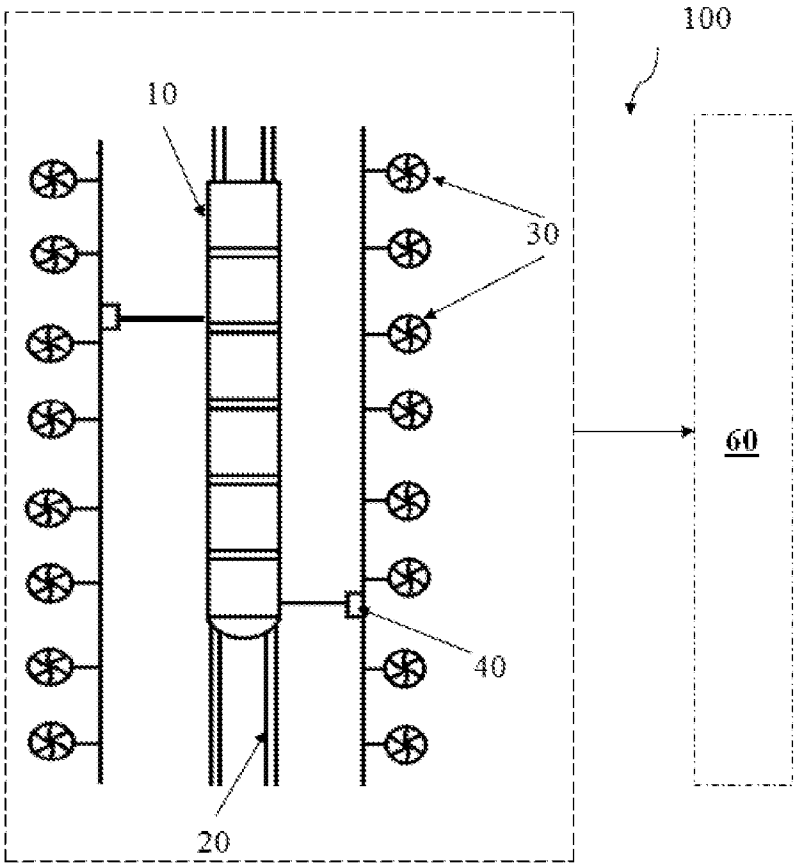


FIGURE 1

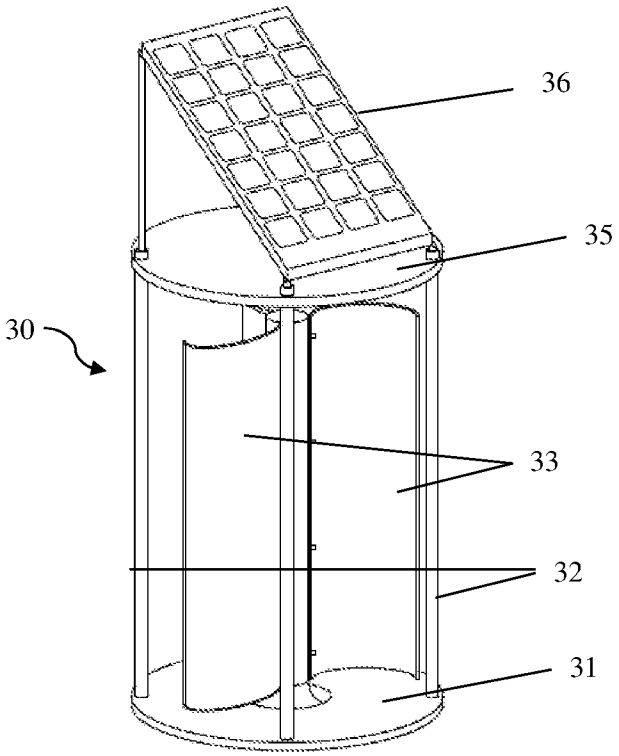


FIGURE 2

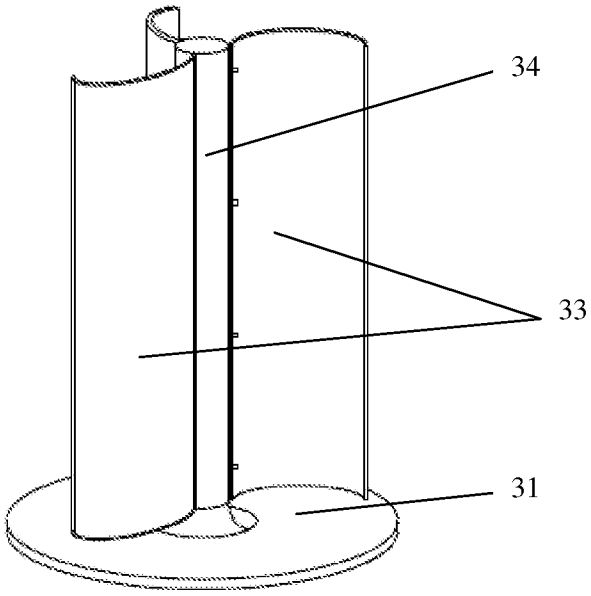


FIGURE 3

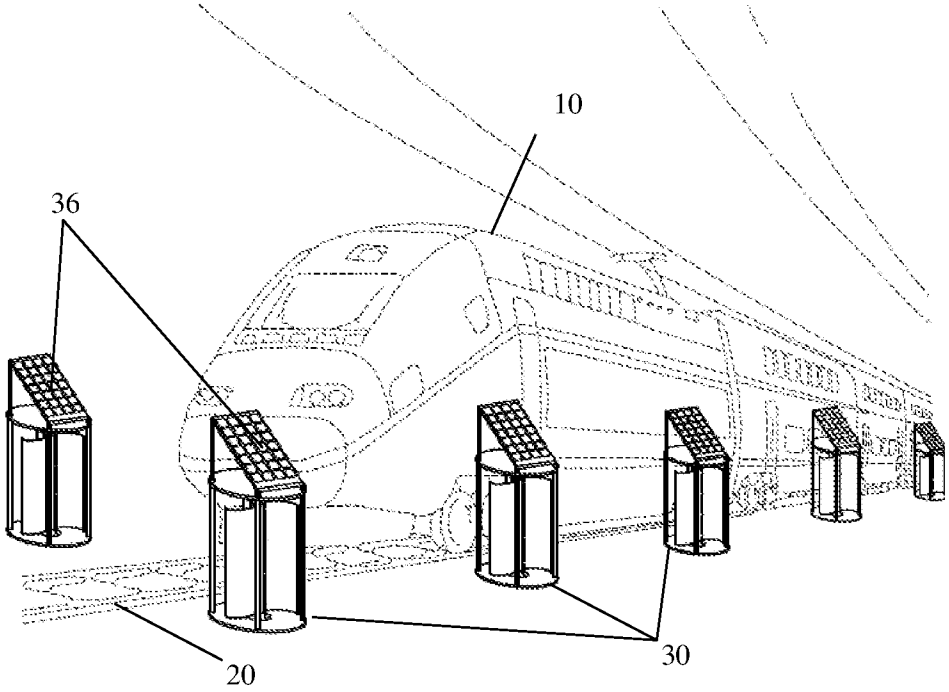


FIGURE 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2019/055664

A. CLASSIFICATION OF SUBJECT MATTER
F03D3/00,H02J15/00,F03D9/11 Version=2019.01

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)

F03D, H02J

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)

DATABASES: TotalPatent One, IPO Internal Database
KEYWORDS: WIND TURBINE, SOLAR PANEL, GRID, RENEWABLE ENERGY

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US9422922B2(ROBERT SANT'ANSELMO ET AL.) 23 AUGUST 2016 (23-08-2016) *Column 3, lines 29-33; column 36, lines 22-30; column 51, line 15 - column 52, line 2; figures 56, 133, 143C*	1-9
A	WO2009015907A2 (TURBO KING LTD) 05 FEBRUARY 2009 (05-02-2009) *Abstract; fig.4; Page 1, line 25- Page 2, line 4*	1-9

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"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
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21-10-2019	21-10-2019
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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Citation	Pub.Date	Family	Pub.Date
US 9422922 B2	23-08-2016	US 20170012464 A1	12-01-2017
WO 2009015907 A2	05-02-2009	GB 2451588 A	04-02-2009