159159
G00002

IN-GROUND IN-LINE ROAD WIND-TURBINE SYSTEM

FIELD OF INVENTION

The invention is in the field of renewable energy, in particular, capturing and converting wind energy created by the motion of motor vehicles to useful hydraulic and electrical energy.

BACKGROUND OF THE INVENTION & PRESENT STATE OF THE ART

Due to the threats of global warming, governments and organisations world-wide are looking into ways of tapping renewable energy sources like solar, wind, waves and geothermal in order to reduce carbon emissions and to obtain carbon credits.

One major source of wind energy is created by motor vehicles like cars, buses, trucks and trailers as they move along the roads and highways. Winds with average speed of one hundred (100) kilometers per hour are easily obtained near highways or major roads. Compared with natural wind and solar energy, this vehicle-created wind energy is more constant and available for longer periods of time in a day.

Also, in an urban area, capturing this wind energy and converting it into useful electrical or hydraulic energy would make a lot of sense as the useful electrical or hydraulic energy can then be fed back to the consumers and buildings nearby. This will reduce the need for large transmission networks to these urban areas.

Various attempts have been made to install wind-turbines as part of the transportation networks or landscape surrounding these networks. There are designs to incorporate wind-turbines as part of road safety barriers or road dividers, or along overhead bridges or gantries.

US patents 7547984 and 7525210 detail methods of installing and interconnecting wind-turbines near highways and road intersections. WO 2008/133872 details a method of installing wind-turbines at various coordinated heights and distances to maximise the capture of the wind energy. US patent application 12/360327 details a combination of fixed and mobile wind-turbines around roads.

However, all these current methods or systems of installing wind-turbines are not satisfactory as often these wind-turbines do not fit aesthetically with the transport networks and physical surroundings. Also, the amount of energy captured will be limited if these wind-turbines are installed at a distance away from the movement of the motor vehicles.

Therefore, there is a need for a simpler and more efficient way of capturing the wind energy created by the motion of the motor vehicles.

OBJECTS OF THE PRESENT INVENTION

It is an object of the present invention to create a simpler, more efficient and less-intrusive and less-obstructive system of capturing the wind energy created by the motion of motor vehicles on roads.

It is another object of the present invention to create an in-ground system of capturing wind energy using wind-turbines which are installed in-line with the direction of the travel of the motor vehicles.

It is also another object of the present invention to create an in-ground system of capturing wind energy which will hopefully result in the adoption of such a system as a standard feature for the construction of new roads and bridges or upgrading of existing ones.

It is yet another object of the present invention to create a modular in-ground system of capturing and converting wind energy which can be easily and safely operated and maintained without any major disruption to the movement of the motor vehicles on the roads or any danger to maintenance personnel.

It is also yet another object of the present invention to create an additional reliable source of renewable energy in the urban area surrounding the roads, resulting in a greener environment.

SUMMARY OF THE PRESENT INVENTION

This patent application is a follow-on of my earlier patent application titled "In-ground Road Wind-Turbine System". Under the present invention, at least one prefabricated duct is installed approximately flush with the road surface and approximately parallel (instead of perpendicular as in my earlier patent application) to the length of the road and direction of the travel of the motor vehicles (cars, buses, trucks, trailers).

Each duct has at least one grille mounted approximately flush with the road surface and approximately in the middle of each road lane such that wind created by the vehicle drag is forced into the duct through a row of grilles as the motor vehicles pass over or near the grilles, turning a row of wind-turbines installed inside the duct. The width of each grille can be as wide as one meter and the length as long as two meters, so that drivers of the motor vehicles can drive their motor vehicles over each grille without experiencing any change in the road condition.

The duct can be made of concrete or metal or a combination of both concrete and metal materials. The shape of the cross-sectional area of the duct is preferably rectangular or square (about 1.5 meters long and wide) though it can also be made circular. The length of each duct can be as long as twenty (20) meters and the multiple ducts can be laid in series to create a total length of all the ducts of up to one kilometer.

In the first embodiment, the rotor shaft of each wind-turbine is connected to a hydraulic pump and each pump is connected to a common hydraulic system which includes pressure accumulators, valves, regulators, hydraulic reservoirs and a

hydraulic motor which drives an electric generator to generate useful electrical energy. Control systems can be incorporated to regulate the electrical energy which can then be fed to nearby buildings or to the grid.

In a second embodiment, the rotor shaft of each wind-turbine is connected to an electric generator having its own regulatory and control means such that the electrical output of each electric generator can be connected to a common electrical distribution system for all the electric generators or directly to the electricity utility grid.

Average wind speeds of 80 km per hour can easily be achieved inside the ducts during traffic rush hours and depending on the length of the each duct (up to twenty meters) and the number of turbines and hydraulic pumps installed or electric generators (up to 15 sets), the renewable energy that can be recovered and converted to electrical energy can be up to sixty kilowatts per duct.

The entire system of ducts and active components is made modular such that each prefabricated duct can be pre-assembled (with the built-in grilles, wind-turbines, hydraulic pumps with the hydraulic system and electric generator or just the electric generator with the controls) and can then be easily inserted into a physical cut-out section of the road surface with minimal future need of opening the grilles and disrupting traffic flow on the roads. In the event of a need for maintenance of the equipment, only one lane of the road needs to be closed at any one time and the traffic diverted to another lane of the road. This will make the installation, operation and maintenance of this in-ground in-line wind-turbine system easier and safer.

BRIEF DESCRIPTION OF THE DRAWINGS

The advantages and objects of the present invention are summarized but not limited to the following drawings, the full scope of which are embodied in the appended claims of the present invention :-

FIG. 1 shows a sketch of the top plan view of the in-ground wind energy capturing system of the present invention on a two-lane road.

FIG. 2 shows a sketch of the front-elevation view of the present invention on a two-lane road.

FIGs. 3A and **3B** show the side cross-sectional elevation and top plan views respectively of an embodiment of the present invention.

FIG. 4 shows a simplified hydraulic schematic diagram of an embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS OF THE INVENTION

FIG. 1 shows a sketch of the top plan view of the in-ground wind energy capturing system **1** of the present invention installed on a two-lane road with the motor vehicles **2** (cars, trucks, buses and trailers) travelling in the direction **3**. The ducts **4** with the grilles **5** are installed flush with the road surface and running parallel to the direction of the travel of the motor vehicles **2**. A control panel **6** for the turbine systems (not shown) in both ducts **4** can be installed adjacent to the road behind the road safety barrier **7**. This will make the operation and maintenance of the turbine system and the ducts **4** safer. In the event that maintenance of the turbines and the ducts **4** on one lane of the road, the vehicles **2** travelling on that lane can be diverted to the other lane of the road.

The width of the duct **4** can be as wide as one meter such that the duct **4** which fits in between the wheels of the vehicles **2** and the drivers of the vehicles **2** will not feel a change in the road condition as the vehicles **2** move over the grilles **5**. The length of each duct **4** can be as long as twenty meters and additional ducts **4** can be installed in front-to-back in series to extend the total length of the installed ducts **4** to as long as one kilometer.

FIG. 2 shows a sketch of the front-elevation view of the present invention **8** on a two-lane road where the motor vehicles **9** travel on the road surface **10** over the grille **13** of the duct **11**, installed under each lane of the road surface **10**. Each duct **11** has a row of wind-turbines **12** installed under the grilles **13** such that the wind created by the drag of the vehicles **9** is pushed into the duct **11** through the grille **13** to turn the

wind-turbine **12** which then turns either a hydraulic pump or an electric generator **14** in the first and second embodiment of the present invention **8** respectively.

The hydraulic systems in the first embodiment or the electrical control systems in the second embodiment can be installed in the compartment **15** under the turbine **12** such that the duct **11** can be self-contained with the final output from the duct **11** being electrical energy or hydraulic energy which can then be fed through electrical cables or hydraulic pipes 17 to a control panel **16** installed behind the road safety barrier **18**. From the control panel **16**, the useful hydraulic or electrical energy can then be further regulated and transmitted to nearby buildings or utility grids (not shown).

FIGs. 3A and **3B** show the side cross-sectional elevation view **19** and top plan view **32** respectively of the first embodiment of the present invention incorporating a hydraulic system. In **FIG. 3A**, the duct **20** incorporates a row of wind-turbines **23** installed below the grilles **22** which are installed flush with the road surface **21**. When the vehicles (not shown) move in the direction **24**, the wind generated by the vehicle drag is forced into the duct **20** through the grilles **22**, turning the wind-turbines **23** in the anti-clockwise direction **25**. The axis of the rotation of the wind-turbine **23** is perpendicular to the direction of the wind and vehicle travel **24**.

Each wind-turbine **23** is attached to and turns a hydraulic pump **26** which is connected by pipes **27** to a hydraulic system **28** (consisting of valves, pressure accumulators, hydraulic reservoirs and control systems) which turns hydraulic motor **29** and electric generator **30** to generate electricity which is then transmitted from the duct **20** via electric cables (not shown). Each hydraulic pump **26** operates independently of each other. A drain **31** can be incorporated in the duct **20** to drain any water that had entered into the duct **20**.

The hydraulic system **28** of each duct can be connected to the hydraulic system **28** of another duct **20** to create an integrated and bigger system. The diameter of the wind-turbine **23** can be as long as one meter and the width of the blade of the wind-turbine **23** can be as wide as one meter. With an average speed of the wind at eighty kilometers per hour during traffic rush hours, the average power generated by each wind-turbine **23** can be as high as four kilowatts. The wind-turbine **23** can be of the Souvanis design. The average length of the duct **20** can be twenty meters and each duct can house at least fifteen wind-turbines **23** and hydraulic pumps **26**, resulting in a total power capacity output of up to sixty kilowatts per duct **20**. A person skilled in the trades of wind turbine and hydraulic system design will be able to construct this embodiment **19** of the present invention using standard parts and non-proprietary knowledge.

The entire duct **20** can be pre-fabricated with concrete and steel materials and installed quickly in a cut-out section of the road surface **21** with minimal disruption to the traffic flow. The active components like the wind-turbines **23**, hydraulic pumps **26**, hydraulic system **28**, hydraulic motor **29**, electric generator **30** and associated piping and valves can be pre-assembled inside the duct **20** prior to the installation of the duct **20**.

FIG. 3B shows the top plan view **32** of the first embodiment of the present invention incorporating a hydraulic system as described above in **FIG. 3A**. The duct **33** has wind-turbines **34** installed which turn in the direction **35** as the vehicles (not shown) travel over the grilles (not shown) and wind-turbines **34**. Each rotor shaft **36** of the wind-turbine **34** is attached to a hydraulic pump **37** which draws hydraulic oil from

hydraulic reservoir **39**. As the hydraulic pump **37** turns, hydraulic pressure is created and accumulated in the pressure accumulator **38** to drive hydraulic motor **40** and electric generator 41 to generate electricity which is then transmitted out of the duct **33** by electric cables (not shown).

FIG. 4 shows a simplified hydraulic schematic diagram **40** of an embodiment of the present invention. The wind turbines **41**, **42**, **43** turn the hydraulic pumps **44**, **45**, **46** respectively creating hydraulic pressure which is accumulated and stored inside pressure accumulator **47**. The pressurized hydraulic oil is then regulated by a control system (not shown) and drives hydraulic motor **48** which drives an electric generator **50** to generate electricity. The hydraulic oil with reduced pressure is then drained into a hydraulic reservoir **49** which is then sucked by the hydraulic pumps **44**, **45**, **46** to repeat the entire cycle again.

The size of the pressure accumulator **47** and hydraulic reservoir **49** can be sized according to the number of hours and period during which the electricity generated will be used. For example, the hydraulic pressure generated during the day-time can be reserved and used to drive the hydraulic motor **48** and electric generator **50** to generate electricity for street lighting during the night-time. This eliminates the need for batteries to store the electricity, making the hydraulic embodiment **40** of the present invention more environmentally-friendly.

In summary, it is possible through the present invention to create and install an in-ground in-line wind-turbine system (to capture and convert the wind energy created by vehicle drag) which is non-intrusive and easy and safe to install, operate and maintain. The present invention will achieve the objects of the invention as stated above.

The present invention does not contain any proprietary information or require any specialized skills to design and install. Any person skilled in the construction and engineering trades will be able to design and install the various embodiments of the present invention without any problems using standard parts and equipment.

CLAIMS:

What is claimed is:-

1. A system of capturing wind energy created by motor vehicles moving over a road surface and converting the said captured wind energy into useful hydraulic and electrical energy, comprising:-
   - a plurality of ducts whereby each said duct is installed approximately flush with the said road surface
   - whereby the longitudinal axis of each said duct is approximately parallel to the direction of the movement of the said motor vehicles along the said road surface
   - whereby each said duct has a row of grilles having constant pneumatic communication with the atmosphere above the said road surface
   - and whereby each said grille of each said duct is installed approximately flush with the said road surface
   - a row of wind-turbines installed inside each said duct and in constant pneumatic communication with the said grilles of the said duct and the said atmosphere above the said road surface
   - means to physically attach the rotor shaft of each said wind-turbine to a hydraulic pump which is then connected to a common hydraulic system
   - means to regulate the said common hydraulic system and operate at least one electric generator to generate electricity
   - means to regulate and transmit the said electricity.

2. The said wind energy capturing system in **Claim 1** whereby the said common hydraulic system include piping, valves, regulators, pressure accumulators, hydraulic reservoirs and hydraulic motors.

3. The said wind energy capturing system in **Claim 2** whereby the said common hydraulic system can either be installed entirely or partially inside the said duct.

4. The said wind energy capturing system in **Claim 3** whereby the said common hydraulic system of each said duct can be connected to the said common hydraulic system of the next said duct.

5. The said wind energy capturing system in **Claim 4** whereby the said duct can be prefabricated with concrete, metal or a combination of both concrete and metal materials.

6. The said wind energy capturing system in **Claim 5** whereby a water drain pipe can be incorporated into the said duct.

7. A system of capturing wind energy created by motor vehicles moving over a road surface and converting the said captured wind energy into useful electrical energy, comprising:-
   - a plurality of ducts whereby each said duct is installed approximately flush with the said road surface
   - whereby the longitudinal axis of each said duct is approximately parallel to the direction of the movement of the said motor vehicles along the said road surface

- whereby each said duct has a row of grilles having constant pneumatic communication with the atmosphere above the said road surface
- and whereby each said grille of each said duct is installed approximately flush with the said road surface
- a row of wind-turbines installed inside each said duct and in constant pneumatic communication with the said grilles of the said duct and the said atmosphere above the said road surface
- means to physically attach the rotor shaft of each said wind-turbine to an electric generator to generate electrical output
- means in each said electric generator to regulate the said electrical output such that the said electrical output from each said electric generator can be connected to a common set of electrical busbars or to the electricity utility grid.

8. The said wind energy capturing system in **Claim 7** whereby the said means to regulate the electrical output include electronic controls, inverters, diodes, resistors and programmable logic controllers.

9. The said wind energy capturing system in **Claim 8** whereby the said duct can be prefabricated with concrete, metal or a combination of both concrete and metal materials.

10. The said wind energy capturing system in **Claim 9** whereby a water drain pipe can be incorporated into the said duct.