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(54) **Title:** SURVEILLANCE AND WEATHER STATIONS ON OVERHEAD POWER LINES

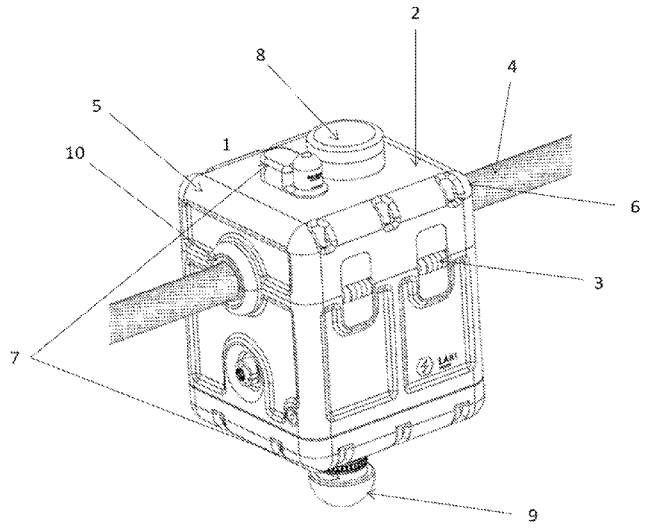


Fig. 1

(57) **Abstract:** The present invention relates to an apparatus method and a system for surveillance and obtaining meteorological and environmental data from different locations. The invention provides a surveillance or monitoring apparatus that can be a meteorological station, adapted to be clamped onto a phase wire of an overhead power line. The apparatus includes a power harvesting section for generating power by magnetic induction of the current transmitted by the phase wire and the obtained power is sufficient to run a plurality of sensors as well as cooling or heating means within the apparatus to ensure safe operating conditions within the apparatus in extreme outdoor temperatures. Furthermore, the apparatus and system of the invention provides a solution for weather forecast institutes and grid operators to predict weather and line conditions on a power grid.

WO 2022/097178 A1

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SURVEILLANCE AND WEATHER STATIONS ON OVERHEAD POWER LINES

Field of the invention

The invention relates to a method, a system and a device for obtaining and transmitting meteorological information from remote locations. Furthermore, the present invention provides a fully operational meteorological station to be mounted on a phase wire of overhead power lines.

Background

Meteorological measurements and weather forecasts based on such measurements are extremely important in modern society. Meteorological measurements from remote location can be crucial for critical infrastructure in such location, such as the power grid and telecommunication system. Such measurements can also be used to get a better coverage of measurements (a denser grid of measurements) that improves forecasts. The electric transmission and distribution system operators are highly dependent on access to local meteorological information for proper operation and maintenance of their power lines. Some climate factors may have major impact on the operation of electric grids which are based on overhead power lines, where warm climate affects the ampacity of overhead power lines and cold climate can cause ice aggregation on the lines with the associated damage to the power structure.

Operators of power grids control the power throughput of their power lines based on the type of conductors used in each section of their power grids. Previously, static line rating has been used to secure the operation of power grids and to prevent damages to the conductors used caused by overheating. However, static rating causes underutilization of power grids and their potential transmission capacity. In the last decades, a new method called Dynamic Line Rating (DLR), sometimes referred to as real-time thermal rating (RTTR), is becoming more widely used by grid operators. The use of DLR is intended to meet the ever-increasing demand for electric power by maximizing the transmission capacity of power grids without damaging the conductors by overheating or compromising the safety in the surroundings of the power lines due to excessive sag of the power line conductors. To be able to employ DLR effectively for the purpose of increasing the ampacity of the power lines, the operators are highly dependent on local meteorological data which

gives detailed information about the weather in the location of the power lines. This meteorological data can also be used for accurate ampacity and weather forecasts for the following days.

Ice aggregation on conductors and mast structures of overhead power lines is another problem for operators of power grids in cold climates and mountainous areas, which is monitored and maintained by sending a maintenance crew to the site for visual inspection.

Prior art solutions for installation of a meteorological station in remote areas has required erecting a high mast to be able to collect various weather data using measurement sensors and instruments in addition to finding a way for powering the whole weather station. Most often such meteorological stations are powered by diesel generators or fuel cells, whereas windmills and solar cells are often not an option due to severe weather conditions in many remote locations. Maintenance tasks such as costly fuel refills at regular intervals, often require specially equipped vehicles and manpower. These prior art meteorological stations have proven both unreliable and costly, leaving owners and operators of electric power grids hesitant when it comes to installing such metering structures.

Surveillance and problem diagnostics of high-voltage power lines can be done by devices extracting power directly from the power lines and thereby eliminating the need for more drastic measures like the building of small transformer station or by connection to external power sources, like batteries, solar cells or diesel generators. WO 2019/030781 discloses a power harvesting and surveillance device using one or several current transformers and associated rectification and power regulating circuitry to generate a direct current power output from the electromagnetic field generated by the alternating current passing through phase wires of high voltage power lines. Each current transformer section of the power harvesting and surveillance device consist of a core with a single secondary winding, a short-circuiting shunt, a rectification circuit, a smoothing capacitor, connected to a DC load that is common to other CT-Sections. The power regulation is achieved by dynamically applying shunts across the secondary windings of the current transformers. The shunts totally short-circuit the secondary windings of each current transformer one by one when needed, thereby controlling the power generation and eliminating heat generation across the shunt and minimizing magnetic flow in the current transformers.

Summary of the Invention

The present invention relates to surveillance devices, such as a meteorological station, adapted to be clamped onto a phase wire of high voltage power line, where the surveillance device generates all the energy it needs for its operation and does not need an external

power source. There are several challenging mechanical and electrical problems which need to be solved in order to successfully provide a functioning meteorological station that is clamped on to a phase wire of a high voltage power line. First of all, such meteorological station must be able to harvest enough power to successfully supply all sensors and other measuring devices, any necessary heaters and/or cooling devices as well as processing means and telecommunication devices with sufficient electricity. The present invention uses a power harvesting system for inductively powering the surveillance device by the electromagnetic field surrounding an alternate current carrying phase wire, which can provide sufficient power for a surveillance device such as a weather station. A typical weather station comprises at least six sensors: wind speed sensor, wind direction sensor, temperature sensor, ambient humidity sensor, barometric pressure sensor, and solar radiation sensor. All these sensors need to be essentially continuously operated, and an incorporated transmission device must be able to transmit by suitable means the collected data, preferably continuously as well. If such station is to be operated in hot climate, e.g. arid desert climate where outdoor temperatures can exceed 40°C, cooling means will typically need to be applied to prevent overheating and malfunctioning of the equipment. Similarly, if a station is operating in cold climate, heating may be necessary to guarantee proper functioning. These requirements call for substantial power needs.

The apparatus of the present invention has unique power harvesting capabilities, to provide for sufficient power to operate one, two, six or even more sensors, as well as for any included heating and/or cooling means. Depending on the type of overhead power line (the power and current being transmitted) that the station is installed on and the configuration of the apparatus, the generated output of the power harvesting section can be as high as 100W, 200W or even 300W, which is much more than is possible with any proposed functionally similar power harvesting devices. This quite high power output that can be provided continuously suffices to run simultaneously a plurality of sensors, thermoelectric cooling or heating device and a transmission device (e.g. Wifi or GPS).

Secondly, an exterior design is required for preventing corona discharge and associated radio interference voltage (RIV) at high voltage levels of the overhead line. The present invention provides a novel design of a housing for the new apparatus, such as specifically a meteorological station and all its components including the shape of the station housing, placement of sensors and measuring devices in and on the outside of the housing as well as special protection devices for preventing corona discharge in the form of a cap structure.

Furthermore, the meteorological station has to be able to endure considerable mechanical strain like continuous phase wire vibration, galloping and shocks. The present invention provides a housing and fastening means for the meteorological station, where material selection and manufacturing techniques provide an improved and strengthened housing to

withstand high-wind conditions, ice aggregation, vibrations, extreme temperatures and other eroding environmental factors.

The present invention provides an apparatus, a method and a system for performing surveillance and/or measuring tasks in locations with access to a power line. The surveillance and/or measuring tasks may comprise monitoring environmental and weather conditions, surveillance of conditions of conductors on a power grid, providing real-time data and data for forecasting of weather conditions and conductor conditions and performance on a power grid, and also in certain embodiments surveillance of communication of aircrafts for air-traffic controllers.

Accordingly, one aspect of the invention provides an apparatus for surveillance, event and/or weather or environmental monitoring, the apparatus comprising a housing adapted to be mounted on a phase wire of an overhead power line, a power harvesting section for generating power by magnetic induction of the current transmitted by the phase wire, a control and supervising section, an output section, and a plurality of sensing or measuring devices for obtaining meteorological and/or environmental data, wherein the apparatus, including said plurality of sensing or measuring devices, is solely powered by the power harvesting section.

The power harvesting section of the apparatus generates power by magnetic induction of the current transmitted through the phase wire on which the apparatus is installed on. In some embodiments, the power harvesting section of uses a power harvesting and regulation technology, where one or more current transformer section having its own a short-circuiting shunt, a rectification circuit, a smoothing capacitor, and are connected to a common DC load. In some embodiments the power harvesting section comprises a plurality of current transformer sections being connected in parallel. The power harvesting section of the surveillance device further operates with a shunting method which totally short-circuits the secondary winding of each current transformer when not needed, which terminates power harvesting of that transformer section and minimizes magnetic flow in the current transformer cores. Furthermore, the common load connected to the DC connection of each rectifier of the current transformer unit(s) in parallel provides a power harvesting system with cold regulation which makes it feasible to mount a surveillance device on high voltage power lines. The common load of the power harvesting system comprises the auxiliary devices which are powered by the power harvesting section of the apparatus.

The present invention provides a novel way of collecting various meteorological data or other data such as surveillance and environmental monitoring, using dedicated stations, including meteorological stations, mounted on the phase wire of an overhead power line.

According to some embodiments the apparatus (e.g. meteorological station) comprises a plurality of sensors and measurement devices to collect data on local weather conditions. A processing unit of the meteorological station receives and stores data from the plurality of sensors and measurement devices. A centralized control application can then communicate with one or more meteorological stations of the invention, collect data from them, and can optionally further process the data and store in a database.

In another aspect, the invention provides a system for monitoring weather and environmental conditions and/or data on conditions and status of the phase wire of an overhead power line, the system comprising an apparatus of the invention and an operational platform as further defined herein, for receiving data from the plurality of sensing or measuring devices.

In some embodiments the system of the present invention provides novel software solutions to process the meteorological data and either present the results on specialized workstations or transfers selected data to the EMS and SCADA systems of the grid operators, thereby providing operators of transmission and distribution grids with detailed meteorological information for management of the operation of a power grid. The data can be used for observing real-time line condition and ampacity as well as to make forecasts for line conditions and ampacity for the following days. Furthermore, consistent and accurate meteorological data collected by the meteorological station of the present invention can be used by the grid operators for maintenance purposes by the aid of machine learning (ML) and artificial intelligence (AI).

The apparatus of the present invention does not require an external power source, as it is powered by a power harvesting section harvesting electric energy from the electromagnetic field surrounding the phase wire on which the apparatus is mounted. The exterior of the apparatus is designed to prevent corona discharge and to withstand harsh weather conditions. This includes selection of material for the housing of the meteorological station, formation of the parts making up the housing and selection of the material used for securing the weather station on power lines.

The apparatus (e.g. meteorological station) comprises a housing (enclosure) for housing the power harvesting section, electronic components and internal auxiliary devices, such as sensors, any heating and cooling devices and communication devices and temperature regulators inside the housing. Some auxiliary devices of the apparatus may be located on the outside of the housing or connected to the apparatus. The main building parts of the enclosure body may be milled from high strength solid metal pieces, such as aluminium bars, for eliminating any need for welded joints on edges and corners of the parts. This design further eliminates damaging of the enclosure caused by long-time vibrations,

shocks and corrosion. Electronic circuit boards inside the apparatus may be coated with heavy lacquer liquid for preventing these components from being disconnected due to vibration and shocks. The components of the enclosure may be attached with heavy bolts to securely clamp the device onto the phase wire. In order to provide a secure and durable fastening of the device onto the power line phase wire, silicon rubber inserts with increased strength are preferably provided between enclosure and conductor, where the insert can endure conductor temperature ranging from -60° C to +230°C.

As overhead power lines are used to carry electricity over large areas, where access may be difficult part of the year and the distance for maintenance can be extensive, the apparatus of the present invention is designed to be used globally regardless of climate and weather extremes. In some embodiments, the surface of the enclosure is hard anodized to protect the device against both strong sun light and corrosive climate conditions like salinity.

In some embodiments the apparatus of the present invention comprises heaters to keep the wind measurement channel of the wind sensor within an optimal range and preferably at constant temperature even in extremely cold weathers. The apparatus of the present invention may further comprise a cooling mechanism and/or air ventilation in hot climate situations to ensure that sub-devices inside the unit and other heat sensitive components are kept at optimal temperature. In some embodiments the apparatus comprises thermoelectric cooling means, which are known as such in the art.

In geographic locations where ambient temperatures do not exceed e.g. 20° or 25°C in the summer time, cooling by a fan and ventilation openings(e.g. grating with suitable filter), thus a fan can supply air into or exhaust air from the enclosure. In other challenging geographic locations, the ambient temperature can rise to e.g. 50°C for a length of time, if the enclosure of the apparatus of the invention is exposed to sunlight at the same time, the heat inside the enclosure can reach even up to 90°C – 100°C. Circulating (hot) air from the outside by use of a fan and ventilation openings is not sufficient in such case to keep the components at an acceptable operating temperature. For such hot climates, the apparatus can suitably be equipped with thermoelectric cooling. To achieve this a 30 to 50W of DC power is typically required, so that efficient cooling can take place. In an embodiment, a number of Peltier modules are then pressed against the inside walls of the enclosures having the "hot side" pressed against them. Heatsinks with rims are then pressed against the "cold side" of the Peltier modules. Ventilation fans circulate air through the rims of the heatsinks thus cooling the electronic circuits inside. Part of the control circuitry of the device includes thermoelectric controller (TEC) to regulate the heat difference between the "hot plate" and the "cold plate". Such a setup is often called thermoelectric heat pump.

According to the Peltier principle, a Peltier element is able to transport heat using the Peltier effect. Inside the Peltier element the Peltier/Seebeck effect produces a temperature difference between two sides when a current is flowing.

Depending on the direction of the DC current flow it is possible to cool and heat with Peltier elements without changing the connectors or mechanical setup. Further advantages are that small designs can be realized and there are no moving parts. The current supplied to the Peltier element is controlled by a TEC controller. When DC power is applied to the Peltier modules they create temperature difference between the "hot plate" and the "cold plate". This temperature difference can be significant if the DC power needed is in place. For example, if the temperature difference created is 60°C, and the Peltier "hot side" is pressed firmly against the inside wall of the enclosure that is 90°C hot, then the temperature at the "cold side" would be 30°C. In other challenging geographic locations, the ambient temperature can very low, e.g. in the range between -20 to -40°C for a length of time. For such cold climates, a thermoelectric device as described can be operated for heating instead of cooling.

In some embodiments the system of the present invention comprises an application for calculating the ampacity of certain parts of an electric grid or certain stretches of power lines based on meteorological data, environmental factors, conductor type data and other information collected from sensors associated with the meteorological station of the present invention. The output of such an application can provide real-time information about the ampacity of the power line in question to operators. Furthermore, such an application can provide weather and ampacity forecasts for the coming hours or days based on the operator's selection. The processed data can be fed through machine learning (ML) and artificial intelligent (AI) processes for general weather forecasts as well as for future optimisation and increased accuracy of the DLR calculations and ampacity estimation. Such DLR calculations can be used for maximizing the transmission capacity of power grids without causing damages the power lines by overheating as well as ensuring the safety in the surrounding of the power lines.

In some embodiments the apparatus comprises one or more image sensor that can be equipped to take still images, video recordings and/or stream live image(s). Such image sensors can be useful as part of a monitoring system for surveying the status of the overhead line and/or as part of an environmental or meteorological monitoring system.

In a useful embodiment, the apparatus comprises sensors for collecting data for a wildfire early warning system. Such embodiment may comprise one or more thermal image sensor and/or one or more smoke detectors. Data collected can then be transmitted to a central data system that determines if an alarm is to be triggered, or such alarm may alternatively

be triggered by primary data analysis in the apparatus control section, and the alarm is then transmitted onwards.

In some embodiments the system of the present invention comprises an application for making calculations and estimation of ice aggregation in progress on power line conductors. Such an application uses meteorological data, environmental factors and other information collected from sensors associated with the meteorological station of the present invention. The output of such an application can provide grid operators a timely warning if action must be taken to prevent outages on a certain power line or to take measures for preventing damages to phase wires and mast structures. The processed data can be fed through machine learning (ML) and artificial intelligent (AI) processes for general weather forecasts as well as for future optimisation and increased accuracy of ice aggregation forecasts.

In some embodiments the system of the present invention comprises an application for notification of events and/or generating alarms when and if critical situation arises on a power grid or on power line conductors. The grid operators can set alarm levels based on location of the power line and in what manner such alarms are generated, such as through EMS and SCADA systems or by email or SMS.

One or more of the following embodiments alone or in combination contribute to solving the problems of providing a surveillance apparatus adapted to be clamped onto a phase wire of high voltage power line: a) the one or more sensing or measuring devices and other electrical components, such as cooling and heating devices are solely powered by the power harvesting section, b) the housing of the apparatus is adapted to shield the one or more sensing or measuring devices and to prevent initiation of electric discharge phenomena and the associated corona effect, and radio interference voltage (RIV), but this include rounding the corners and edges of the housing and providing a shielding structure for some sensors, c) a power harvesting section having a plurality current transformer units with their DC connections connected to a common load in parallel, and d) a hard ionized housing milled from high strength solid metal pieces.

The present invention provides a novel method and system of devices for surveillance of weather and environmental conditions by monitoring weather and environmental conditions in certain locations of a power grid, where the locations may be strategically selected to aid weather forecasts and optimise the performance of a power grid. The surveillance devices of the invention are clamped onto conductors of power lines to provide local meteorological or environmental data from different locations. Where the data is used to provide real-time conditions of locations on a power grid and to provide measurements

and data to prepare weather forecasts and forecasts for performance of individual lines on a power grid as a whole for the coming hours or days.

The device and method of the present invention is therefore suitable for remote locations where there is a power line, but no access to utility power from the grid, as the power harvesting section of the device transforms the electromagnetic field surrounding current carrying phase wire of high-voltage power line to a stable DC voltage power source for sensors and measurement devices in the surveillance apparatus.

It is an object of the present invention to overcome and/or ameliorate the aforementioned drawbacks of the prior art and to provide an improved and/or alternative and/or additional method and device for obtaining data on weather and environmental conditions using electrically self-sufficient surveillance devices clamped on a phase wire of a high-voltage power line. Moreover, it is a preferred object of the present invention to provide an meteorological station clamped on a phase wire of a high-voltage power line with a casing designed to shield or prevent sensing and measuring devices from initiating corona effect, radio interference voltage and other electric disturbances into the environment close to high-voltage power line the meteorological station is clamped on. Furthermore, it is one preferred object of the present invention is to provide a method and device for monitoring and forecasting weather and environmental conditions on location associated with a power grid. Another preferred object of the present invention is to provide a device and system to estimate line conditions and for management of operation and maintenance of a power grid. It is one preferred object of the present invention to provide a method and system to determine or estimate and generate forecasts for ampacity of the power lines and/or ice aggregation on a power line.

The object(s) underlying the present invention is (are) particularly solved by the features defined in the independent claims. The dependent claims relate to preferred embodiments of the present invention. Further additional and/or alternative aspects are discussed below.

An object of the present invention is solved by an apparatus for monitoring conditions of low voltage power lines, where the apparatus comprises i) a housing adapted to be mounted on overhead power lines, ii) a power harvesting section, a control and supervising section, iii) an electrical power output section, and iv) one or more monitoring devices, where the power harvesting section comprises at least one current transformer unit for powering monitoring devices of the apparatus.

The apparatus comprises a power output section, to provide power for all auxiliary devices (sensors etc.) that are housed inside or on the outside or surface of the weather station housing. Each power output preferably incorporates current measurement circuitry (measuring amperage) that a Power Management Controller can use to monitor total power

usage of the power outputs along with determining if there is a fault in one or more of the auxiliary devices.

Another preferred object of the present invention is solved by an apparatus for providing electricity to power mobile networks equipment, where the apparatus comprises i) a housing adapted to be mounted on power lines, ii) a power harvesting section, iii) a control and supervising section, iv) an electrical power output section and v) a power outlet, wherein the housing further comprises transmission cells for broadband cellular networks, wireless local area networks and/or narrowband networks.

Another preferred object of the present invention is solved by a system for monitoring environmental events, where the system comprises i) at least one docking and charging device, where the docking and charging device further comprises a) a housing adapted to be mounted on power lines, a power harvesting section, b) a control and supervising section, c) an electrical power output section and d) a power outlet, and the system further comprises ii) one or more external devices for monitoring environmental events, and iii) a remote data platform for receiving data from the one or more electronic devices, wherein the housing further comprises a docking and charging portion for external devices.

Another preferred object of the present invention is solved by an apparatus for monitoring weather and environmental conditions, where the apparatus comprises i) a housing adapted to be mounted on a phase wire of a high-voltage power line, ii) a power harvesting section, iii) a control and supervising section, vi) an output section, and v) one or more sensing or measuring devices for obtaining meteorological and/or environmental data, where the one or more sensing or measuring devices are solely powered by the power harvesting section.

Another preferred object of the present invention is solved by a system for monitoring weather and environmental conditions, where the system comprises i) one or more devices for monitoring weather and environmental conditions, where the device(s) further comprise: a) a housing adapted to be mounted on a phase wire of a high-voltage power line, b) a power harvesting section for supplying the meteorological station with electric DC power, c) one or more sensing or measuring devices for obtaining local meteorological or environmental data, d) a control and supervising section for power management of the system, and e) an output section for the one or more sensing or measuring devices, said output section further comprising a wireless communication module for communicating data on weather and environmental conditions, ii) operational platform for receiving and optionally analysing data from the one or more devices. The one or more sensing or measuring devices are solely powered by the power harvesting section. Furthermore, the

local meteorological or environmental data is processed and transmitted from the one or more devices to the operational platform.

Another preferred object of the present invention is solved by a method for monitoring weather and environmental conditions, where the method comprising the steps of:

a) providing one or more devices for monitoring weather and environmental conditions according to the present invention,
b) an operational platform for grid operators for receiving data from the meteorological station
c) obtaining local meteorological or environmental data at the location of the one or more devices for monitoring weather and environmental conditions
d) processing and transmitting the local meteorological or environmental data from the one or more devices to the operational platform to estimate line conditions and for management of operation and maintenance of a power grid.

One of the preferred objects of the present invention is solved by an apparatus for monitoring weather and environmental conditions, where apparatus comprises i) a housing, ii) a power harvesting section, iii) a control and supervising section, iv) an output section, and v) one or more sensing or measuring devices for obtaining local meteorological and/or environmental data. The housing is adapted to shield the one or more sensing or measuring devices and to prevent them from initiating electric discharge phenomena and the associated corona effect, and radio interference voltage (RIV) and other electric disturbances commonly present near conductors transmitting high voltage electricity.

Another preferred object of the present invention is solved by a system for optimizing operation of a power line or power grid, where the system comprises i) one or more devices for monitoring weather and environmental conditions, where the device(s) further comprise a) a housing adapted to be mounted on a phase wire of a high voltage power line, b) a power harvesting section, c) a control and supervising section, d) a power output section, and e) one or more sensing or measuring devices for obtaining local meteorological or environmental data, ii) operational platform for grid operators for receiving and optionally analysing data from the one or more devices. The local meteorological or environmental data is processed and transmitted from the one or more devices to the operational platform to estimate line conditions and for management of operation and maintenance of a power grid.

One of the preferred objects of the present invention is solved by a system for applying dynamic line rating control of power lines that transmit electricity at high voltages or a power grid, where the system comprises i) one or more devices for monitoring weather and environmental conditions, and where the device(s) further comprise a) a housing

adapted to be mounted on a conductor of a high voltage power line, b) a power harvesting section, c) a control and supervising section, d) an output section, and e) one or more sensing or measuring devices for obtaining local meteorological or environmental data, ii) operational platform for grid operators for receiving data from the meteorological station. The local meteorological or environmental data is processed and transmitted from the one or more devices for monitoring weather and environmental conditions to the operational platform for applying dynamic line rating control and ampacity forecasts of the conductors for maximizing the ampacity of individual power lines or power grids.

Another preferred object of the present invention is solved by a system for determining and/or estimating the ampacity of power lines, where the system comprises i) one or more devices for monitoring weather and environmental conditions according to the present invention, ii) an operational platform for grid operators for receiving data from the meteorological station, and where the local meteorological or environmental data is processed and transmitted from the device(s) to the operational platform to determine or estimate the ampacity of the power lines and generate ampacity forecasts for the days ahead.

One of the preferred objects of the present invention is solved by a system for determining and/or estimating ice aggregation on power lines, where the system comprises i) one or more devices for monitoring weather and environmental conditions according to the present invention, ii) an operational platform for grid operators for receiving data from the meteorological station, and where the local meteorological or environmental data is processed and transmitted from the device(s) to the operational platform to determine or estimate ice aggregation on a power line.

Another preferred object of the present invention is solved by an apparatus for monitoring weather and environmental conditions, where the apparatus comprises i) a housing adapted to be mounted on a phase wire of an underground conductor, ii) a power harvesting section, iii) a control and supervising section, iv) an output section, and v) one or more sensing or measuring devices for obtaining meteorological and/or environmental data. The one or more sensing or measuring devices are positioned above ground and connected to the power harvesting section, and the one or more sensing or measuring devices are solely powered by the power harvesting section.

One of the preferred objects of the present invention is solved by a system and method for monitoring air traffic and managing air traffic control, where the system or method comprises i) providing a surveillance terminal housing adapted to be mounted on a phase wire of a high voltage power line, where the surveillance terminal further comprises a) a power harvesting section, b) a control and supervising section, c) an output section, and

d)one or more detecting means for detecting ADS-B communication of aircrafts, where the one or more detecting means are solely powered by the power harvesting section.

Another preferred object of the present invention is solved by an apparatus for monitoring weather and environmental conditions, where the apparatus comprises i) a housing, ii) a power harvesting section, iii) a control and supervising section, iv) an output section, and v) one or more sensing or measuring devices for obtaining local meteorological and/or environmental data, where the housing is adapted to be mounted on a phase wire of a high-voltage power line.

In the present context the terms "surveillance device", "apparatus/device for monitoring weather and environmental conditions", "meteorological station" refer to a surveillance apparatus to be clamped on a conductor comprising housing with a power harvesting section and auxiliary devices, where all components requiring electricity are powered by the power harvesting section of the apparatus.

In the present context the term "Power Harvesting Section/Device/Unit (PHD)" refers to a device which transforms the electromagnetic field surrounding current carrying phase wire of high-voltage power line to a stable DC voltage power source.

In the present context the terms "overhead power line" "phase wire", "power transmission line" and "conductor" refer to segments of power structure intended to transmit electricity at low or high voltages as an overhead powerline. The operating voltage of overhead power transmission lines may range from low voltage lines with less than 1000 volts to ultra-high voltage overhead lines with voltage levels higher than 800 kV.

The apparatus and system of the present invention can function with an overhead power line falling into any of the above subcategories.

In the present context the term "auxiliary devices" refers to devices such as, but not limited to sensors, measurement devices, heating and cooling devices, telecommunication devices and other devise which require electricity in the surveillance apparatus.

In the present context the terms "operational platform" and "centralized control application" refers to a remote centralized software and data platform, or operational and management system for receiving data from remote surveillance devices. Preferably the operational platform comprises a back-end system for receiving data and transmitting control messages, and a user interface. Thus, the operational platform can collect the received data, store in a database and/or use for processing and analysis.

All embodiments listed below relate to both the apparatuses, system and the method of the present invention.

In an embodiment of the present invention the apparatus further comprises one or more detecting means for detecting ADS-B communication of aircrafts.

In an embodiment of the present invention the apparatus further comprises a telecommunication module for remote communication and control.

In an embodiment of the present invention the method further comprises a circuitry health check monitoring and reporting. The health check monitoring and reporting refers to the real-time monitoring and reporting of current and voltages levels in the electronic circuitry within the device, temperature and moisture/humidity within the device and the amperage and temperature of the conductor passing through the devices conductor channel. This does not refer to other measurements, such as environmental measurements like wind speed, wind direction, ambient temp and humidity, ambient light level, solar radiation, conductor tilt and roll, conductor vibration and gallop etc.

In an embodiment of the present invention the power harvesting section comprises one or more current transformer units, where each current transformer unit comprises i) a core configured to be located around an alternate current carrying conductor and one secondary winding arranged around each core, ii) an AC to DC rectifier, and iii) a shunting unit configured to totally short circuit the ends of each secondary winding, where the electrical power output of each current transformer unit is connected in parallel to form a common electric power output.

In an embodiment of the present invention the electric power output of each of the one or more current transformer units is independently connectable to common electric power output.

In an embodiment of the present invention the apparatus further comprises transmission cells for transmitting and receiving communications/data using standard protocols for networks such as, but not limited to, 3GPP based cellular networks such as GSM, UMTS, LTE, NB-IoT, LTE-M, EC-GSM-IoT and 5G-NR, wireless local area networks including IEEE 802.11, satellite networks, Wireless Personal Area Networks including IEEE 802.15 (e.g. Bluetooth, ZigBee, Z-Wave), Ethernet networks including IEEE 802.3 or other wired serial protocols e.g. RS232, RS485, I2C, SPI, Modbus.

In an embodiment of the present invention at least one of the sensors is an image sensor or camera and the data from the one or more electronic devices is image data.

In an embodiment of the present invention the remote data platform performs image analysis of image data provided by the one or more electronic devices that are either a part of the system or sent to/collected by the system from an external device.

In an embodiment of the present invention the images may be from ordinary cameras or thermal cameras, and wherein the image analysis is based on a single image, multiple images or videos taken by one or more camera devices.

In an embodiment of the present invention the remote data platform performs image analysis of image data to detect environmental events such as, but not limited to lightnings, electric flashovers, forest fires, corona effects, line icing, line sag and clearance, local weather, vegetation growth, proximity of trees and other plants to power line, traffic of people, vehicles, aircraft or animals, river or water flood events, line galloping and other line movements, and sudden or gradual corrosion of power lines or mast structures.

In an embodiment of the present invention the apparatus, including said plurality of sensing or measuring devices, is solely powered by the power harvesting section of the apparatus, and the apparatus is clamped onto an overhead powerline and is free of any connection to a mast structure or ground structures.

In an embodiment of the present invention the building components of the housing are milled from high strength solid metal pieces, such as aluminium.

In an embodiment of the present invention the building components of the housing are assembled together with heavy bolts to securely clamp the apparatus onto phase wire intended for transmitting electricity at high voltages.

In an embodiment of the present invention the corners and edges of the housing are rounded.

In an embodiment of the present invention the surface of the housing is hard anodized.

In an embodiment of the present invention the housing comprises an exterior shield to partially cover one of the sensors or measuring devices.

In an embodiment of the present invention the exterior shield is cap adapted to be placed on a sensor, such as a wind sensor.

In an embodiment of the present invention the exterior shield is adapted to be placed on a sensor on the surface of the housing below the phase wire.

In an embodiment of the present invention the apparatus further comprises a connector for an external sensor or device that can subsequently be installed on the phase wire without being a part of the apparatus itself, such as a load cell, charging device and/or communications system.

In an embodiment of the present invention the apparatus further comprises heaters to keep components of the unit and sensors within range of their operating temperatures, such as the wind measurement channel of the wind sensor, at optimal operating temperatures.

In an embodiment of the present invention the apparatus further comprises a cooling mechanism like thermoelectric heat pump and preferably also air ventilation to keep components of the unit and sensors within range of their optimal operating temperatures, such as cooling fans for central processing units (CPUs).

In an embodiment of the present invention the apparatus further comprises an antenna for wireless telecommunication, mobile networks, satellite networks, Wi-Fi, Bluetooth and the Global Positioning System (GPS).

In an embodiment of the present invention the power harvesting section comprises i) at least one current transformer unit, ii) a DC/DC regulation module, and iii) a charging control.

In an embodiment of the present invention the power harvesting section comprises one or more current transformer units, where each current transformer unit comprises: i) a core configured to be located around a primary wire, ii) one secondary winding arranged around each of the at least core, wherein each secondary winding has a first end and a second end, iii) a rectifier configured to convert an alternating current to a direct current, wherein the rectifier comprises two AC connections for alternating current and two DC connections for direct current, wherein the first end and the second end of the secondary winding are connected to the AC connections of the rectifier, and iv) a current shunt arranged and configured to totally short the ends of the secondary winding, wherein a common load is connected to the DC connection of the current transformer unit, and wherein the DC connection of the rectifier of the current transformer unit is connected to the common load in parallel.

In an embodiment of the present invention the power harvesting section comprises a plurality current transformer units. In such an embodiment, the rectifiers that are connected to the load are connected in parallel and for each current shunt, a shunt controller unit for controlling the state of the respective shunting unit. Furthermore, each shunt controller unit comprises a voltage level state input and is configured to control the state of the respective shunt unit in dependence of the voltage level state input, where each voltage level state input is based on a voltage across the load and where each shunt controller unit may comprise a clock input where each controller unit is configured to only change a state of the respective shunt unit in dependence of the clock input. Furthermore, in such an embodiment, the system further comprises a zero-crossing detection element

for detecting zero crossing states of a sensed current and a system control unit, where the system control unit is configured to generate the voltage level state inputs for each shunt controller unit based on the voltage across the load.

In an embodiment of the present invention each rectifier comprises a plurality of MOSFETs, such as at least 4 MOSFETs.

In an embodiment of the present invention each current shunt comprises a plurality of MOSFETs, such as at least 2 MOSFETs.

In an embodiment of the present invention the control and supervising section further comprises i) at least a primary controller, ii) a power management controller, and iii) a measurement and data acquisition module.

In an embodiment of the present invention the output section further comprises power outputs for the one or more sensing or measuring devices and a wireless telecommunication module.

In an embodiment of the present invention the one or more of the sensors and or measuring devices are positioned near the centre of one side of the housing, such as the bottom side of the housing, i.e. the side facing away from the conductor.

In an embodiment of the present invention the one or more of the sensors and or measuring devices are selected from, but not limited to; wind sensor(s), ambient temperature sensor(s), ambient humidity sensor(s), accelerometer/inclinometer, salinity sensor(s), solar radiation sensor, thermal radiometry sensor, conductor temperature sensor (i.e. thermometer for phase wire), line current sensor, line to ground voltage sensor, vibration sensor, conductor, tension meter, load cell circuitry and connector for phase wire tension measurement, phase wire sag sensor Phase wire clearance sensor, Light Detection And Ranging (LiDAR) sensor), Automatic Dependent Surveillance–Broadcast (ADS-B) sensor, GPS sensor, and Real-Time Kinematic (RTK) sensor.

In an embodiment of the present invention the system or method further comprises using the data on local weather and environmental conditions to provide weather forecast data.

In an embodiment of the present invention the system or method further comprises using the data on local weather and environmental conditions to correct and/or provide improved accuracy of live weather report or weather forecasts of a location, such as a location near the meteorological station or on the same grid and for example to provide weather forecasts and/or improve accuracy of weather forecasts from external parties such as official weather institutes.

In an embodiment of the present invention the system or method further comprises using the data on local weather and environmental conditions to provide forecasts for local weather and environmental conditions for power grid operators.

In an embodiment of the present invention the data on local weather and environmental conditions are used to provide estimates of thermal capacity and forecasts of ampacity for power grid operators.

In an embodiment of the present invention the data on local weather and environmental conditions are used for the purposes of Dynamic Line Rating operation of a power grid.

In an embodiment of the present invention the data on local weather and environmental conditions are used to provide ice aggregation forecast or forecast line icing conditions on power line conductors on a power grid.

In an embodiment of the present invention the data on local weather and environmental conditions are used to notify of events or generate alarm signals in energy management systems, such as EMS or SCADA , and/or by the aid of SMS and/or email message and/or by the aid of specialized mobile app.

In an embodiment of the present invention the data on local weather and environmental conditions is fed through machine learning (ML) and artificial intelligent (AI) processes.

In an embodiment of the present invention the data on local weather and environmental conditions is fed through machine learning (ML) and artificial intelligent (AI) processes for optimization of the operations of the power grid, including increased accuracy of Dynamic Line Rating calculations, line icing forecasts and weather forecasts.

In an embodiment of the present invention the system or method further comprises a database for storing the data on local weather and environmental conditions and data on phase wire conditions for future forecast of weather and line conditions.

In an embodiment of the present invention the operational platform is a part of an Energy Management System (EMS) and/or Supervisory Control And Data Acquisition (SCADA) system.

In an embodiment of the present invention the operational platform is a software and data platform.

In an embodiment of the present invention the applying dynamic line rating control of the power lines includes obtaining local data on one or more of i) the temperature of the

conductor, ii) wind speed, iii) wind direction, iv) overcast (cloud cover), v) ambient temperature, vi) humidity, vii) vibration frequency, and viii) solar radiation.

In an embodiment of the present invention the temperature, sag, clearance and/or conductor current of the phase wire is determined using one or more of i) a wind sensor, ii) an ambient temperature sensor, iii) a humidity sensor, vi) a solar radiation sensor, v) an accelerometer/inclinometer, vi) a vibration sensor, vii) a conductor temperature sensor, viii), a thermal radiometry sensor, and ix) a conductor current sensor.

In an embodiment of the present invention the temperature of the phase wire is determined using one or more of i) an accelerometer/inclinometer, a thermal radiation sensor such as a high accuracy thermal radiation camera.

In an embodiment of the present invention data on present or estimated ice aggregation is used to determine line conditions and for management of operation and maintenance of a power grid.

In an embodiment of the present invention data on present or estimated ice aggregation is used for maximizing the operational safety of power grids

In an embodiment of the present invention present or estimated ice aggregation is determined by obtaining local data on one or more of; i) the temperature of the phase wire, ii) wind speed, iii) wind direction, iv) ambient temperature and humidity, and v) images of the conductor, such as photos or video images.

In an embodiment of the present invention data on the one or more sensing or measuring devices are solely powered by the power harvesting section.

In embodiments using a plurality of current transformers, all the current transformers and their participation in the power generation may be regulated in the same manner, that is they may be totally shunted one by one in sequential order. The power control circuitry comprises an autonomous analogue circuitry, commonly powered by the secondary windings.

Description of various embodiments

The present invention will become more fully understood from the detailed description given hereinafter and the accompanying drawings which are given by way of illustration only, and thus, are not limitative of the present invention, and wherein:

FIG. 1 is an overview of the apparatus of the present invention.

FIG. 2 outlines sensors and measuring devices on a meteorological station of the present invention.

FIG. 3 is diagram of a current transformer unit of the present invention.

FIG. 4 is a diagram of a power harvesting section for the apparatus of the invention employing six current transformer units.

FIG. 5 is an overview of the apparatus and the various components of its units and components.

FIG. 6 shows an embodiment of the operational platform (remote platform) of the system of the invention.

Figure 1 shows the apparatus 1 for monitoring weather and environmental conditions mounted on a conductor 4 of a high-voltage power line. The figure shows a housing 2 which is clamped on a phase wire by means of hinges 3 for opening and closing the housing during mounting and dismounting on and off the phase wire 4. Furthermore, isolating inserts 10 are arranged between housing and phase wire 4 to secure durable fastening onto the power line and to isolate the metal material of the housing 2 from the phase wire 4. The housing is designed for preventing corona discharge and associated radio influence voltage which can occur on a phase wire, such that the edges 5 and corners 6 of the housing 2 are rounded. Some of the sensors and measuring devices 7 are mounted on/in the housing as well as a communication antenna 8. The drawing further shows an anti-corona cap structure 9 for preventing measuring device 7 from generating corona effect.

Figure 2 indicates sensors and measuring devices arranged on/in the housing. Fig. 2A shows a GPS/mobile antenna 8 arranged on the top of the housing as well as a solar radiation sensor 11. A wind speed sensor 12 is mounted on the bottom of the housing, where the wind sensor 12 has anti-corona cap structure 9. The figure further shows a salinity sensor 13 and a connector for an external load cell 14 on one side of the housing. In Fig. 2B the bottom panel of the housing is shown. The wind sensor 12 is positioned in the centre of the bottom panel with a sensor(s) for ambient temperature, humidity 15 and barometric pressure in a cavity 16 of the housing panel.

Figure 3 outlines an embodiment of the power harvesting section of the device of the present invention for extracting power from electrical conductors 4 having one current transformer unit 20, which is not shunted. The current transformer unit comprises one core 21 configured to be located around a primary wire 4, one secondary winding 22 is arranged around the core 21. The secondary winding 22 has a first end and a second end, a rectifier 23 configured to convert an alternating current to a direct current, wherein the

rectifier comprises two AC connections for alternating current and two DC connections for direct current, wherein the first end and the second end of the secondary winding 22 are connected to the AC connections of the rectifier 23 and a load 24 is connected to the DC connection of each rectifier 23. The load in the drawing is shown as a BURDEN component it the circuitry but is in fact the common load of components and auxiliary devices in the apparatus powered by the power harvesting section. The secondary winding 22 is connected to the rectifier 23 through a current shunt 25 arranged and configured to totally short circuit the ends of the secondary winding when needed. The power harvesting section further comprises a zero-crossing detection section 26, which is connected in series to the current transformer unit 20. A shunting unit 32 is configured to shunt the device circuit in such a way that no current runs through the rectifier to the load, i.e. total short circuiting shunting such that no voltage is generated across the rectification circuit (cold regulation). The current shunt 25 preferably comprises MOSFET- transistors which completely short circuits the secondary winding of the current transformer unit and thereby eliminates power losses and heat generation in power regulation circuit.

As the power harvesting section is used to power components of a surveillance device, such as the meteorological station of the present invention, on high voltage power line, the transformer core 21 is placed around the phase wire 4 to induce current in the secondary winding 22, which is wound around the core 21. The induced AC current is rectified from AC power to DC power and fed to the common DC load 24 of the DC power output, i.e. the devices powered by the power harvesting section, such as the control circuitry, sensors and communication devices. In case the voltage across the system becomes too high, the shunting unit 32 shunts the secondary winding of each individual current transformer unit 20 when needed, in the zero-crossing of the AC current detected by the zero-crossing detection 26. The shunting and rectification circuitry of the power harvesting section is shown in the lower part of the diagram of Fig. 3, where the zero-crossing component 26 is connected in series to the current transformer unit 20. A DC voltage component 27 serves as a voltage level detection input for controlling operation of current shunts 25 and is configured along with state latch 28 to dynamically turn the current shunts 25 on and off when needed. An optically isolated MOSFET driver 29 along with blocking transistor pair of the current shunts 25 provide the shunting mechanism and both the optically isolated MOSFET driver 29 and the current shunt 25 preferably comprise MOSFET transistors.

Figure 4 shows an embodiment of a power harvesting section with six current transformer units 20a – 20f for a combined inductive power extraction from an AC power line. One secondary winding 22a has the zero-crossing component circuitry connected to it, but otherwise is not different from the additional secondary windings 20b-f. All of the secondary windings 22, share a single common DC load 24, since it is placed on the DC

side of the circuit. Each secondary winding 22, 22a comprises its own shunting unit 32 (depicted in the figure as the current shunt 25 and the optically isolated MOSFET driver 29), so that each of the windings can be dynamically and independently shunted when needed and therefore totally short circuited for precise regulation of overall power extraction. That is, each secondary winding may comprise a current shunt 25 and a shunt controller unit 33 comprising state latch 28 and the optically isolated MOSFET driver 29. All of the secondary windings can also provide power for the basic electronic power regulation circuitry (i.e. the analog and control logic 31, the zero-crossing detection 26 etc.) and for any sensors or devices implemented as a part of the power extraction device. The DC sides of the rectifiers of the current transformer units are connected to the common DC load 24, such as the power inputs of the sensing and measuring devices to be powered. The DC outputs of the current transformer units are connected in parallel, therefore the DC outputs are added to one another. Thus, the overall summed DC power output at the common DC load 24, may be the sum of the (hypothetical) DC power outputs of each current transformer unit. Smoothing capacitors 30 have the purpose of smoothing the AC ripple in the DC power output.

Figure 5 shows a block diagram for the power management and communication systems of the apparatus of the present invention. The figure shows a power harvesting section 100, a control and supervisory system 200 and a distributing and communicating system 300 in an embodiment of meteorological station. The Power Management Controller (PMC) 220 controls and supervises the Power Harvesting Section (PHS) 100. The PMC also controls the high side MOSFET circuitry that switches 12 volts , 5 volts, 3.3 volts and 1.8 volts DC to external devices connected to the system.

Each power output preferably incorporates current measurement circuitry (measuring amperage) that the Power Management Controller can use to monitor total power usage of the power outputs along with determining if there is a fault in one or more of the auxiliary devices. This is a part of the "the health check monitoring function", that along with an array of temperature and voltage level measurements throughout the electronic circuitry of the device generate alarms if fault or abnormal function within is detected.

Based on the Health Check Monitoring Function, the device automatically turns the power outputs on or off for protecting the measurement data integrity and to ensure correct function of the weather station. This unique feature allows for auxiliary device fault analytic capability, using stored "health" parameters that are programmed into non-volatile memory before the weather station is shipped to the customer.

The power outputs can be remotely re-configured to supply e.g. 48VDC, 24VDC, 12VDC, 5VDC and 3.3VDC, depending on the type of the auxiliary devices and power requirements.

Those voltage levels can suitably be pre-configured before weather stations are shipped to customers. If the customer needs to include his own device in the weather station enclosure, a device needing certain voltage level, the voltage and power output levels can be remotely re-configured and stored in non-volatile memory.

Preferably, the main properties of the Power Management Controller and the Power Output Section (300) are the following:

- Provides power for auxiliary devices needing 48VDC, 24VDC, 12VDC, 5VDC or 3.3VDC.

- Provides precise measurement of amperage drawn by each of the auxiliary device for fault analytic purposes performed by the Power Management Controller

- Provides power to fans for air-ventilation cooling purposes.

- Provides power to thermoelectric coolers that dispose heat from the inside of the weather station enclosure to the outside environment were air-ventilation cooling does not work effectively. This applies to weather stations located in geographical locations where the ambient temperature can reach 45°C and air-ventilation technics would not work properly.

The Primary Controller (PC) 210 communicates with the PMC 220 over a serial communication link and collects measurement data, e.g. current, voltage and temperature values, time stamps them and stores in non-volatile memory for later collection and use. The PC 210 also reads measurement data from the auxiliary circuits 230 of the system and stores in non-volatile memory or sends through a mobile communication device 310 and network to remote centre. The wireless network module 310 is further adapted to wirelessly communicate with control centre and/or devices outside of the system.

The figure further shows detailed interaction of different modules and circuits within the system. The PHS 100, comprising the power harvesting module 110, the DC/DC regulation module 120, the charging control module 130 and the reserve battery system 140, communicates with the power management controller 220 which controls among other things the distribution of DC power through the power output section 320 having power outputs for the sensing or measuring devices and a wireless telecommunication module.

As mentioned above, the total power output of the apparatus can readily be 200 or 300W. This will depend on the current flowing in the phase wire that the apparatus is mounted on, for example, if the current is 200A the power harvesting section in a present preferred embodiment will deliver up to 100W of power, at 400A current the power harvesting section delivers 200W of DC power, at 600A current the power harvesting section delivers 300W and at 800A the power harvesting section can deliver 400W.

The auxiliary circuits of the device in the embodiment of Fig. 5 are real time clock 231 for measurement time stamping, FRAM 232 for measurement data storage, accelerator sensor 233 for tilt and incline measurements, temperature sensors 234 for monitoring temperature within the apparatus, load cell amplifier 235 for use with external tension load cell, wind sensor 236, ambient temperature and humidity sensors 237 and solar radiation sensor 238.

Fig. 6 illustrates an example of an operational platform of the system of the invention. An apparatus 1 is remotely located on an overhead line (not shown), the figure depicts the MCU 600 (microcontroller unit) of the apparatus and two sensors are represented, here as two cameras 601, 602. The MCU of the apparatus communicates preferably via internet 603 using safe protocols. The operational platform shows on hand a power server application 610, that handles interaction with the apparatus, data collect ion, data processing and reporting, and a user interface (UI) 611 for user interaction (presenting data, status information etc. and for receiving user input for control functions, data handling etc.

As used herein, including in the claims, singular forms of terms are to be construed as also including the plural form and vice versa, unless the context indicates otherwise. Thus, it should be noted that as used herein, the singular forms "a," "an," and "the" include plural references unless the context clearly dictates otherwise.

Throughout the description and claims, the terms "comprise", "including", "having", and "contain" and their variations should be understood as meaning "including but not limited to", and are not intended to exclude other components.

The present invention also covers the exact terms, features, values and ranges etc. in case these terms, features, values and ranges etc. are used in conjunction with terms such as about, around, generally, substantially, essentially, at least etc. (i.e., "about 3" shall also cover exactly 3 or "substantially constant" shall also cover exactly constant).

The term "at least one" should be understood as meaning "one or more", and therefore includes both embodiments that include one or multiple components. Furthermore, dependent claims that refer to independent claims that describe features with "at least one" have the same meaning, both when the feature is referred to as "the" and "the at least one".

Use of exemplary language, such as "for instance", "such as", "for example" and the like, is merely intended to better illustrate the invention and does not indicate a limitation on the scope of the invention unless so claimed. Any steps described in the specification may

be performed in any order or simultaneously, unless the context clearly indicates otherwise.

All of the features and/or steps disclosed in the specification can be combined in any combination, except for combinations where at least some of the features and/or steps are mutually exclusive. In particular, preferred features of the invention are applicable to all aspects of the invention and may be used in any combination.

Claims

1. An apparatus for surveillance, event and/or weather or environmental monitoring, said apparatus comprising:
   - a housing adapted to be mounted on a phase wire of an overhead power line,
   - a power harvesting section for generating power by magnetic induction of the current transmitted by the phase wire,
   - a control and supervising section,
   - an output section, and
   - a plurality of sensing or measuring devices for obtaining meteorological and/or environmental data,

   wherein the apparatus, including said plurality of sensing or measuring devices, is solely powered by the power harvesting section.

2. The apparatus according to claim 1 or 2, wherein said output section is able to continuously transmit data from one or more of said plurality of sensing or measuring devices.

3. The apparatus according to claim 1, further comprising heating and/or cooling means.

4. The apparatus according to claim 3, comprising one or more cooling means powered with power generated by said power harvesting section, selected from a thermoelectric cooling device and a cooling fan and optionally comprising ventilation on said housing.

5. The apparatus according to claim 3, comprising thermoelectric heating means.

6. The apparatus according to any of the preceding claims, wherein said power harvesting station can generate at least 100W output and preferably at least 200W output and more preferably at least 300W output.

7. The apparatus according to claim 1, wherein the corners and edges of the housing are rounded.

8. The apparatus according to claim 1, wherein the housing is adapted to shield one or more of the plurality of sensing or measuring devices and to prevent them from initiating electric discharge phenomena and the associated corona effect and/or radio interference voltage (RIV).

9. The apparatus according to claim 1, wherein the housing comprises an exterior shield to partially cover at least one of the sensors or measuring devices which is exterior of the housing.

10. The apparatus according to claim 9, wherein the exterior shield is a cap adapted to be placed on a sensor, such as a wind sensor.

11. The apparatus according to claim 9, wherein the exterior shielding cap is adapted to be placed on a sensor that extends from a bottom surface of the housing below the phase wire.

12. The apparatus according to claim 1, wherein the apparatus further comprises sensing or measuring devices for obtaining data on conditions and status of the phase wire of the overhead power line.

13. The apparatus according to claims 1 -12, wherein the one or more of the sensors and or measuring devices are selected from:
    - wind speed sensor,
    - wind direction sensor,
    - ambient temperature sensor,
    - ambient humidity sensor,
    - accelerometer/inclinometer,
    - salinity sensor,
    - solar radiation sensor,
    - thermal radiometry sensor,
    - conductor temperature sensor,
    - image sensor,
    - thermal image sensor,
    - smoke detector,
    - line current sensor,
    - line to ground voltage sensor,
    - vibration sensor, conductor,
    - conductor tension meter,
    - load cell circuitry and connector for conductor tension measurement,
    - conductor sag sensor,
    - conductor clearance sensor,
    - Light Detection And Ranging (LiDAR) sensor),
    - Automatic Dependent Surveillance–Broadcast (ADS-B) sensor,
    - GPS sensor, and
    - Real-Time Kinematic (RTK) Base station.

14. The apparatus according to claim 13, which is a weather station comprising at least the following sensors and measuring devices: wind speed sensor, wind direction sensor, temperature sensor, ambient humidity sensor, barometric pressure sensor, and solar radiation sensor.

15. The apparatus according to claim 13, comprising one or more sensor to collect data for a wildfire early warning system.

16. The apparatus according to any of claims 1-14, wherein the building components of the housing are milled from high strength solid metal bars, such as aluminium.

17. The apparatus according to any of claims 1-15, wherein the building components of the housing are assembled together with bolts and configured to securely clamp the apparatus onto said phase wire of said overhead power line.

18. The apparatus according to any of claims 1-16, wherein the surface of the housing is hard anodized.

19. A system for monitoring weather and environmental conditions and/or data on conditions and status of the phase wire of an overhead power line, said system comprising one or more apparatus according to any of claims 1 to 18 and an operational platform for receiving and processing data from the plurality of sensing or measuring devices.

20. The system according to claim 19, wherein data on the current status of power lines and environmental data is processed and transmitted from the one or more apparatus to the operational platform to determine or estimate ice aggregation on the power line.

21. The system according to claim 19, wherein the data on weather and environmental conditions and/or data on conditions and status of the phase wire of the high-voltage power line is used to notify of events or generate alarm signals in energy management systems, such as EMS or SCADA, and/or by the aid of SMS and/or email message and/or by the aid of specialized mobile app.

22. The system according to claim 19, wherein the data on weather and environmental conditions and/or data on conditions and status of the phase wire of a high-voltage power line is fed through machine learning (ML) and artificial intelligent (AI) processes.

23. The system according to claim 19, wherein the data on weather and environmental conditions and/or data on conditions and status of the phase wire of a high-voltage

power line is fed through machine learning (ML) and artificial intelligent (AI) processes for optimization and increased accuracy of future DLR calculations, ice aggregation forecasts "general" weather forecasts.

24. The system according to any of claims 19 to 23, further comprising a database for storing the data on weather and environmental conditions and/or data on conditions and status of the phase wire of a high-voltage power line for future forecast of weather and line conditions.

25. A method for monitoring weather and environmental conditions and/or conditions and status of a phase wire of an overhead power line, said method comprising the steps of:

a) providing one or more apparatus according to any of claims 1 - 18,

b) obtaining data on weather and environmental conditions and/or data on conditions and status of the phase wire of the high-voltage power line at the location of the one or more apparatus

c) transmitting said data to a remote operational platform or remote control station to estimate line conditions and for management of operation and maintenance of a power grid.

26. The method according to claim 25, comprising processing said data to estimate line conditions and for management of operation and maintenance of a power grid.

27. The method according to claim 25 or 26, comprising determining or estimating the ampacity of the overhead power line.

28. The method according to any of claims 25 to 27, comprising using acquired data to facilitate Dynamic Line Rating of a power grid of the overhead line.

29. The method according to any of claims 25 to 28, wherein the method further comprises using the data on weather and environmental conditions to provide weather forecast data.

30. The method according to any of claim 25 to 29, wherein the method further comprises using the data on weather and environmental conditions to correct and/or provide improved accuracy of live weather report of a location near the meteorological station.

31. The method according to any of claim 25 to 30, wherein the method further comprises using the data on weather and environmental conditions to provide forecasts for local weather and environmental conditions for power grid operators.

32. The method according to any of claim 25 to 31, wherein the data on weather and environmental conditions and/or data on conditions and status of the phase wire of a high-voltage power line is used to provide estimates of thermal capacity and forecasts of ampacity for power grid operators.

33. The method according to any of claim 25 to 32, wherein the data on weather and environmental conditions and/or data on conditions and status of the phase wire of a high-voltage power line is used to facilitate Dynamic Line Rating of a power grid.

34. The method according to any of claim 25 to 33, wherein the data on weather and environmental conditions and/or data on conditions and status of said phase wire of the overhead power line is used to evaluate and/or forecast ice aggregation on the overhead powerline.

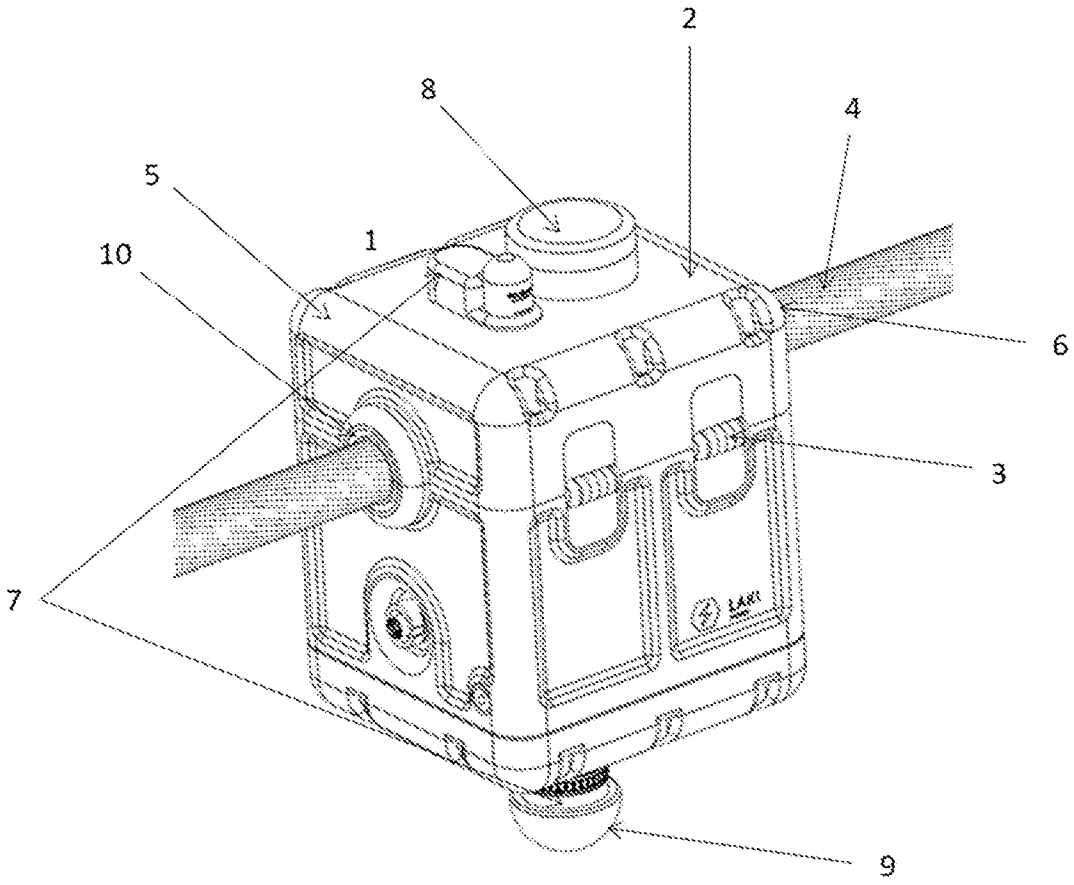
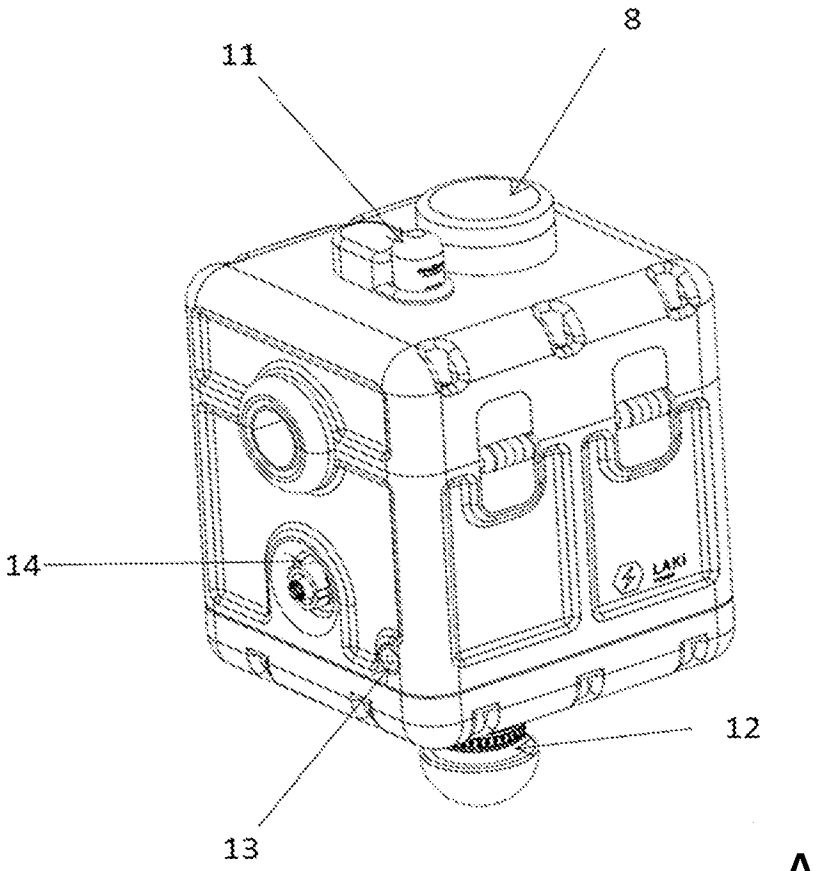


Fig. 1



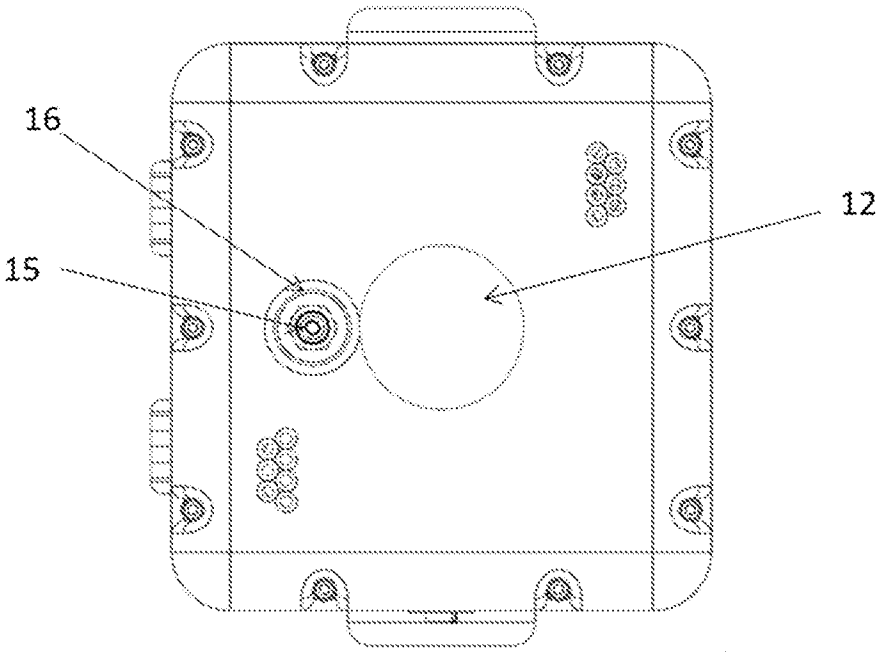


Fig. 2

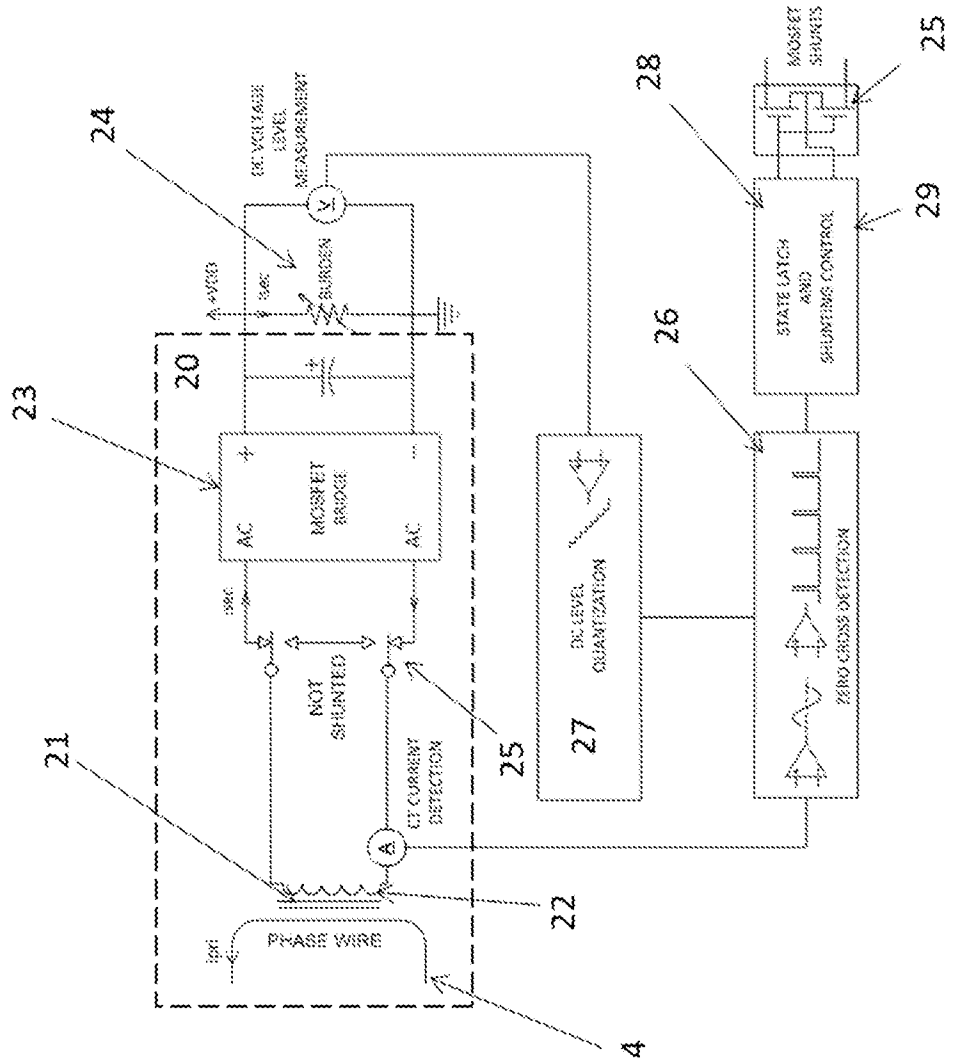

24
DC VOLTAGE LEVEL MEASUREMENT
V
A-WIRE
Sec
BURDEN
20
23
MOSFET BRIDGE
+
-
AC
AC
Sec
NOT SHUNTED
CT CURRENT DETECTION
A
21
25
22
PHASE WIRE
Sec
4
27
DC LEVEL QUANTIZATION
26
28
STATE LATCH AND SHUNTING CONTROL
ZERO CROSS DETECTION
MOSFET SHUNTS
25
29

Fig. 3

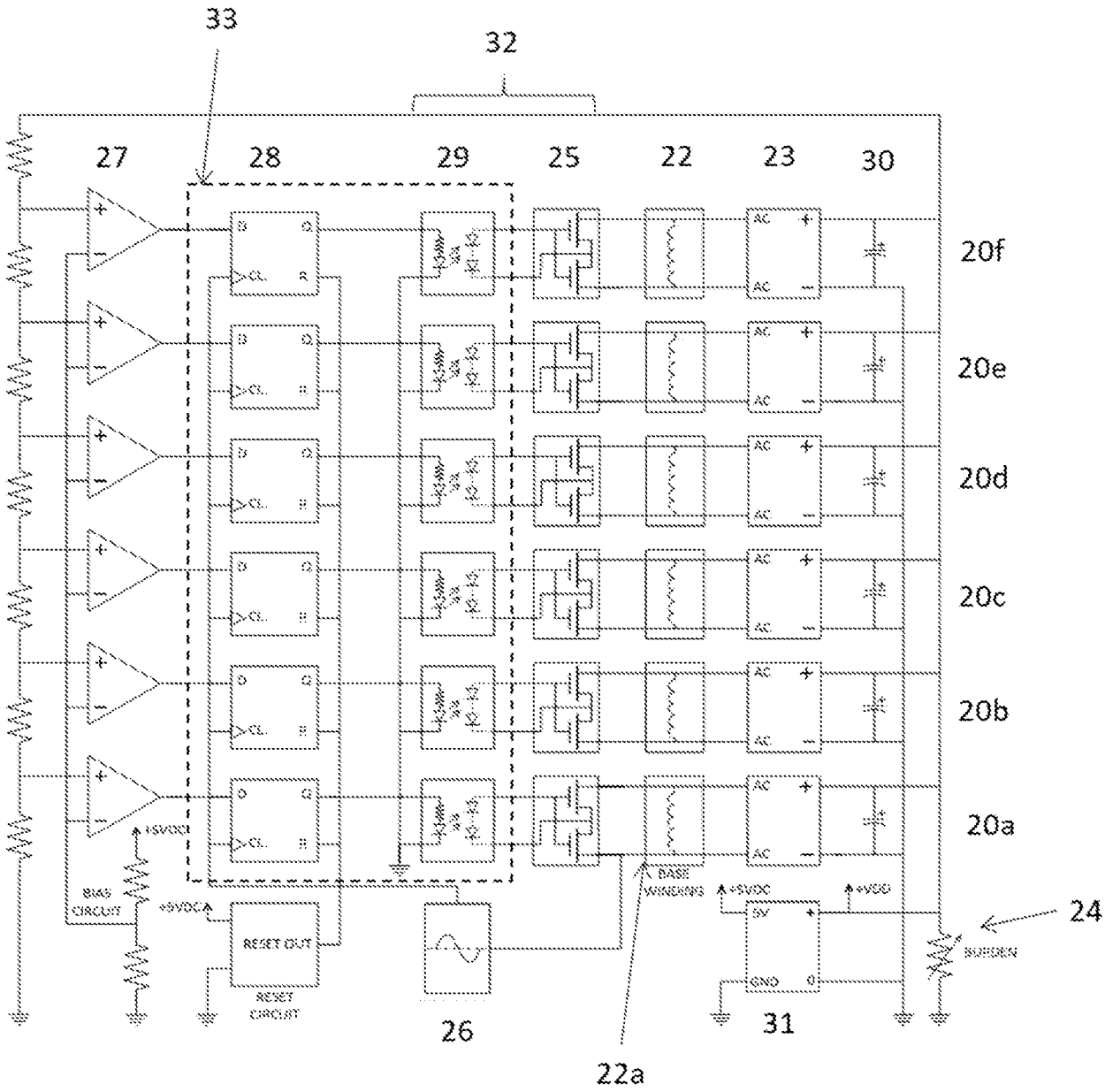

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20f
20e
20d
20c
20b
20a
24
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22a
31
BIAS CIRCUIT
RESET OUT
RESET CIRCUIT
BASE WINDING
BURDEN
+5VDC
+VDD
5V
GND

Fig. 4

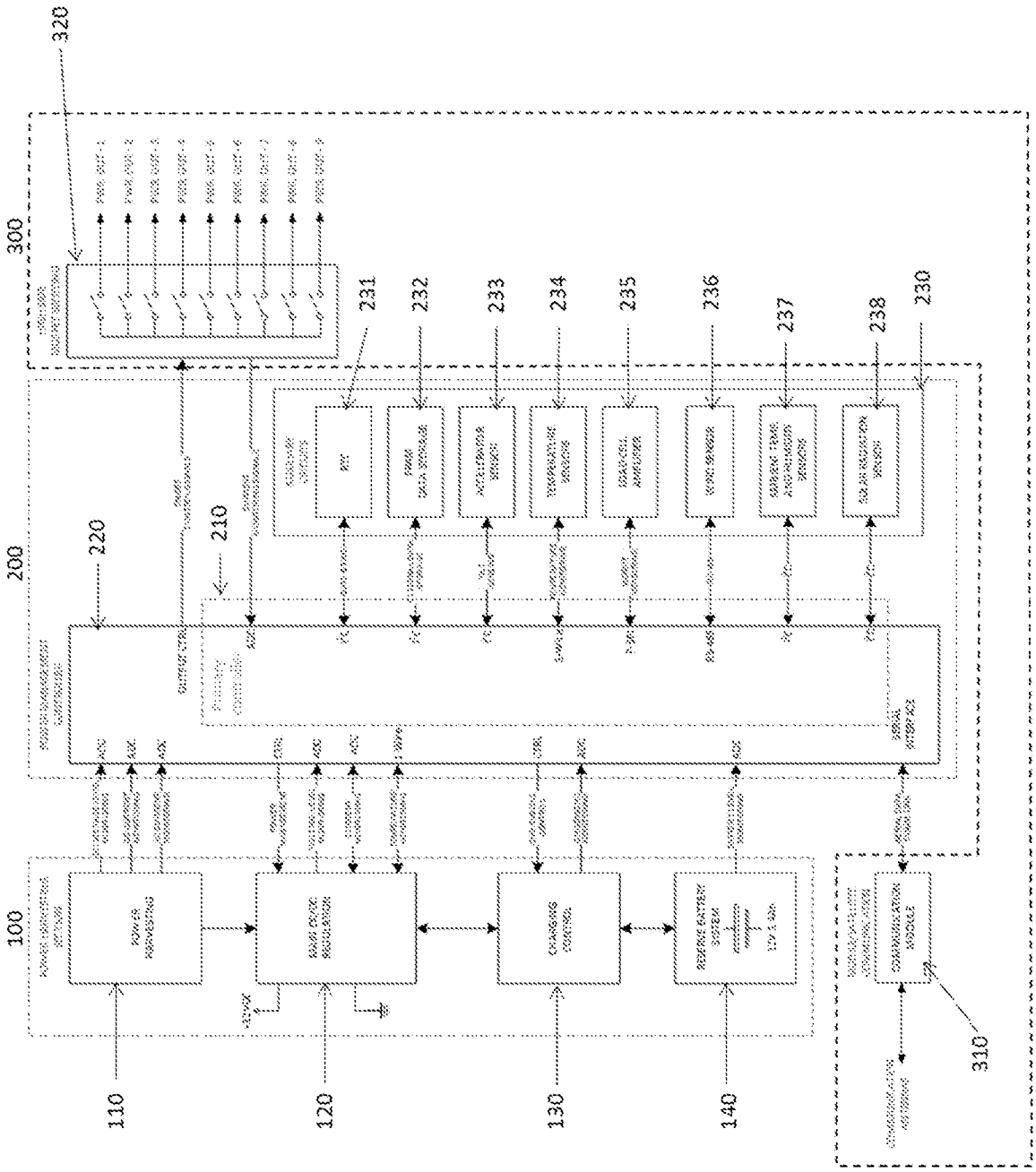

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Fig. 5

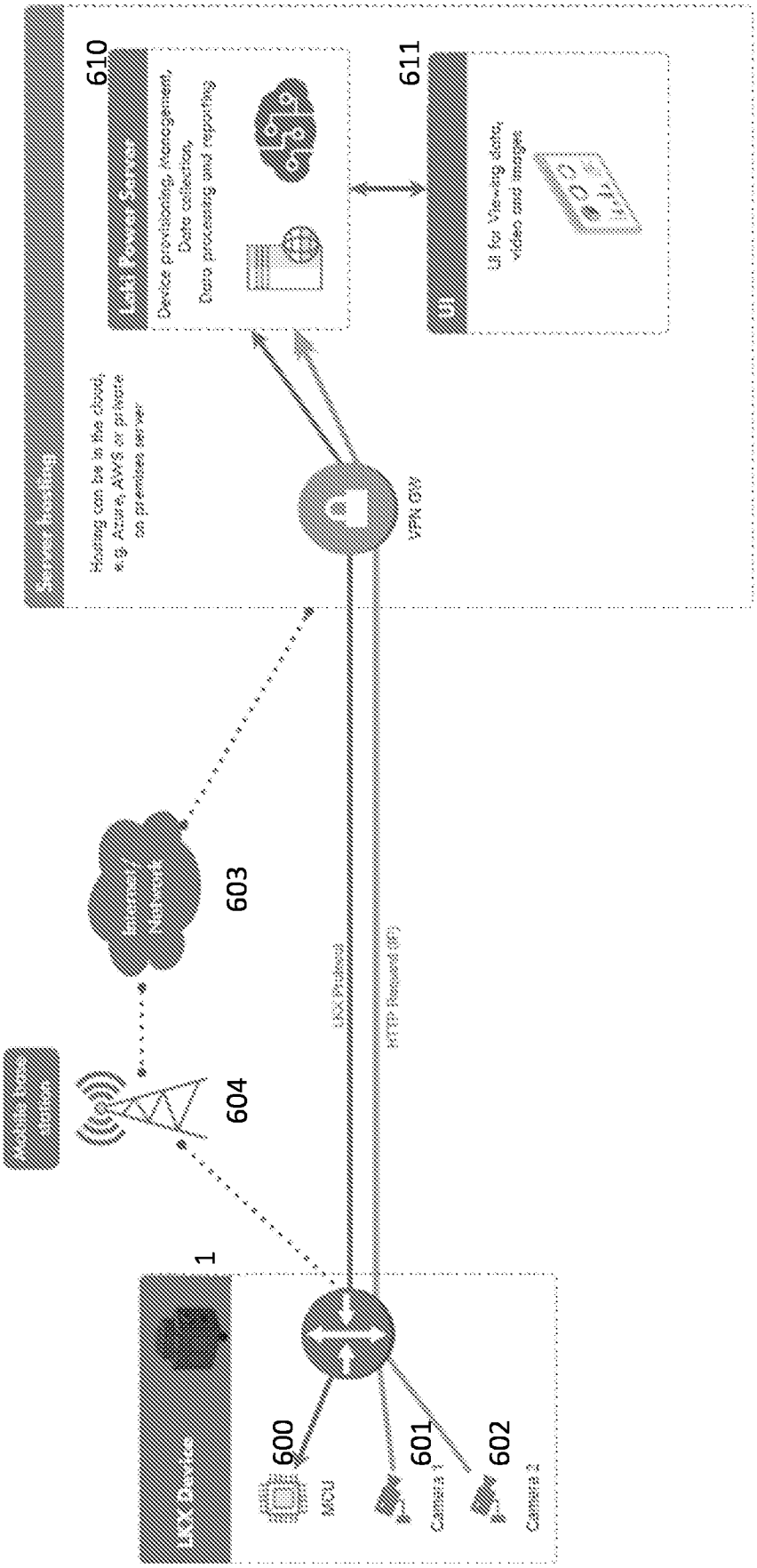

610
611
Device provisioning, management,
Data collection,
Data processing and reporting
Hosting can be in the cloud,
e.g. Azure, AWS or private
on premises server
VPN GW
603
604
1
600
601
602
MCU
Camera 1
Camera 2

Fig. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/IS2021/050011

A. CLASSIFICATION OF SUBJECT MATTER
INV. H02J50/00 H02J13/00 H02G1/02 G01R31/08 G01W1/02
ADD. H02J50/10

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)
H02J H02G G01R G01W

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 938 159 B1 (AMPACIMON S A [BE]) 24 August 2016 (2016-08-24)	1,2,6-8, 12-16, 18-21, 25-27, 30,32,34
A	claims 1, 9; figures 1, 4 paragraphs [0016], [0017], [0019], [0024], [0025], [0027] - [0029], [0031], [0033], [0040] - [0042], [0052], [0053]	3-5, 9-11,17, 22-24, 28,29, 31,33

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[x] Further documents are listed in the continuation of Box C.

[x] 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

"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
2 February 2022	10/02/2022

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Sulic, Tomislav

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IS2021/050011

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 2014/260598 A1 (MILLER GARY MICHAEL [US]) 18 September 2014 (2014-09-18)	1-6, 9-26,28, 30,33,34
A	claim 16; figures 1, 5, 9, 14, 17A paragraphs [0014], [0057] - [0059], [0064], [0066], [0070], [0073], [0076], [0096], [0098] paragraphs [0104], [0146] - [0149], [0155], [0156], [0160]	7,8,27, 29,31,32
X	US 2010/114392 A1 (LANCASTER MARK [US]) 6 May 2010 (2010-05-06)	1,2,6, 12-15, 19,21, 24-33
A	claim 1; figure 1 paragraphs [0016], [0018] - [0020], [0022] - [0005]	3-5, 7-11, 16-18, 20,22, 23,34

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IS2021/050011

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