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OFFICIAL JOURNAL
OF
THE PATENT OFFICE

निर्गमन सं. 44/2021	शुक्रवार	दिनांक: 29/10/2021
ISSUE NO. 44/2021	**FRIDAY**	**DATE: 29/10/2021**

पेटेंट कार्यालय का एक प्रकाशन
PUBLICATION OF THE PATENT OFFICE

(12) PATENT APPLICATION PUBLICATION

(21) Application No.202121043296 A

(19) INDIA

(22) Date of filing of Application :24/09/2021

(43) Publication Date : 29/10/2021

(54) Title of the invention : METHOD AND SYSTEM FOR PROVIDING INTEGRATED SOLUTIONS TO INTERNET-OF-THINGS (IOT) BASED POWER GRIDS

(51) International classification	:H04L0029080000, G06Q0050060000, A01M0001220000, G06F0119060000, G01N0027020000
(86) International Application No	:NA
Filing Date	:NA
(87) International Publication No	: NA
(61) Patent of Addition to Application Number	:NA
Filing Date	:NA
(62) Divisional to Application Number	:NA
Filing Date	:NA

(71)**Name of Applicant :**

1)MS. PALLAVI GAJBHIYE (Research Scholar)

Address of Applicant :Department of Electrical and Electronics Engineering, Rabindranath Tagore University, Bhojpur(Post), Near Bangrasiya Chouraha, Bhopal, Madhya Pradesh, India-464993 ----------- -----------

2)DR. K. NARASIMHAIAH ACHARI (Associate Professor & HOD)

3)DR. M. RAMASEKHAR REDDY (Assistant Professor)

4)DR. M. ANKA RAO (Assistant Professor)

5)DR. A. MUNI SANKAR (Associate Professor)

6)MR. S. SRIDHAR (Assistant Professor)

Name of Applicant : NA

Address of Applicant : NA

(72)**Name of Inventor :**

1)MS. PALLAVI GAJBHIYE (Research Scholar)

Address of Applicant :Department of Electrical and Electronics Engineering, Rabindranath Tagore University, Bhojpur(Post), Near Bangrasiya Chouraha, Bhopal, Madhya Pradesh, India-464993 ----------- -----------

2)DR. K. NARASIMHAIAH ACHARI (Associate Professor & HOD)

Address of Applicant :Department of Electrical and Electronics Engineering, Srinivasa Ramanujan Institute of Technology (Autonomous), Rotarypuram (V), B.K.Samudram (Mandal), Anantapur, Andra Pradesh, India-515701 ----------- -----------

3)DR. M. RAMASEKHAR REDDY (Assistant Professor)

Address of Applicant :Department of Electrical Engineering, JNTUA College of Engineering, Anantapur, Anantapur, Andhra Pradesh State, India. Pin: 515002, ----------- -----------

4)DR. M. ANKA RAO (Assistant Professor)

Address of Applicant :Department of Electrical Engineering, JNTUA College of Engineering, Anantapur, Anantapur, Andhra Pradesh State, India. Pin: 515002, ----------- -----------

5)DR. A. MUNI SANKAR (Associate Professor)

Address of Applicant :Department of Electrical and Electronics Engineering, Sree Rama Engineering College, Tirupati, Andhra Pradesh State, India. Pin: 517507, ----------- -----------

6)MR. S. SRIDHAR (Assistant Professor)

Address of Applicant :Department of Electrical Engineering, JNTUA College of Engineering, Anantapur, Anantapur, Andhra Pradesh State, India. Pin: 515002, ----------- -----------

(57) Abstract :

The invention disclosed herein relates to providing integrated solutions to Internet-of-Things (IOT) based power grids. The invention more specifically relates to utilization of plurality of IOT sensors for wide-scale distribution of intelligent energy storage units that are positioned within the electric grid so as to make the electric grid smart. Smart system data management and visualization may be enabled by utilizing data collected from the IOT sensors arranged at plurality of locations of the power grid, and by implementing a robust chronological portfolio of operations and strategies, moving from the associated network through a defined collection agent and ultimately to a centralized storage system where data may be queried, parsed, aggregated and ultimately visualized using a series of algorithms and graphical user interfaces.

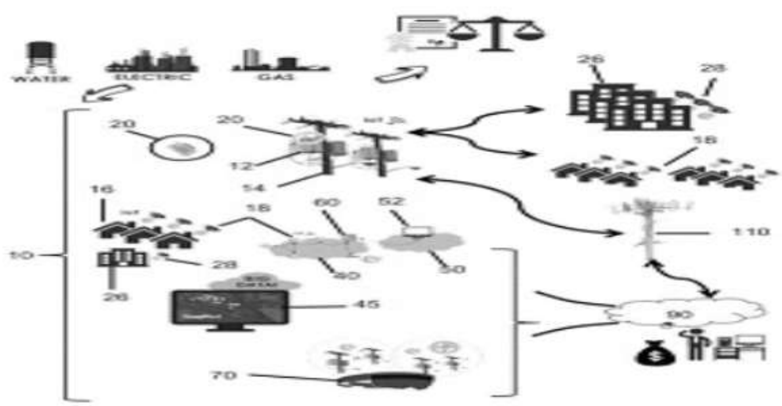

FIG. 1

No. of Pages : 16 No. of Claims : 5

FORM 2

THE PATENT ACT, 1970

(39 OF 1970)

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THE PATENT RULES, 2003

COMPLETE SPECIFICATION

[SEE SECTION 10 AND RULE 13]

TITLE: METHOD AND SYSTEM FOR PROVIDING INTEGRATED SOLUTIONS TO INTERNET-OF-THINGS (IOT) BASED POWER GRIDS	
APPLICANTS:	
MS. PALLAVI GAJBHIYE (Research Scholar)	Department of Electrical and Electronics Engineering, Rabindranath Tagore University, Bhojpur(Post), Near Bangrasiya Chouraha, Bhopal, Madhya Pradesh, India-464993
DR. K. NARASIMHAIAH ACHARI (Associate Professor & HOD)	Department of Electrical and Electronics Engineering, Srinivasa Ramanujan Institute of Technology (Autonomous), Rotarypuram (V), B.K.Samudram (Mandal), Anantapur, Andra Pradesh, India-515701
DR. M. RAMASEKHAR REDDY (Assistant Professor)	Department of Electrical Engineering, JNTUA College of Engineering, Anantapur, Anantapur, Andhra Pradesh State, India. Pin: 515002
DR. M, ANKA RAO (Assistant Professor)	Department of Electrical Engineering, JNTUA College of Engineering, Anantapur, Anantapur, Andhra Pradesh State, India. Pin: 515002.
DR. A.MUNI SANKAR (Associate Professor)	Department of Electrical and Electronics Engineering, Sree Rama Engineering College, Tirupati, Andhra Pradesh State, India. Pin: 517507

MR. S. SRIDHAR (Assistant Professor)	Department of Electrical Engineering, JNTUA College of Engineering, Anantapur, Anantapur, Andhra Pradesh State, India. Pin: 515002.

The following specification particularly describes the invention and the manner in which it is to be performed

METHOD AND SYSTEM FOR PROVIDING INTEGRATED SOLUTIONS TO INTERNET-OF-THINGS (IOT) BASED POWER GRIDS

FIELD OF THE INVENTION

[0001] The invention generally relates to providing integrated solutions to Internet-of-Things (IOT) based power grids. More particularly, the invention relates to utilization of plurality of IOT sensors for wide-scale distribution of intelligent energy storage units that are positioned within the electric grid so as to make the electric grid smart.

BACKGROUND OF THE INVENTION

[0002] Although Internet of Things ("IoT") is currently being implemented in some commercial settings, such conventional IoT deployments do not appear to fully utilize the full interconnectedness with IoT-capable sensors, and, based on analysis of sensor data from these IoT-capable sensors, determine one or more actions to be taken and identify one or more devices (be they household devices, vehicular components, devices disposed in, on, or along a roadway, and/or devices disposed throughout a population area, etc.) for performing the determined one or more actions. Such conventional IoT deployments also do not appear to autonomously control each of the identified one or more devices to perform tasks based on the determined actions to be taken.

[0003] The consumption of energy in the form of electricity is a modern facet of modern living. However, the production of energy often requires the activation of large turbine generators that convert mechanical energy into electrical energy. This mechanical energy is typically created by moving water, steam, and/or gas across the blades of the turbine thereby causing them to revolve, these revolutions then in turn cause a giant magnet to turn, which in turn creates a magnetic field that causes electrons in an associated electrical circuit to flow. Such flow is termed "electricity."

[0004] Proliferation of the "Internet of Things" (IoT) is driving interconnected smart systems. In particular, smart grids are following this trend though the establishment of smart energy, gas and water management. Interconnected components are now providing an unprecedented level of intelligence supporting numerous operational actions. This landscape is ushering in vast amounts of unstructured data and the need for intelligent data parsing, analysis and action systems.

[0005] For instance, electricity may be produced by the running of water over the blades of the turbine, such as at a hydroelectric plant, and/or may be produced by nuclear energy, solar power, or wind power. However, for wide scale use purposes, such energy producing facilities require large physical plants and/or farms of photovoltaic cells or fields of wind turbines. Because of the need for large physical facilities and the undesirable polluting side effects of producing energy, e.g., by the burning of fossil fuels, the power plants that generate such electricity are often located in places that are remote from the residential neighborhoods that ultimately use the produced electricity.

[0006] With this IoT understanding and backdrop, currently there is a need within global smart grid networks, e.g., in urban and remote locations with limited electric infrastructure, for communications with transformers, residential and commercial meters and other Internet/wireless connected IoT devices. These targeted locations do not have sufficient infrastructure to fully deploy a smart grid or Internet infrastructure.

[0007] Hence, there is a need for more robust and scalable solutions for implementing Internet of Things functionality, and, in particular embodiments, to methods, systems, apparatus, and computer software for implementing smart environment functionality, which includes, without limitation, smart home, building, or customer premises functionality, smart vehicle functionality, smart roadway functionality, smart city functionality, etc.

SUMMARY OF THE INVENTION

[0008] The invention disclosed herein describes the method for utilizing plurality of IOT sensors for wide-scale distribution of intelligent energy storage units that are positioned within the electric grid so as to make the electric grid smart.

[0009] Interconnected and non-interconnected IoT smart systems are aided by both wired and wireless sensor-rich networking technology. Smart devices are enabled by a multitude of sensors in order to identify, isolate, capture, and process data into multiple marketing sectors such as energy, health care and transportation, for example.

[00010] Smart system data management and visualization may be enabled by implementing a robust chronological portfolio of operations and strategies, moving from the associated network through a defined collection agent and ultimately to a centralized storage system where data may be queried, parsed, aggregated and ultimately visualized using a series of algorithms and graphical user interfaces.

[00011] The entirety of this construct is bi-directional, allowing both information and actions to flow into the construct and out of the construct. Actions may initiate either internally to or externally of the described construct.

BRIEF DESCRIPTION OF THE DRAWINGS

[00012] FIG. 1 is a diagram showing an establishment of a baseline, power grid centric, smart utility mesh network, according to some embodiments of the present invention.

[00013] FIG. 2 shows an example data center facility that includes a site substation, a transformer, a generator, and a centralized facility that houses computing hardware.

[00014] FIG. 3 illustrates how one data center may communicate with another data center that is located within a different power grid.

DESCRIPTION OF THE INVENTION

[00015] By way of example, FIG. 1 shows an example of a smart power grid network generally indicated as 10, according to some embodiments of the present invention. The smart power grid network 10 may take the form of, or may be configured to include, one or more digital data and delivery and receipt mesh networks like element 40. Each digital data and delivery and receipt mesh network 40 may include one or more communication nodes such as the transformer module or device 20 for exchanging information upstream and downstream between the communication nodes and a central location, e.g., which takes the form of the private network 50 in FIG. 1. The one or more communication nodes may be configured to be able exchange such upstream and downstream information between themselves in order to exchange such upstream and downstream information between a respective communication node and the central location like element 50.

[00016] In FIG. 1, the smart power grid network 10 may include transformers like element 12 for providing electric energy to residential homes and commercial buildings like elements 16, 26, each having a respective electrical meter like elements 18, 28 for measuring the associated electrical energy usage. The smart power grid network 10 may also include transformer monitor/data collection devices 20 configured to collect data about the electrical energy usage in relation to residential homes and commercial buildings 16, 26 from the respective electrical meter like element 18, 28. For example, each electrical meter 18, 28 may provide metered data signaling containing information about metered data related to associated electrical signaling being supplied from the transformer 12 to the building or structure 16, 26 in the grid network 10. Moreover, transformer monitor/data collection devices 20 may receive associated signaling containing information about electrical signaling data related to electricity being processed by the transformer 12 located and arranged in the grid network and to which the transformer monitoring device 20 is mounted, as well as other wireless network data related to other communication nodes forming part of other wireless network devices deployed in the grid network. In effect, the collected data received by the transformer monitor device 20 may include some combination of the electrical signaling data related to the transformer, the metered data related to the electrical meter and/or the other wireless network data related to other communication nodes in the grid network, e.g., which may include digital content as set forth in further detail below.

[00017] In such instances, communication between the individual and/or collective of smart energy storage units may take place between them, such as on a local level, where individual systems communicate e.g., via WiFi, Bluetooth, Low Energy Bluetooth, Dash7, Zigbee, or even PLC, so as to create a local storage network that is capable of aggregating all storage and/or discharge into one system. Additionally, this networked communication system can have one coordinator that connects to and controls all of the individual energy storage units, and may further be connected to the internet, e.g., the world wide web, such as via cellular, WIFI, LAN connection, or the like. In such an instance, the coordinator, e.g., via the internet, may be configured to connect a secure cloud server (DRMS), which cloud server can further be connected to the Distributed Services Organization or other grid operator or third party may then control any and all of the interconnected storage units so as to control them individually or collectively such as with respect to charging and discharging.

[00018] Accordingly, as can be seen with respect to the above, the smart energy storage units disclosed herein are highly stackable, expandable, and configurable so to be able to form various different types of internal and/or external networks, such as to form one or more of a fento, a pico, a nano, a micro, a macro, a mega, and/or a super smart grid. Further, as each individual smart asset, e.g., smart energy storage unit, includes a control unit, the control unit may be configured to learn based on usage of each individual storage unit, e.g., with respect to times of charge and discharge, rate, time of day, and the like, and/or the collection of storage units, such as via the associated software and/or hardware, so as to better perform its function and/or functions, such as in concert. This modular design allows grid operators and/or end users, e.g., electricity customers, to build a networked system in small pieces. This will further help with determining the most effective system configuration prior to making large upfront investment therein.

[00019] Further, as grid operators and/or customers expand the network to include more and more smart assets, e.g., smart energy storage units, the system software can be configured to recognize the new units in the expanded network, and those units can be added into the collective networked system milieu, such as by asking the customer to opt in and thereby all the new units to be joined the grid. In a manner such as this, the networked grid can be built organically unit by unit and a system map of the distributed storage platform can be determined and/or otherwise implemented. In various instances, the hardware may also be configured so as to be physically stackable, such as in instances where multiple physical storage units are desired to be co-located.

[00020] FIG. 2 illustrates a data center complex 200 that includes a data center 205, an environmental control infrastructure 210, a site substation 215, a connection 220 to a power grid 225, a transformer substation 230, and a generator station 235. The data center 205 may include any number of servers or other types of computing devices configured in a manner similar to the computer system 100 of FIG. 1. As an example, the computer system 100 may be a server running in the data center 205.

[00021] The data center 205 may include any number of servers organized with a server rack. Further, the data center 205 may include any number of these server racks (e.g., hundreds or even thousands of different server racks resulting in hundreds or thousands of different servers). A server is able to provide computing resources or services to any number of clients. For instance, instead of storing data locally within their enterprises, many clients desire to store their data at a data center. Additionally, many clients elect to use SAAS services, PAAS services, and/or IAAS services, each of which is provided by the servers in a data center. Accordingly, the data center 205 is able to provide for any type of computing need.

[00022] The environmental control infrastructure 210 includes any type of infrastructure useful in controlling the climate conditions of the data center 205. As examples only, the environmental control infrastructure 210 may include a full-scale heating, ventilation, and air conditioning (HVAC) system. Such a system includes any number of humidifiers, dehumidifiers, fans, cooling stations, furnaces, evaporator coils, vents, condensing units, and so forth, along with any supporting infrastructure associated with those components.

[00023] Attention will now be directed to FIG. 3 which shows two different power grids, namely power grid 400 and power grid 405. Power grids 400 and 405 are example implementations of the power grid 300 from FIG. 3. To illustrate, power grid 400 includes a power station 410 and a data center 415. Similarly, power grid 405 includes a power station 420 and a data center 425. Power station 410 primarily provides electricity to the power grid 400 while power station 420 primarily provides electricity to the power grid 405. In some instances, electricity from power grid 400 may be provided to the power grid 405 (e.g., in situations where the power grids 400 and 405 are relatively close to each geographically) while in other instances the two power grids 400 and 405 are completely isolated from one another.

[00024] Regardless of whether the power grids 400 and 405 share electricity, FIG. 3 shows that the data center 415 is able to communicate with the data center 425 via connection 430. This connection 430 may be any type of connection, including, but not limited to, a wired connection or a wireless connection (e.g., a radio connection).

[00025] Because of this connection 430, the data centers 415 and 425 are able to transmit data back and forth with one another. This data may include any type of data. For instance, the data may include diagnostic data regarding how each data center is operating. The data may include bandwidth data to inform its counterpart that it is able to take on more computing tasks. The data may include information about each data center's respective power grid and whether that power grid is reliable or not.

[00026] FIG. 4 is a schematic type diagram of an electrical power distribution network 80 illustrating this described downstream fault isolation scheme, where like elements to the network 30 are identified by the same reference number. In this example, the fault 54 occurs between the fault interrupters 40 and 42 on the line 34. Also, fault interrupters 82 and 84 are provided on a feeder line 86 that is electrically coupled to the feeder line 34 between the fault interrupters 38 and 40. When the fault 54 occurs, the fault interrupter 36 sends a fault detection message to the fault interrupter 38 on communication path 88, the fault interrupter 38 sends a fault detection message to the fault interrupter 40 on communication path 90 and a fault detection message to the fault interrupter 82 on communication path 92, and the fault interrupter 40 sends a fault detection message to the fault interrupter 42 on communication path 94. Also, when the fault 54 occurs, the fault interrupter 42 experiences LoV when the fault interrupter 40 opens under the downstream fault protection scheme, and the fault interrupters 82 and 84 experience a DoV. In this situation, the fault interrupter 42 will open because it knows its immediate upstream section is faulted after it detects the LoV and receives the fault detection message from the fault interrupter 40. Therefore, the downstream fault isolation scheme is faster than known downstream fault isolation schemes because the fault interrupter 42 will open as soon as it receives the LoV message, and does not need to wait until it receives an open message from the fault interrupter 40 as was done in the known networks. The fault interrupter 82 will not mistakenly decide that its immediate upstream section is faulted because it will initially detect a DoV, but healthy voltage returns after the DoV, since the fault interrupter 40 will interrupt the fault 54. Note that if the fault interrupter 82 is adjacent to the fault interrupter 40, and the fault 54 is a three-phase bolted fault that is very close to the fault interrupter 40, it is possible that the fault interrupter 82 will detect almost a complete loss of voltage that may be registered as a LoV.

[00027] Accordingly, the disclosed embodiments optimize resources in a cloud computing environment (e.g., a data center). By dynamically moving data and services around to different data centers in different geographic regions, the embodiments are able to capitalize on ancillary services as well as to help balance the power grid during times of surplus or times of need. By deriving learned characteristics of the power grid and the data center, the embodiments are able to shift resources while still maintaining a desired level of reliability, assurance, and/or availability to clients. Furthermore, deciding which mitigation operations to perform is based, at least partially, on the power generation abilities, the power storage abilities, and/or the power consumption abilities of the data center. It will be appreciated that the embodiments are able to make predictions and respond to those predictions very quickly (e.g., within a threshold number of milliseconds after the prediction is generated). Further, the embodiments are able to perform mitigation operations within a threshold number of milliseconds in response to a predicted power grid fluctuation. In this manner, the embodiments provide a robust and reliable mechanism for responding to the fluctuations that occur in a power grid in order to help balance the power grid, to help schedule the operations of the data center, and to facilitate in providing ancillary services to the power grid.

[00028] The present invention may be embodied in other specific forms without departing from its spirit or characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

WE CLAIM:

1. A smart power grid comprising: a plurality of Internet of Things (IOT) sensors, a CPU, a measuring module, which is connected with the CPU; and
a module, which is used for data interaction with the CPU, implementation of point-to-point electricity transaction among the nodes in the blockchain network in the area, and storage of distributed electricity measurement and transaction data.

2. The smart power grid with IOT sensors, wherein the smart energy storage unit is integrated within an electric appliance.

3. The smart power grid with IOT sensors, wherein the master controller is coupled to a user interface, the user interface configured for receiving user commands to program the control unit to withdraw energy from the local electric circuit and to supply energy to the local electric circuit.

4. The smart power grid comprising IOT sensors, wherein a master controller includes a user interface to receive user commands to program the control unit to withdraw energy from the local electric circuit and to supply energy to the local electric circuit.

5. The smart power grid, wherein the master controller is associated with a memory for storing user use commands.

ABSTRACT

The invention disclosed herein relates to providing integrated solutions to Internet-of-Things (IOT) based power grids. The invention more specifically relates to utilization of plurality of IOT sensors for wide-scale distribution of intelligent energy storage units that are positioned within the electric grid so as to make the electric grid smart. Smart system data management and visualization may be enabled by utilizing data collected from the IOT sensors arranged at plurality of locations of the power grid, and by implementing a robust chronological portfolio of operations and strategies, moving from the associated network through a defined collection agent and ultimately to a centralized storage system where data may be queried, parsed, aggregated and ultimately visualized using a series of algorithms and graphical user interfaces.

COMPLETE SPECIFICATION

Sheet No. 1

Total No of Sheets. 4

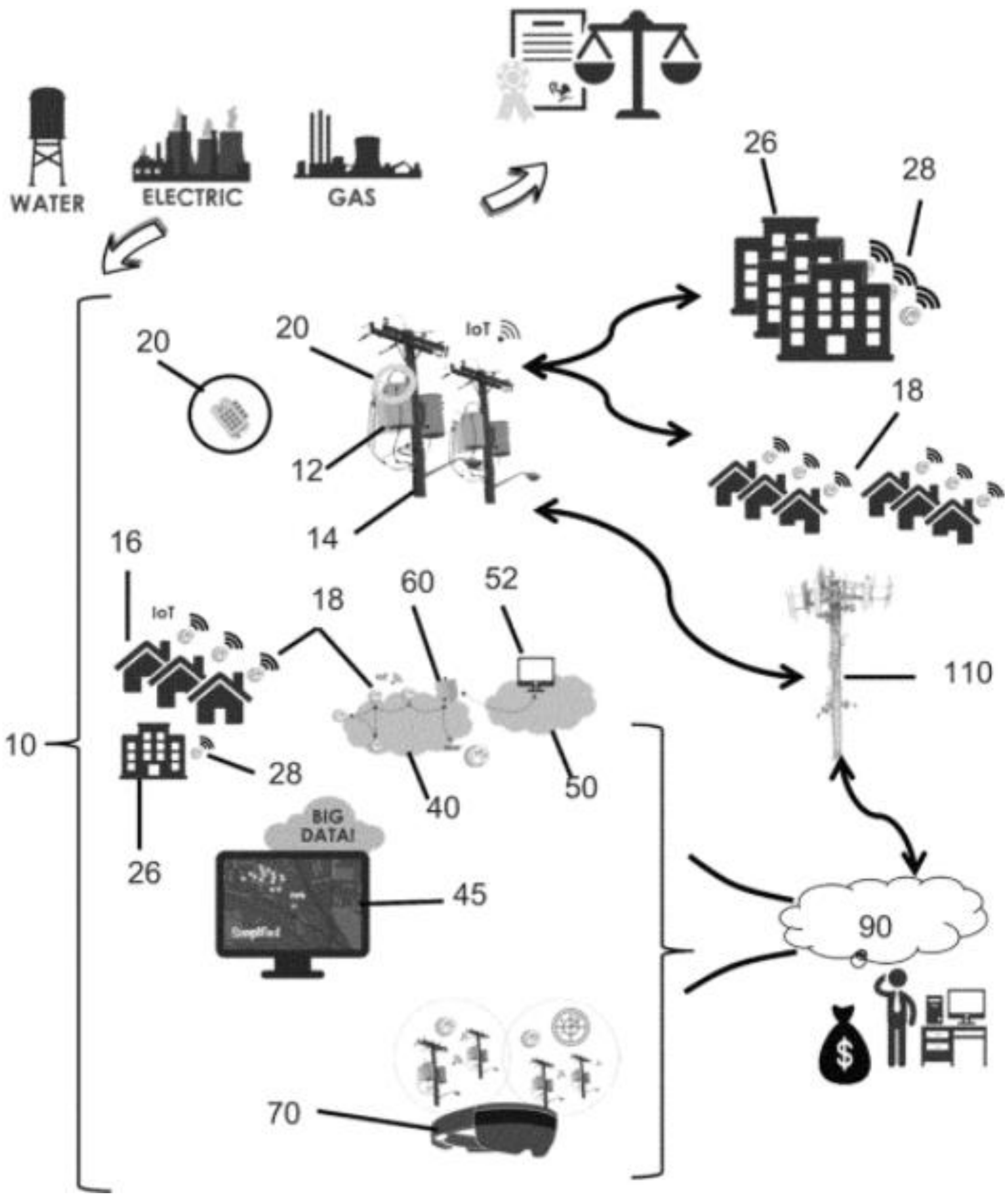

FIG. 1

COMPLETE SPECIFICATION

Sheet No. 2

Total No of Sheets. 4

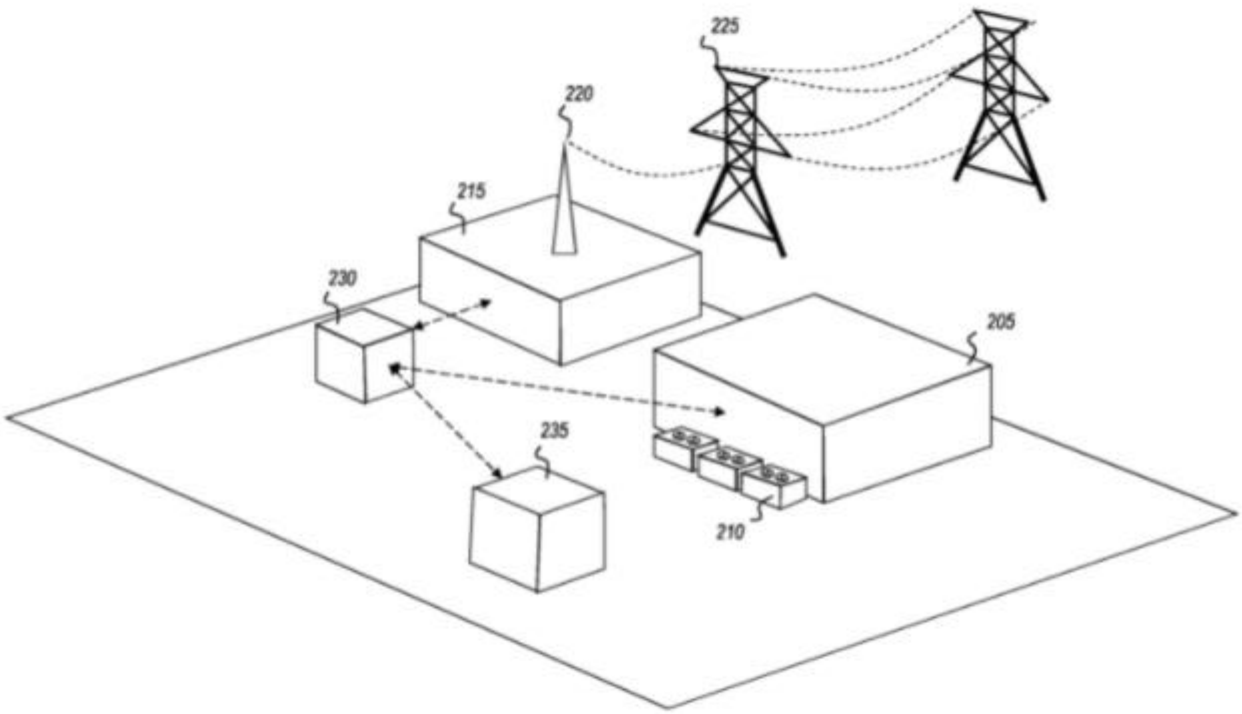

FIG. 2

COMPLETE SPECIFICATION

Sheet No. 3

Total No of Sheets. 4

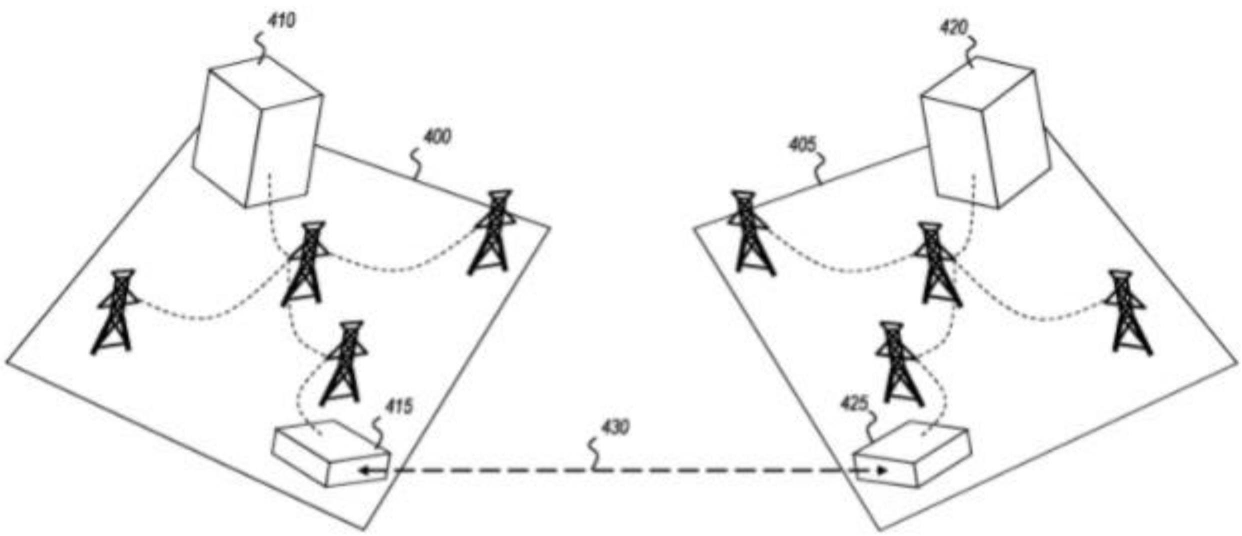

FIG. 3

COMPLETE SPECIFICATION

Sheet No. 3

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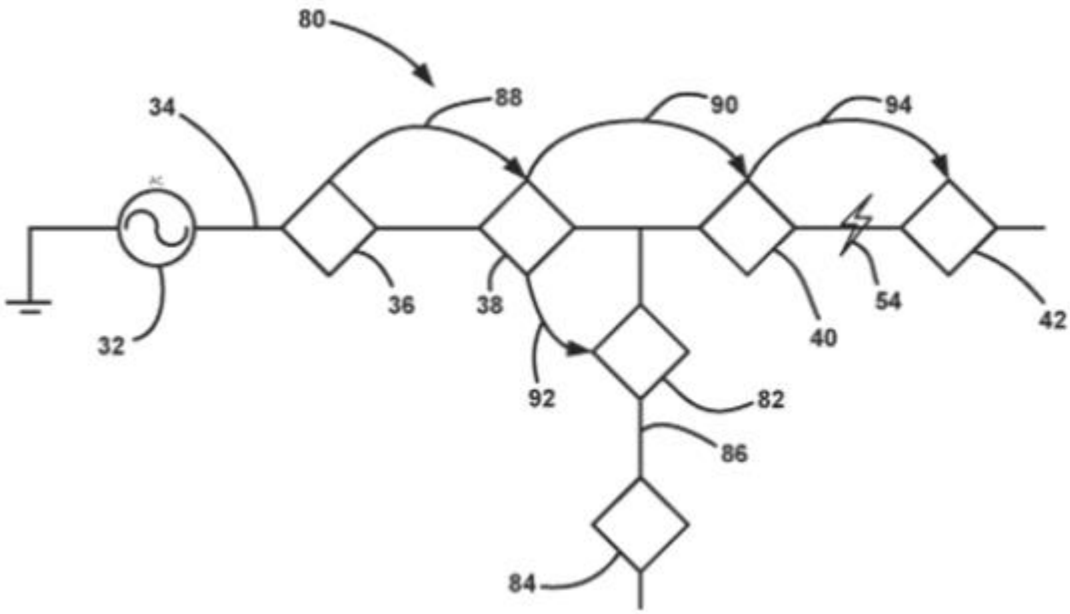

FIG. 4

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निर्गमन सं. 38/2021	शुक्रवार	दिनांक: 17/09/2021
ISSUE NO. 38/2021	FRIDAY	DATE: 17/09/2021

पेटेंट कार्यालय का एक प्रकाशन
PUBLICATION OF THE PATENT OFFICE

(12) PATENT APPLICATION PUBLICATION

(21) Application No.202141040185 A

(19) INDIA

(22) Date of filing of Application :04/09/2021

(43) Publication Date : 17/09/2021

(54) Title of the invention : DROOP CHARACTERISTICS BASED POWER SUPPLY FOR ELECTRIC TRACTION SYSTEM

(51) International classification	:H02J0003380000, B60L0015000000, B60L0053240000, H02J0003360000, H02M0005220000
(31) Priority Document No	:NA
(32) Priority Date	:NA
(33) Name of priority country	:NA
(86) International Application No	:PCT//
Filing Date	:01/01/1900
(87) International Publication No	: NA
(61) Patent of Addition to Application Number	:NA
Filing Date	:NA
(62) Divisional to Application Number	:NA
Filing Date	:NA

(71)**Name of Applicant :**

1)VENKATASUPURA VEMULAPATI

Address of Applicant :Assistant Professor, Department of EEE, Sri Venkateswara College of Engineering, Tirupathi, Andhra Pradesh 517502, INDIA Andhra Pradesh India

2)Dr. N VISALI

3)Dr. Y N VIJAYKUMAR

4)Dr. SHAIK RAFI KIRAN

5)P. SUNEETHA

6)DANDU SRINIVAS

7)Dr. V SEKHAR

8)P VENKATA VARAPRASAD

9)Dr. AVAGADDI PRASAD

10)Dr. K. HARSHAVARDHANA REDDY K

11)Dr. KUMAR K

(72)**Name of Inventor :**

1)VENKATASUPURA VEMULAPATI

2)Dr. N VISALI

3)Dr. Y N VIJAYKUMAR

4)Dr. SHAIK RAFI KIRAN

5)P. SUNEETHA

6)DANDU SRINIVAS

7)Dr. V SEKHAR

8)P VENKATA VARAPRASAD

9)Dr. AVAGADDI PRASAD

10)Dr. K. HARSHAVARDHANA REDDY K

11)Dr. KUMAR K

(57) Abstract :

Abstract The single-phase traction system needs a performance enhancement due to the issues that is involved with the single-phase transformer-based control. Serious power quality issues arise during interfacing of the traction system such as imbalance in current and voltage at the single-phase transformer. The present innovation proposes a solution to the power quality issues due to intermittent switching (disengage and engage) of the drivetrain load. An alternate methodology to supply power to the AC drivetrain system is detailed. On AC traction side MMC (multi module converter) based converter is connected to self-synchronizing inverters. The drivetrain side inverter is developed based on the droop characteristics and it is carried out keeping in mind the perimeters of Indian railway. The AC voltage and current imbalance that occurs in the traction system while sudden connection and disconnection of the traction in the single phase supply with transformer interfacing is a serious power quality issue. The present innovation relates to develop an alternate topology for continuous and steady state supply of power to the AC traction system. The MMC based converter system with the DC link is connected to the self-synchronizing inverters at the AC traction side. The droop characteristic based control of the traction side inverter is developed for the specification of Indian scenario system.

No. of Pages : 10 No. of Claims : 5