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(54) **Title:** METHOD AND DEVICE FOR IMPROVING POWER FACTOR AND HARMONICS THROUGH ACTIVE CONTROL OF ELECTRIC APPLICANCES

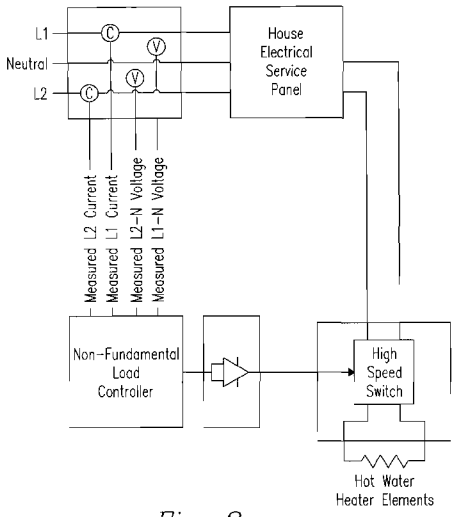

Fig. 2

(57) **Abstract:** A system, method and device for controlling and modifying the current drawn by an electrical load in a way that will improve the electrical power factor and harmonic quality of at least a portion of an electrical power system. In one embodiment of the invention, the invention includes a controller device that monitors the electrical current entering a site and modifies or corrects power quality of the current by directing how power will be consumed by the appliances at a site to improve the harmonic and power factor qualities of the electrical current entering the site.

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DEVICE, METHOD, AND SYSTEM FOR IMPROVING ELECTRICAL POWER FACTOR AND HARMONIC POWER QUALITY THROUGH ACTIVE CONTROL OF POWER QUALITY IMPROVING ELECTRICAL APPLIANCES

STATEMENT AS TO RIGHTS TO INVENTIONS MADE UNDER FEDERALLY-SPONSORED RESEARCH AND DEVELOPMENT

[0001] This invention was made with Government support under Contract DE-AC0576RLO1830 awarded by the U.S. Department of Energy. The Government has certain rights in the invention.

PRIORITY

[0002] This invention claims priority from a provisional patent application entitled High Pressure Enzymatic Digestion System for Protein Characterization, application No. 60/952,929 filed July 31, 2007, and from a Utility patent application entitled Device, Method and System for Improving Electrical Power Quality through Active Control of Power Quality Improving Electrical Appliances, application No 12/181,954 filed July 29, 2008.

BACKGROUND OF THE INVENTION

Field of the Invention

[0003] The invention generally relates to the improvement of electrical power factor and harmonic power quality at the interface between an electric

utility and a utility customer site through the active control of one or more electric appliances at the utility customer's site.

Background Information

[0004] In the field of electrical power transmission, electrical energy is typically delivered to the electrical consumer as a 60-hz voltage signal. Certain loads, like the inexpensive power rectifier power supplies that are typically supplied with small appliances and computer equipment, pollute the local harmonic content of the electrical supply. Certain applications and facilities such as research facilities and hospitals can be particularly sensitive to the presence of this harmonic pollution. This electrical pollution can decrease the overall distribution grid efficiency and in some cases cause these utilities to over design their distribution and transmission infrastructure. Severe harmonic pollution from one customer's load can affect the performance of and harm a neighboring electrical power customer's loads. Various standards such as IEEE-519 restrict the non-fundamental harmonic components that can be reflected back into the electrical power grid by the electrical loads from these consuming devices. Most electric power customers pay the same for energy consumed by them regardless of its harmonic pollution content.

[0005] Harmonic pollution as addressed here includes non-unity power factor electrical currents and those electrical current harmonics above the fundamental 60-Hz AC (alternating current) frequency used in the electrical power distribution system. Reductions in power factor are caused, for example, by rotating induction machines of the type found in clothes washers, dryers, dishwashers, and in refrigeration compressors. Home electronics, computers, and battery chargers and other appliances that possess inexpensive rectifiers, both reduce power factor and create harmonic current pollution at the sites where they reside. The growing abundance of computers and these other appliances in homes and businesses now threatens to become an unchecked, growing source of reduced electric power factor and increased harmonic power quality pollution.

[0006] Generally speaking, poor power factor and harmonic pollution from individual residential and commercial appliances can aggregate to become problematic for utilities on distribution feeders. Poor power factor may be mitigated at individual appliances by active power factor correction. Several commercial power factor correction integrated circuits may now be applied to the designs of battery chargers and universal power supplies to force their rectifier stages to consume unity power factor current. Both power factor and harmonic pollution may be corrected at the site-level by expensive power

electronic harmonic correctors or, to a lesser degree, by controlled, distributed capacitors. Thus far, such large and active filters have been applied to large commercial and industrial site loads due to their great expense. Unlike active filters and capacitor banks, the present invention does not require the use of electrical energy storage components. Capacitor banks are used at the feeder, substation-level to correct power factor and to reduce harmonic pollution loads, a portion of which would otherwise be passed along through the substation to further aggregate at the transmission levels. However, the utility capacitor bank performs a power factor correction only near the substation where it is located.

[0007] The effects of poor feeder-level power factor and harmonic pollution are poor voltage support, energy system inefficiency, and reduction in system component life. In addition, thermal losses in the system reduce overall system efficiency of the distribution system. The additional heat on the lines and transformers can also reduce the usable lifetimes of those power system components and can force de-rating of their capacities during heavy load conditions. What is needed therefore is a system and device that overcomes these problems and provides the desired results.

[0008] The present invention provides a cost effective and practical solution to address these issues. Additional advantages and novel features of

the present invention will be set forth as follows and will be readily apparent from the descriptions and demonstrations set forth herein. Accordingly, the following descriptions of the present invention should be seen as illustrative of the invention and not as limiting in any way.

SUMMARY

[0009] The present invention is a system, method and device for controlling and modifying the current drawn by an electrical load in a way that will improve the electrical power factor and harmonic quality of at least a portion of an electrical power system. In one embodiment of the invention, the invention includes a controller device that monitors the electrical current entering a site and modifies or corrects power quality of the current by directing how power will be consumed by the appliances at a site to improve the harmonic and power factor qualities of the electrical current entering the site.

[0010] Depending upon the particular embodiment of the present invention, the controller device may be incorporated into any of a variety of devices. Examples of which may include, but are not limited to, an electric power supply, a battery charger, an electric or hybrid transportation vehicle, industrial fork lifts, a water heater, a stove, an oven, an electric space heater, or lighting. The controller device may include a slow feedback loop that satisfies

any of a variety of needs including needs of the appliance process, the need for harmonic correction, the steady-state need for power factor correction, or any combination of process needs, harmonic correction, and steady-state power factor correction.

[0011] This device method and system may be appropriately modified for use in a variety of residential, commercial, and industrial applications. This device provides a variety of additional features including decreasing reliance of a utility on capacitor banks, increasing electrical distribution efficiency, reducing voltage support for a utility, allowing for retrofitting of the present invention on existing devices and systems, including various automotive and industrial applications, and doing so without the reliance on electrical energy storage.

[0012] In one embodiment of the invention, the method for improving the power quality at a site includes the step of conducting a current that supplements and corrects the sum of the other load currents in a designated area. This method may be implemented by a variety of types of devices that modify the current drawn by an electrical load so as to improve a site's aggregate power factor of its current waveform. This device preferably has a controller configured to selectively consume preselected energies having a designated characteristic.

[0013] While these controllers can be alternatively configured in a variety of embodiments, in one embodiment, the controller modifies the current drawn by an electrical load in a way that will improve the harmonic quality of a site's aggregate current waveform. In some embodiments, such a controller modifies the current drawn by an electrical load in a way that will improve a site's aggregate power factor of its current waveform. The controlled electric load may or may not possess electrical energy storage. These controllers may be implemented in a variety of types of devices such as consumer electronics or a transportation vehicle like an electric or hybrid transportation vehicle or industrial machinery such as a fork lift or other device. In other embodiments the controller and the electrical load possess no electrical energy storage.

[0014] In some embodiments the electrical load is a resistive electrical element, such as those found in water heaters, stoves, ovens, electric space heaters, dimmable lighting and other applications. In other embodiments the electrical load may result from dissipation in transistors. In some embodiments of the invention, the controller includes a slow feedback loop that satisfies process needs, the steady-state need for power factor correction, or both. In another embodiment of the invention, the controller that modifies the current drawn by an electrical load in a way that will improve a site's aggregate

harmonic content of its current waveform. A controller may include an electrical energy storage device, such as the power supply for a battery charger, like those that are found in electric or hybrid transportation vehicles or industrial fork lifts. In other embodiments the controller and the electrical load possess no electrical energy storage.

[0015] In other embodiments the electrical load results from dissipation in transistors. In some embodiments such a device may also include a slow feedback loop that satisfies process needs, the steady-state need for harmonic current correction, or any combination of process needs, harmonic correction, and steady state power factor correction.

[0016] In summary, this invention improves the quality of the AC electrical current at the interface between a site and the utility that serves the site. A "power quality improving appliance" at that site will overcompensate for the aggregate poor power factor and harmonic pollution of any other appliances at the site. The net effect is that the site appears from the utility side to be an improved, if not ideal, consumer of electrical power. The power quality improving appliance can help the site meet and exceed IEEE 519 (or other local) power quality requirements placed on the site by the local utilities while serving mundane appliance functions, like the heating of water, for example.

[0017] The purpose of the foregoing abstract is to enable the United States Patent and Trademark Office and the public generally, especially the scientists,

engineers, and practitioners in the art who are not familiar with patent or legal terms or phraseology, to determine quickly from a cursory inspection the nature and essence of the technical disclosure of the application. The abstract is neither intended to define the invention of the application, which is measured by the claims, nor is it intended to be limiting as to the scope of the invention in any way.

[0018] Various advantages and novel features of the present invention are described herein and will become further readily apparent to those skilled in this art from the following detailed description. In the preceding and following descriptions I have shown and described only the preferred embodiment of the invention, by way of illustration of the best mode contemplated for carrying out the invention. As will be realized, the invention is capable of modification in various respects without departing from the invention. Accordingly, the drawings and description of the preferred embodiment set forth hereafter are to be regarded as illustrative in nature, and not as restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Figure 1 is a chart showing waveforms demonstrating improvement in a site's current with a controlled power quality improving appliance of one embodiment of the present invention.

[0020] Figure 2 is a functional block diagram of one embodiment of the present invention.

[0021] Figure 3 is an example of one embodiment of a current sensing circuit.

[0022] Figure 4 is an example of another embodiment of an ac voltage monitoring circuit.

[0023] Figure 5 is an example of one embodiment of a power quality improving appliance power electronic circuit of the present invention.

[0024] Figure 6 is a power quality improving appliance driver circuits for two power IGBT switches.

DETAILED DESCRIPTION OF THE INVENTION

[0025] The following description includes the preferred best mode of one embodiment of the present invention. It will be clear from this description of the invention that the invention is not limited to these illustrated embodiments but that the invention also includes a variety of modifications and embodiments thereto. Therefore the present description should be seen as illustrative and not limiting. While the invention is susceptible of various modifications and alternative constructions, it should be understood, that there is no intention to limit the invention to the specific form disclosed, but, on the contrary, the invention is to cover all modifications, alternative constructions, and equivalents

falling within the spirit and scope of the invention as defined in the claims. While the described invention is best applied to the correction of site-level current harmonics, similar principles may be applied to the correction of other elements or factors including local voltage harmonics.

[0026] In one embodiment of the invention, the invention improves the quality of the AC (alternating current) electrical current at the interface between a site and the utility that serves the site. In one configuration, an embodiment of the invention located at the site overcompensates for the aggregate poor power factor and harmonic pollution of any other appliances at the site. The net effect is that the site appears from the utility side to be an improved, if not ideal, consumer of electrical power. The power quality improving appliance can help the site meet and exceed IEEE 519 (or other local) power quality requirements placed on the site by the local utilities while serving mundane appliance functions, like the heating of water, for example.

[0027] In one embodiment of the invention, the device of the present invention (described hereafter) is utilized to build current waveforms. Referring now to Figure 1, a view of the representative waveforms present at a particular site from a circuit simulation is shown. Waveform I_b is the original current draw that was measured at a residence having three personal computers without the

device of the present invention operating. The signal I_L is the envelope of total current that could be used by an appliance equipped with the present invention in this site. This resistive appliance current is necessarily in phase with the voltage (not shown) applied to the appliance. For example, the current envelope could be created by a water heater resistive heating element. The envelope represents the maximum current that the appliance could draw uncontrolled.

[0028] The signal $I_{L\ Prime}$ is the current drawn by the power quality improving appliance, the device of one embodiment of the present invention. This power quality improving appliance can draw up to the current magnitude shown in the signal I_L. This observation points out a unique control attribute of this embodiment of the power quality improving (PQI) appliance: the device need possess no significant energy storage and is therefore able to correct power quality through its opportunistic consumption of additional power at the right times within each half cycle. While this embodiment is shown in this application of the present embodiment, it is to be distinctly understood that the invention is not limited thereto but may be variously embodied according to the needs and necessities of a user.

[0029] The signal I_a is the sum of the site's aggregate line current plus the current drawn by the power quality improving appliance. This signal is

"improved" in that it has higher power factor and less harmonic pollution than I_b, the site's current prior to applying the power quality improving appliance's load. The block configuration of the system of the present invention is set forth in Figure 2. Figure 2 shows the presence of a site current and voltage metering circuit, a control signal circuit, a power electronic circuit and power switch driver circuits. The site current and voltage metering circuit monitors and scales the site's line current and voltage. The control signal circuit uses the site's current, voltage, and another demand signal to control the appliance in which the present invention is connected. The power electronic circuit includes the power electronic switches and controls the power current into the appliance containing the device of the present invention. The power switch driver circuits drive the power electronic switches on and off, including necessary floating power sources and optical isolation. More detailed descriptions of these items are provided hereafter.

[0030] The site current and voltage metering circuit monitors the voltages and currents, preferably from a location near the site's electrical panel. The voltage can be scaled by a voltage divider and then buffered. The current can be measured by using current transformers. The signals from both the current and voltage are then scaled and rectified through a precision rectifier for use by the control circuit. The site current and voltage metering circuit may be placed on

the same circuit board as the control signal circuit. Both the current and voltage control signals are preferably immune from noise and free from phase shifts. The voltage signal is usually more sinusoidal than the current signal at the site electrical panel and may be filtered. It is preferred that the current signal sensor pass through all site current frequencies up to about 10 kHz, all of which can be mitigated by the power quality improving appliance. Example circuit components of the overall current and voltage metering circuit are shown in Figures 3 and 4.

[0031] The purpose of the control signal circuit is to accept signals that are proportional to the magnitudes of the site's voltages and currents and to formulate the correction response to these signals that will make the site's electrical load current be more in phase and more sinusoidal. The output is therefore a signal proportional to the error between the actual magnitude of the site's electrical load current and the ideal, desirable electrical load current. One embodiment of the control signal circuit presents this error signal as a pulse-width-modulation ("PWM") output that can then be used directly to modulate the appliance's power electronic circuit via its driver circuits.

[0032] In this preferred embodiment of the invention, one additional input is used by the control signal circuit. This input scales the ideal, desirable

load current against which the actual site's electrical load current is compared. By increasing the scale of the ideal load current, one increases power to the power quality improving appliance and increases the amount of improvement or correction that can be had by operating the appliance. By decreasing the scale of the ideal load current, one decreases the power to the power quality improving appliance and diminishes the degree to which the appliance can correct the site's current. The changes in this scaling factor generally occur slowly, compared to the 50 or 60-Hz waveshape. The magnitude of the scaling can be assigned as any beneficial function of (1) the site's need for power quality improvement (measured THD, for example), (2) the appliance's load demand (water temperature deficit, for example), (3) externally asserted demand signals, (4) grid frequency signals, (5) any other load objective. The appliance will also function with a constant applied scaling factor.

[0033] Observe that the control signal circuit shares many attributes with commercially available power factor control integrated circuits like the Linear Technologies LT1249. Available power factor control integrated circuits are intended for control of the input stage of individual power electronic rectifier circuits. We are able to advantageously apply the functions of the power factor control integrated circuit to the control of the power quality improving appliance. While a power factor correction integrated circuit is not essential to

the function of the appliance, the appliance may be considered a novel application for a power factor correction integrated circuit.

[0034] The output of power factor correction integrated circuits is usually a PWM output. Depending on the assigned power electronic switch type of the appliance, the switching frequency may be either appropriate or inappropriate. For example, the output of the LT1249 is a 100-kHz PWM signal. This switching frequency may work directly for MOSFET power switches, but it is too fast for many contemporary IGBT power switches. The user may therefore have to supply circuitry that will reduce the PWM switching frequency while maintaining the duty cycle of the PWM signal.

[0035] In another embodiment of this invention, the error signal obtained from outputs of the power factor correction integrated circuit may be applied directly to control one or more transistors without employing a PWM signal, thereby both controlling the electric current of the power quality improving appliance and dissipating useful thermal energy directly from the controlled transistors.

[0036] The purpose of the power electronic circuit block is to modulate the electrical power current used by the appliance. The power electronic circuit of

Figure 5 is failsafe in either the switches' conductive and non-conductive failure modes, the circuit functions like a bidirectional switch, directly controlling the applied ac voltage. No DC (direct current) energy storage buses are required. It accommodates inductive loading. The power switches may be identically driven by the same isolated PWM drive signal. The drivers for the two switches are referenced to the two line potentials. The driver circuit power supplies are easily designed using simple transformer power supply circuits. The driver circuits for the two power switches are nearly identical. The resistor shown in Figure 5 dissipates power for the appliance. It could be the heating element of a water heater, space heater, or range. The element may be partially or completely inductive, too. Furthermore, the element need not be collocated with the remainder of the circuit, a fact that enables appliance retrofit markets for this invention. The uppermost diodes in the figure may be eliminated if the power switches have the ability to withstand reversed potentials. In the preferred embodiment, IGBT power switches were selected for their ease of switching and for their ruggedness and ability to withstand moderate voltages. This preference does not preclude the fabrication of power circuits with MOSFETs and other electronic power switches.

[0037] Example driver circuits for two power quality improving appliance IGBT power switches are shown in Figure 6. These driver circuits, with minor

modifications, would be applicable to the control of a variety of MOSFET and IGBT and BJT transistors. These driver circuits are only examples of specific embodiments that would enable the present invention. Driver circuits must be designed for specific chosen power switches. The example selection of IGBT switches is not intended to narrow the applicability of this invention.

[0038] The shown driver circuits employ a transformer-coupled rectifier power supply circuit that creates a positive and negative unregulated rail voltage above and below the reference voltage. The reference voltage is established by connecting the power electronic circuit's reference voltage point to its respective driver's transformer center tap. The unregulated voltage sources are then connected to positive and negative linear voltage regulator circuits that establish regulated voltage rails both above and below the reference voltage. MOS gates are driven by about 15 Volts. A small negative voltage allows us to rapidly turn off the power electronic switches and to hold them off more reliably. This driver power supply circuit permits us to use ground referenced MOS drivers like the Maxim LT4420/9 6-ampere MOS driver chips. It is preferable that the MOS drivers' electronic switch's reference voltage be connected to the driver circuits via short, low impedance wires or traces.

[0039] A preferably PWM control signal is sent to the driver circuit via an optically isolated transistor. Depending on the appliance application, the control logic of the driver may be designed failsafe in either the on or off state of the power electronic switches. For water heating, where additional failsafe temperature control may exist, the drivers should be designed so as to fail in the conducting state should no control signal be received. Therefore, the failure of the driver circuit to receive a control signal still permits the power quality improving appliance to fulfill its function as a water heater.

[0040] The present invention provides a significant advantage over other devices in the prior art. Customer sites that fail to include one of the devices of the present invention may continue to exhibit and contribute to propagation of poor electric power factor and in poor harmonic power quality. This is the default situation in many locations, where almost no electricity consumers correct their own power quality. The growing prevalence of computers and other home electronic equipment will exacerbate power quality. Very bad power quality offenders may affect nearby electric power customers who have equipment that is intolerant of poor power quality. Hospitals, for example, place high importance on both electrical power quality and reliability. Presently, electric customers need adhere only to harmonic power quality limits imposed by standard IEEE-519. Some customers must also correct their own power

factors. The alternative to the present invention includes costly active electric filters that fulfill a similar objective at an electrical site. The present invention provides a cost effective reliable and practical way to increase the efficiency of power systems and to avoid the various problems associated with poor power factor or poor harmonic power quality.

[0041] While various preferred embodiments of the invention are shown and described, it is to be distinctly understood that this invention is not limited thereto but may be variously embodied to practice within the scope of the following claims. From the foregoing description, it will be apparent that various changes may be made without departing from the spirit and scope of the invention as defined by the following claims.

What is claimed is:

1. A method for improving the power quality of an electrical distribution circuit characterized by the step of :

conducting a current that corrects the sum of the other electrical load currents in the electrical distribution circuit.

2. A controller that modifies the current drawn by an electrical load so as to improve a site's aggregate current waveform by selectively consuming preselected energies having a designated characteristic.

3. The controller of claim 2 wherein said preselected energies are selected from the group consisting of factors that will improve the quality of a site's aggregate current waveform, factors that will improve an aggregate power factor of a current waveform, factors that will improve a site's aggregate power factor of its current waveform, factors that will improve a site's aggregate harmonic quality of its current waveform.

4. The controller of claim 2 wherein the said electric load is at least one device selected from the group consisting of an electrical energy

storage device, a power supply circuit, a water heater, an electric range, an electric space heater, and at least one transistor.

5. The controller of claim 2 further comprising a slow feedback loop.

6. The controller of 5 wherein said slow feedback loop is configured to perform a task selected from the group consisting of satisfying process needs, providing steady-state harmonic current correction and combinations thereof.

7. The controller of claim 2 wherein said controller modifies current drawn by an electrical load in a way that will improve both a site's aggregate harmonic content and aggregate power factor of its current waveform.

8. The controller of claim 2 wherein said controller is power factor correction integrated circuit.

9. The controller of claim 2 wherein said controller is power factor correction integrated circuit.

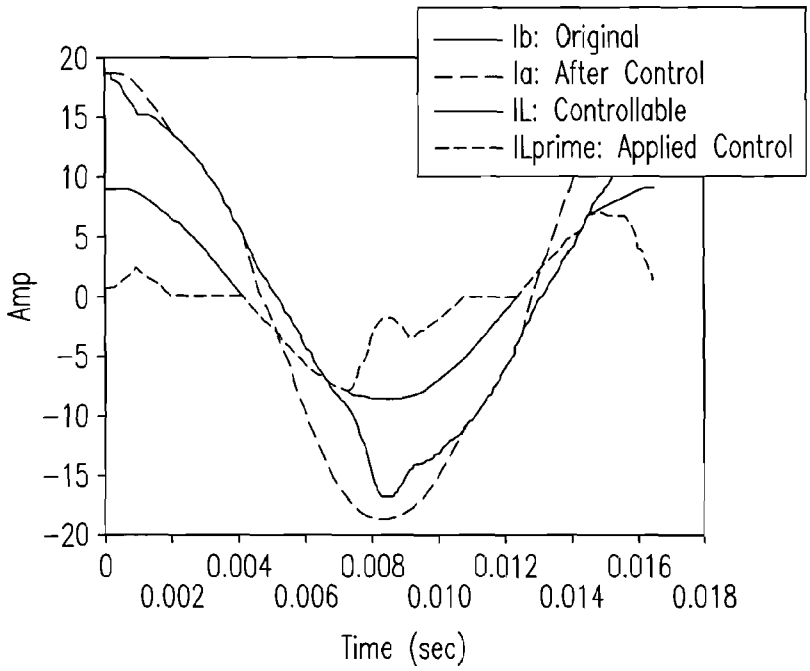
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Fig. 1

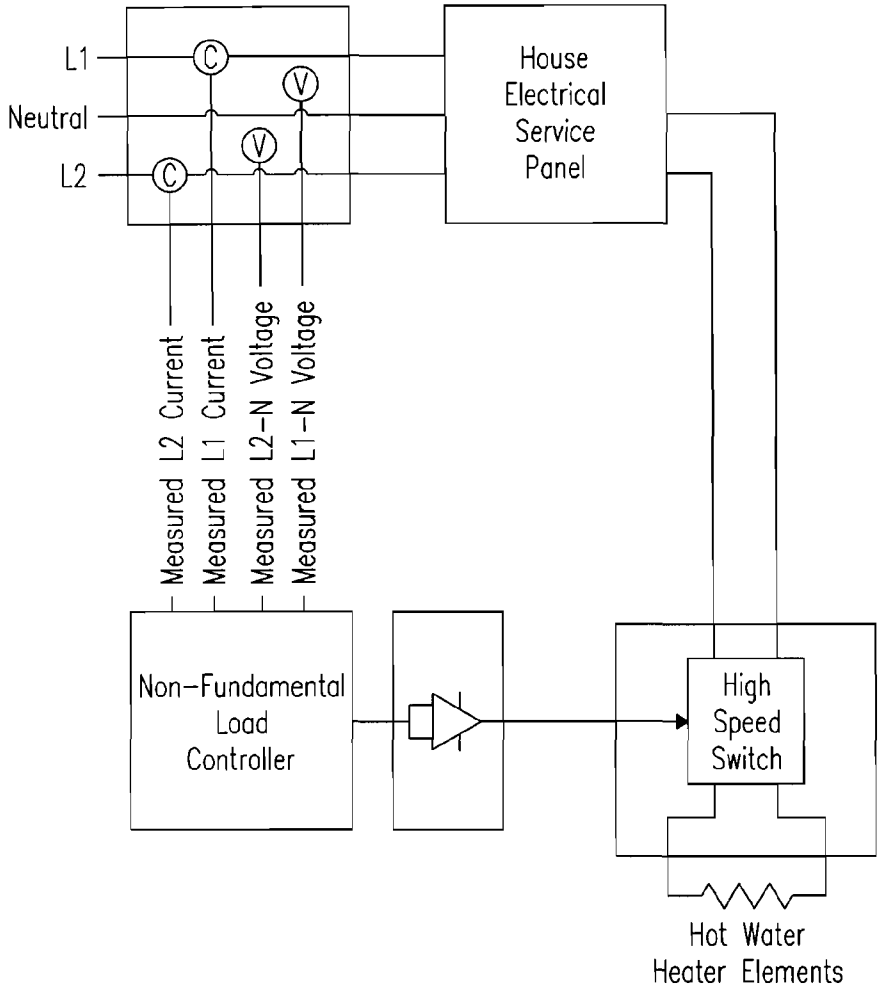
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Fig. 2

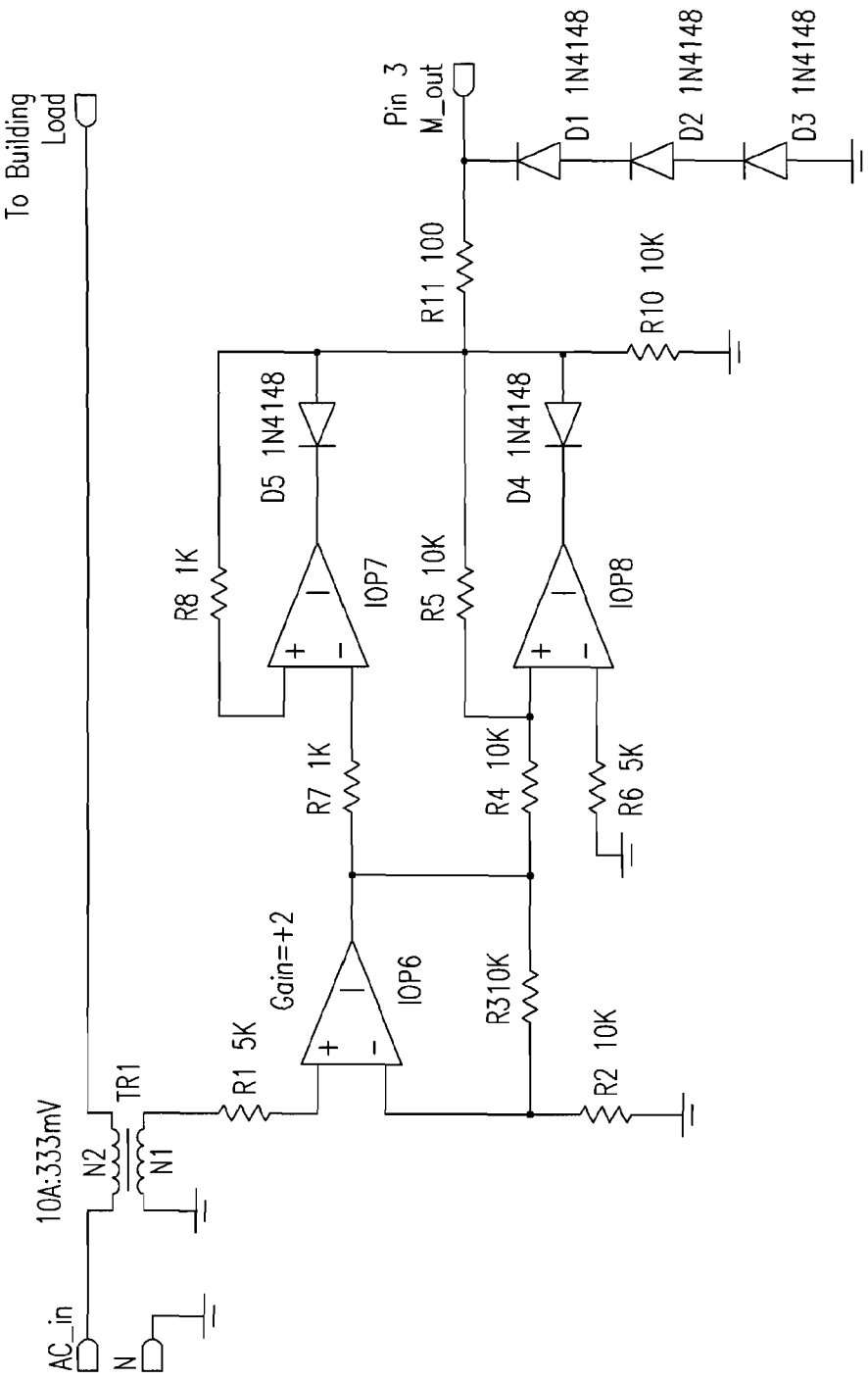
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Fig. 3

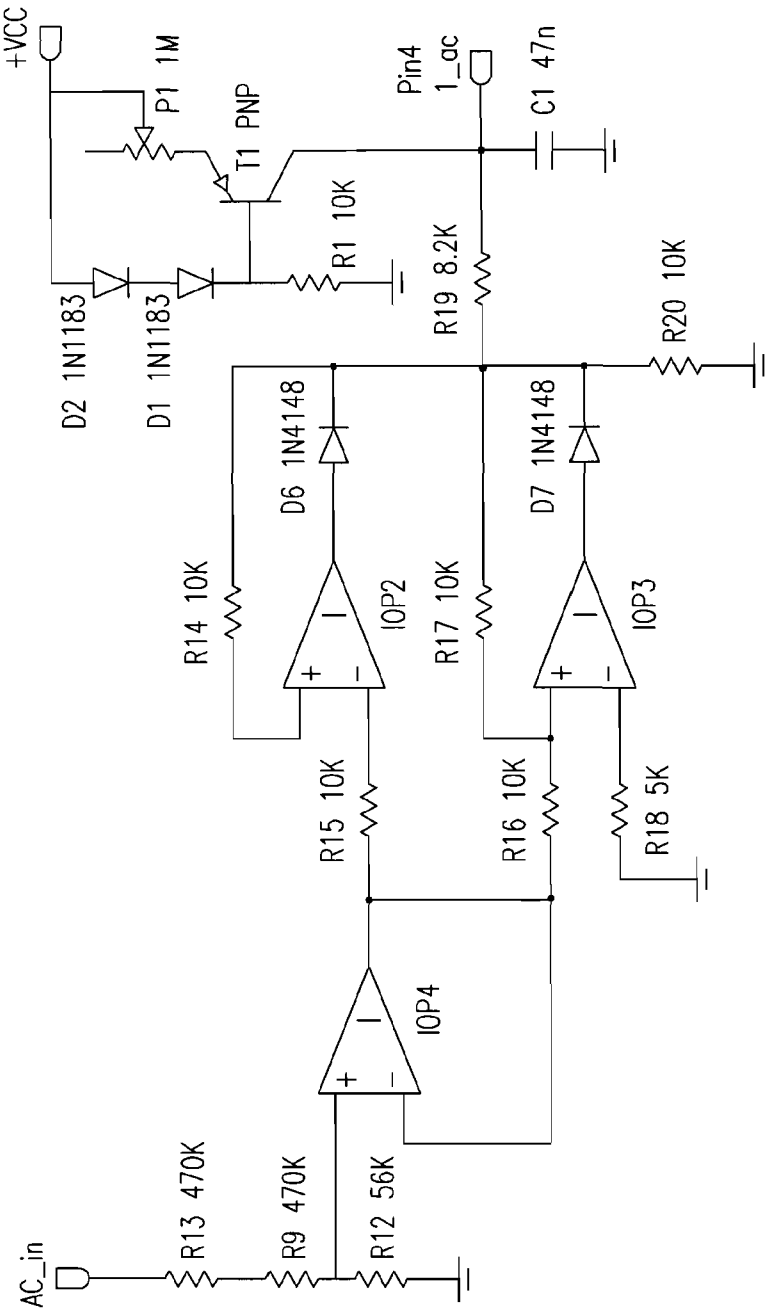
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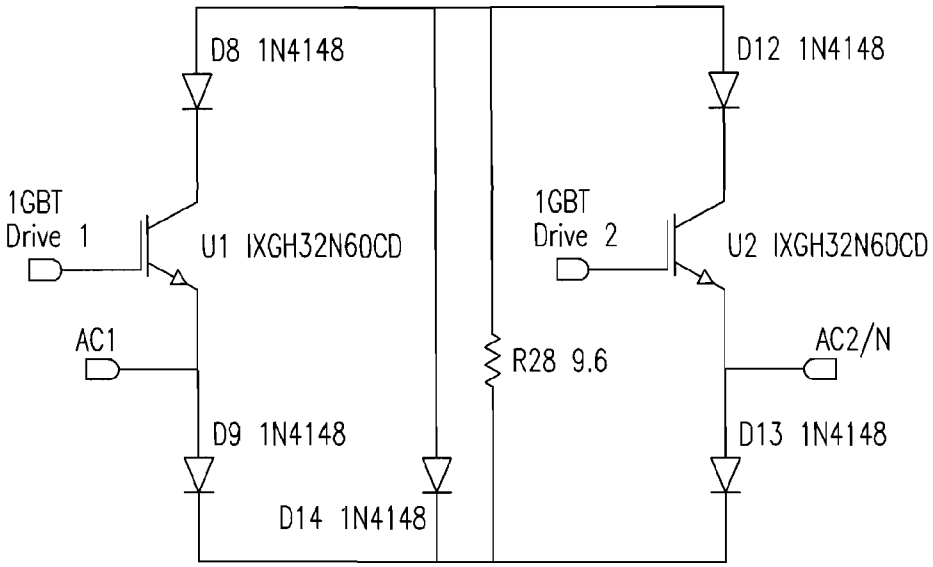
Fig. 4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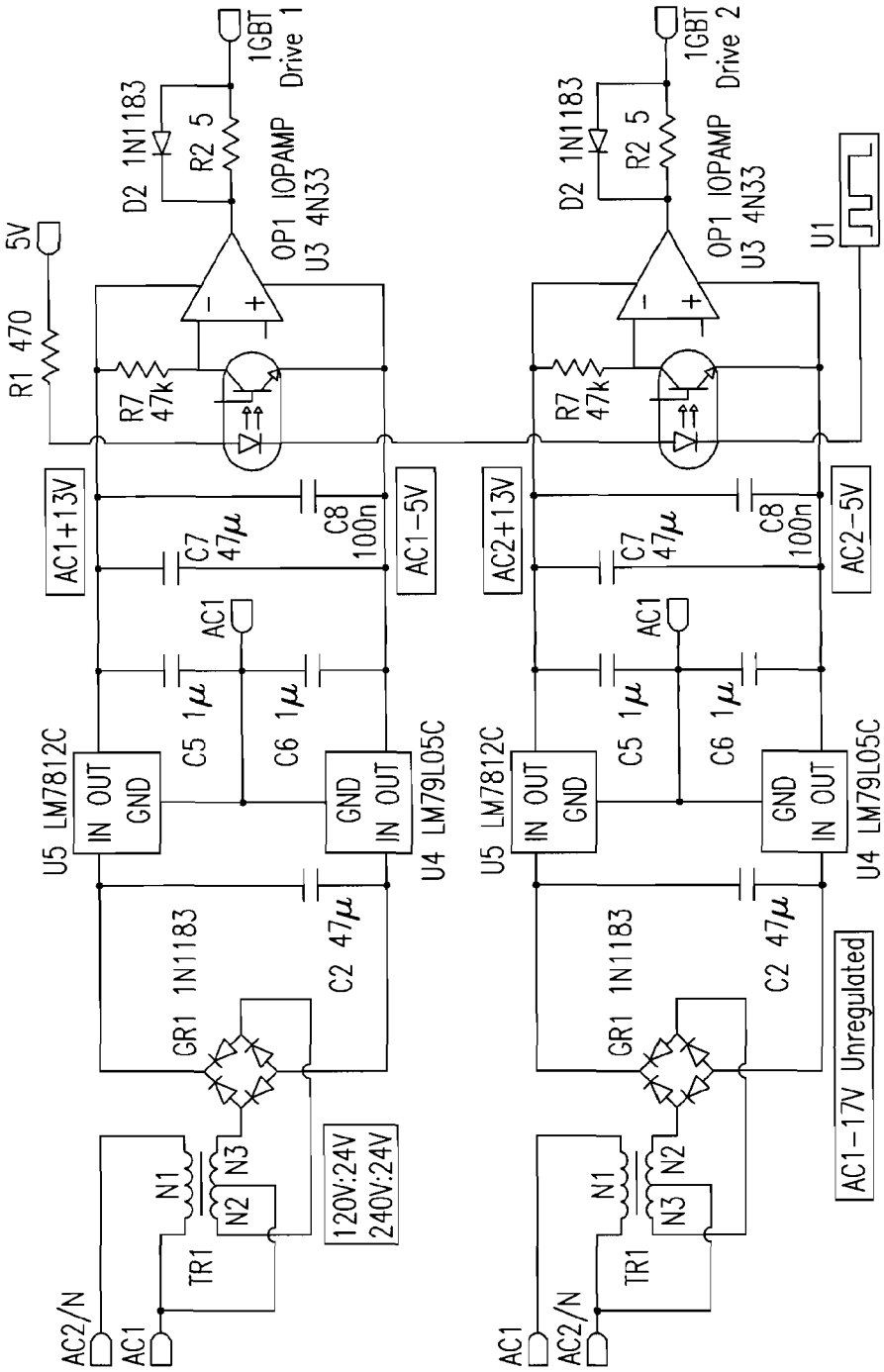
D14 1N4148

Fig. 5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C6 1µ
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120V:24V
240V:24V
AC2/N
AC1
D2 1N1183
R2 5
IGBT Drive 2
OP1 IOPAMP U3 4N33
R7 47k
U1
AC2+13V
C7 47µ
C8 100n
AC2−5V
AC1
C5 1µ
C6 1µ
U5 LM7812C
IN OUT GND
GND IN OUT
U4 LM79L05C
C2 47µ
GR1 1N1183
N1
N2
N3
TR1
AC1−17V Unregulated
AC1
AC2/N

Fig. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2008/071703

A. CLASSIFICATION OF SUBJECT MATTER
INV. H02J3/18 H02M1/42

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 G05F H02M

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 practical, search terms used)
EPO-Internal, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	HAMMERSTROM D J ET AL: "Controller Design of Power Quality-Improving Appliances" POWER ELECTRONICS SPECIALISTS CONFERENCE, 2007. PESC 2007. IEEE, IEEE, PI, 17 June 2007 (2007-06-17), pages 1164-1169, XP031218450 ISBN: 978-1-4244-0654-8 the whole document ----- -/--	1-9

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document 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
10 November 2008	19/11/2008

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	Braccini, Roberto

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2008/071703

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KEY T ET AL: "Comparison of standards limiting harmonic distortion in power systems" PROCEEDINGS OF THE INDUSTRIAL & COMMERCIAL POWER SYSTEMS TECHNICAL CONFERENCE. MEMPHIS, MAY 6 - 9, 1991; [PROCEEDINGS OF THE INDUSTRIAL & COMMERCIAL POWER SYSTEMS TECHNICAL CONFERENCE], NEW YORK, IEEE, US, vol. -, 6 May 1991 (1991-05-06), pages 57-62, XP010044722 ISBN: 978-0-7803-0021-7	

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: -

The initial phase of the search revealed a very large number of documents relevant to the issue of novelty. So many documents were retrieved that it is impossible to determine which parts of claims 1-9 may be said to define subject-matter for which protection might legitimately be sought (Article 6 PCT).

Moreover, the present claims 1-9 relate to an extremely large number of possible methods/apparatus. Support and disclosure in the sense of Article 6 and 5 PCT is to be found however for only a very small proportion of the methods/apparatus, see Figures 2, 4, 5 and 6 and corresponding passages of the description. The non-compliance with the substantive provisions is to such an extent, that the search was performed taking into consideration the non-compliance in determining the extent of the search of claims 1-9 (PCT Guidelines 9.19 and 9.23).

Independently of the above reasoning, present claims 1, 2, 3, 6 and 7 encompass methods/apparatus defined only by their desired property or effect, namely "correcting the other electrical load currents" and "improving a site's aggregate current". However, the description does not provide support and disclosure in the sense of Article 6 and 5 PCT for any such apparatus/method having the said property or effect and there is no common general knowledge of this kind available to the person skilled in the art.
In other words, claims 1, 2, 3, 6 and 7 do not meet the requirements of Article 6 PCT in that the matter for which protection is sought is not clearly defined. The claims attempt to define the subject-matter in terms of the result to be achieved (desideratum), which merely amounts to a statement of the underlying problem, without providing the technical features necessary for achieving this result.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.2), should the problems which led to the Article 17(2)PCT declaration be overcome.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2008/071703

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

see FURTHER INFORMATION sheet PCT/ISA/210

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.