SUPPLEMENTAL APPENDIX D

PART 19 OF 27

Europäisches Patentamt
European Patent Office
Office européen des brevets

European Patent Office
Postbus 5818
2280 HV Rijswijk
NETHERLANDS
Tel: +31 70 340 2040
Fax: +31 70 340 3016

Application No. : 17 150 670.2

Consultation by telephone with the applicant / representative

Despatch with a time limit of 1 month(s)

Participants

Applicant:	AMPT, LLC
Representative:	Kador & Partner PartG mbB
Member(s) of the Examining Division:	Van der Meer, Paul

Result of consultation

See Separate Sheet

29.10.2019
. . . . . .
Date

Van der Meer, Paul
. . . . . .
Examiner

Enclosure(s):

The examining division discussed minor outstanding issues with Dr. Eger of Kador & Partner legal representative of AMPT LLC.

1 *Embodiment versus example*

The description refers on page 11 lines 1 and 2 to embodiments disclosed in figures 4 and 7, and refers to figures 9a and 9b as some examples of this common timing signal for the embodiment of this embodiment, i.e. figure 7. The timing signals of figures 9a and 9b are strongly linked to the switches in example of figure 7 through their reference numbers (43-46). Since, figure 7 is disclosed in figure 1 of prior-art document **D1**, and figures 9a and 9b are disclosed in figures 2A-2C of prior-art document **D1**, to both of these figures can only be referred to as examples, since their subject matter falls outside the scope of the claims.

2 *Time limit*

It was agreed upon to set a 1 month time limit to finalize the required amendments to the description and the claims.

Europäisches Patentamt
European Patent Office
Office européen des brevets

European Patent Office
Postbus 5818
2280 HV Rijswijk
NETHERLANDS
Tel: +31 70 340 2040
Fax: +31 70 340 3016

Kador & Partner PartG mbB
Corneliusstraße 15
80469 München
ALLEMAGNE

Formalities Officer
Name: Dubret, Françoise
Tel: +31 70 340 - 3584
or call
+31 (0)70 340 45 00

EINGEGANGEN
09. Dez. 2019
KADOR & PARTNER

Application No.	Ref.	Date
17 150 670.2 - 1201	K 64 917/14sw	05.12.2019
Applicant: AMPT, LLC		

Communication under Rule 71(3) EPC

1. Intention to grant

You are informed that the examining division intends to grant a European patent on the basis of the above application, with the text and drawings and the related bibliographic data as indicated below.

A copy of the relevant documents is enclosed.

1.1 In the text for the Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

Description, Pages

1a	received on	30-11-2017	with letter of	30-11-2017
1-15, 46-48	filed in electronic form on			11-11-2019

Claims, Numbers

1-21	filed in electronic form on	11-11-2019

Drawings, Sheets

1/9-9/9	filed in electronic form on	27-08-2019

With the following amendments to the above-mentioned documents proposed by the division

Description, Pages

Delete Previous: 16-45, 49-57

Claims, Numbers 1, 12

Comments

DESCRIPTION
Pages 16-45: Description adapted to amended claims (Art. 84 EPC); removed examples of alternative claims since these render the scope of protection unclear.
Pages 49-57: (PAGE DELETED) -Deletion of irrelevant and/or superfluous information (Rule 48(1)(c) EPC, Guidelines F-II, 7.4)
CLAIMS
Pages 1, 3, CLAIMS 1, 12: Scope of claim unclear - clarified (Art. 84 EPC); missing essential feature: clarified how the magnetically coupled inductors (56) are connected to their respective DC-DC converter.
Page 1, Claim 1: Error(s) in spelling, grammar, typography corrected
Page 1, Claim 1: Insertion of reference signs in claims (Rule 43(7) EPC)

1.2 Bibliographic data

The title of the invention in the three official languages of the European Patent Office, the international patent classification, the designated contracting states, the registered name(s) of the applicant(s) and the other bibliographic data are shown on **EPO Form 2056** (enclosed).

2. Invitation

You are invited, **within a non-extendable period of four months** of notification of this communication,

2.1 to EITHER approve the text communicated above and verify the bibliographic data (Rule 71(5) EPC)

(1) by filing a translation of the claim(s) in the other two official languages of the EPO

	Fee code	EUR
(2a) by paying the fee for grant including the fee for publication:	**007**	925.00
minus any amount already paid (Rule 71a(5) EPC):		0.00
Total amount:		925.00
(3) by paying additional claims fees under Rule 71(4) EPC; number of claims fees payable: 0	**016**	0.00
minus any amount already paid (Rule 71a(5) EPC):		0.00
Total amount:		0.00

Important: If the translations of the claims and fees have already been filed and paid respectively in reply to a previous communication under Rule 71(3) EPC, e.g. in the case of resumption of examination after approval (see Guidelines C-V, 6), **agreement as to the text to be granted** (Rule 71a(1) EPC) must be expressed within the same time limit (e.g. by approving the text and verifying the bibliographic data, by confirming that grant proceedings can go ahead with the documents on file and/or by stating which translations of the claims already on file are to be used).

Note 1: See "Notes concerning fee payments" below.
Note 2: Any overpaid "minus" amounts will be refunded when the decision to grant (EPO Form 2006A) has been issued.

Note 3: For the calculation of the grant fee under Article 2(2), No. 7, RFees (old fee structure), the number of pages is determined on the basis of a clean copy of the application documents, in which text deleted as a result of any amendments by the examining division is not shown. Such clean copy is made available via on-line file inspection only.

2.2 OR, in the case of disapproval, to request reasoned amendments or corrections to the text communicated above or keep to the latest text submitted by you (Rule 71(6) EPC).

In this case the translations of the claims and fee payments mentioned under point 2.1 above are NOT due.

The terms "amendment(s)" and "correction(s)" refer only to amendments or corrections of the application documents and not of other documents (e.g. bibliographic data, the designation of the inventor, etc.).

If filing amendments, you must identify them and indicate the basis for them in the application as filed. Failure to meet either requirement may lead to a communication from the examining division requesting that you correct this deficiency (Rule 137(4) EPC).

2.3 Bibliographic data

Where you request a change or correction of bibliographic data in response to the Rule 71(3) communication, this will **not** cause the sending of a further communication under Rule 71(3) EPC. You will still have to pay the fees and file translations in reply to the Rule 71(3) communication in the case of 2.1 above, unless you also file a reasoned request for amendments or corrections in response to the Rule 71(3) communication (see case 2.2 above).

3. Loss of rights

If neither of the two possible actions above (see points 2.1 or 2.2) is performed in due time, the European patent application will be deemed to be withdrawn (Rule 71(7) EPC).

4. Further procedure

4.1 In the case of point 2.1 above

4.1.1 The decision to grant the European patent will be issued, and the **mention of the grant** of the patent will be published in the European Patent Bulletin, if the requirements concerning the translation of the claims and the payment of all fees are fulfilled and there is agreement as to the text to be granted (Rule 71a(1) EPC).

Note on payment of the renewal fee:
If a renewal fee becomes due before the next possible date for publication of the mention of the grant of the European patent, publication will be effected only after the renewal fee and any additional fee have been paid (Rule 71a(4) EPC).

Under Article 86(2) EPC, the obligation to pay renewal fees to the European Patent Office terminates with the payment of the renewal fee due in respect of the year in which the mention of the grant of the European patent is published.

Note on payment of the designation fee(s):
If the designation fee(s) become(s) due after the communication under Rule 71(3) EPC, the mention of the grant of the European patent will not be published until these fees have been paid (Rule 71a(3) EPC).

4.1.2 After publication, the **European patent specification** can be downloaded free of charge from the EPO publication server https://data.epo.org/publication-server.

4.1.3 Filing of translations in the contracting states

As regards translation requirements prescribed by the contracting states under Article 65(1) EPC, please consult the website of the European Patent Office
www.epo.org →Law & practice →Legal texts, National law relating to the EPC
www.epo.org →Law & practice →All Legal texts →London Agreement

In the case of a valid extension or validation

As regards translation requirements prescribed by the extension or validation states, please consult the website of the European Patent Office
www.epo.org →Law & practice →Legal texts, National law relating to the EPC

Failure to supply a prescribed translation in a contracting state, or in an extension or validation state may result in the patent being deemed to be void *ab initio* in the state concerned (Art. 65(3) EPC).

4.2 In the case of 2.2 above

If the present communication under Rule 71(3) EPC is based on an auxiliary request and, within the time limit, you maintain the main request or a higher ranking request which is not allowable, the application will be refused (Art. 97(2) EPC).

If the examining division gives its consent to the requested amendments or corrections, it will issue a new communication under Rule 71(3) EPC; otherwise, it shall resume the examination proceedings (Rule 71(6) EPC).

5. Filing of a divisional application

Any divisional application relating to this European patent application must be filed directly with the European Patent Office in Munich, The Hague or Berlin and will be in the language of the proceedings for the present application, or if the latter was not in an official language of the EPO, the divisional application may be filed in the language of the present application as filed (see Article 76(1) and Rule 36(2) EPC). Any such divisional application must be filed while the present application is still pending (Rule 36(1) EPC; Guidelines A-IV, 1.1.1).

6. Notes concerning fee payments

6.1 Making payments

For payments made via deposit account, please note that as from 1 December 2017 debit orders will only be carried out if filed in an electronically processable format (xml), using an accepted means of filing as laid down in the Arrangements for deposit accounts (ADA), published in the Supplementary publication in the Official Journal.

All relevant information related to the modes of payment of fees to the EPO can be retrieved from the EPO website at "**Making Payments**".

6.2 Information concerning fee amounts

Procedural fees are usually adjusted every two years, on even years, with effect from 1 April. Therefore, before making a payment, parties should verify the amounts actually due on the date of payment using the applicable version of the Schedule of fees and expenses, published as a Supplement to the Official Journal of the EPO, available on the EPO website (**www.epo.org**) at **www.epo.org/schedule-of-fees**. The "Schedule of fees" table allows the viewing, downloading and searching of individual fee amounts, both current and previous.

6.3 Note to users of the automatic debiting procedure

The fee for grant, including the fee for publication, and any additional claims fees due under Rule 71(4) EPC will be debited automatically on the date of filing of the translations of the claims, or on the last day of the period of this communication. However, if the designation fee(s) become(s) due as set out in Rule 71a(3) EPC and/or a renewal fee becomes due as set out in Rule 71a(4) EPC, these should be paid separately by another permitted way of payment in order not to delay the publication of the mention of the grant. The same applies in these circumstances to the payment of extension and validation fees. The same applies in these circumstances to the payment of extension and validation fees.

Note: If a waiver is expressed in response to a Rule 71(3) communication (see OJ EPO 2015, A52), the fee for grant, including the fee for publication/printing, and any additional claims fees will not be debited automatically. These fees must be paid separately by another means of payment allowed under the Rules relating to Fees.

Examining Division:

Chairman:	Standaert, Frans
2nd Examiner:	Zeljkovic, Sandra
1st Examiner:	Van der Meer, Paul

Europäisches Patentamt • European Patent Office • Office européen des brevets

Dubret, Françoise
For the Examining Division
Tel. No.: +31 70 340 - 3584 **Branch at The Hague**

Enclosures: Text intended for grant

EPO Form 2056

Europäisches Patentamt
European Patent Office
Office européen des brevets

European Patent Office
Postbus 5818
2280 HV Rijswijk
NETHERLANDS
Tel: +31 70 340 2040
Fax: +31 70 340 3016

Annex to EPO Form 2004, Communication pursuant to Rule 71(3) EPC

Bibliographical data of European patent application No. 17 150 670.2

For the intended grant of the European patent, the bibliographical data are set out below, for information:

Title of invention:	- HOCHEFFIZIENTES UND VERSCHACHTELTES SOLARSTROMVERSORGUNGSSYSTEM - HIGH EFFICIENCY INTERLEAVED SOLAR POWER SUPPLY SYSTEM - SYSTÈME D'ALIMENTATION ÉLECTRIQUE SOLAIRE ENTRELACÉ DE HAUT RENDEMENT
Classification:	INV. H02M1/00 H02J3/38 H02M7/49 ADD. H02N10/00 H02M3/158
Date of filing:	15.03.2013
Priority claimed:	
Contracting States* for which fees have been paid:	AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Extension States* for which fees have been paid:	
Validation States* for which fees have been paid:	
Applicant(s):**	AMPT, LLC 4850 Innovation Drive Fort Collins, CO 80525 US
Inventor(s):	Ledenev, Anatoli 719 Parliament Ct. Fort Collins, CO Colorado 80525 US

*) If the time limit for the payment of designation fees according to Rule 39(1) EPC has not yet expired and the applicant has not withdrawn any designation, **all Contracting States/Extension States/Validation States** are currently still deemed to be designated. See also Rule 71a(3) EPC and, if applicable, the above Note to users of the automatic debiting procedure.

**) If two or more applicants have designated different Contracting States, this is indicated here.

HIGH EFFICIENCY INTERLEAVED SOLAR POWER SUPPLY SYSTEM

I. TECHNICAL FIELD

The present invention focuses on the field of providing solar power including but not limited to residential and commercial power systems and arrays. In particular it relates to processes, devices, and circuitry that can provide such power in a more efficient manner. It also can find application in general power systems that have some of the more fundamental attributes of solar power sources with the same effects.

II. BACKGROUND

The value of solar power for society has been known for many years. It offers clean energy but requires harnessing the energy and feeding it into electrical grid or other load. Efficiency in generation is of particular interest. One aspect that has proven particularly challenging is the ability to harvest the energy efficiently across the entire power spectrum desired. Because the influx of solar energy can vary and because the photovoltaic effect itself can vary, electrical challenges exist that to some degree remain. In addition to the technical issues, regulatory limits such as desirable for safety and the like can also pose challenges. In addition, the combination of photovoltaic sources such as in the strings of panels or the like combines to make efficient harvesting of the energy an issue. As an example, an interesting fact that is frequently under the current technology the most efficient generation of power (likely at the highest voltage after conversion) is a situation where no substantial power is delivered. This seeming paradox is an issue that remains challenging for those in the field. Similarly the desire to generate more and more power such as through larger strings of panels has become an issue due to regulatory limits and the like.

The present invention provides circuits and methods through which many of these challenges can be reduced or even eliminated. It provides designs with unusual efficiency in power generation and provides considerable value to those desiring to utilize solar or other power sources efficiently.

EP 2 515 424 A2 is concerned with a DC-DC converter. The converter has a primary half-bridge which is connected in parallel to a primary terminal and is provided with a series circuit comprising switching elements. A secondary half-bridge is connected in parallel to a secondary terminal and is provided with a series circuit comprising switching elements.

Switching circuits for extracting power from an electric power source is disclosed in US 2012/0043818 A1. Each switching circuit includes an input port electrically coupled to a respective one of an electric power source, an output port, and a first switching device adapted to switch between its conductive and non-conductive states to transfer power from the input port to the output port.

US 2003/0218449 discloses methods and circuitry for combining the outputs of multiphase power converters.

A control device for a switching arrangement with a direct current source feeding a load through a semiconductor rectifier regulator unit having two controllable semiconductor rectifier elements of identical conductance direction as part of the regulator unit is disclosed in US 4,634,943.

Solar power circuits seeking to reduce or eliminate the risk of damage to components of photovoltaic power circuits are disclosed in US 2011/0210611 A1. In certain embodiments, diodes are used to prevent reverse current flow.

EP 0 383 971 relates to a supply circuit for a multi-system locomotive. The supply circuit contains a first and second power converter which are each connected in an electrically conductive manner to a first and second inverter by means of a first and second intermediate circuit capacitor.

Different systems to achieve solar power conversion with circuitry that can be used to harvest maximum power from a solar source or strings of panels for DC or AC use are disclosed in TW 2010037958.

Miwa et. Al in "High Efficiency Power Factor Correction Using Interleaving Techniques", Proceedings of the Annual Applied Power Electronics Conference and Exhibition, Feb. 23-27, 1992, p. 557-568 studies a highly efficient power factor correction converter for computer applications.

III. DISCLOSURE OF INVENTION

Accordingly, the present invention includes a variety of aspects, circuits, and processes in varied embodiments which may be selected in different combinations to suit differing needs and achieve various goals. It discloses devices and methods to achieve unusually high efficiency solar and other power delivery in a way that is more beneficial to a variety of loads. The embodiments present some initial ways to achieve high efficiency power delivery or generation and show the general understandings which may be adapted and altered to achieve the following and other goals. Of course, further developments and enhancements may be possible within keeping of the teachings of the present invention.

As stated, one of the basic goals of embodiments of the invention is to provide highly efficient solar and other power generation. It can provide efficient power converters and other circuitry which can achieve this goal in multiple ways.

Another goal of embodiments of the invention is to be able to provide enhanced strings of power sources such as may be found in a power array or other solar installation or the like.

Yet another goal of embodiments of the invention is to provide better operational efficiency over all power generation regimes. In keeping with this goal, another aspect is to provide higher operational voltage that can be closer to, but not exceeding, the regulatory or other limit across all power generations situations.

Still another goal of embodiments of the invention is to provide lower inductance, low capacitance, and lower energy storage both at the input and output levels. A similar goal is to provide lesser ripple in outputs for electrical circuitry operating on solar and other power sources.

Naturally other goals of the invention are presented throughout the specifications and claims.

IV. BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a schematic of circuitry as configured for a phased interleave embodiment of the present invention.

Figures 2a and 2b are timing diagrams to achieve control according to various embodiments of the present invention.

Figure 3 is an efficiency related type of value diagram conceptually comparing several operational modes of the present invention with some traditional systems.

Figure 4 is a schematic of circuitry as configured for a tapped coupled inductor embodiment of a phased interleave design for the present invention.

Figure 5 is a schematic of tapped coupled inductor circuitry as configured for a portion of an additive string voltage embodiment of the present invention.

Figure 6 is a schematic of circuitry as configured for one interpanel configuration embodiment of the present invention.

Figure 7 is a schematic of circuitry as configured for one more phased string example.

Figure 8 is a conceptual diagram of boundary controlled modes of the present invention.

V. MODE(S) FOR CARRYING OUT THE INVENTION

As mentioned earlier, the present invention includes a variety of aspects, which may be combined in different ways. The following descriptions are provided to list elements and describe some of the embodiments of the present invention. These elements are listed with initial embodiments, however it should be understood that they may be combined in any manner and in any number to create additional variations. The variously described examples and preferred embodiments should not be construed to limit the present invention to only the explicitly described systems, techniques, and applications. Further, this description should be understood to support and encompass descriptions and claims of all the various embodiments, systems, techniques, methods, devices, and applications with any number of the disclosed elements, with each element alone, and also with any and all various permutations and combinations of all elements in this or any subsequent application.

As shown in figure 1, solar power generation can involve accepting one more sources of power (1) such as may be generated by one or more individual photovoltaic sources (2). As is well known, the photovoltaic source can be a solar panel (19)(as shown in figure 6) or even individual solar cells (20)(also as shown in figure 6). In figure 1, the sources (2) can be aggregated to create one conceptual photovoltaic source of power (1). The individual output (3) from one of the photovoltaic sources (2) may be a DC power output. This DC power output (3) can be converted into a modified version of DC power. This may, but need not occur at the module level, such as by a module or other type of converter which is not shown but which could, but need not exist for each panel (19) or each photovoltaic source (2). Such a converter may be configured to

operate on or with individual panels or modules and can control power harvesting to achieve individual maximum power point operation as is known.

As mentioned, in an embodiment of the present invention such as shown in figure 1, the output of a collection of solar panels or more generally sources (2) can be aggregated to create one conceptual photovoltaic source of power (1). This, perhaps aggregated, source of power, also a DC power output, and here considered a first photovoltaic source of power (5), may be further handled or converted by a DC-DC photovoltaic converter, perhaps here shown as a base phase DC-DC photovoltaic converter (6) to provide a base phase switched output (71).

Similarly, another aggregated source of power, here considered a second photovoltaic source of power (7), may also be converted by a DC-DC photovoltaic converter, here shown as an altered phase DC-DC photovoltaic converter (8) to provide an altered phase switched output (72). Both the base phase DC-DC photovoltaic converter (6) and the altered phase DC-DC photovoltaic converter (8) can have their outputs combined through combiner circuitry (9), to provide a conversion combined photovoltaic DC output (10). In addition, both the base phase DC-DC photovoltaic converter (6) and the altered phase DC-DC photovoltaic converter (8) can be similarly controlled, such as through a synchronous phase control (11) that synchronously operates switches or the like in the two converters so their operations are switch timing responsive in sync with each other, whether opposing or otherwise. Both the base phase DC-DC photovoltaic converter (6) and the altered phase DC-DC photovoltaic converter (8) can be considered combined as together presenting a low photovoltaic energy storage DC-DC photovoltaic converter (15) which can act on two sources or power (1) and can provide a low photovoltaic energy storage DC output (65). These outputs may be combined to present an array or other enhanced low photovoltaic energy storage DC output (66).

In typical applications, it is common for the conversion combined photovoltaic DC output (10) to be provided as an input to a load, shown as a photovoltaic DC-AC inverter (12) as but one possibility. The photovoltaic DC-AC inverter (12) can provide a photovoltaic AC power output (13). This may be connected to a grid or the like. As also shown, strings of such power can be connected in parallel (14) to provide greater power to the photovoltaic DC-AC inverter (12). It is also possible to provide an integrated system such as by having both the low photovoltaic energy storage DC-DC photovoltaic converter (15) and the photovoltaic DC-AC inverter (12) integrated to present a combined high efficiency DC-DC-AC photovoltaic converter (16).

In operation, the system can accept first power from the first photovoltaic source of power (5), accomplish base phase DC-DC conversion to create a base phase DC power delivery through the base phase DC-DC photovoltaic converter (6). In similar fashion accepted power from a second source of power such as the second photovoltaic source of power (7) can be converted through an altered phase DC-DC converting process to provide and create an altered phase DC power delivery. Both the base phase DC-DC photovoltaic converter (6) and the altered phase DC-DC photovoltaic converter (8) can have switches to achieve their operations. These switches can be controlled by some type of controller perhaps a synchronous phase control (11). The output of the altered phase DC power delivery and the base phase DC power delivery can be combined to achieve the mentioned conversion combined photovoltaic DC output (10).

To allow for greater power generation, it is possible that the process of combining the different power deliveries can involve the process of series combining the power deliveries. The combiner circuitry (9) can be configured as series power configured circuitry so that voltage or the like of the two power generators are added. As discussed later in reference to figures 4, 6, and 7, it can be understood that the combiner circuitry (9) can involve one or more of either or both an inductance and/or a capacitance. These elements can be configured to have unusually low energy storage requirements for a photovoltaic system, and so the present invention can achieve unusually low input and output converter energy storage as discussed later. In such a configuration, the circuitry can be considered as involving a low photovoltaic energy storage inductor (17) and/or a low photovoltaic storage capacitor (18) of which the low photovoltaic energy storage DC-DC converter (59) is comprised. When configured as a series power combining circuit, the combiner circuitry (9) can present additive voltage circuitry that adds the output voltage of one power supply such as the base phase switched output to the output voltage of another power supply such as the altered phase switched output. The step of adding voltage can allow greater power generation or delivery efficiency while not exceeding the regulatory limits as mentioned earlier. It can also be achieved by low inductance adding of the voltages through the teachings of the present invention.

As mentioned, the converters can be based on a switch-mode type of operation. Such converters can have a number of different switches through which operations can achieve the desired goals. Varying types of converters are shown in different embodiments of the present invention. As shown in figures 4, 5, 6, and 7, the converters can have switches (e.g., 21-46) that can be

controlled to achieve the desired goals. This control can be specific to embodiments of the present invention and can be an important aspect in achieving the goals as desired as well as an important difference in operation as compared to previous similar circuitries. Further, some of the switches such as those labeled (44 & 45 and the like) can be active switches, diodes, or even a combination of diodes with an active switch. The affirmative control of the switches can be by the synchronous phase control (11) as mentioned earlier. As shown in Figure 1, one literal or conceptual synchronous control can activate multiple converters so that their switches are synchronous in operation. Naturally, two or more separate controls with a common timing can be used as long as their clock cycles are common so that the two converters are operated under one timing mode.

Control can be by duty cycle controlling the switches in the converters. A duty cycle controller (51) can be provided common to both converters as shown, and as such it can be considered a common duty cycle controller to achieve the step of common duty cycle control so that switches in the two converters can be operated synchronously according to desired schedules. By providing a common controller or at least synchronously controlling the converters, embodiments of the invention can be considered as providing a common timing signal for switch operation. This common timing signal can specifically cause modes of operation in accordance with the invention. For example, figures 2a and 2b show some examples of this common timing signal for the tapped magnetically coupled inductor embodiments of the invention such as shown in figure 4. In these figures, a roughly 25% (figure 2b) and 12½% (figure 2a) duty cycle operation is conceptually presented showing the operation of switches (21-28) as indicated. Although not shown, operation from 0% to 100% is possible, of course. As may be understood in the context of comparing the operations of switches (21 & 24), switches (26 & 27), switches (22 & 23), and switches (25 & 28) the synchronous and opposing modes of control can be seen. These switches can be sequentially operated so that the outputs of each converter oppose each other and switched at different times. As may be appreciated from figure 2b, this can offer advantages such that the opposing modes of operation can compensate for and offset an effect of each other in the combiner circuitry (9) and thus allow lower energy storage and more efficient operation. By presenting an opposing phase controller (52), embodiments of the invention can be configured such that one converter is on, generating power, active or the like when another is off or the like and vice versa. Through such affirmative control of switches, opposing phase

controlling of the step of converting the power can achieve the reductions in energy storage as well as reduced ripple and other advantages. This opposing phase controller (52) can be diametrically opposing such as by providing a 180^0 photovoltaic converter switch controller and 180^0 photovoltaic converter switch controlling the DC output or the converters as shown. In this fashion the converter components can deliver power according to an interleaved schedule or process to effect advantages mentioned.

Similarly, by the interleave design, advantages can also be achieved. This can the understood conceptually with reference to figure 3 with the bottom axis representing the percentage of duty cycle operation. Perhaps non-quantitatively, figure 3 can be understood as representing an efficiency type of value across the duty cycles ranges. It also compares one traditional operation with some of the improved modes of operation. In the previous systems, converters may have presented efficiency (or more appropriately inefficiency) across a 0% to 100% duty cycle range as shown conceptually in figure 3 by the curve labeled (53). By understanding that for some values and in some instances the figure 3 conceptual plot can be considered as presenting inefficiency or even a conversion energy along a vertical axis, it can be seen that significant inefficiency exists for many traditional systems at anything other than the 0% and 100% duty cycle areas. From this, it can be conceptually understood that in many traditional operating modes (designs with a full duty cycle energy configuration), converters were often least efficient at a midpoint of operation. They were most efficient at the 0% duty cycle of operation (no power) and also at the 100% duty cycle mode of operations (no conversion) but these can be less significant from a conversion perspective. Thus as those skilled in the art well understood, during the most significant situations of power generation or at least delivery, such as in the 50% to 100% duty cycle range of operation – often the most common locations -- the converter was on average not that efficient. For example, for a maximum 60 volt panel output, a more traditional, full cycle ripple energy converter could provide an output ranging from 0 to 60 volts. At 0% duty cycle (0 volts), there was no power delivered; at 50% duty cycle there was power but at worst efficiency; at 100% there was no conversion achieved. Embodiments of the present invention show that this mode of operation can be improved upon. As explained later, entire efficiency is enhanced by the phased modes of operation now available through the present invention.

With respect to the curve labeled as (54), one can understand that this particular mode shows operation of embodiments designed to achieve a half duty cycle energy configuration. As may be conceptually understood from this plot, the efficiency can be improved (inefficiency reduced) through embodiments of the present invention. Similarly in the curve labeled (55), an operation mode using a half duty cycle energy configuration with or without the phased operational mode can be understood. As shown, even further advantages can be achieved (this may not be available for some of the embodiments of the present invention). Even the aspect of varying the voltage across all operational regimes is changed for embodiments of the present invention. Output voltage does not vary in this manner for the present invention, it remains relatively constant and so a high delivery voltage (itself a more efficient way to deliver power) can be achieved.

Figure 3 can be considered as indicating amount of ripple such as through the low photovoltaic storage energy inductor (17) or the like, ripple current storage energy, and even the sweet spot character across the various duty cycles. The number of sweet spots available in operation, with substantial power delivery, for the high efficiency conversion operations according to the present invention is improved. Sweet spots (highest practical efficiency and/or relatively little or no inefficiency) can be understood to exist at locations on the plot where it touches the bottom axis. A sweet spot can exist for some traditional circuitry at 0% and 100% of operation. Unfortunately, these are often locations of least interest as they may be less common or at least may not involve substantial power delivery. In embodiments of the present invention, sweet spots can exist at 50% and 100% or even at 25% and 50%. Through such designs and mode of operation, embodiments can thus provide an augmented sweet spot photovoltaic output. These augmented sweet spots can now exist even at substantial power conversion locations of operation and can be an effect caused by the new opposing phase mode of operational control by the synchronous control (11). As shown in figure 3, for embodiments of the present invention, a sweet spot can now exist even at locations where significant power conversion occurs, not just at extremes of operational modes as in many traditional designs. Thus, the invention can provide a converted power generation or delivery sweet spot photovoltaic output as well as an augmented sweet spot photovoltaic output. As is well known, solar panels can have temperature effects; they generate power differently in different temperature conditions, and to a significant extent the variation in duty cycle can be due to this (as well as partial shading, etc.). In fact, the

depiction in figure 3 can be considered as indicating a temperature effect with a hot temperature power generation condition more likely at the 100% duty cycle and a cold temperature power generation condition more likely at the 50% duty cycle for maximum power harvesting. For many traditional systems operation at a colder temperature had a mode of relatively lower conversion efficiency. Through embodiments of the invention, high efficiency can exist at such reduced temperature power generation conditions and the invention can thus present a photovoltaically reduced temperature condition sweet spot photovoltaic output. For certain designs, it can even present a cold operational regime sweet spot photovoltaic output. As shown in figure 3, for embodiments of the present invention, a sweet spot can exist at the 50% duty cycle range rather than a poorly efficient level of power delivery, not just a top as in many traditional designs and so the invention can provide a cold operational regime sweet spot photovoltaic power output.

As mentioned above, converters may be affirmatively switched to achieve best modes of operation. A variety of converter topologies are possible and several are shown in the figures. Figure 5 shows a particular type of converter as applied to an individual panel that has a tapped magnetically coupled inductor element (56). This is one example of a tapped magnetically coupled inductor arrangement. As shown the tapped magnetically coupled inductor element (56) has an inductor tap (57). This embodiment is affirmatively switched through switches (31 through 42) for the various converters as shown in figure 5. These switches are activated by a duty cycle controller (51) to which the converter is switch timing responsive. As shown, this converter can include two pairs of series switches (e.g., 31 & 33)(32 & 34) connected at midpoints (58) at which the tapped magnetically coupled inductor element (56) is connected.

Each low photovoltaic energy storage DC-DC photovoltaic converter (59) can include its own low photovoltaic energy storage inductor (60) and low energy storage output capacitor (61) so as to provide a low photovoltaic inductance DC output (62). Figure 5 shows multiple applications of the tapped magnetically coupled inductor arrangements whereby each converts its own power output, perhaps such as from a solar panel (19). These converted, high efficiency photovoltaic outputs (62) may be series combined as shown to present an output string. Only a portion of a typical string is depicted. Often numerous panels are combined to approach the maximum allowed operating voltage. In this embodiment, however, an excess voltage arrangement can be configured. By using a half duty cycle energy configuration and individual power source

conversion as shown, the string can be configured to provide a double maximum voltage arrangement such that a maximum regulatory or other allowed output can be one-half of the theoretically available panel voltage output. To stay under the maximum amount, the output can be boundary limited by including a photovoltaic boundary output controller (63) which may be part of each individual duty cycle controller, as depicted, or which may be conceptually a collective control for all converters in the string. For configurations applying a quarter duty cycle energy configuration and the individual power source conversion as shown, the string can even be configured to provide a quadruple maximum voltage arrangement such that a maximum regulatory or other allowed output can be one-quarter of the theoretically available panel voltage output. Additional duty cycle energy options (one-eighth, one-tenth, etc.) are also possible, of course. Again, a photovoltaic boundary output controller (63) can be included. Importantly, even with this boundary limitation, power is still harvested efficiently. Embodiments of the invention can be extremely efficient as compared to traditional designs. In fact, the invention can present a photovoltaic output that is at least about 98%, 99%, and 99.5% efficient from the perspective of its conversion process across a duty cycle range (averaged across the range of operation, an occurrence-based range of delivery, or a range of typical expected operation). It can even approach only wire losses in delivering power. Traditional designs rarely can achieve this level of efficiency.

For embodiments utilizing phased operational modes, interconnection and operation such as shown in figure 4 can be achieved. In this embodiment, the two pairs of series switches (e.g., 21 & 23)(22 & 24) connected at midpoints (58), can have the output from the tapped magnetically coupled inductor element (56) combined such as through the low photovoltaic energy storage inductor (17) so as to provide a low photovoltaic inductance DC output (64), and also a low energy storage output capacitor (18) to present another type of low photovoltaic energy storage DC-DC photovoltaic converter (59). In similar fashion to that of the individual panel conversion design of figure 5, the arrangement of figure 4 can also have an excess voltage arrangement. Such configurations can be of a half duty cycle energy configuration and so a half duty cycle controller can be used with the converted string configured to provide a double maximum voltage arrangement. In this configuration, again, to stay under the maximum amount, the output can be boundary limited by including a photovoltaic boundary output controller (63).

Embodiments such as the phased converter shown in figure 4 can also be achieved through a buck power converter appearing arrangement such as shown in figure 7. In this example circuitry resembling two buck DC-DC power converters can be used to create one high efficiency converter such as the low photovoltaic energy storage DC-DC photovoltaic converter (15) shown. In this example two pairs of series switches (43 & 44)(45 & 46) connected at midpoints (67) can have the output from the switched element combined such as through the low photovoltaic energy storage inductor (17) so as to provide a low photovoltaic inductance DC output (62), and also a low energy storage output capacitor (18) to present the low photovoltaic energy storage DC-DC photovoltaic converter (15). Figures 9a and 9b show some examples of this common timing signal for this example. In these figures, a roughly 50% (figure 9a) and 75% (figure 9b) duty cycle operation is conceptually presented showing the operation of switches (43-46) as indicated. Again, although not shown, operation from 0% to 100% is possible, of course. As may be understood in the context of comparing the operations of switches (43 & 44) and switches (46 & 45), the synchronous and opposing modes of control can be seen. These switches can be sequentially operated so that the outputs of each converter oppose each other and are switched at different times. As with figures 2a and 2b, this also offer advantages such that the opposing modes of operation can compensate for and offset an effect of each other in the combiner circuitry (9) and thus allow lower energy storage and more efficient operation.

As mentioned earlier, embodiments of the invention can operate at high operational voltages. Whereas in most, more traditional systems, output efficiency varied across the operational regime as shown in the curve (53) in figure 3, in embodiments of the present invention, the output can be relatively stable. As also indicated conceptually in figure 3 when considering the vertical axis as a type of ripple indication, mainly just the ripple varies – and even this is at a lower level of ripple than previous. The output voltage can be controlled to be relatively constant across all operational regimes without any compromise in power delivery. In fact, not only is there no loss in power delivery, the present invention can achieve higher power delivery. By utilizing a phased operational mode, this power output voltage such as present at the enhanced low photovoltaic energy storage DC output (66)(for the embodiment in figure 1), low photovoltaic inductance DC output (64)(for the embodiment in figure 4), and high efficiency photovoltaic outputs (62)(for the embodiment in figure 5 and the example in figure 7) can be a high multi operational

regime output such that it is, at least in a photovoltaic sense, at a relatively high voltage or the like in any or even across all operational conversion regimes where substantial power is delivered. The high multi operational regime output can even be a high average photovoltaic voltage output (averaged across the range of operation, an occurrence-based range of delivery, or a range of typical expected operation). This high average photovoltaic voltage output or high multi operational regime output can be controlled to be near or even at the maximum desired or allowable for enhanced efficiency, perhaps less some guard band tolerance. Thus, embodiments can be configured or controlled to achieve an at least about 80%, 90%, or even 95% or more of a maximum voltage photovoltaic output across a typical operational range.

Beyond merely the level of voltage, embodiments can also present particular levels of high efficiency such as at sweet spots or the like. Considering the diagram of figure 3 as conceptually depicting temperature effect with a hot temperature generation at or near the 100% duty cycle and cold temperature operation at or near the 50% duty cycle, it can be understood that most significant, nominal operation will often occur in the 50% to 100% range. As discussed above with respect to the sweet spots shown conceptually in figure 3, designs can present dual nominal operational range high efficiency photovoltaic power outputs where sweet spot operation exists at two substantial power delivery locations. This is shown conceptually in figure 3 at 50% & 100% for the embodiments characterized as the half duty cycle energy configuration embodiments, and at 50%, 75%, and 100% for the embodiments characterized as the quarter duty cycle energy embodiments. Similarly, embodiments can be considered as presenting at least one high efficiency converted power generation or delivery mode photovoltaic output such as those referenced above and may even provide a two or dual high efficiency spots at which power conversion or delivery occurs.

In providing a low inductance output or low energy storage conversion, both the energy storage experienced at an input and at an output can be unusually low, at least from a photovoltaic perspective. Input inductance can be particularly low for the module level converter designs. This can be significant and can benefit the applied load perhaps such as the photovoltaic DC-AC inverter (12). Through proper coordination, this can offer advantages and can even encourage the use of the integrated design such as the combined high efficiency DC-DC-AC photovoltaic converter (16) design shown in figure 1.

As previously mentioned, a low energy storage converter, perhaps comprising a low energy storage, a low energy inductance, and/or a low energy capacitance, are advantages of the present invention. Recalling that figure 3 can be viewed as conceptually indicating the amount of ripple current storage energy across the duty cycle range, it can be understood that the amount of storage energy is significantly reduced through embodiments of the present invention. Whereas traditional systems indicate significant energy storage needs equivalent to a full cycle of ripple energy (as suggested by the peak height of curve (53) at 50%), in embodiments of the present invention, this energy can be considerably reduced by half or even a quarter as shown. Specifically, for a 50% to 100% design shown by curve (54), the peak height at 25% and 75% is about one-half the amount of energy storage indicated for a traditional system with equivalent switching frequency, equivalent types of switches, and the like. Similarly, for a 25% to 50% design shown by curve (55), the peak height at about 12½%, 37½%, etc. is about one-quarter the amount of energy storage indicated for a traditional system. The reduced values of conversion energy storage, inductance, and capacitance can be achieved at these reduced levels. Thus, for the embodiments characterized as the half duty cycle energy configuration embodiments, such designs can have a not more than about one-half duty cycle range ripple current photovoltaic energy storage converter, a not more than about one-half of traditional photovoltaic energy storage converter, a not more than about one-half duty cycle range ripple current photovoltaic energy storage inductor, a not more than about one-half of traditional photovoltaic energy storage inductor, a not more than about one-half duty cycle range ripple current photovoltaic energy storage capacitor, and a not more than about one-half of traditional photovoltaic energy storage capacitor. Similarly, for the embodiments characterized as the quarter duty cycle energy configuration embodiments, such designs can have a not more than about one-quarter duty cycle range ripple current photovoltaic energy storage converter, a not more than about one-quarter of traditional photovoltaic energy storage converter, a not more than about one-quarter duty cycle range ripple current photovoltaic energy storage inductor, a not more than about one-quarter of traditional photovoltaic energy storage inductor, a not more than about one-quarter duty cycle range ripple current photovoltaic energy storage capacitor, and a not more than about one-quarter of traditional photovoltaic energy storage capacitor. Similar aspects can exist for other embodiments (one-eighth, one-tenth, etc.) This can allow greater power delivery to the load such as the photovoltaic DC-AC inverter (12) or the like.

A further embodiment of the invention is illustrated in figure 6. In this design, an individual panel (19) can be enhanced by providing an interpanel or other conversion design that may be integral to, attached to, or provided with the panel (19). In this embodiment, multiple photovoltaic power cells (20) can be aggregated perhaps conceptually to present a solar panel (19) perhaps in its own assembly. The solar panel (19) power delivery can be conceptually split at some point and so there can be at least one split panel DC-DC photovoltaic converter (68). As discussed above, this can actually be comprised of two converters, perhaps such as a base phase DC-DC photovoltaic converter (6) and the altered phase DC-DC photovoltaic converter (8). These converters can have their outputs combined through combiner circuitry to provide a conversion combined photovoltaic DC output and this type of combiner circuitry can be configured as an interpanel photovoltaic cell addition circuitry (70).

The split panel DC-DC photovoltaic converter (68) can have affirmative switches as shown, that may be controlled by an internal or external duty cycle controller (51) to provide a high efficiency (or low energy storage or low inductance) photovoltaic DC output (69). Again this can be configured as to have a tapped magnetically coupled inductor arrangement or a buck converter appearing arrangement. Each can include a low photovoltaic energy storage inductor (17), a low photovoltaic inductance DC output, and a low energy storage output capacitor (18) as discussed above. This type of low photovoltaic energy storage DC-DC photovoltaic converter (59) can achieve the advantages discussed above. It may or may not require a photovoltaic boundary output controller.

As shown in figure 8, for those embodiments of any of the above that include a photovoltaic boundary output controller (63), it may be understood that this controller can control voltage (73), current (74), maximum power point (75), power delivery (perhaps even by over voltage boundary control to regulate the output power), or other aspects that may need to be limited such as to meet regulatory concerns or the like. This may, of course, exist for high temperature operation (76) or low temperature operation (77). Voltage control can be the most important for regulatory and other reasons, and so embodiments can present some controller as a photovoltaic output voltage limit controller. The photovoltaic boundary output controller (63) can limit output at a boundary hierarchally, that is with an ordered decisional process as to which limit applies and overrides other limits as well. This control can also be optimized for the inverter, inverter input sweet spot control, or otherwise. Some such levels are shown in figure 8. Inverter

optimization control can be provided as one way of achieving converter operation that is optimized for a load, perhaps such as a photovoltaic DC-AC inverter (12). As such, embodiments may include (again, separately or as part of an existing controller or control software) a photovoltaic inverter optimized converter controller.

As mentioned above, the above converter and other inventive designs can be applied to a wide range of power situations. Almost any varying source of power can be enhanced by such power conversion and control. These powers can be consumer power, industrial power, individual consumer or such device or battery power, and even large scale grid power sources, and all such applications should be understood as encompassed within the present application and disclosure.

As can be easily understood from the foregoing, the basic concepts of the present invention may be embodied in a variety of ways. It involves both conversion techniques as well as devices to accomplish the appropriate conversion. In this application, the conversion techniques are disclosed as part of the results shown to be achieved by the various devices described and as steps which are inherent to utilization. They are simply the natural result of utilizing the devices as intended and described. In addition, while some devices are disclosed, it should be understood that these not only accomplish certain methods but also can be varied in a number of ways. Importantly, as to all of the foregoing, all of these facets should be understood to be encompassed by this disclosure.

The discussion included in this application is intended to serve as a basic description. The reader should be aware that the specific discussion may not explicitly describe all embodiments possible; many alternatives are implicit. It also may not fully explain the generic nature of the invention and may not explicitly show how each feature or element can actually be representative of a broader function or of a great variety of alternative or equivalent elements. Again, these are implicitly included in this disclosure. Where the invention is described in device-oriented terminology, each element of the device implicitly performs a function. Apparatus claims may not only be included for the device described, but also method or process claims may be included to address the functions the invention and each element performs. Neither the description nor the terminology is intended to limit the scope of the claims that will be included in any subsequent patent application.

It should also be understood that a variety of changes may be made without departing from the essence of the invention. Such changes are also implicitly included in the description. They still fall within the scope of this invention. A broad disclosure encompassing the explicit embodiment(s) shown, the great variety of implicit alternative embodiments, and the broad methods or processes and the like are encompassed by this disclosure and may be relied upon when drafting the claims for any subsequent patent application. It should be understood that such language changes and broader or more detailed claiming may be accomplished at a later date (such as by any required deadline) or in the event the applicant subsequently seeks a patent

filing based on this filing. With this understanding, the reader should be aware that this disclosure is to be understood to support any subsequently filed patent application that may seek examination of as broad a base of claims as deemed within the applicant's right and may be designed to yield a patent covering numerous aspects of the invention both independently and as an overall system.

Further, each of the various elements of the invention and claims may also be achieved in a variety of manners. Additionally, when used or implied, an element is to be understood as encompassing individual as well as plural structures that may or may not be physically connected. This disclosure should be understood to encompass each such variation, be it a variation of an embodiment of any apparatus embodiment, a method or process embodiment, or even merely a variation of any element of these. Particularly, it should be understood that as the disclosure relates to elements of the invention, the words for each element may be expressed by equivalent apparatus terms or method terms -- even if only the function or result is the same. Such equivalent, broader, or even more generic terms should be considered to be encompassed in the description of each element or action. Such terms can be substituted where desired to make explicit the implicitly broad coverage to which this invention is entitled. As but one example, it should be understood that all actions may be expressed as a means for taking that action or as an element which causes that action. Similarly, each physical element disclosed should be understood to encompass a disclosure of the action which that physical element facilitates. Regarding this last aspect, as but one example, the disclosure of a "converter" should be understood to encompass disclosure of the act of "converting" -- whether explicitly discussed or not -- and, conversely, were there effectively disclosure of the act of "converting", such a disclosure should be understood to encompass disclosure of a "converting" and even a "means for converting." Such changes and alternative terms are to be understood to be explicitly included in the description. Further, each such means (whether explicitly so described or not) should be understood as encompassing all elements that can perform the given function, and all descriptions of elements that perform a described function should be understood as a non-limiting example of means for performing that function.

REFERENCES

U.S.PATENTS

Patent Number	Kind Code	Issue Date	Name of Patentee or Applicant of cited Document
6696823		2004-02-24	IKOR ACQUISITION CORP

U.S.PATENT APPLICATION PUBLICATIONS

Publication Number	Kind Code	Publication Date	Name of Patentee or Applicant of cited Document
20120223584	A1	2012/09/06	AMPT, LLC
20120032515	A1	2012-02-09	AMPT, LLC

FOREIGN PATENT DOCUMENTS

Foreign Document Number	Country Code	Kind Code	Publication Date	Name of Patentee or Applicant of cited Document
WO 02/17469	WO	A1	2002-02-28	IKOR ACQUISITION CORP
2009/051853	WO	A1	2009-04-23	AMPT, LLC

Claims

1. A method of highly efficiently delivering solar energy power comprising the steps of:

- accepting a first power from a first photovoltaic source of power (5) by a DC input port of a base phase photovoltaic DC-DC converter (6);

- base phase DC-DC converting (6) said first power (5) by utilizing a first tapped magnetically coupled inductor (56) with a first inductor tap (57) to output a base phase DC power delivery (71) connected to said first inductor tap (57), wherein both inputs of said first tapped magnetically coupled inductor (56) are connected to both respective outputs of said base phase photovoltaic DC-DC converter (6);

- accepting a second power from a second photovoltaic source of power (7) by a DC input port of an altered phase photovoltaic DC-DC converter (8);

- altered phase DC-DC converting (8) said second power by utilizing a second tapped magnetically coupled inductor (56) with a second inductor tap (57) to output an altered phase DC power delivery (72) connected to said second inductor tap (57), wherein both inputs of said second tapped magnetically coupled inductor (56) are connected to both respective outputs of said altered phase photovoltaic DC-DC converter (8);

- synchronous phase controlling (11) said step of base phase DC-DC converting said first power with said step of altered phase DC-DC converting said second power;

- low storage inductance series power combining (9) said base phase DC power delivery (71) with said altered phase DC power delivery (72) through additive voltage circuitry that includes a low inductance storage series combination inductor (17) connected between said first and second inductor taps to add an output voltage of said base phase DC power delivery to an output voltage of said altered phase DC power delivery with a low energy storage output capacitor (18) to provide a conversion combined photovoltaic DC output (10) at a maximum power point (75); and

- photovoltaic boundary output controlling (63) said step of base phase DC-DC converting said first power and said step of altered phase DC-DC converting said second power for a maximum voltage (73) that overrides said maximum power point (75) or for a maximum current (74) that overrides said maximum power point at at least some times of operation.

2. A method of highly efficiently delivering solar energy power as described in claim 1 wherein said step of low storage inductance series power combining (9) said base phase DC power delivery (71) with said altered phase DC power delivery (72) comprises the step of adding said voltages through additive voltage circuitry that includes a not more than about one half duty cycle range ripple current photovoltaic energy storage inductor.

3. A method of highly efficiently delivering solar energy power as described in claim 2 wherein

said step of low storage inductance series power combining (9) said base phase DC power delivery (71) with said altered phase DC power delivery (72) comprises the step of adding said voltages through a not more than about one quarter duty cycle range ripple current photovoltaic energy storage inductor.

4. A method of highly efficiently delivering solar energy power as described in claim 1 wherein said step of synchronous phase controlling (11) comprises the step of synchronously duty cycle controlling.

5. A method of highly efficiently delivering solar energy power as described in claim 4 wherein said step of synchronously duty cycle controlling comprises the step of common duty cycle controlling.

6. A method of highly efficiently delivering solar energy power as described in claim 4 and further comprising the steps of:

- establishing said conversion combined photovoltaic DC output (10) as a converted DC photovoltaic input to a photovoltaic DC-AC inverter; and

- inverting said converted DC photovoltaic input into a photovoltaic AC power output.

7. A method of highly efficiently delivering solar energy power as described in claim 1 wherein said step of synchronous phase controlling (11) comprises the step of common timing signal controlling.

8. A method of highly efficiently delivering solar energy power as described in claim 1 wherein said step of synchronous phase controlling (11) comprises the step of opposing phase controlling.

9. A method of highly efficiently delivering solar energy power as described in claim 1 wherein said step of photovoltaic boundary output controlling said base phase further comprises the step of temperature limit controlling.

10. A method of highly efficiently delivering solar energy power as described in claim 1 wherein said inductor between said first and second inductor taps (57) comprises a low photovoltaic energy storage inductor (17).

11. A method of highly efficiently delivering solar energy power as described in claim 1 wherein said step of low storage inductance, series power combining said base phase DC power delivery (6) with said altered phase DC power delivery (8) comprises the step of establishing a double maximum voltage arrangement.

12. A high efficiency solar energy power system comprising:

- a first photovoltaic source of power (5);

- a base phase DC-DC photovoltaic converter (6) connected with its input port to said first photovoltaic

source of power (5) and configured to establish a base phase DC power delivery(71), said base phase DC-DC photovoltaic converter (6) comprising a first tapped magnetically coupled inductor (56) with a first inductor tap (57), wherein both inputs of said first tapped magnetically coupled inductor (56) are connected to both respective outputs of said base phase photovoltaic DC-DC converter (6); ~~(57),~~

- a second photovoltaic source of power (7);

- an altered phase DC-DC photovoltaic converter (8) connected with its input port to said second

photovoltaic source of power (7) and configured to establish an altered phase DC power delivery (72), said altered phase DC-DC photovoltaic converter (8) comprising a second tapped magnetically coupled inductor (56) with a second inductor tap (57), wherein both inputs of said second tapped magnetically coupled inductor (56) are connected to both respective outputs of said altered phase photovoltaic DC-DC converter (8); ~~(57),~~

- a synchronous phase control circuitry (11) to which said base phase DC power delivery (71) and said altered phase DC power delivery (72) are switch timing responsive;

- low stored energy inductance series power additive combiner circuitry (9) connecting said base phase DC power delivery (71) and said altered phase DC power delivery (72), and comprising a low inductance storage series combination inductor (17) connected between said inductor taps (57) to add an output voltage of said base phase DC power delivery with an output voltage of said altered phase DC power delivery with a low energy storage output capacitor (18) to provide a conversion combined photovoltaic DC output (10); and

- a photovoltaic boundary output controller (63) to which said converters are responsive at at least some times of operation.

13. A high efficiency solar energy power system as described in claim 12 wherein said low stored energy inductance series combination inductor (17) comprises a not more than about one half duty cycle range ripple current photovoltaic energy storage inductor.

14. A high efficiency solar energy power system as described in claim 12 wherein said low stored energy inductance series combination inductor (17) comprises a not more than about one quarter duty cycle range ripple current photovoltaic energy storage inductor.

15. A high efficiency solar energy power system as described in claim 12 wherein said synchronous phase control circuitry (11) comprises a common duty cycle controller to which said base phase DC-DC photovoltaic converter and said altered phase DC-DC photovoltaic

converter are each responsive.

16. A high efficiency solar energy power system as described in claim 12 wherein said synchronous phase control circuitry (11) comprises opposing phase control circuitry.

17. A high efficiency solar energy power system as described in claim 16 wherein said base phase DC-DC photovoltaic converter and said altered phase DC-DC photovoltaic converter each comprise a buck switching circuitry.

18. A high efficiency solar energy power system as described in claim 12 wherein said photovoltaic boundary output controller (63) comprises a base phase photovoltaic boundary output controller to which said base phase DC-DC photovoltaic converter is responsive at at least some times of operation and an altered phase photovoltaic boundary output controller to which said altered phase DC-DC photovoltaic converter is responsive at at least some times of operation.

19 A high efficiency solar energy power system as described in claim 12 wherein said conversion combined photovoltaic output (10) is provided at maximum power point (75) when said maximum power point is not overridden by said photovoltaic boundary output controller (63).

20 A high efficiency solar energy power system as described in claim 19 wherein said photovoltaic boundary output controller (63) controls for a maximum voltage (73) that overrides said maximum power point or for a maximum current (74) that overrides said maximum power point at at least some times of operation.

21 A high efficiency solar energy power system as described in claim 19 wherein said photovoltaic boundary output controller (63) controls for a temperature limit.

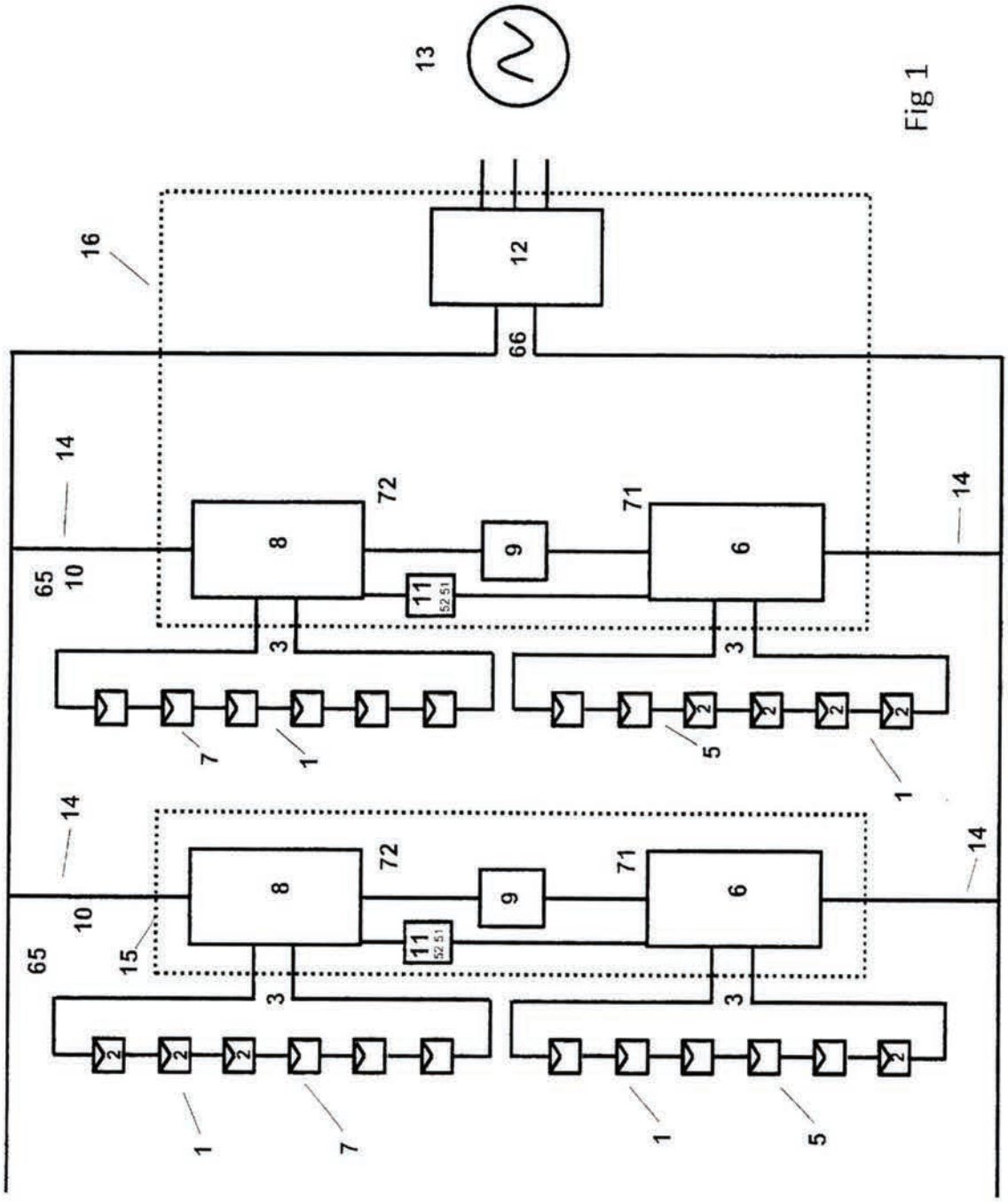


Fig 1

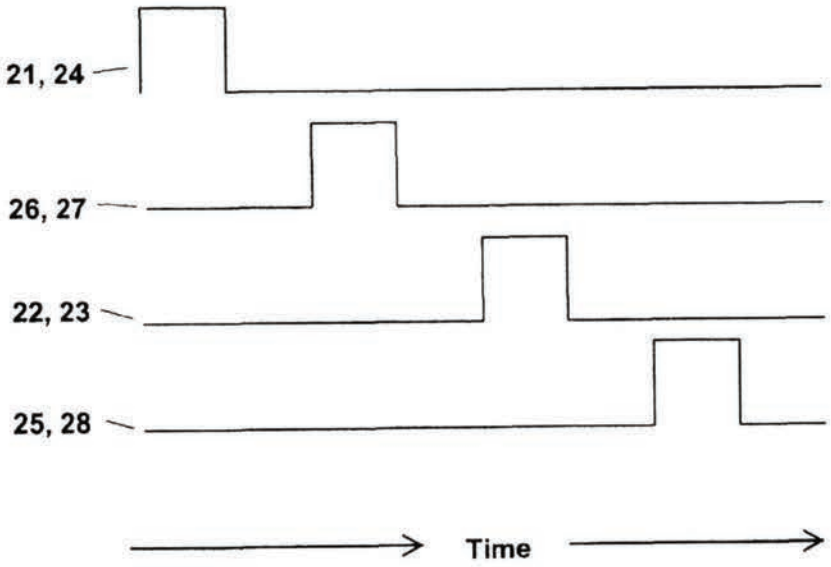


Fig 2a

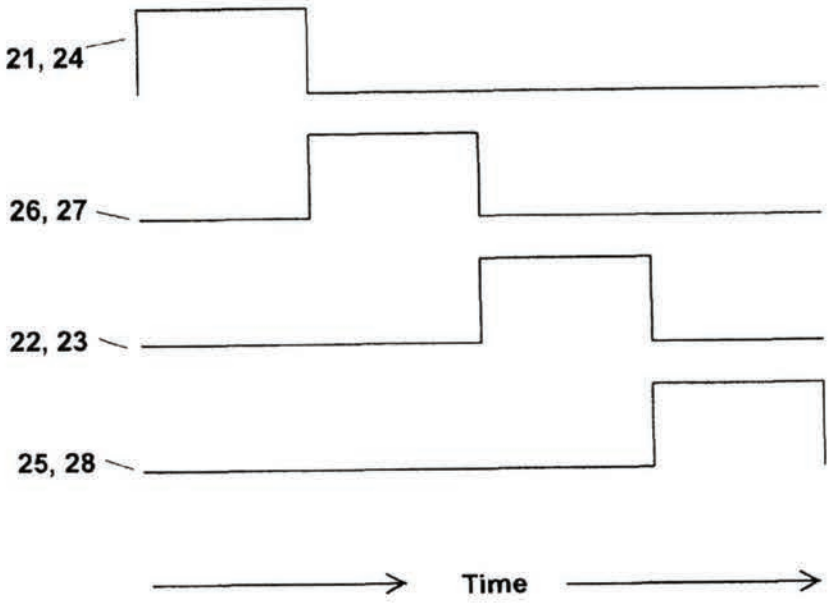


Fig 2b

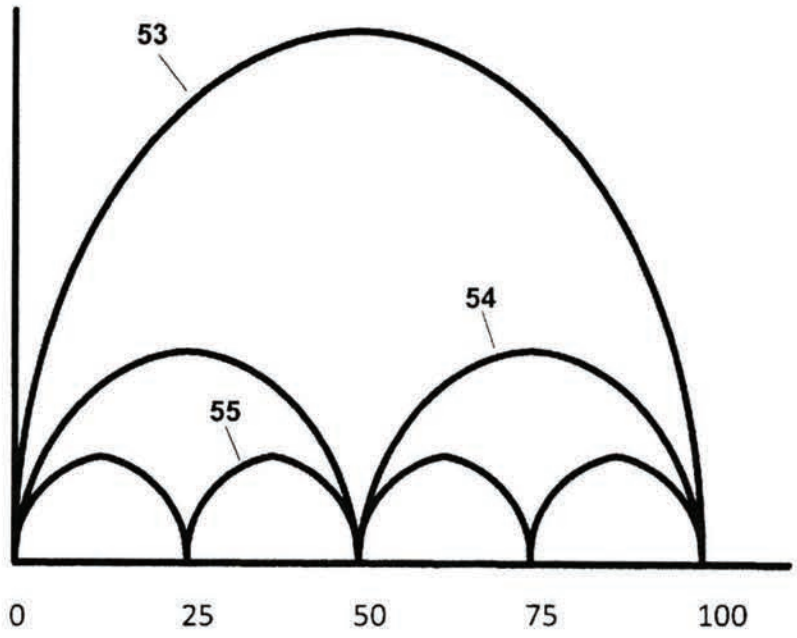


Fig 3

4/9

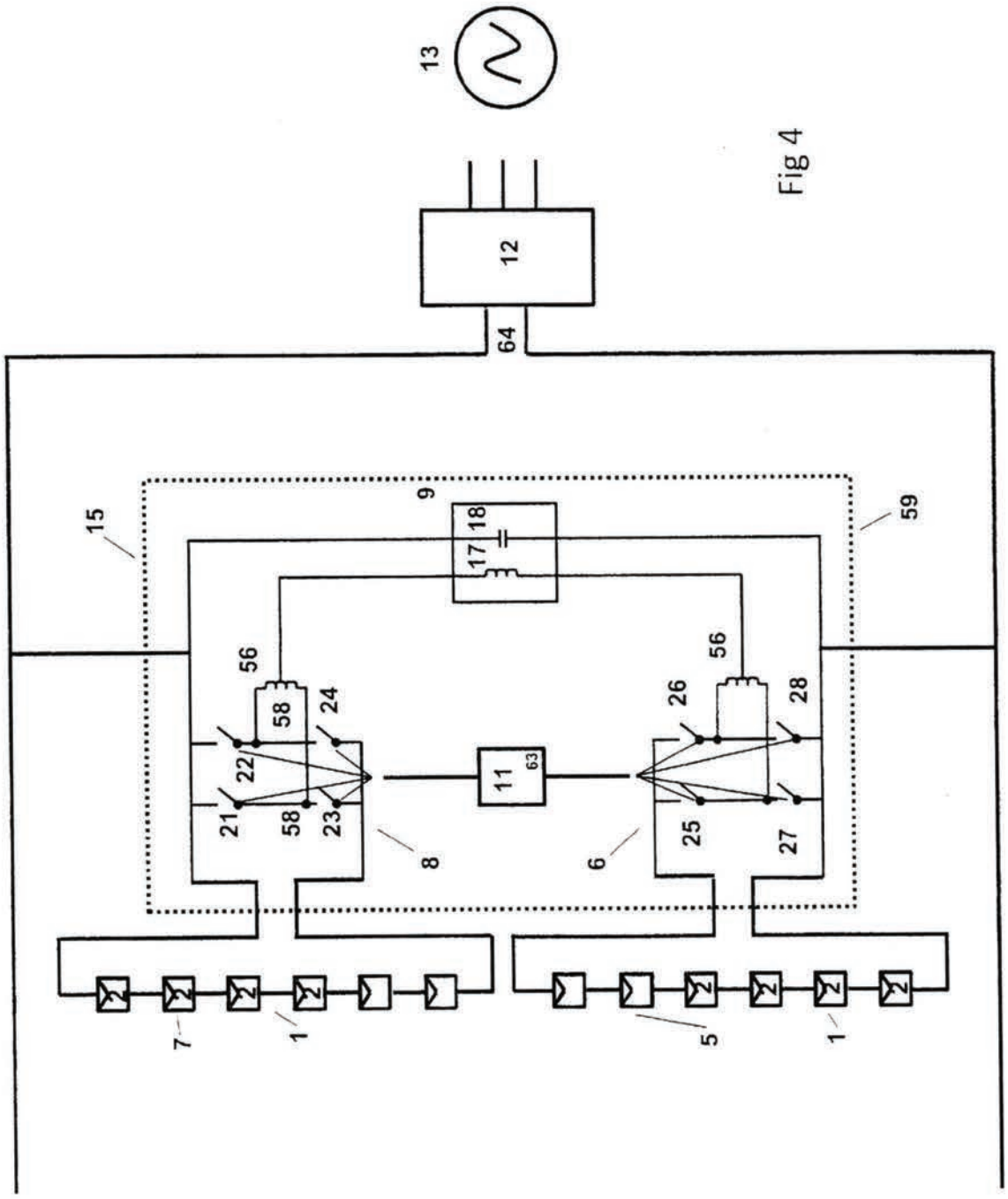


Fig 4

Fig 5

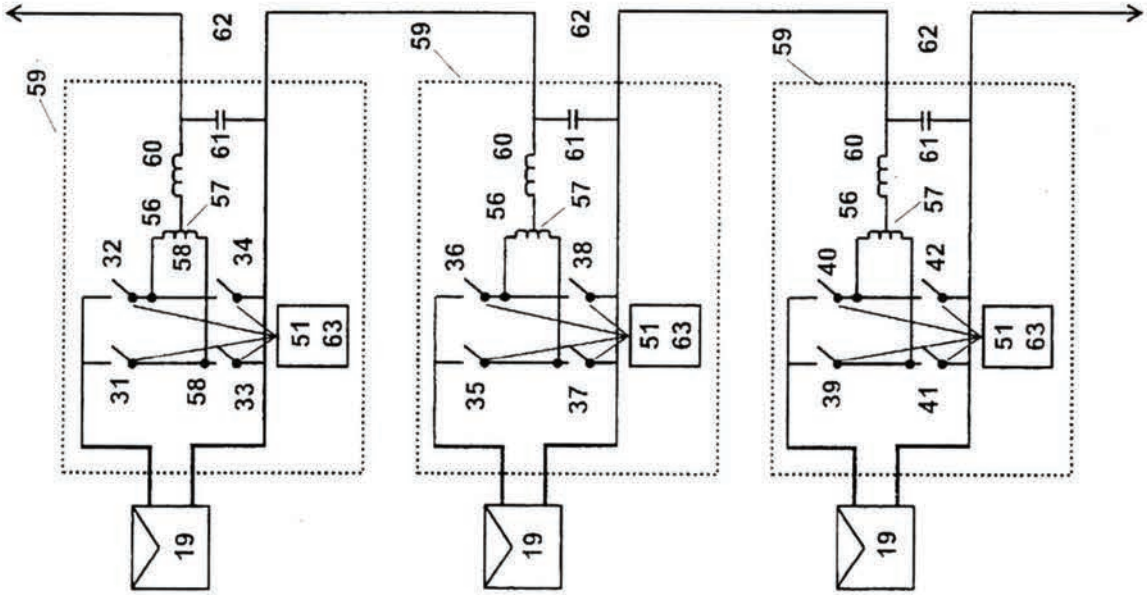
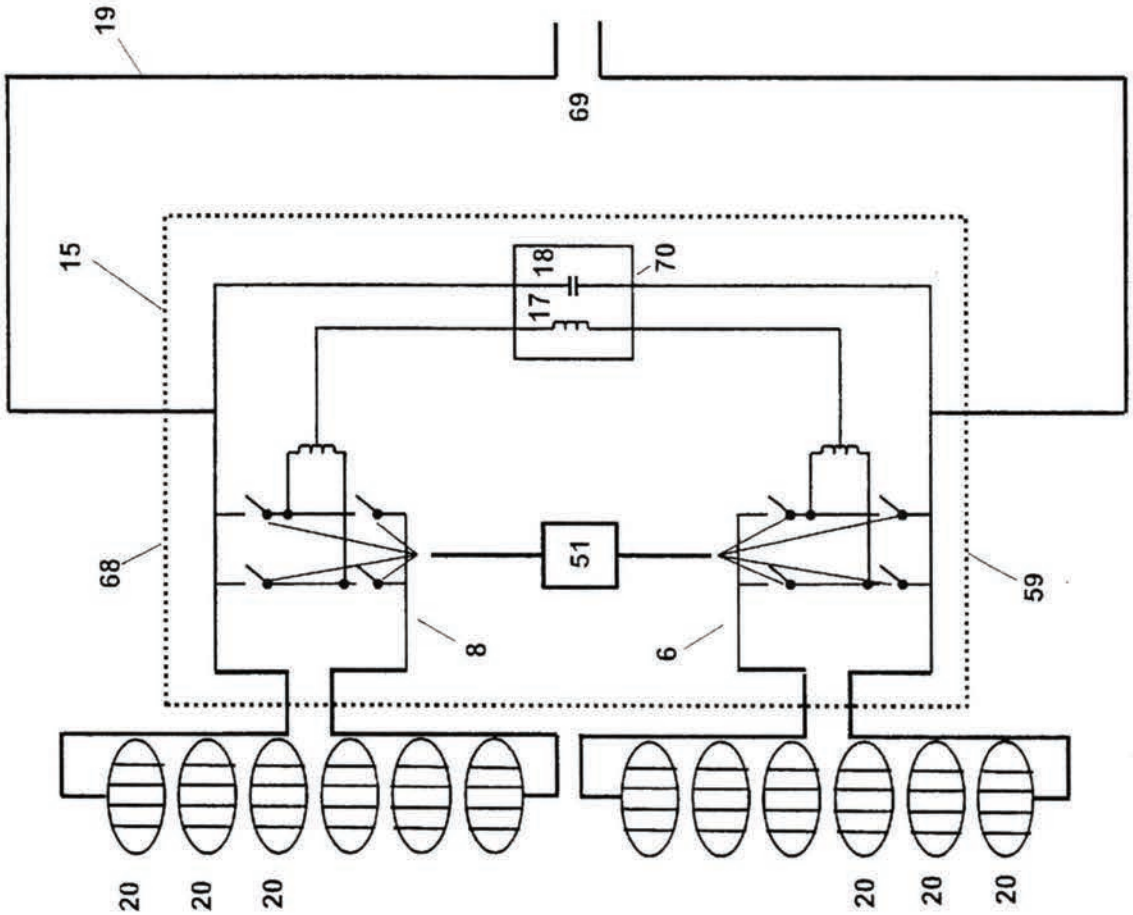


Fig 6



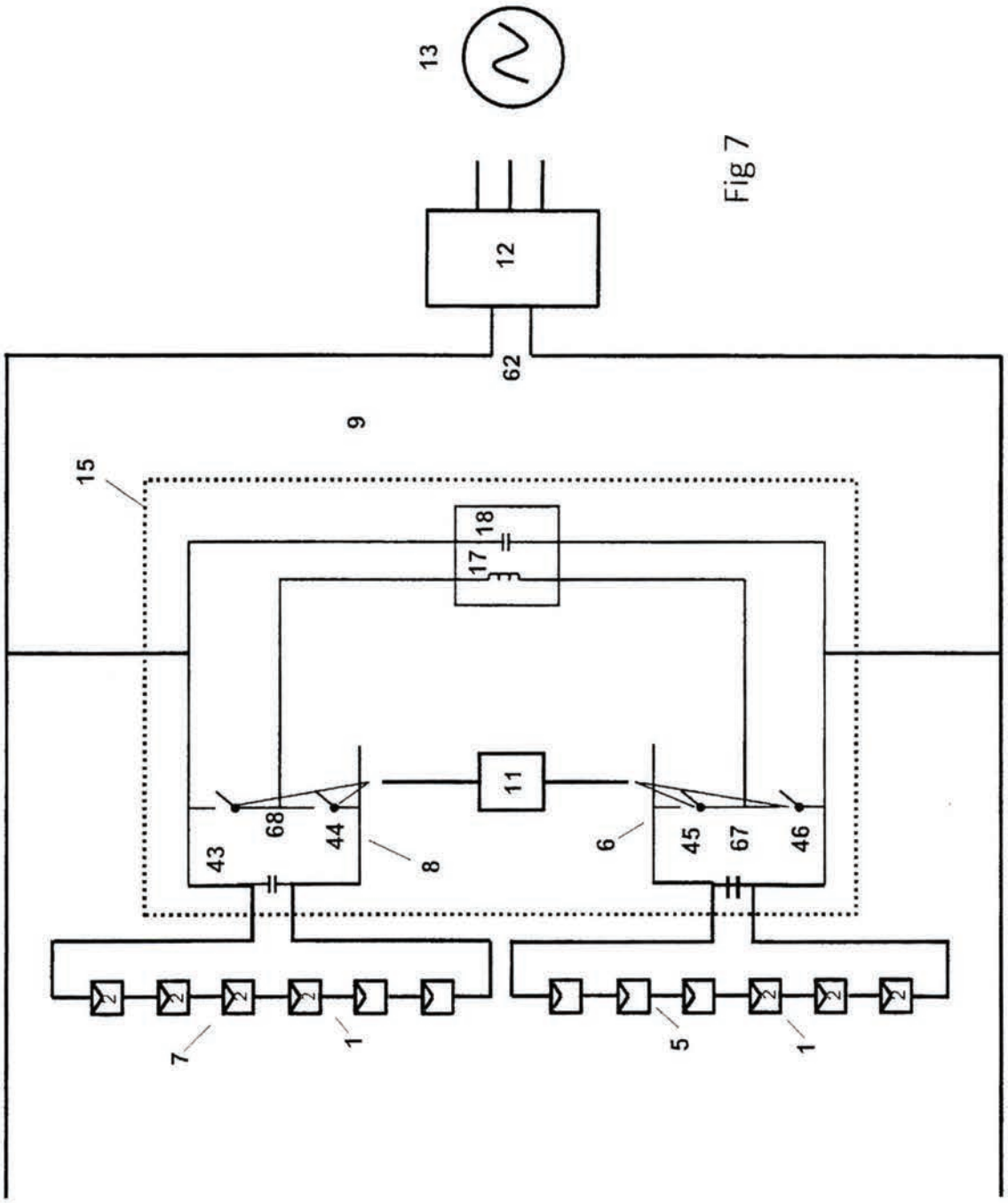
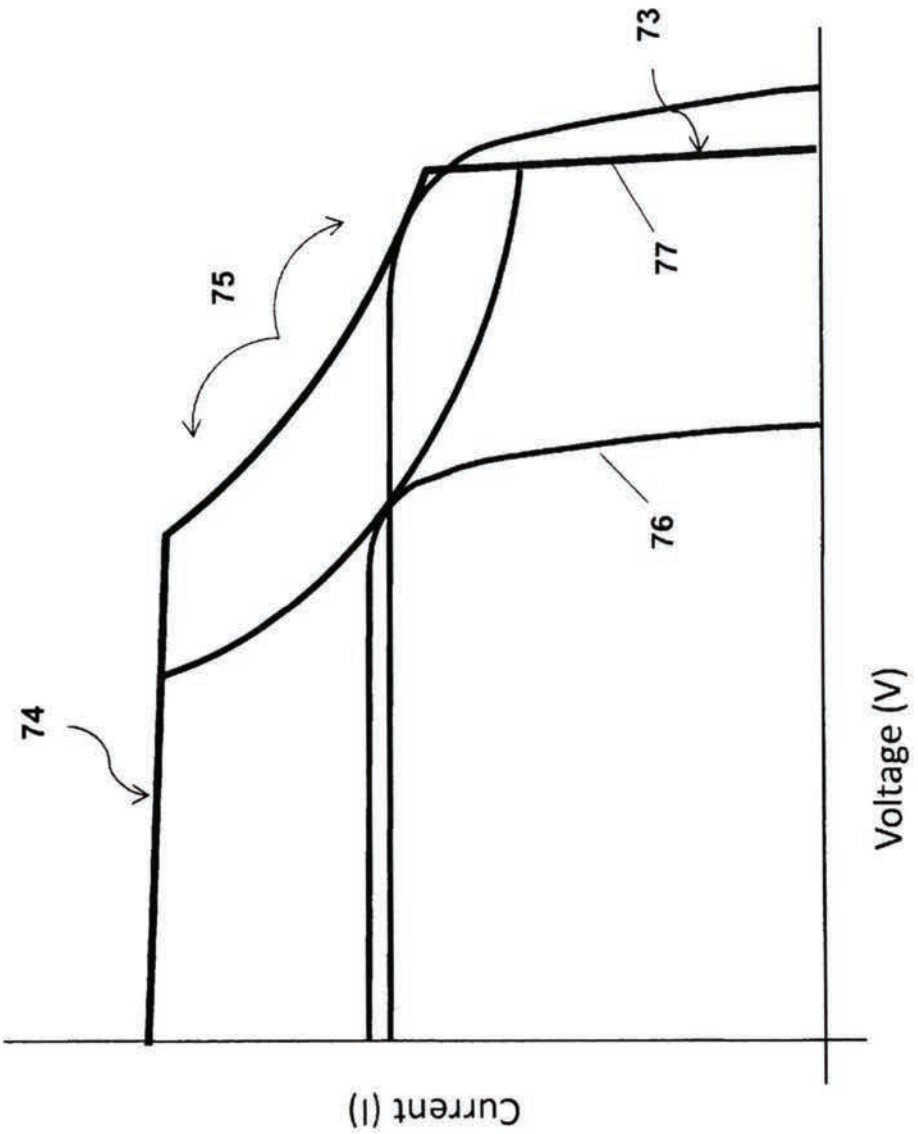


Fig 7

Fig 8



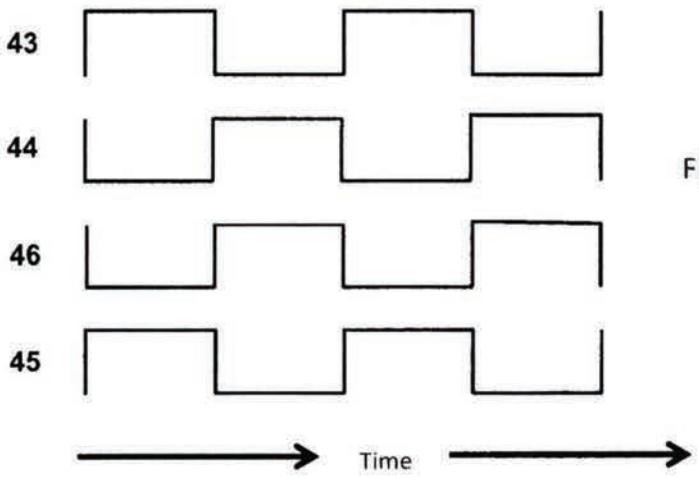


Fig. 9A

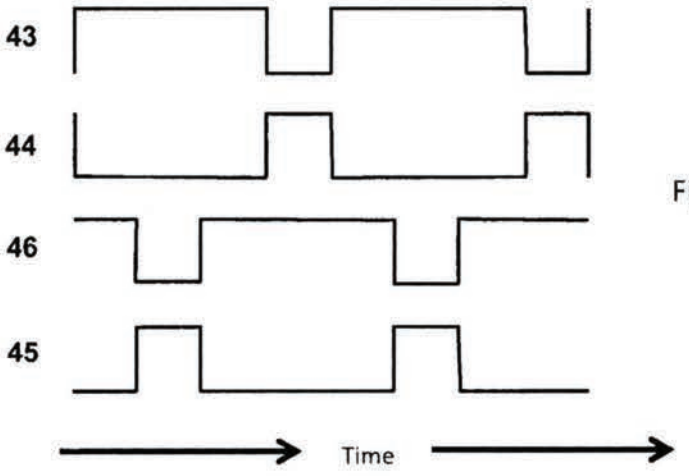


Fig. 9B

Europäisches Patentamt
European Patent Office
Office européen des brevets

European Patent Office
80298 MUNICH
GERMANY
Tel: +49 89 2399 0
Fax: +49 89 2399 4465

Kador & Partner PartG mbB
Corneliusstraße 15
80469 München
ALLEMAGNE

Formalities Officer
Name: Rosswag, Isabella
Tel: +49 89 2399 - 5206
or call
+31 (0)70 340 45 00

Substantive Examiner
Name: Meyer, Andreas Hans
Tel: +49 89 2399 - 2703

EINGEGANGEN
FT: 3. April 20
06. Dez. 2019
T: 6. Jan. 20
KADOR & PARTNER

Application No.	Ref.	Date
08 796 302.1 - 1202	K 57 633/3ba	04.12.2019
Applicant AMPT, LLC		

Communication pursuant to Article 94(3) EPC

The examination of the above-identified application has revealed that it does not meet the requirements of the European Patent Convention for the reasons enclosed herewith. If the deficiencies indicated are not rectified the application may be refused pursuant to Article 97(2) EPC.

You are invited to file your observations and insofar as the deficiencies are such as to be rectifiable, to correct the indicated deficiencies within a period

of 4 months

from the notification of this communication, this period being computed in accordance with Rules 126(2) and 131(2) and (4) EPC. One set of amendments to the description, claims and drawings is to be filed within the said period on separate sheets (R. 50(1) EPC).

If filing amendments, you must identify them and indicate the basis for them in the application as filed. Failure to meet either requirement may lead to a communication from the Examining Division requesting that you correct this deficiency (R. 137(4) EPC).

Failure to comply with this invitation in due time will result in the application being deemed to be withdrawn (Art. 94(4) EPC).

Registered letter

Meyer, Andreas Hans
Primary Examiner
For the Examining Division

Enclosure(s): 2 page/s reasons (Form 2906)

The examination is being carried out on the **following application documents**

Description, Pages

1-122	as published

Claims, Numbers

1-16	received on	23-09-2019	with letter of	23-09-2019

Drawings, Sheets

1-8	as published

1. Novelty/Inventivenness (Art. 54/56 EPC)

The Applicant argues in his response letter dated September 23, 2019 that the control carried out by the centralized controller is not a remote control since it is a wired control. The Examiner disagrees with this point of view. The term "remote" only implies a distance which exceeds a particular threshold value which varies from application to application. "Remote" does not necessarily imply "wireless".

The Applicant further argues that, in document D8, a change of signals GA - GC may not be interpreted as a "transistion between different power generation operational modes" since it is generally aimed in document D8 to create maximum input power at all boost choppers. A change of an operational mode would imply to change between maximum power input and non-maximum power input. The Examiner disagrees: As already mentioned in the last communication, the term "power generation operational mode" is so broad that any change of one of signals GA - GC may be interpreted as a "transistion between different power generation operational modes", as mentioned in claim 1.

The Examiner agrees that document D8 does not show to carry out the control wirelessly. However, sending controlling signals wirelessly is a measure falling within the daily routine of the skilled person.

Thus, the subject-matter of claim 1 is not inventive over document D8.

Europäisches Patentamt
European Patent Office
Office européen des brevets

European Patent Office
Postbus 5818
2280 HV Rijswijk
NETHERLANDS
Tel: +31 70 340 2040
Fax: +31 70 340 3016

Kador & Partner PartG mbB
Corneliusstraße 15
80469 München
ALLEMAGNE

EINGEGANGEN
- 8. Nov. 2019
KADOR & PARTNER

Formalities Officer
Name: Dubret, Françoise
Tel: +31 70 340 - 3584
or call
+31 (0)70 340 45 00

Substantive Examiner
Name: Van der Meer, Paul
Tel: +31 70 340 - 3632

Application No.	Ref.	Date
13 877 614.1 - 1201	K 63 425/13sc	31.10.2019
Applicant AMPT, LLC		

Result of consultation

A copy of the result of consultation of 29.10.2019 is enclosed for your information.

Europäisches Patentamt • European Patent Office • Office européen des brevets

Van der Meer, Paul
For the Examining Division

Enclosure(s): Copy of result of consultation (Form 2036)

Europäisches Patentamt
European Patent Office
Office européen des brevets

European Patent Office
Postbus 5818
2280 HV Rijswijk
NETHERLANDS
Tel: +31 70 340 2040
Fax: +31 70 340 3016

Application No. : 13 877 614.1

Consultation by telephone with the applicant / representative

Despatch for information

Participants

Applicant:	AMPT, LLC
Representative:	Kador & Partner PartG mbB
Member(s) of the Examining Division:	Van der Meer, Paul

Result of consultation

See Separate Sheet

29.10.2019
. . . . . .
Date

Van der Meer, Paul
. . . . . .
Examiner

Enclosure(s):

The examining division discussed identical subject matter and double patenting with Dr. Eger of Kador & Partner legal representative of AMPT LLC.

1 *Identical subject matter vs double patenting*

This application comprises identical claimed subject matter as file EP17150670. The latter being in the grant stage; it is referred to the attached communication for more details. According to the examining division there is no other subject matter in the application that could be used to define a new set of claims distinguishing itself from the amended claim set of file EP17150670. The representative will contact the applicant to inform him that this application cannot serve as a divisional for the reasons mentioned above.

2 *Time limit*

It was agreed upon to set a 2 months time limit to finalize this step in the procedure.

BoxInterferences@uspto.gov
Tel: 571-272-9797

Entered: December 31, 2019

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Anatoli Ledenev
and
Robert M. Porter**,**
Junior Party
(Patent 8,004,116),

v.

Meir Adest,
Guy Sella, Lior Handelsman, Yoav Galin,
Amir Fishelov, Meir Gazit, Yaron Binder
and
Nikolay Radimov,
Senior Party
(Application 13/430,388).

Patent Interference No. 106,054 (JTM)
(Technology Center 2800)

Before SALLY G. LANE, JAMES T. MOORE, and DEBORAH KATZ, *Administrative Patent Judges*.

MOORE, *Administrative Patent Judge*

JUDGMENT - Bd. R. 127(a)

A decision granting Motion 1 of senior party Meir Adest, Guy Sella, Lior Handelsman, Yoav Galin, Amir Fishelov, Meir Gazit, Yaron Binder and Nikolay Radimov has been entered. (Decision, Paper 186). As a result of this Decision, all the involved claims of senior party Anatoli Ledenev and Robert M. Porter are unpatentable to Ledenev and Ledenev lacks standing to continue in the interference. Bd. R. 201. Accordingly, we enter judgment against Ledenev.

Order

It is

ORDERED that judgment on priority is entered against junior party Ledenev as to Count 1, the sole Count of the interference (Declaration, Paper 1, 4);

FURTHER ORDERED that claims 1–29 of Ledenev patent 8,004,116, which correspond to Count 1, are CANCELED. (Declaration, Paper 1, 4); 35 U.S.C. § 135(a);[1]

FURTHER ORDERED that the parties are directed to 35 USC § 135(c) and Bd. R. 205 regarding the filing of settlement agreements;

FURTHER ORDERED that a party seeking judicial review timely serve notice on the Director of the United States Patent and Trademark Office; 37 C.F.R. §§ 90.1 and 104.2. *See also* Bd. R. 8(b). Attention is directed to *Biogen Idec MA, Inc., v. Japanese Foundation for Cancer Research*, 785 F.3d 648,

[1] Any reference to a statute in this Judgment is to the statute that was in effect on March 15, 2013 unless otherwise indicated. See Pub. L. 112-29, § 3(n), 125 Stat. 284, 293 (2011).

654–57 (Fed. Cir. 2015) (determining that pre-AIA § 146 review was eliminated for interference proceedings declared after September 15, 2012); and

FURTHER ORDERED that a copy of this judgment be entered into the administrative records of the involved Ledenev patent and involved Adest application.

Attorney for Ledenev

Luke Santangelo
Alfred K. Wiedmann, Jr.
SANTANGELO LAW OFFICES, P.C.
luke@idea-asset.com
alw@idea-asset.com

W. Todd Baker
OBLON, McCLELLAND, MAIER & NEUSTADT, L.L.P.
tbaker@oblon.com

Attorney for Adest

Frederic M. Meeker
Michael S. Cuviello
Joseph M. Skerpon
BANNER & WITCOFF, LTD.
fmeeker@bannerwitcoff.com
mcuviello@bannerwitcoff.com
jskerpon@bannerwitcoff.com

BoxInterferences@uspto.gov
Tel: 571-272-9797

Entered: December 31, 2019

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Anatoli Ledenev[1]
and
Robert M. Porter,
Junior Party
(Patent 8,004,116),

v.

Meir Adest,[2]
Guy Sella, Lior Handelsman, Yoav Galin,
Amir Fishelov, Meir Gazit, Yaron Binder
and
Nikolay Radimov,
Senior Party
(Application 13/430,388).

Patent Interference No. 106,054 (JTM)
(Technology Center 2800)

Before SALLY G. LANE, JAMES T. MOORE, and DEBORAH KATZ,
Administrative Patent Judges.

MOORE, *Administrative Patent Judge*

DECISION ON MOTIONS

---

[1] The real party in interest is identified as AMPT, LLC. Paper 10, 1.

[2] The real party in interest is identified as Solaredge Technologies, Ltd. Paper 5, 1.

37 C.F.R. § 41.125

I. BACKGROUND

An interference was declared between application 13/430,388 ("Junior Party" or "Adest") and patent 8,004,116 ("Senior Party" or "Ledev"). Paper 1. The interference was redeclared to correct the accorded benefit dates. Paper 14.

After a conference call, the Board authorized numerous motions to be filed. Paper 17. Those authorized motions included Ledenev Motion 3 (no interference-in-fact); Ledenev Motion 4 (designating claims as not corresponding to the count); Adest Motion 1 (unpatentability of Ledenev claims 1–29); and Adest Motion 2 (motion for benefit).

After a second conference call, the Board authorized Ledenev Motion 7 (unpatentability, all claims). Paper 55. The Board also granted Ledenev Motion 8 seeking permission to file a reissue application. Paper 103.

The various motions, oppositions, and replies have been filed. The Board has awaited an initial determination on the fate of reissue application 15/469,087. In the absence of any such determination being presented to us to date, the Board has now elected to proceed with this interference on the present record to prevent further delay.

II. THE TECHNOLOGY

This interference concerns photovoltaic power systems that are said to be highly efficient. Ex. 2001, Title. There are many variables that affect a photovoltaic system, including non-uniformity of panels, partial shade, dirt or accumulated matter on the panels, damaged panels, and degradation due to age of

the panels. *Id.* 2:38-44 There are many ways to interconnect panels, converters, and controllers. *Id.* 2:45-59.

In Ledenev's description of the technical field of the subject matter, it is said that certain aspects of the invention may be responsible for the high efficiency and harvest maximum power from a solar cell, a solar panel, or strings of panels. These aspects include providing electrical power conversion in a multimodal manner, establishing a system that can alternate between differing processes, and differing systems that can achieve efficiencies in conversion that are said to be extraordinarily high compared to traditional systems. Ex. 2001, 1:20–31.

III. The Interference Count

The count is a "McKelvey" count, and recites the subject matter of the present interference. More specifically, the count comprises two alternatives –

> Application 13/430,388, Claim 62. An efficient solar energy power system comprising:
>
> a plurality of solar panels, each solar panel of said plurality of solar panels having a DC photovoltaic output;
>
> a plurality of DC photovoltaic inputs, each DC photovoltaic input configured to receive power from a respective one of said DC photovoltaic outputs of said plurality of solar panels;
>
> a plurality of buck+boost DC-DC power converters, each buck+boost DC-DC power converter configured to receive said power from a respective one of said plurality of said DC photovoltaic inputs, and each buck+boost DC-DC power converter configured to convert substantially all of said power accepted by said respective DC photovoltaic input to converted DC power;
>
> a control circuit configured to control each of said buck+boost DC-DC power converters to convert substantially all of said power accepted by said respective DC photovoltaic input to said converted DC power, and

wherein said control circuit is configured to control each of said buck+boost DC-DC power converters into multiple configurations;

a converted DC power output coupled to said plurality of buck+boost DC-DC power converters and configured to receive said converted DC power;

a DC-AC inverter configured to receive said converted DC power from said converted DC power output; and

an AC power output configured to receive converted AC power from said DC-AC inverter.0

or

Patent 8,004,116 Claim 1. An efficient solar energy power system comprising:

a plurality of solar panels, each said solar panel having a DC photovoltaic output;

a DC photovoltaic input that accepts power from said DC photovoltaic output;

at least one substantially power isomorphic photovoltaic DC-DC power converter responsive to at least one said DC photovoltaic input;

substantially power isomorphic maximum photovoltaic power point converter multimodal functionality control circuitry to which said at least one substantially power isomorphic photovoltaic DC-DC power converter is responsive;

a converted photovoltaic DC power output connected to said at least one substantially power isomorphic photovoltaic DC-DC power converter;

at least one photovoltaic DC-AC inverter responsive to said photovoltaic DC power output; and

a photovoltaic AC power output responsive to said at least one photovoltaic DC-AC inverter.

(Paper 1, 4; Paper 7, 3–4; Ex. 2001, 22:48–67).

A "buck" converter is a step-down converter, while a "boost" converter is a step-up converter. Ex. 2001, 11:28–29 and 44.

IV. Ledenev Motion 7 (Paper 61)(Unpatentability)

We take up Ledenev Motion 7 first. We permitted Ledenev Motion 7 to be filed as it was potentially dispositive of the interference. Paper 55, Page 4.

Ledenev Motion 7 challenges the patentability of Adest claims 62–66, 68–81, 83–94, and 138. Paper 61, 1.

The cited art in the motion is as follows:

Seki, et al., US Patent 6,636,431, issued October 21, 2003 (hereinafter "Seki", Ex. 2017).

Linear Technology Spec Sheet, LTC3780 High Efficiency, Synchronous, 4-Switch Buck-Boost Controller, LT0413 Rev F 1-30 (2005) (hereinafter "LTC3780", Ex. 2018).

Roy, et al., Battery Charger Using Bicycle, EE318 Electronic Design Lab Project Report, EE Dept., IIT 1-12 (April 2006) (hereinafter "Roy", Ex. 2019).

Chomsuwan, et al. Photovoltaic Grid-Connected Inverter Using Two-Switch Buck-Boost Converter, IEEE 1527-1530 (2002) (hereinafter "Chomsuwan", Ex. 2020).

Caricchi, et al., 20kW Water-Cooled Prototype of a Buck-Boost Bidirectional DC-DC Converter Topology for Electrical Vehicle Motor Drives, 18 Via Eudossiana 00184, 887-892 (1995) (hereinafter "Carrichi", Ex. 2021).

Nino, US Patent Application Publication No. 2005/0218876A1, published October 6, 2005 (hereinafter "Nino", Ex. 2022).

Linear Technology Spec Sheet, LTC3440 Micropower Synchronous Buck-Boost DC/DC Converter LT0814 Rev C 1-20 (2001) (hereinafter "LTC3440", Ex. 2023).

Midya, et al., Buck or Boost Tracking Power Converter, 2 IEEE Power Electronics Letters 4, 131-134 (2002) (hereinafter "Midya", Ex. 2024).

Viswanathan, et al., Dual-Mode Control of Cascade Buck-Boost PFC Converter, 35th Annual IEEE Power Electronics Specialists Conference 2178-2184 (2004) (hereinafter "Viswanathan", Ex. 2025).

We begin with Adest claim 62. Appendix 3 to Ledenev Motion 7 states that Seki is an anticipatory reference for claim 62, and that Seki in combination with Chomsuwan renders claim 62 obvious along with LTC3780 and Chomsuywan. Paper 61, 27.

Ledenev asserts that, as regards the independent claims (including claim 62):

> The Adest independent claims, claims 62, 78 and 81, generally claim simply a converter (specifically, a buck+boost DC-DC power converter) that is connected between solar panels on one side of it and an inverter (that converts DC power to AC power) on the other. The solar panels provide DC power, the converters convert it, and the inverter turns it into AC. To this basic manner of hooking up a converter to deliver AC power from solar panels, the independent claims also add limitations relative to efficiency or maximum power point control. Ex. 2012, ¶14.

Paper 61, 3.

We observe that claim 62 has several elements, simplified here for sake of discussion:

- a plurality of solar panels,

- a plurality of DC inputs,

- a plurality of buck+boost DC-DC power converters,

- a control circuit configured to control each of said buck+boost DC-DC power converters and configured to control each of said buck+boost DC-DC power converters into multiple configurations;

- a converted DC power output;

- a DC-AC inverter; and

- an AC power output.

In short, Adest claim 62 claims a control circuit that can reconfigure each of the power converters connected individually to the solar panels, and convert those controlled DC outputs to AC power through an inverter.

In Appendix 2 of Motion 7, Ledenev asserts that:

> 5. Seki discloses Adest's buck+boost converter (Ex. 2012, p. 62, 2nd row, 2nd column) in a photovoltaic harvesting application (Ex. 2012, p. 61, 2nd row for claim 62, 2nd column, ignoring the claim number column) with an ability to convert at efficiencies up to about 98%. It also discloses an inverter (inherently) (Ex. 2012, p. 63 (3rd row, 2nd column)), converted output stringing (Ex. 2012, p. 68, 5th row, 2nd 15 column), or stringing that renders such configuration obvious. Ex. 2012, ¶¶ 39-41.

We are then pointed to Seki Figure 8 (Paper 61, 9–10) as illustrating the elements of Claim 62. Original Figure 8 is reproduced below:

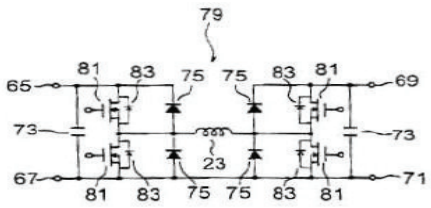


FIG. 8

This figure is said to be "topologically the same as that of Fig. 7 of the Adest '815 provisional application" which is asserted to be the same as claim 62. Paper 61, 10. Exactly how, though, is unexplained in the briefing and left to us to decipher.

As regards Figure 8, Seki states:

> Referring to FIG. 8, a symmetrical DC/DC converter 79 according to a fourth embodiment of this invention uses FETs 81 as the switching circuits 77 (77a-77d.) illustrated in FIG. 7. Each of the FETs 81 has a body diode 83 which can be used as a rectifier.
>
> As illustrated in FIG. 8, the diode 75 as a high performance diode which is low in forward voltage Vf than the body diode 83 and short in recovery time is connected in parallel to the body diode 83 of each FET 81 to be oriented in the same direction. With this structure, the symmetrical DC/DC converter 79 is operable irrespective of the body diode 83.
>
> Referring to FIG. 9, a symmetrical DC/DC converter 85 according to a fifth embodiment of this invention has a structure in which the diode operation in the DC/DC converter in FIG. 8 is realized by synchronous rectification so as to improve the efficiency.
>
> Specifically, in the fifth embodiment, a diode 21 is connected to one end of each FET 81 through a resistor 87 so as to perform analog control in a manner such that the output of an operational amplifier 89 is not saturated on a minus side.
>
> As described above, according to the first through the fifth embodiments of this invention, it is possible to provide a symmetrical

> DC/DC converter operable in a desired energy transfer direction and at a desired step-up or a desired step-down ratio.

Ex. 2017, 5:59–6:15. We find that Seki thus describes a controlled step up or step down converter which can operate bidirectionally.

Further, Ledenev points to witness testimony, apparently in the place of explanatory briefing:

> Appendix 2 of the Second Declaration of Eric A. Seymour (Prior Art Reference Claim Charts (Adest Claims)) presents Mr. Seymour's opinion that all Adest claims are unpatentable, in the form of a claim chart for each of two exemplary pieces of prior art treated as primary references – Seki and LTC3780. See also, Ex. 2012, ¶¶28 and 29, pp. 60-103, and Appendix 3 (p. 105).
>
> As shown in Appendix 1 of Mr. Seymour's 2nd Declaration (the Construction Chart for Adest Claims), Adest's independent claims – claims 62, 78 and 81 – describe a certain type of converter electrically connected in a very straightforward manner (which was well known at the time of their filing in 2006 as shown, e.g., in Chomsuwan (Ex. 2020, p. 1527, Fig. 1) to collect solar power and deliver it to an inverter, which then converts it to AC power so it can be delivered to, e.g., the power grid. Ex. 2012, pp. 47-48 (claim 62)…"

Paper 61, 8.

We discern from these arguments we have found for claim 62 within Ledenev Motion 7, the argument and evidence for unpatentability of claim 62 is that Seki describes a buck+boost converter in a photovoltaic harvesting apparatus with an efficiency of up to 98%, an inverter (inherently), and converted output stringing. Ledenev then asserts the skilled artisan would have combined LTC3780

which describes 98% efficiency, and Chomsuwam, which describes maximum power point control, would have been obvious because all relate to dual mode DC power conversion, and the motivation to provide enhanced efficiency. Paper 61, 11. While this may in fact be true, we are left without guidance as to how the art directs us to the elements arranged as claimed in Adest's claims. A claim chart in the motion would have been useful. *See*, e.g. 37 C.F.R. § 41.121 (e).

In search of further detail within the motion, we look to the specifically cited Figure in Chomsuwan. It is reproduced below.

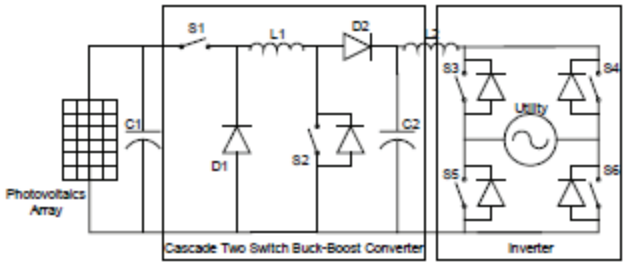


Fig. 1. The proposed system.

Ex. 2020, 1527.

Figure 1 depicts the proposed system.

It is evident to us that there is a photovoltaic array connected to a buck+boost converter and thence to an inverter and from there potentially to a utility.

However, it is not apparent to us, from a careful reading of Ledenev Motion 7, how Ledenev urges that all this ties in to the specific claim language of claim 62. More specifically, and *inter alia*, we do not see where Ledenev

Motion 7 asserts the plurality of converters are to be found or where the control circuit of claim 62, which can reconfigure the converters, are to be found.

We are pointed, without the benefit of specific argument, to the additional testimony of witness Eric Seymour, presented as Exhibit 2012. This approach violates 37 CFR § 106 (b) (3) and the Standing Order ¶ 106.2, prohibiting the incorporation of arguments by reference.[3] In our view, the motion has not made out a case of unpatentability of claim 62 to this point.

At this stage, we must address a procedural point raised by Adest. Adest asserts that this incorporation by reference by Ledenev is improper. Paper 93, 6. Adest is correct, for the reasons noted above. Adest further asserts that without the incorporation by reference, the motion fails to make out a case. *Id.* 7-9. We, to this point in this decision, agree with Adest on this issue.

Ledenev takes issue with the Adest's assertion that absent incorporation by reference, it failed to make out a case, at least for the independent claims. More specifically, Ledenev asserts in reply that:

> Sufficient detail as to all independent claim limitations appears explicitly in Ledenev Motion 7 (see, e.g., p. 11, l. 2-6, p. 12, l. 4-6 and p. 13, l. 20-22 regarding efficiency; p. 9, l. 13-14 and p. 13, l. 18-20 regarding converter control; p. 9, l. 3-8 and 11, l. 11-12 regarding solar application; p. 13, l. 12-20 and p. 14, l. 5-8 regarding converter-to-panel connection; p. 14, l. 5-8 regarding inverter limitation; p. 13, l. 18-19 regarding MPP (found in Adest claim 81 only); and p. 13, l. 18-20 regarding strings of panels (found in claim 81 only), all of Ledenev Motion 7, Paper No. 61).

[3] Adest Opposition 7 notes that, absent this improper incorporation by reference, the motion likely fails. Paper 93, 7-9.

Paper 118, 1. Again, the panel is left to hunt for the meaning to these strings of evidentiary citations and how one of ordinary skill in the art would tie them to the specific structures claimed and arranged in each claim.

Ledenev also points us to Appendix One of Exhibit 2012 for its arguments concerning construction of the claims. Paper 61, 3. Again, these arguments are not contained in the brief.

We therefore determine that the motion does not put forth a sufficient meaningful argument *in the motion itself* to establish the elements of unpatentability of the independent claims.

Continuing, as regards the dependent claims, Ledenev states:

> Any alleged insufficiently specific treatment in Ledenev Motion 7 of certain other dependent claims is, respectfully, insufficient reason to ignore Ledenev's motion as to such claims for the following reasons:
> (i) Ledenev Expert Declaration II (Ex. 2012) presents arguments on a numbered claim basis, so, respectfully, a reader can still expeditiously gather arguments as to all dependent claims beyond Ledenev Motion 7 itself.
> (ii) Ledenev's arguments were lengthy because of requirements to: construe every single limitation of 32 claims; show each limitation of each of such claims in the art; and rebut the 41 C.F.R. 207(c) presumption; and
> (iii) the prior art does indeed render such claims unpatentable, and allowing unpatentable claims to issue due to any alleged imperfect rule compliance would disserve the public interest.

Paper 118, 1-2.

We find statement (i) to be an attempt to bypass the Board's express rules. The content of the briefs and the page limitations are set at 37 CFR § 41.106. We

will not disregard the rules and look "beyond Ledenev Motion 7 itself" for arguments which by rule must have appeared in the brief. We also find statement (ii) to be unpersuasive because the Board is always available for requests for relief from the rules by miscellaneous motion if sufficient justification is given. Standing Order ¶ 3.1. No request to enlarge the page limits was made with a persuasive reason. Nor was a request for a conference call to discuss the matter made. Statement (iii) is unpersuasive because it assumes the burden of proof has been met, when we cannot determine effectively at this stage whether it has. It is only the assertion of counsel that they will prevail, which is not evidence thereof.

The arguments concerning the remaining claims suffer from this same infirmity.

Ledenev Motion 7 is therefore denied.

V. Adest Motion 1 – (Paper 49) (Unpatentability)

Adest moves for judgment against Ledenev on the grounds that all claims in U.S. Patent No. 8,004,116 are unpatentable under Pre-AIA 35 U.S.C. § 112, first and second paragraphs, for failing to contain sufficient written description of the invention, and for failing to particularly point out and distinctly claim the subject matter which the applicant regards as his invention. Paper 49, 1.

A. *Indefiniteness*

1. Legal Principles

"[A] patent is invalid for indefiniteness if its claims, read in light of the specification delineating the patent, and the prosecution history, fail to inform, with reasonable certainty, those skilled in the art about the scope of the invention."

Nautilus, Inc. v. Biosig Instruments, Inc., 572 U.S. 898, 901 (2014).

2. Discussion

"*said photovoltaic output" "said photovoltaic DC power output," and "at least one said DC photovoltaic input"*

Adest first asserts that each of Ledenev independent claims 1, 17, and 20 is indefinite because a person of ordinary skill in the art cannot determine its scope with reasonable certainty. Paper 49, 9. More specifically, Adest asserts it is uncertain whether the claim requires a plurality of solar panels to operate with a single power converter and inverter, or instead, requires each solar panel to operate with its own dedicated power converter and inverter. This is said to be because these claims are replete with ambiguous antecedent problems with respect to outputs/input for these elements in the phrases, "said DC photovoltaic output," "said photovoltaic DC power output," and "at least one said DC photovoltaic input." *Id.*

We begin with claims 1, 17, and 20.

Claim 1 recites as follows:

> 1. An efficient solar energy power system comprising:
> a plurality of solar panels, each said solar panel having a DC photovoltaic output;
> a DC photovoltaic input that accepts power from said DC photovoltaic output;
> at least one substantially power isomorphic photovoltaic DC-DC power converter responsive to at least one said DC photovoltaic input;
> substantially power isomorphic maximum photovoltaic power point converter multimodal functionality control circuitry to which said at least one substantially power

isomorphic photovoltaic DC-DC power converter is responsive;

a converted photovoltaic DC power output connected to said at least one substantially power isomorphic photovoltaic DC-DC power converter;

at least one photovoltaic DC-AC inverter responsive to said photovoltaic DC power output; and

a photovoltaic AC power output responsive to said at least one photovoltaic DC-AC inverter.

Ex. 2001, 22:48–67.

Claim 17 recites as follows:

17. An efficient solar energy power system comprising:

a plurality of solar panels, each said solar panel having a DC photovoltaic output;

a DC photovoltaic input that accepts power from said DC photovoltaic output;

first modality photovoltaic DC-DC power conversion circuitry responsive to said DC photovoltaic input;

second modality photovoltaic DC-DC power conversion circuitry responsive to said DC photovoltaic input;

at least one photovoltaic DC-DC power converter responsive to at least one said DC photovoltaic input;

high efficiency multimodal converter functionality control circuitry to which said at least one photovoltaic DC-DC power converter is responsive and wherein said high efficiency multimodal converter functionality control circuitry is configured to switch at least some times between said first modality photovoltaic DC-DC power conversion circuitry and said second modality photovoltaic DC-DC power conversion circuitry;

a converted photovoltaic DC power output connected to said at least one photovoltaic DC-DC power converter;

at least one photovoltaic DC-AC inverter responsive to said photovoltaic DC power output; and

a photovoltaic AC power output responsive to said at least one photovoltaic DC-AC inverter.

Ex. 2001, 25:63–26:21.

Claim 20 reads as follows:

20. An efficient solar energy power system comprising:
at least one string of a plurality solar panels, at least one of said solar panels having a DC photovoltaic output;
a DC photovoltaic input that accepts power from said DC photovoltaic output;
at least one multiple panel dedicated substantially power maximum photovoltaic power point DC-DC power converter responsive to at least one said DC photovoltaic input;
maximum photovoltaic power point converter multimodal functionality control circuitry to which said at least one multiple panel dedicated substantially power maximum photovoltaic power point DC-DC power converter is responsive;
a converted photovoltaic DC power output connected to said at least one multiple panel dedicated substantially power maximum photovoltaic power point DC-DC power converter;
at least one photovoltaic DC-AC inverter responsive to said photovoltaic DC power output; and
a photovoltaic AC power output responsive to said at least one photovoltaic DC-AC inverter.

Ex. 2001, 26:44–67.

Each of these claims, generically, claim a solar power system including solar panels with outputs, some form of control, a DC-DC power converter that accepts power through an input, DC power outputted to a DC-AC converter, and AC power output.

said DC photovoltaic output" (claims 1,17, and 20)
"at least one said DC photovoltaic input" (claim 1, 17, and 20)

According to Adest, each of independent claims 1, 17, and 20 is indefinite because a person of ordinary skill in the art cannot determine its scope with reasonable certainty. Adest asserts that it is uncertain whether the claim requires a plurality of solar panels to operate with a single power converter and inverter, or instead, requires each solar panel to operate with its own dedicated power converter and inverter. Paper 49, 9.

First, Adest asserts that "said DC photovoltaic output" lacks antecedent basis in claims 1, 17, and 20. More specifically, these claims are said to introduce "a plurality of solar panels, each [or at least one of] said solar panel having a DC photovoltaic output" and therefore the scope of the claims include a plurality of DC photovoltaic outputs, rendering subsequent reference to a singular "said DC photovoltaic output" ambiguous as to which of the plurality of DC photovoltaic outputs "said DC photovoltaic output" is referring. *Id.* 9-10.

Second, Adest asserts that "said photovoltaic DC power output" lacks antecedent basis in claims 1, 17, and 20. Those claims introduce "a DC photovoltaic output" and "a converted photovoltaic DC power output." Adest observes that "said photovoltaic DC power output" is an ambiguous mix of these two previously introduced distinct elements, and a person of ordinary skill in the art cannot determine with reasonable certainty which, if any, of these different

outputs is referenced by "said photovoltaic DC power output," rendering claims 1, 17, and 20 indefinite. *Id.* 10-11.

Third, Adest asserts that "at least one said DC photovoltaic input" also lacks antecedent basis in claims 1, 17, and 20. These claims introduce the singular "a DC photovoltaic input" and Adest notes that "at least one said DC photovoltaic input" indicates that the input is selected from among a plurality of inputs; otherwise, "at least one" would be superfluous. Accordingly, Adest asserts a person of ordinary skill in the art cannot determine with reasonable certainty which inputs are referenced in the phrase "at least one said DC photovoltaic input," rendering these claims indefinite. *Id.* 11.

Initially, we are not persuaded that there is a lack of antecedent basis for the term "said DC photovoltaic output." It appears to us each panel has an output, and that is the antecedent basis for "said output" which is referenced by the singular following "input." Ex. 2001, 22:49–50 and 51–52. The plurality of panels in the claim ensures there will be a plurality of these outputs and inputs, at least for claim 1.

We also are not persuaded of ambiguity in the use of the terms "said photovoltaic DC power output," "a DC photovoltaic output," and "a converted photovoltaic DC power output." The claim recites a DC photovoltaic output providing power to a DC photovoltaic input; providing converted photovoltaic DC power output and providing that power to an inverter. Ex. 2001; 22:48–67. To the extent Adest appearts to be arguing that the word "converted" was not carried forward to the next element of the claim, it is apparent to us that one of ordinary

skill in the art would understand the functioning of the system. We find this argument unconvincing.

To the third point, Ledenev asserts that the claims themselves cover one converter per panel and also one converter per plurality of panels, and such is made clear by reference to the specification and claim 20. Paper 78, 4. Ledenev specifically points to claim 25 of the '116 patent, which describes one converter per plurality of panels. *Id.* Professor Seymour[4] so testifies as well. Ex. 2028, ¶ 11.

But we fail to see why these potential alternatives are, in this instance, necessarily ambiguous - although they may render the claim broad and inclusive of many embodiments. The use of "at least one" opens the claim up to the point where there may, and may not, simultaneously be a plurality of each device feeding others or receiving feeds from other devices.

Indeed, we credit the testimony of Eric Seymour's Third Declaration that the energy source can be a single panel or a string of panels. Ex. 2028, ¶ 11. He observes that claim 25 recites a choice of at least one individual panel dedicated converter and at least one multiple panel dedicated converter. To our way of thinking, the claim covers all these alternatives and one of ordinary skill in the art

[4] We find Professor Seymour to be qualified to testify as to the technical subject matter of this interference. Ex. 2012, ¶¶ 4–8.

could determine whether a particular arrangement falls within the scope of the claim.

To this end, we find ourselves in agreement with Ledenev that claim 25, which is dependent on claim 17 and specifically recites both sets of possibilities, is instructive as to the claim interpretation. Ex. 2001, 28:40–47. Although the claim is broad, we are not persuaded that it is indefinite. We are therefore unpersuaded by this first group of contentions from Adest.

"substantially power isomorphic"

Adest also asserts that the term "substantially power isomorphic" has no meaning in the art and as a consequence claims 1–3, 5, 6, 9–11, 18, 19, 21, and 24–27 are indefinite. Paper 49, 13. Adest relies upon the testimony of Marc E. Herniter in support of this contention.[5] Professor Herniter testifies that, despite consulting the Random House Webster's Unabridged Dictionary, he was unable to find a definition of "isomorphic" that pertained to power conversion. Ex. 1004, ¶¶ 27–28. He also testifies that the specification includes only a brief discussion of the term, and that discussion would leave one of ordinary skill in the art unsure what the features of a substantially power isomorphic power conversion were, be they efficiency or other feature. *Id.* ¶¶ 32–33.

Ledenev, on the other hand, urges that one of ordinary skill in the art can easily discern from the specification the definition of substantially power

[5] We find Professor Herniter to be qualified to testify as to the technical subject matter of this interference. Ex. 1004, ¶¶ 4–7.

isomorphic. Paper 78, 11–13. This is said to be because the description establishes that "substantially power isomorphic" requires conversion without generating substantial heat, at from 97% efficiency to 99.2% or wire loss transmission efficiency. Ex. 2001, 13:8-28. We are pointed to the following passages:

- "It [the system] can even provide a substantially power isomorphic photovoltaic DC power conversion that does not substantially change the form of power into heat rather than electrical energy by providing as high as 99.2% efficiency." Ex. 2001, col. 13, l. 16-20.

Professor Seymour testifies that because isomorphism and low heat generation both appear for the first time, in the same sentence, and because both are presented in an explicatory manner ("provide … isomorphic … power conversion that does not … change … power into heat rather than electrical energy"), a person having ordinary skill in the art would have known with reasonable certainty that isomorphic conversion results in low heat generation. Ex. 2028, ¶ 32

- The same paragraph introducing the "isomorphic" term states that "such operation [isomorphic converter control] can be at levels of 20 from 97%, 97.5, 98, 98.5 up to either 99.2 or essentially the wire transmission loss efficiency…" Ex.2001, col. 13, l. 25-27.

Dr. Seymour testifies that highly efficient power conversion was known in 2007 and the specification defines the levels. Ex. 2028, ¶ 33.

- Claim 5 recites "isomorphic…converter…control circuitry is selected from the group consisting of: at least about 98% efficient…circuitry, at least about 98.5% efficient…circuitry…." Ex. 2001, 23:23-39.

In reply, Adest urges that the "substantially power isomorphic" term recites that it "can" have certain efficiencies, but does not require them, and the open ended list of efficiencies is not a clear definition, and consequently the term is indefinite. Paper 115, 8–9.

We have carefully weighed the testimony of Professor Seymour (Ex. 2028) ("A PHOSITA would have known that the efficiencies indicated in this passage relate to, and define, isomorphism" ¶ 31) versus that of Professor Herniter that "one of ordinary skill in the art would not know how the phrase 'substantially isomorphic power' defines or limits the 'photovoltaic DC-DC power converter' as recited in claim 1." Ex. 1004, ¶ 28.

On balance, we find the evidence of record supports the testimony of Professor Seymour rather than Professor Herniter. We find the term isomorphic to be capable of being reasonably interpreted as keeping power in its electrical form without dissipating it as substantial amounts of heat. We find the specification particularly persuasive on this point. It is reproduced below in pertinent part:

> As mentioned earlier, an aspect of significant important is the level of efficiency with which the converter operates. This is defined as the power going out after conversion over the power coming in before conversion. A portion of the efficiency gain is achieved by using switchmode operation of transistor switches, however, the topology is far more significant in this regard. Specifically, by the operation of switches and the like as discussed above, the system can go far beyond the levels of efficiency previously

> thought possible. It can even provide a substantially power isomorphic photovoltaic DC-DC power conversion that does not substantially change the form of power into heat rather than electrical energy by providing as high as about 99.2% efficiency. This can be provided by utilizing substantially power isomorphic photovoltaic converter functionality and a substantially power isomorphic photovoltaic impedance converter and by controlling operation of the switches so that there is limited loss as discussed above. Such operation can be at levels of from 97, 97.5, 98, 98.5 up to either 99.2 or essentially the wire transmission loss efficiency (which can be considered the highest possible).

Ex. 1001, 13:8–28.

We read the specification as more limiting than Adest asserts, and along the lines admitted as limiting by Ledenev. While it is true that the efficiency levels are stated using the term "can be" and not "must be," we find that these efficiency levels give one of ordinary skill in the art a reasonable range to apply to the term "substantially power isomorphic." Accordingly, we are unpersuaded by this contention.

Adest also appears to assert indefiniteness in that "substantially power isomorphic photovoltaic DC-DC power conversion" is provided by three features in Ledenev's specification. Paper 49, 15. More specifically:

- "utilizing substantially power isomorphic photovoltaic converter functionality." Ex. 1001, 13:21-22;

- utilizing "a substantially power isomorphic photovoltaic impedance converter." Ex. 1001, 13:22-23; and

- "controlling operation of the switches so that there is limited loss as discussed above." Ex. 1001, 13:23-25.

According to Adest, Ledenev does not describe distinct structures or operations of these three features, and Ledenev appears to disclose performing the function of power conversion by controlling only one set of switches in the power converter, i.e., T1-T4/T21-T24 in Figs 5a and 5b. (Ex. 1001, 10:11-42.) Paper 49, 15–16.

Professor Herniter testifies that it is unclear whether the aspect of not changing the form of power into heat is an aspect or result of substantially power isomorphic photovoltaic DC-DC power conversion itself or whether it is some additional feature provided by the switchmode operation and topology of the DC-DC converter. Ex. 1004 ¶ 31. Adest thus urges indefiniteness in this term in that the specification is unclear as to whether these three features are the same thing or three distinct things, and if they are distinct, what are the distinct structures and distinct operations of each that distinguish the features. *Id.*, ¶ 32. Professor Herniter concudes that this ambiguity as to the only structure or structures identified as providing "substantially power isomorphic . . . conversion," further results in the claimed "substantially power isomorphic" converter and circuitry to be indefinite. *Id.,* ¶¶ 32-35.

Ledenev in opposition notes that the specification indicates that isomorphic conversion results from operation and from topology. Paper 78, 14, citing Ex. 2001, 13:11-14. Professor Seymour testifies that synchronous switching providing low losses accomplishes this. Ex. 2028, ¶ 39. He concludes that a person having ordinary skill in the art could have readily used such topology and operational protocol to achieve isomorphic power conversion. *Id.,* ¶¶ 37-41.

We find Professor Seymour's testimony to be credible and carry more weight than Professor Herniter's. Professor Seymour points to where the specification provides several examples as to how the efficiencies discussed are accomplished. More particularly, and *inter alia*:

- "A portion of the efficiency gain is achieved by using switchmode operation of transistor switches, however, the topology is far more significant in this regard." Ex. 2001, 13:11-14.

- "This [efficiency] can be provided by utilizing substantially power isomorphic photovoltaic converter functionality and a substantially power isomorphic photovoltaic impedance converter and by controlling operation of the switches so that there is limited loss as discussed above." Ex. 2001, 13:20-25.

- "In the case of the impedance being changed such that the uotput voltage is lower than the input voltage (buck), T3 can be forced to be in a continuous conduction state and T4 in a non-conducting state with T1 and T2 operated in a switchmode duty cycle state. This duty cycle of operation can be synchronous in that the transistor T2 may be switched synchronously with T1 (with inverted duty cycle). T2 may be a low $R_{DS(ON)}$ FET having much lower losses than a diode in this location. By such synchronous operation this circuit can have extremely high efficiency as mentioned more generally below." Ex. 2001, col. 11, l. 28-38.

- "One aspect that contributes to such efficiency is the fact that minimal amounts of energy are stored during the conversion process." Ex. 2001, 13:29-31.

It appears to us that these passages in Ledenev explain at least one method of achieving the high efficiency required to achieve the claimed "isomorphic"

qualities. This description, viewed through the lens of one of ordinary skill in the art, appears to provide sufficient and reasonable means to understand that the isomorphic conversion as a whole can be the result of a plurality of these factors. We therefore are not persuaded by Ledenev's contention in this regard.

"multimodal"

Adest asserts that independent claims 1, 17, and 20 each recite one of the following limitations that lacks sufficient written description or otherwise is indefinite: "multimodal functionality" (claims 1 and 20) and "multimodal converter functionality" (claim 17). *See* Ex. 1001, 22:57, 26:7, 26:54-55. Dependent claims 2, 3, 5, 6, 18, and 21 additionally recite one of these limitations. Ex. 1001, 22:5, 22:11-12, 22:25-26, 22:42-43, 26:23-24, 27:45. Paper 49, 17–18.

According to Adest, Ledenev references thirty–eight different types of undefined "mode" circuitry from which "multimodal functionality" could be selected, including "all permutations and combinations" of such thirty-eight different mode circuitries. *Id.,* citing Ex. 1001, 24:67.

Adest observes that this at least results in approximately 275 billion different possibilities of "multimodal functionality" which are also not described. Paper 49, 18, citing Ex. 1004, ¶ 38.

In response, Ledenev observes that at least two modes - increasing and decreasing impedance – e.g. "buck" and "boost" - are described. Paper 78, 15.

Indeed, Ledenev points out that Adest's own witness admitted during cross-examination that the two different modes of operation constituted multimodal.

> Q. Having had it explained as providing both a boost and a buck capability, would a person understand the red circled circuitry to be first modality photovoltaic DC-to-DC power conversion circuitry?
> A. Uh-huh, yeah. I think it was – I explained that.
>
> Q. Would a person of ordinary skill in the art in 2007 understand the portion circled in purple in figure 5B as being second modality photovoltaic DC-to-DC power conversion circuitry?
> A. I think they could have.

Ex. 2027, p. 197:3–15. *See also* Ex. 1004, ¶ 39 ("The '116 patent does include several modes of operation").

Accordingly, Adest fails to provide us sufficient persuasive evidence that one of ordinary skill in the art could not reasonably understand the scope of "multimodal" in claims 1, 17, and 20.

"all permutations and combinations of the above"

As noted above, breadth of a claim does not mean the claim is necessarily indefinite. For claims 6 and 21, Adest observes the claims make such combinations, and makes an allegation that there are many combinations and possibilities. Paper 78, 20–21. While this statement is literally true, a large number of possibilities does not necessarily by itself mean that a claim is indefinite. Professer Herniter opines that one of ordinary skill in the art would not know which modes would or could be combined. Ex. 1004 ¶ 62, citing ¶¶ 37–39. He is of the opinion that the circuitries discussed in the claims are not discussed in the specification, and it is not disclosed how one would combine these circuits into a functional circuit. *Id.*

On the other hand, Ledenev observes that claims 6 and 21 each specify only 38 distinct alternative species, and the text "all permutations and combinations" does not create any additional species. Professor Seymour testifies that a person of ordinary skill in the art could readily determine infringement of claims 6 and 21.

While there could be a large number of permutations and combinations, we are not persuaded that a person of ordinary skill in the art could not reasonably determine the scope of the claims. Professor Herniter has not demonstrated an instance to us of any doubt as to the scope or an actual example of incompatible modes.

Accordingly, we are unpersuaded by this contention concerning claims 6 and 21.

"traditional" and "improved"

Adest asserts that the terms "traditional" and "improved" in claims 15 and 16 are subjective and undefined. *Id.,* 21–22. Claims 15 and 16 are reproduced below:

> 15. An efficient solar energy power system as described in claim 14 wherein said first power capability comprises a traditional power conversion capability and wherein said second power capability comprises an improved power conversion capability.
>
> 16. An efficient solar energy power system as described in claim 15 and further comprising a shunt switch operation disable element to bypass said improved power conversion capability.

Ex. 1001, 25:54–62.

Professor Herniter testifies, convincingly, that the term "traditional"

could be any type of power conversion ever published in the literature. He further testifies that guidance on interpreting the term is minimal, providing onl;y one example of an inverter. He additionally testifies that the '116 patent fails to provide any guidance as to what qualifies as the claim 15 feature of a "traditional power conversion capability" or an "improved power conversion capability." He is of the opinion that the vagueness of the terms "traditional" and "improved," and the lack of any clarifying disclosure in the '116 patent, render one of ordinary skill in the art unable to determine the scope of claim 15. Ex. 1004, ¶¶ 63–66.

Ledenev asserts that these terms are definite in that they have their common sense meaning – known aand providing better performance. Paper 78, 19. Professor Seymour testifies that as the '116 Patent juxtaposes the terms "traditional" and "improved" against one another, it provides context that points directly to their opposing (and common sense) meanings – known and not known (and providing better performance), respectively. Ex. 2028, ¶ 28.
He also points to additional text from the '116 Patent describing where the inventive systems can achieve efficiencies in conversion that are extraordinarily high compared to traditional systems. According to Dr. Seymour, this suggests that traditional capabilities are known capabilities. It is therefore Dr. Seymour's view that the specification would have guided a person of ordinary skill in the art, in 2007,
to a reasonably certain understanding that the inventor considers certain technical capabilities e.g., isomorphic power conversion – as improved. He asserts that such

a skilled person would have been able to identify the scope of claims 15 and 16 with reasonable certainty. *Id,* ¶ 56.

We find this testimony of Dr. Seymour to be of very little persuasive value. We instead credit Professor Herniter's testimony that the terms are subjective and vague. The term "traditional" is given no clear metes and bounds and there is no boundary on what constitutes "improved."

We are therefore persuaded that Adest has shown that claims 15 and 16 are indefinite, as one of ordinary skill in the art cannot reasonably ascertain their scope.

B. Written Description

1. Legal Principles

"To satisfy [the written description] requirement, the specification must describe the invention in sufficient detail so 'that one skilled in the art can clearly conclude that the inventor invented the claimed invention as of the filing date sought.'" *In re Alonso*, 545 F.3d 1015, 1019 (Fed. Cir. 2008), citing *Lockwood v. Am. Airlines, Inc.*, 107 F.3d 1565, 1572 (Fed. Cir. 1997). We thus consider what the specification reasonably would have conveyed to one of ordinary skill in the art, as well as the predictability of the art, in evaluating whether the specification provides sufficient written description for the claimed invention. *Bilstad v. Wakalopulos*, 386 F.3d 1116, 1125 (Fed. Cir. 2004); *Noelle v. Lederman*, 355 F.3d 1343, 1350 (Fed. Cir. 2004). "Such description need not recite the claimed invention in haec verba but must do more than merely disclose that which would render the claimed invention obvious." *ICU Medical, Inc. v. Alaris Medical*

Systems, Inc., 558 F.3d 1368, 1377 (Fed. Cir. 2009). A "mere wish or plan" for obtaining the claimed invention does not satisfy the written description requirement. *Regents of the Univ. of Cal. v. Eli Lilly & Co*., 119 F.3d 1559, 1566 (Fed. Cir. 1997).

In interference proceedings the language of each claim is given its broadest reasonable interpretation as read in light of the specification as it would be interpreted by one of ordinary skill in the art. *See In re Sneed*, 710 F.2d 1544, 1548 (Fed. Cir. 1983) (citations omitted).

Adest asserts that the above claim limitations lack sufficient written description. More specifically, it is Adest's position that if the claim were to cover a configuration having a single "DC photovoltaic output" and more than one "DC-DC power converter," then the claim necessarily covers a configuration where two (or more) DC-to-DC power converters are connected to the same DC photovoltaic output. Paper 49, 11-12, *citing* Ex. 1004, ¶¶ 21. However, Adest urges that Ledenev fails to disclose such a configuration. Consequently, it is Adest's position that the Ledenev's claims reciting them should be rendered unpatentable for lack of sufficient written description. Paper 49, 11-12.

Dr. Herniter testifies that "if one were to assume that the singular interpretation was intended, the claim would lack written description support because there is no disclosure of multiple DC-DC power converters accepting power from a single power source as would be required by the claim according to this assumption." Ex. 1004, ¶ 23.

Ledenev responds that the claims as originally filed contained such language and as such can be support for themselves. Paper 78, 10. More specifically, Ledenev contends that claims 1, 11 and 18, original claims in the PCT application, recited a system having "at least one solar energy source" and "at least one…DC-DC power converter." *Id.*, citing Ex. 2029, pp. 36-37 and 39.

As our reviewing court has stated, the question is a bit more complex than "is it there or not?":

> Furthermore, while it is true that original claims are part of the original specification, *In re Gardner*, 480 F.2d 879, 879 (CCPA 1973), that truism fails to address the question whether original claim language necessarily discloses the subject matter that it claims. Ariad believes so, arguing that original claims identify whatever they state*, e.g.,* a perpetual motion machine, leaving only the question whether the applicant has enabled anyone to make and use such an invention. Oral Argument 37:26–38:00. We disagree that this is always the case. Although many original claims will satisfy the written description requirement, certain claims may not. For example, a generic claim may define the boundaries of a vast genus of chemical compounds, and yet the question may still remain whether the specification, including original claim language, demonstrates that the applicant has invented species sufficient to support a claim to a genus. The problem is especially acute with genus claims that use functional language to define the boundaries of a claimed genus. In such a case, the functional claim may simply claim a desired result, and may do so without describing species that achieve that result. But the specification must demonstrate that the applicant has made a generic invention that achieves the claimed result and do so by showing that the applicant has invented species sufficient to support a claim to the functionally-defined genus

Ariad Pharmaceuticals, Inc. v. Eli Lilly and Co., 598 F.3d 1336, 1349 (Fed. Cir. 2010).

Ledenev asserts that one of ordinary skill in the art would have known of multiple converters for a single energy source. Paper 78, 10, , citing Ex. 2030, Fig. 7. According to Professor Seymour, such a person could have readily applied such known technology to a photovoltaic system to configure two or more converters for each panel. Ex. 2028, ¶ 26.

Ledenev US 8,004,116 B2 (Ex. 2001) was application serial number 12/955,704, a continuation of 12/682,889, filed as a PCT application PCT/US2008/057105. Ex. 2001 [63]. The PCT application is provided to us as Exhibit 2029. A careful reading of the Exhibit reveals the original text of claims 1 and 11, as filed. They are reproduced below:

> 1. A vacillatory conversion mode solar energy power system comprising:
> - at least one solar energy source having a DC photovoltaic output;
> - a DC input that accepts power from said DC photovoltaic output;
> - first modality photovoltaic DC-DC power conversion circuitry responsive to said DC input;
> - second modality photovoltaic DC-DC power conversion circuitry responsive to said DC input;
> - alternative mode photovoltaic power converter functionality control circuitry configured to alternatively switch at at least some times between said first modality photovoltaic DC-DC power conversion circuitry and said second modality photovoltaic DC-DC power conversion circuitry;
> - a photovoltaic DC-DC power converter responsive to said alternative mode photovoltaic power converter functionality control circuitry;

- a photovoltaic DC power output connected to said photovoltaic DCDC power converter;
- a photovoltaic DC-AC inverter responsive to said photovoltaic DC power output; and
- a photovoltaic AC power output responsive to said photovoltaic DC-AC inverter.

Ex. 2029, 33.

11. An efficient solar energy power system comprising:

- at least one solar energy source having a DC photovoltaic output;
- a DC input that accepts power from said DC photovoltaic output;
- at least one substantially power isomorphic photovoltaic DC-DC power converter responsive to said DC input;
- substantially power isomorphic photovoltaic converter functionality control circuitry to which at least one of said substantially isomorphic DC-DC power converters are responsive;
- a photovoltaic DC power output connected to said photovoltaic DC-DC power converter;
- a photovoltaic DC-AC inverter responsive to said photovoltaic DC power output; and
- a photovoltaic AC power output responsive to said photovoltaic DC-AC inverter.

Ex. 2029, 36–37.

The first issue, squarely joined, is whether "first modality photovoltaic DC-DC power conversion circuitry responsive to said DC input; second modality photovoltaic DC-DC power conversion circuitry responsive to said DC input" (claim 1) and "at least one substantially power isomorphic photovoltaic DC-DC

power converter responsive to said DC input" (claim 11) supports the "at least one" DC-DC converter language in the '116 claims.

In this instance, utilizing a plurality of DC-DC converters was contemplated in the claims of the PCT application. Accordingly, we find that the language "at least one" has sufficient written description support.

The second issue is whether "a photovoltaic DC-AC inverter responsive to said photovoltaic DC power output" in both claims 1 and 11 above in the PCT application is sufficient to how that Ledenev had possession of the later claimed "at least one photovoltaic DC-AC inverter responsive to said photovoltaic DC power output" as recited in the claims of the '116 application. This question is much more difficult to answer. The original claims do not have language supporting feeding multiple DC-AC inverters from the DC power output.

Ledenev points out original claims 1 and 11 describe a system "comprising" an inverter. Paper 78, 10-11. Ledenev urges that the term "comprising" is used in conjunction with "a" or "an" article, such claim is properly interpreted as covering one or more of such articles absent a clear intent to limit only coverage to only one such article. *Id.*, citing *Baldwin Graphic Systems, Inc., v. Siebert, Inc*., 512 F.3d 1338, 1342-1343 (Fed. Cir. 2008). The problem with this position is that we are not concerned with infringement or indefiniteness in this analysis, but written descriptive support. It is of no moment that one of ordinary skill in the art could have made a multi inverter setup, the question is whether one skilled in the art can clearly conclude that the inventor invented the claimed invention as of the filing date sought.

We cannot conclude that the prior PCT application describes the claimed invention, including an embodiment with a plurality of inverters. As such, claims 1, 17, and 20 lack written descriptive support. As all the remaining claims depend directly or indirectly from those three claims, they too lack written descriptive support.

We therefore GRANT Adest Motion 1.

VI. Adest Motion 2 – for Benefit

As we have granted Adest Motion 1, and Junior Party Ledenev has no remaining claims, we dismiss Adest Motion 2. (Paper 48).

VII. Ledenev Motion 4 – Designating Claims as Not Corresponding to the Count

Ledenev Motion 4 (Paper 35) seeks to have claims 4, 15, and 16 designated as not corresponding to the count. However, as Adest Motion 1 has been granted, and these claims are unpatentable, we dismiss Ledenev Motion 4.

VII. Order

It is hereby ORDERED that:

Ledenev Motion 7 is DENIED.
Adest Motion 1 is GRANTED.
Adest Motion 2 is DISMISSED.
Ledenev Motion 4 is DISMISSED.

FURTHER ORDERED that judgment against Ledenev will be entered in a separate paper to follow.

Attorney for Ledenev

Luke Santangelo
Alfred K. Wiedmann, Jr.
SANTANGELO LAW OFFICES, P.C.
luke@idea-asset.com
alw@idea-asset.com

W. Todd Baker
OBLON, McCLELLAND, MAIER & NEUSTADT, L.L.P.
tbaker@oblon.com

Attorney for Adest

Frederic M. Meeker
Michael S. Cuviello
Joseph M. Skerpon
BANNER & WITCOFF, LTD.
fmeeker@bannerwitcoff.com
mcuviello@bannerwitcoff.com
jskerpon@bannerwitcoff.com

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

33549 7590 02/12/2020
SANTANGELO LAW OFFICES, P.C.
125 SOUTH HOWES, THIRD FLOOR
FORT COLLINS, CO 80521

EXAMINER
KAPLAN, HAL IRA

ART UNIT	PAPER NUMBER
2836	

DATE MAILED: 02/12/2020

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/679,745	08/17/2017	Anatoli Ledenev	AMPT-DualMode-Cont7	6963

TITLE OF INVENTION: Feedback Based Photovoltaic Conversion Systems

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0.00	$0.00	$500	05/12/2020

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

33549 7590 02/12/2020
SANTANGELO LAW OFFICES, P.C.
125 SOUTH HOWES, THIRD FLOOR
FORT COLLINS, CO 80521

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/679,745	08/17/2017	Anatoli Ledenev	AMPT-DualMode-Cont7	6963

TITLE OF INVENTION: Feedback Based Photovoltaic Conversion Systems

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0.00	$0.00	$500	05/12/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
KAPLAN, HAL IRA	2836	307-082000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑Issue Fee ❑Publication Fee (if required) ❑Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/679,745	08/17/2017	Anatoli Ledenev	AMPT-DualMode-Cont7	6963

33549 7590 02/12/2020

SANTANGELO LAW OFFICES, P.C.
125 SOUTH HOWES, THIRD FLOOR
FORT COLLINS, CO 80521

EXAMINER	
KAPLAN, HAL IRA	

ART UNIT	PAPER NUMBER
2836	

DATE MAILED: 02/12/2020

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 15/679,745	Applicant(s) Ledenev et al.	
	Examiner HAL KAPLAN	Art Unit 2836	AIA (FITF) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to Applicant's amendments filed November 7, 2019 and December 2, 2019.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are See Continuation Sheet . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☑ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☑ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/HAL KAPLAN/
Primary Examiner, Art Unit 2836

Continuation of 3. The allowed claim(s) is/are: 80,85-86 and 100-129

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application is being examined under the pre-AIA first to invent provisions.

2. The Examiner wishes to thank the Applicant for the time and courtesies extended in the telephone interview on February 6, 2020. Corrections have been made by Examiner's Amendment as discussed.

Drawings

3. The drawings were received on August 17, 2017. These drawings are acceptable.

EXAMINER'S AMENDMENT

4. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in an interview with Alfred K. Wiedmann Jr. on February 6, 2020.

5. The application has been amended as follows:

In claim 80, line 3, please change the text "each said power converters" to – each of said power converters --.

In claim 80, line 8, please change the text "altering" to – alternating --.

In claim 80, line 10, please change the text "converter DC output, and" to – converter DC output at other than maximum power point, and --.

In claim 80, line 11, please change the text “said converter DC output, and” to – said converter DC output at other than said maximum power point, and --.

In claim 107, line 3, please change the text “each said power converters” to – each of said power converters --.

In claim 107, line 8, please change the text “altering” to – alternating --.

In claim 107, line 10, please change the text “converter DC output, and” to – converter DC output at other than maximum power point, and --.

In claim 109, line 2, please change the text “107wherein” to – 107 wherein --.

In claim 110, line 1, please change the text “claim 80” to – claim 107 --.

In claim 117, line 3, please change the text “each said power converters” to – each of said power converters --.

In claim 117, line 8, please change the text “altering” to – alternating --.

In claim 117, line 10, please change the text “converter DC output, and” to – converter DC output at other than maximum power point, and --.

Please add the following new claims:

127. (New) The grid powering solar power system of claim 80 wherein, during said overvoltage boundary condition control and said overcurrent boundary condition control, said operational power exhibits a proportionality between voltage and current.

128. (New) The grid powering solar power system of claim 107 wherein, during said overcurrent boundary condition control, said operational power exhibits a proportionality between voltage and current.

129. (New) The grid powering solar power system of claim 117 wherein, during said overvoltage boundary condition control, said operational power exhibits a proportionality between voltage and current.

6. The following is an examiner's statement of reasons for allowance:

Claims 80, 85-86, 100-106, and 127 are allowed because none of the prior art of record discloses or suggests converter functionality control circuitry that, during operation of the grid powering solar power system to produce operational power that is sufficient to power the grid, is capable of alternating between: maximum power point tracking, overcurrent boundary condition control of converter DC output at other than maximum power point, and overvoltage boundary condition control of the converter DC output at other than the maximum power point, in combination with the remaining claimed features.

Claims 107-116 and 128 are allowed because none of the prior art of record discloses or suggests converter functionality control circuitry that, during operation of the grid powering solar power system to produce operational power that is sufficient to power the grid, is capable of alternating between: maximum power point tracking, and overcurrent boundary condition control of converter DC output at other than maximum power point, in combination with the remaining claimed features.

Claims 117-126 and 129 are allowed because none of the prior art of record discloses or suggests converter functionality control circuitry that, during operation of the grid powering solar power system to produce operational power that is sufficient to power the grid, is capable of alternating between: maximum power point tracking, and

overvoltage boundary condition control of the converter DC output at other than maximum power point, in combination with the remaining claimed features.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Response to Arguments

7. Applicant's arguments, see Remarks, filed November 7, 2019 and December 2, 2019, with respect to the objections to the specification, drawings, and claims have been fully considered and are persuasive. The objections have been withdrawn.

8. Applicant's arguments, see Remarks, filed November 7, 2019 and December 2, 2019, with respect to the provisional double patenting rejections of claims 80 and 85-86, and the rejections of claims 80 and 85-86 under 35 U.S.C. 102(b) have been fully considered and are persuasive. The rejections of claims 80 and 85-86 have been withdrawn. Claims 81-84 and 87-99 have been canceled.

Conclusion

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to HAL KAPLAN whose telephone number is (571)272-8587. The examiner can normally be reached on 9:30AM-5:00PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Rexford Barnie can be reached on 571-272-7492. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/HAL KAPLAN/
Primary Examiner, Art Unit 2836

Europäisches Patentamt
European Patent Office
Office européen des brevets

European Patent Office
80298 MUNICH
GERMANY
Tel: +49 89 2399 0
Fax: +49 89 2399 4465

Kador & Partner PartG mbB
Corneliusstraße 15
80469 München
ALLEMAGNE

Formalities Officer
Name: Ghilini, Marie
Tel: +49 89 2399 - 6121
or call
+31 (0)70 340 45 00

Substantive Examiner
Name: Meyer, Andreas Hans
Tel: +49 89 2399 - 2703

Application No.	Ref.	Date
17 209 600.0 - 1202	K 66 424/13sw	07.02.2020
Applicant AMPT, LLC		

Communication pursuant to Article 94(3) EPC

The examination of the above-identified application has revealed that it does not meet the requirements of the European Patent Convention for the reasons enclosed herewith. If the deficiencies indicated are not rectified the application may be refused pursuant to Article 97(2) EPC.

You are invited to file your observations and insofar as the deficiencies are such as to be rectifiable, to correct the indicated deficiencies within a period

of 4 months

from the notification of this communication, this period being computed in accordance with Rules 126(2) and 131(2) and (4) EPC. One set of amendments to the description, claims and drawings is to be filed within the said period on separate sheets (R. 50(1) EPC).

If filing amendments, you must identify them and indicate the basis for them in the application as filed. Failure to meet either requirement may lead to a communication from the Examining Division requesting that you correct this deficiency (R. 137(4) EPC).

Failure to comply with this invitation in due time will result in the application being deemed to be withdrawn (Art. 94(4) EPC).

Registered letter

Meyer, Andreas Hans
Primary Examiner
For the Examining Division

Enclosure(s): 3 page/s reasons (Form 2906)
EP-1388927-A2, US-20040085048-A1, US-20050093526-A1

1. New documents

The following documents are newly cited by the Examiner. A copy of the documents is annexed to the communication and the numbering will be adhered to in the rest of the procedure.

D2 EP 1 388 927 A2 (VLT CORP [US]) 11 February 2004 (2004-02-11)

D3 US 2004/085048 A1 (TATEISHI TETSUO [US]) 6 May 2004 (2004-05-06)

D4 US 2005/093526 A1 (NOTMAN ANDREW [GB]) 5 May 2005 (2005-05-05)

2. Article 84 EPC

2 The application does not meet the requirements of Article 84 EPC, because claim 1 is not clear.

2.1 The phrase 'synchronous duty cycle switch loss maximum photovoltaic power point conversion efficiency' does not make sense, and cannot be understood.

2.2 The requirement that the conversion of DC power has an efficiency of at least 97% is a 'result to be achieved' (Guidelines F-IV 4.10). From the publication of the parent application WO2009/051853, p18, lines 26-27, this is achieved from a combination of the switch topology and the method of operating the switches. As the independent claims must comprise all the essential features necessary for achieving the technical effect (Guidelines F.IV 4.5.2), these features must be included in a clear and complete manner.

2.3 It is not clear from the phrase 'efficiency up to wire transmission loss, transistor on-state loss, and synchronous duty cycle switch loss maximum photovoltaic power point conversion efficiency' whether the listed alternatives are intended to be used simultaneously or individually (but see §3.3 below).

2.4 The only example of a 'dual mode photovoltaic DC-DC converter' that is given in the description is a buck-boost converter. Claim 1 should therefore be limited to this disclosed embodiment.

3. Article 76(1) EPC

3 Claim 1 introduces subject-matter which extends beyond the content of the parent application (EP08732274) contrary to Article 76(1) EPC.

3.1 The phrase 'synchronous duty cycle switch loss maximum photovoltaic power point conversion efficiency' does not have any literal support in the parent application.

3.2 Further, as it does not make any sense (see paragraph 1.1 above), it is not possible to unambiguously determine if the intended feature was disclosed using other terminology.

3.3 It is noted that the upper limit of the efficiency is not considered to be an essential feature, so this objection can be overcome by deletion.

3.4 The following proposed wording of claim 1 would possibly overcome the above objections. In fact, the Examining Division is of the opinion that the embodiment relected by claim 1 proposed below is more or less the only embodiment disclosed in the application documents sufficiently clear enough to enable the skilled person to carry out the invention. However, it is the present opinion of the Examining Division that even the subject-matter reflected by claim 1 proposed below is not inventive over documents D2-D4, respectively (cf. item 4 below).

Claim 1 wording proposal:

A solar power system, comprising: DC power from a solar energy source (1); at least one dual mode photovoltaic DC-DC converter (4) to which said DC power is input; converter functionality control circuitry (8) configured to control said at least one dual mode photovoltaic DC-DC converter [note: upper limit of efficiency is not restrictive]; a converted DC output from said at least one dual mode buck-boost photovoltaic DC-DC converter; and a load to which said converted DC output is input;

wherein in a first mode the output voltage is lower than the input voltage (p16, lines 8-10) and in a second mode the output voltage is higher than the input voltage (p16, lines 17-18);

wherein said dual mode converter comprises at least one pair of input semiconductor switches (T1, T2, T21, T22) (publication of parent application, p14, lines 27-29; fig. 5), at least one pair of output semiconductor switches (T3. T4, T23, T24), and at least one inductor (L1) (fig. 5), one of each pair of semiconductor switches (T1, T3; T21, T23)