

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SMA SOLAR TECHNOLOGY AMERICA, LLC,
Petitioner,
v.

TIGO ENERGY, INC.,
Patent Owner.

Patent 9,966,848
Filing Date: December 28, 2016
Issue Date: May 8, 2018
Title: SYSTEMS AND METHODS FOR ENHANCED EFFICIENCY
AUXILIARY POWER SUPPLY MODULE

Inter Partes Review No.: IPR2023-01175

**PETITION FOR *INTER PARTES* REVIEW
UNDER 35 U.S.C. §§ 311-319 AND 37 C.F.R. § 42.100 *et seq.***

TABLE OF CONTENTS

PETITIONER’S EXHIBIT LIST	3
I. MANDATORY NOTICES PURSUANT TO 37 C.F.R. § 42.8(A)(1),.....	4
A. Real Parties in Interest, § 42.8(b)(1)	4
B. Related Matters, § 42.8(b)(2)	4
C. Lead & Back-Up Counsel and Service Information	5
II. COMPLIANCE WITH THE REQUIREMENTS FOR A PETITION	6
A. Payment of Fees	6
B. Grounds for Standing	6
III. OVERVIEW OF THE ’848 PATENT	7
A. Brief Description	7
B. Relevant Prosecution History.....	10
C. Earliest Priority Date for the Claims	10
IV. OVERVIEW OF PRIOR ART	11
A. DE3725476 (Mieth)(Ex.1002)	11
B. U.S. Patent No. 6,246,592 (Balogh)(Ex.1003)	15
C. U.S. Patent No. 6,798,177 (Liu)(Ex.1005)	16
V. SUMMARY OF ARGUMENT.....	18
VI. IDENTIFICATION OF CHALLENGE PURSUANT TO 37 C.F.R. § 42.104(B) AND STATEMENT OF THE RELIEF REQUESTED	18
A. Claims for Which Review is Requested and Grounds on Which Challenge is Based	18
B. How Claims Are to Be Construed and Level of Skill.....	19
1. How Claims Are to Be Construed	19
2. Level of Skill.....	20
VII. SPECIFIC GROUNDS FOR UNPATENTABILITY	20
A. Ground A: Anticipation of claims 1, 4, 5, 7-10, 13, 14, and 16-18 in view of Mieth	20
1. Independent Claim 1	20

2.	Dependent Claim 4	33
3.	Dependent Claim 5	34
4.	Dependent Claim 7	37
5.	Dependent Claim 8	42
6.	Dependent Claim 9	45
7.	Independent Claim 10	49
8.	Dependent Claim 13	51
9.	Dependent Claim 14	52
10.	Dependent Claim 16	52
11.	Dependent Claim 17	53
12.	Dependent Claim 18	53
B.	Ground B: Obviousness of claims 1, 4, 5, 7-10, 13, 14, and 16-20 in view of Mieth and Balogh.....	53
1.	Independent Claim 1	54
2.	Independent Claim 10	61
3.	Independent Claim 19	61
4.	Dependent Claim 20	72
C.	Ground C: Obviousness of claims 2, 3, 6, 11, 12, and 15 in view of Mieth and Liu, or over Mieth-Balogh, and further in view of Liu	73
1.	Dependent Claim 2	73
2.	Dependent Claim 3	75
3.	Dependent Claim 6	78
4.	Dependent Claim 11	84
5.	Dependent Claim 12	84
6.	Dependent Claim 15	84
D.	CONCLUSION	85
VIII.	CERTIFICATE OF COMPLIANCE WITH WORD COUNT	86
IX.	CERTIFICATE OF SERVICE.....	87
X.	CLAIM LISTING APPENDIX	88

PETITIONER'S EXHIBIT LIST

Exhibit	Description
Ex.1001	U.S. Patent No. 9,966,848
Ex.1002	Certified English Translation of DE3725476 (Mieth)
Ex.1003	U.S. Patent No. 6,246,592 (Balogh)
Ex.1004	The IEEE Standard Dictionary of Electrical and Electronics Terms, Sixth Edition 1996 (IEEE)
Ex.1005	U.S. Patent No. 6,798,177 (Liu)
Ex.1006	File wrapper of U.S. Patent No. 9,966,848
Ex.1007	Declaration of Dr. Doug Holberg
Ex.1008	German Language DE3725476 (Mieth)
Ex.1009	Allen, Philip E., and Douglas R. Holberg. "CMOS Analog Circuit Design" (2002) ("CMOS")
Ex.1010	Solibro GmbH Data Sheet, CIGS THIN FILM SOLAR MODULE SL2 ("Solibro")
Ex.1011	MITSUBISHI ELECTRIC Data Sheet, PHOTOVOLTAIC MODULE ("ME")
Ex.1012	US Patent Publication No. 2007/0001653 (Xu)
Ex.1013	U.S. Patent Publication No. 2006/0207192 (Durham)
Ex.1014	Arias et al., "A Modular PV Regulator Based on Microcontroller with Maximum Power Point Tracking," IEEE, IAS 2004
Ex.1015	U.S. Patent No. 4,617,529 (Suzuki)

Note Regarding Page Citations

For exhibits including page numbers as originally published, Petitioner's citations are to those original page numbers for compliance with 37 C.F.R. § 42.63(d)(2)(ii).

Petition for *Inter Partes* Review

SMA Solar Technology America, LLC ("Petitioner") petitions for *inter partes* review of claims 1-20 of U.S. Patent No. 9,966,848 ("the '848 patent")(Ex. 1001).

I. MANDATORY NOTICES PURSUANT TO 37 C.F.R. § 42.8(A)(1), 37 C.F.R. § 42.8(b)(1)&(2):

A. Real Parties in Interest, § 42.8(b)(1)

The real party-in-interest is Petitioner SMA Solar Technology America, LLC. No unnamed entity is funding, controlling, or directing this Petition, or otherwise has had an opportunity to control or direct this Petition or Petitioner's participation in any resulting IPR.

B. Related Matters, § 42.8(b)(2)

Petitioner is not aware of any disclaimers, reexamination certificates or other petitions for *inter partes* review for the '848 Patent. The '848 patent is the subject of a civil action: *Tigo Energy Inc. v. SMA Solar Technology America LLC*, 22-915-VAC (D. Del.).

No references relied upon herein for disclosing elements of the issued claims were cited during prosecution of the '848 patent. It is noted that one reference, Ex. 1012, U.S. Patent Publication No. 2007/0001653 (Xu), that was disclosed by the applicant for the 15/392,960 filing (Application Number for the '848 patent), is not being relied upon herein for teaching any element of the issued claims, but rather is relied upon solely as evidence of the general knowledge of a PHOSITA prior to the priority date of the '848 patent. No arguments presented in this Petition were raised during prosecution of the '848 patent.

37 C.F.R. § 42.8(b)(3)&(4):

C. Lead & Back-Up Counsel and Service Information

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II. COMPLIANCE WITH THE REQUIREMENTS FOR A PETITION FOR *INTER PARTES* REVIEW

A. Payment of Fees

The undersigned authorizes the charge of fees to Deposit Account No. 50-1733.

B. Grounds for Standing

This petition is filed within one year of service of a complaint against SMA Solar Technology America LLC, in *Tigo Energy Inc. v. SMA Solar Technology America LLC*, 22-915-VAC (D. Del.).

Petitioner certifies the '848 patent is available for review and Petitioner is not barred/estopped from requesting review challenging claims 1-20.

III. OVERVIEW OF THE '848 PATENT

A. Brief Description

The '848 patent is directed to a power supply in a solar system.

Ex.1001,1:50-51;Ex.1007,¶63. Figure 4 shows a power supply having a first stage 401 and a second stage 402 that are buck converters. The first stage 401 receives an input voltage from a photovoltaic ("PV") panel and outputs a first voltage at a first output. The second stage 402 is connected to the first stage 401.

Ex.1001,1:51-56;Ex.1007,¶64. The second stage 402 operates in two states: (1) a first, deactivated state, and (2) a second, enabled state. In the second state the second stage 402 generates a second voltage at a second output using the first voltage to supply a micro-controller with a voltage. Ex.1001,8:41-48;Ex.1007,¶64.

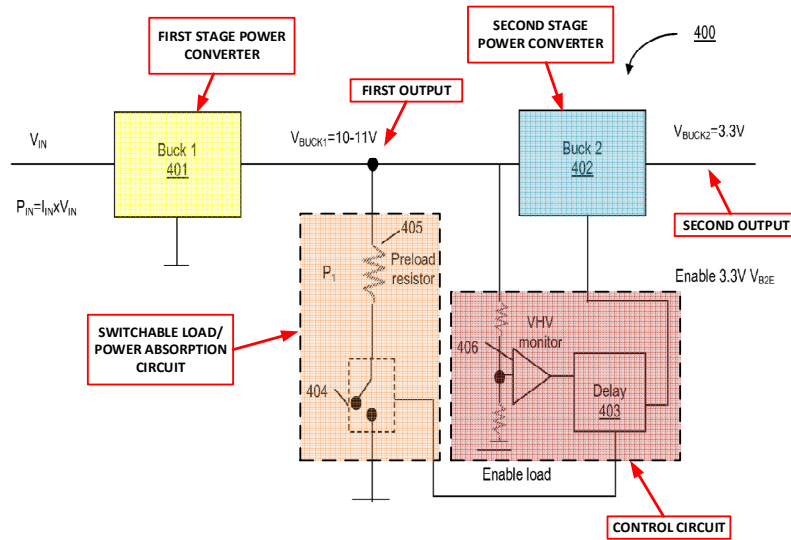
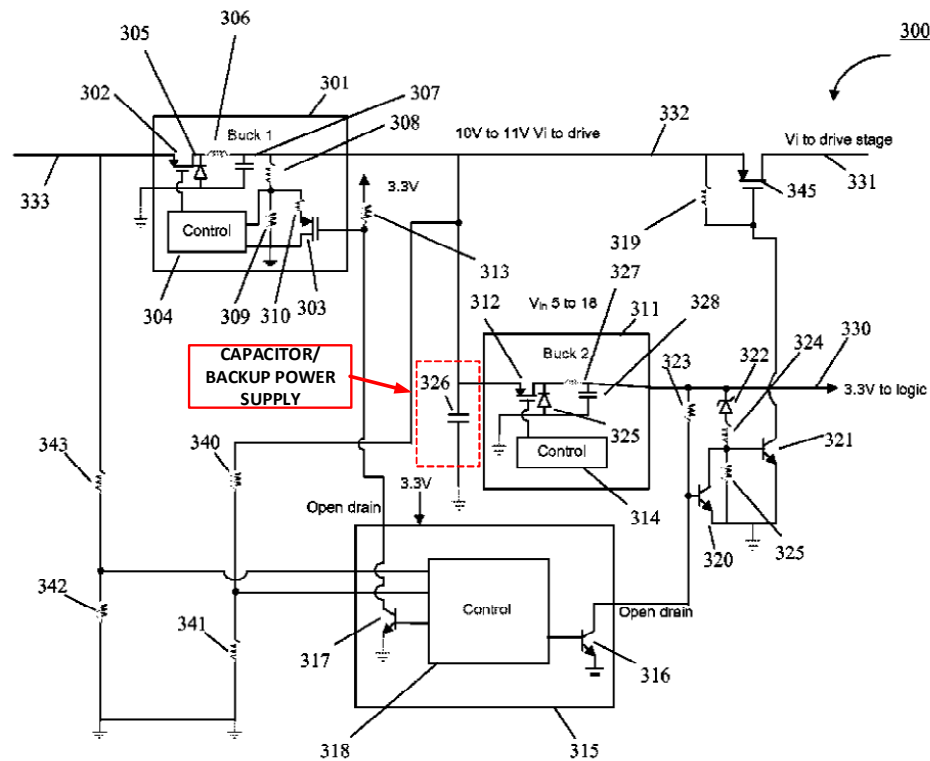


Figure 4

The power supply includes a control circuit (406,403) to prevent false start problems when the solar panel is providing insufficient power. Ex.1001,8:19-22;Ex.1007,¶65. The control circuit, in the first state, connects a preload resistor 405 to the first output by closing a switch 404 via a first control signal to emulate the load of the second stage 402 on the first stage output prior to activating the second stage 402 via a second control signal. Ex.1001,8:22-23,8:35-37;Ex.1007,¶65. If the first stage output voltage exceeds a threshold, the control circuit disconnects the preload resistor 405 by opening the switch 404 via the first control signal. Ex.1001,8:41-45;Ex.1007,¶65. The control circuit employs a delay 403 to delay the second control signal with respect to the first control signal to ensure the second stage operation remains disabled until after the switch 404 is opened, thus providing a “break before make condition,” wherein the switch 404

opens before the second stage 402 is enabled in the second state. Ex.1001,8:40-48;Ex.1007,¶65.

In another embodiment (Figure 3 of Ex.1001), a capacitor 326 is connected to the input of the second stage 311/402. Ex.1001,9:32-34;Ex.1007,¶66.



Ex.1001,Figure3

Capacitor 326 operates as a backup power supply to keep the second stage 311/402 running longer than the first stage 401. Thus, in the first state, the capacitor 326 is charged and absorbs power, and when the first stage 401 is inoperative/unstable, the capacitor discharges to keep the second stage 402 running to provide the second voltage at the second output. Ex.1001,4:60-66;Ex.1007,¶67.

B. Relevant Prosecution History

The '848 patent was filed as App. No. 15/392,960 on December 28, 2016, as a continuation of App. No. 14/822,227 (issued as Patent No. 9,584,021), filed on August 10, 2015, which is a continuation of App. No. 12/787,205 (issued as Patent No. 9,143,036) filed on May 25, 2010, which claims priority to U.S. App. No. 61/275,734, filed on September 2, 2009, and U.S. App. No. 61/336,743, filed on January 26, 2010. Ex.1001,P.1;Ex.1006,P.93. At least 61/275,734, and arguably 61/336,743, do not provide support under 35 U.S.C. §112, first paragraph, for the claimed subject matter. Petitioner does not rely on prior art published in the time period between the priority dates and the non-provisional filing date of May 25, 2010, but reserves the right to challenge the priority date of the '848 Patent.

No substantive Office Actions were issued in the '960 application. An allowance was issued on December 19, 2017. Subsequent to the allowance, an amendment under 37 C.F.R. §1.312 was filed to address an informality. Ex.1006,P.3.

C. Earliest Priority Date for the Claims

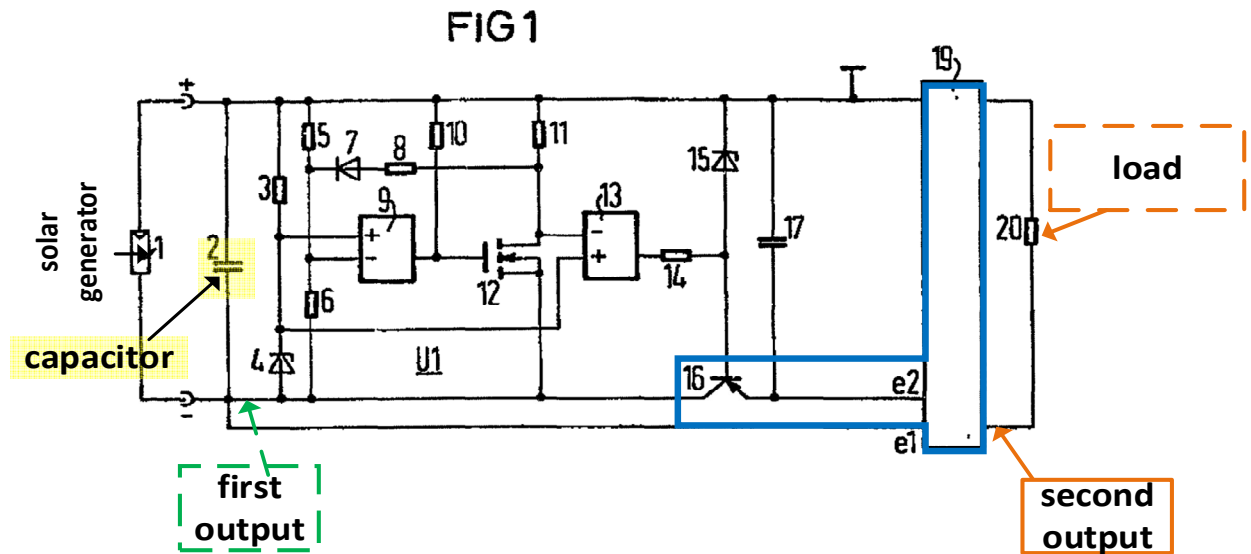
The earliest alleged priority date for the '848 patent claims is September 2, 2009. Each reference in the grounds for unpatentability predates this date and constitutes available prior art under 35 U.S.C. § 311(b).

IV. OVERVIEW OF PRIOR ART

A. DE3725476 (Mieth)(Ex.1002)

Mieth discloses a circuit and method that supplies power to a load 20 from a solar generator 1. Ex.1002,8:8-9;Ex.1007,¶71. For energy sources that vary in performance, like a solar converter (due to time of day/weather conditions), the circuit operates in two different states, depending on the power provided by the energy source at the solar generator 1. Ex.1002,1:23-28;5:22-27;Ex.1007,¶72. In a first state, lower source voltages, a preliminary load 11 is switched “in” to the circuit, while a downstream auxiliary power supply circuit 19 is disabled. In a second state, higher source voltages, the preliminary load 11 is switched “out” of the circuit, and the solar generator 1 is connected to the auxiliary power supply. Ex.1002,1:28-34;claim 1, 2:10-34;Ex.1007,¶72.

Fig.1(annotated A) shows solar generator 1 as an input source that provides direct current to a first stage capacitor 2 that provides a first voltage at a first output.

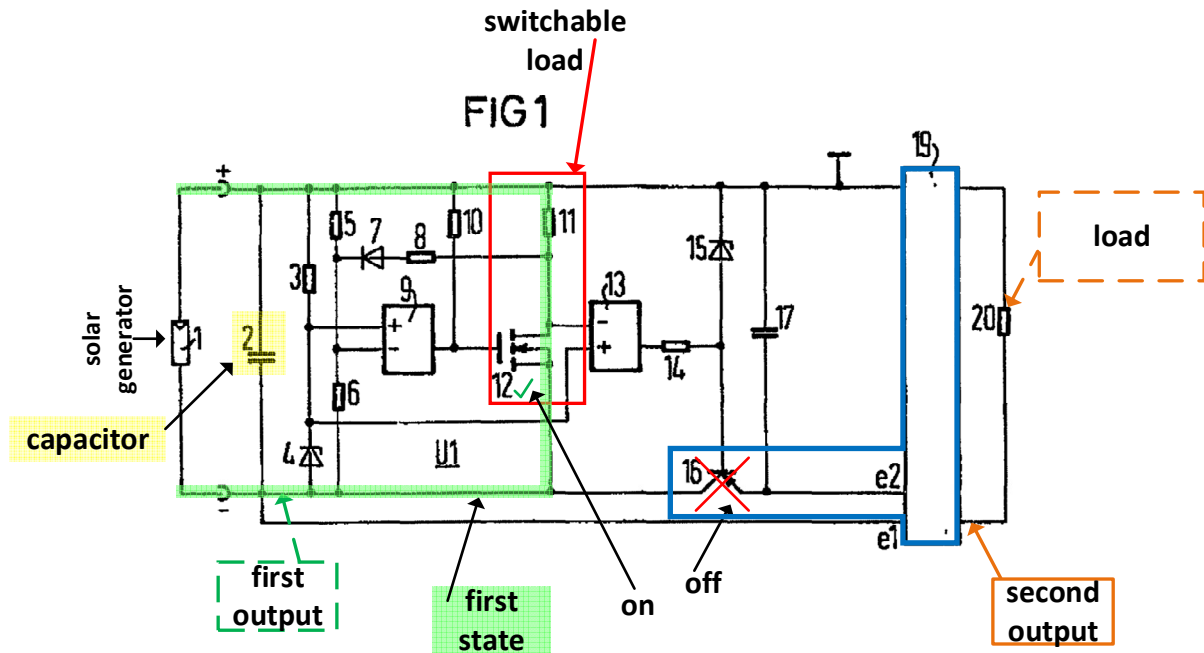


Ex.1002, Fig.1(annotated A)

The circuit includes a first comparator 9 and second comparator 13 that operate to generate the first and second states. In the first state (low voltages), first comparator 9 “trips” and switches “in” preliminary load 11, while second comparator 13 is not tripped, resulting in auxiliary power supply 19 being disabled.

Ex.1002,6:14-23;9:15-32;Ex.1007,¶74.

Fig.1(annotated B) highlights the first state at low source voltages; first comparator 9 is “high” and preliminary load 11 is switched “in” due to transistor 12 being “on.”

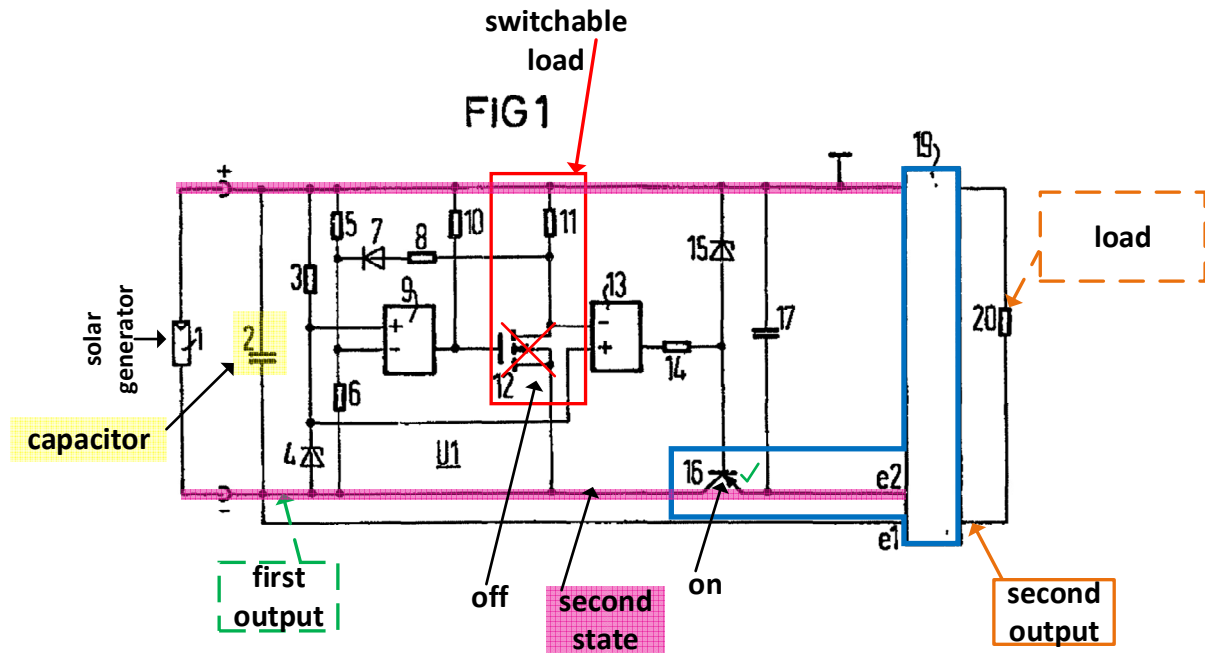


Ex.1002, Fig.1(annotated B)

Further, in the first state, the second comparator 13 output is “high”, shutting pnp bipolar transistor 16 “off,” and power supply apparatus 19 is disabled.

Ex.1002,12:12-19;Ex.1007,¶76.

Fig.1(annotated C) illustrates the second state when power provided by solar generator 1 provides high voltages at the first output. With higher voltages, the voltage at first comparator 9 exceeds a reference voltage, causing first comparator 9 output to transition “low” and turn off transistor 12 (*i.e.*, “switching out” the switchable load/resistor 11).



Ex.1002, Fig.1(annotated C)

With transistor 12 “off”, the negative input of second comparator 13 is pulled high, causing second comparator 13 output to go “low”, turning on transistor 16. With transistor 16 conducting, the first output is passed to the e2 input of auxiliary power converter 19, enabling such circuitry, which provides the second output to load 20. Ex.1002,12:21-30;Ex.1007,¶78. Auxiliary power converter 19 is also connected to the solar generator 1 via an input e1. Ex.1002,8:29-35. Mieth does not discuss the function of input e1; a person having ordinary skill in the art (PHOSITA) understands that input e1 may provide additional functionality to the circuit of Mieth that is extraneous to the detailed description. Ex.1007,¶78.

Mieth discloses a “break before make” operation between the first and second states. An exit from the first state (when preliminary load 11 is “switched

in”) is concluded before the second state (when auxiliary power converter 19 is enabled) is initiated. This “break before make” is facilitated by the cascaded first and second comparators 9 and 13. When the voltage at the first output exceeds the reference voltage, the first comparator 9 output goes “low” to turn off transistor 12. Only after transistor 12 stops conducting does the second comparator 13 output transition from “high” to “low” to activate transistor 16. Ex.1007,¶79. Thus, a delay is built into the cascaded comparator arrangement to ensure that the first control signal that disables preliminary load 11 always occurs before the second control signal that enables power supply apparatus 19. Thus, Mieth teaches a delay between first and second control signals. *Id.*

B. U.S. Patent No. 6,246,592 (Balogh)(Ex.1003)

Balogh is a United States patent that issued on June 12, 2001. Balogh discloses that cascaded power converter arrangements that include two or more power converters are well known. Ex.1003,1:21-22;Ex.1007,¶86. Balogh further discloses that cascaded converters are commonly used to provide large input to output voltage conversion ratios. Ex.1003,1:25-28. Solar power applications often employ high voltages where cascaded power converter systems having large input to output voltage conversion ratios are advantageous. Ex.1007,¶¶86-87.

Balogh discloses multiple cascaded buck converter arrangements in prior art Figs.1B-1D, respectively. One arrangement is illustrated in Fig.1D shown below.

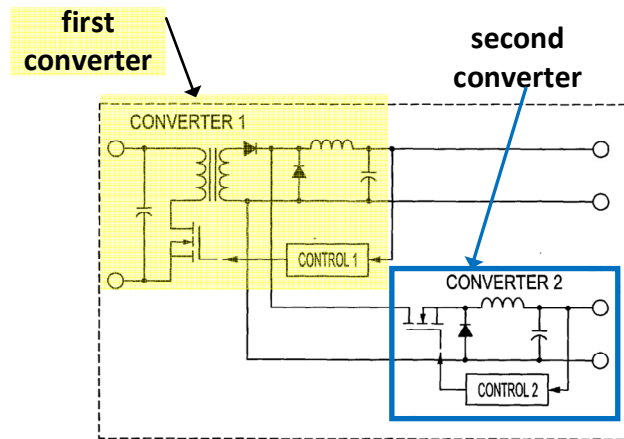


FIG. 1D
PRIOR ART

In Fig.1D, an isolated DC-DC converter (converter 1) feeds a post regulator circuit (converter 2) to form first and second buck converter stages, respectively. The first converter is a transformer-coupled input power converter that steps down the input voltage to an intermediate voltage. Ex.1003,1:61-66,3:8-13. The second converter is a buck power converter. Ex.1003,1:62-63;Ex.1007,¶88.

C. U.S. Patent No. 6,798,177 (Liu)(Ex.1005)

Liu is a United States patent that published on September 28, 2004. Liu discloses a multi-stage converter circuit that employs a storage capacitor in-between, and in parallel with, the two converter stages. The multi-stage converter circuit includes an input stage 50, a storage or reservoir capacitor 58, and an output stage 60 that connects to a power amplifier (“PA”) 68. Ex.1005, Fig.5, 4:25-28; Ex.1007, ¶90.

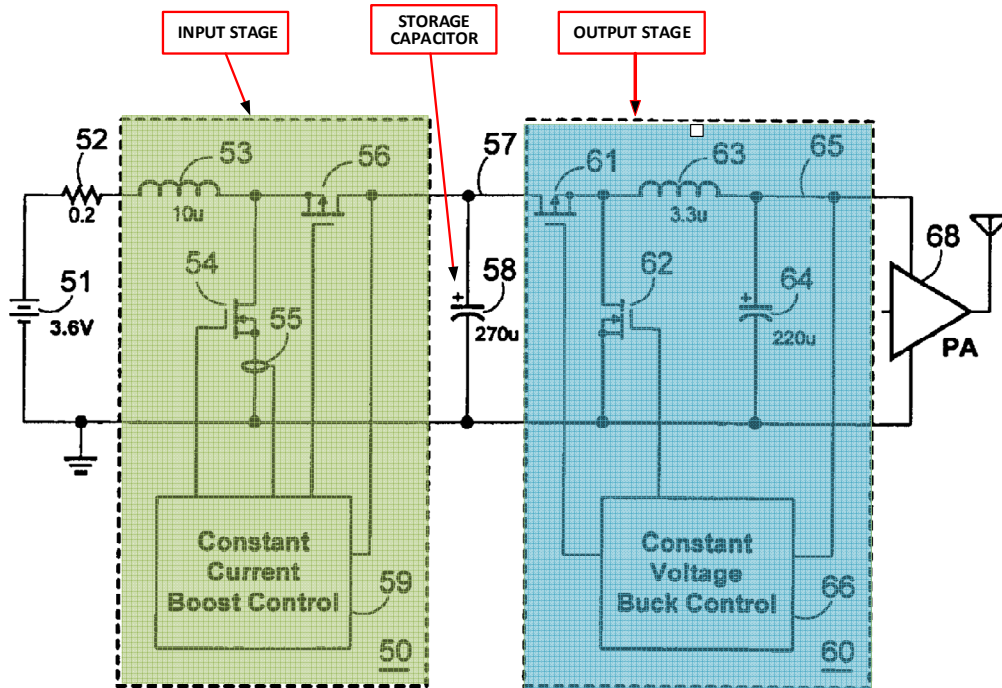


FIG. 5

The input stage 50 charges the storage capacitor 58 and increases the voltage across the capacitor. The output stage 60 down-converts the voltage on reservoir capacitor 58 to an output voltage, for example, 3.4V, needed by the PA 68, which the output stage 60 regulates. The storage/reservoir capacitor 58 supplies energy to PA 68, such that if input stage 50 ceases operating, the output stage continues powering PA 68 for some further time period. *Id.*,4:36-50;Ex.1007,¶¶91.

V. SUMMARY OF ARGUMENT

The '848 patent claims a method to supply power, an apparatus that supplies power, and a power supply. The prior art herein is replete with this power supply. Mieth teaches most elements of the '848 patent's independent claims. For independent claim elements arguably not taught by Mieth, Balogh teaches first stage power converter features and cascaded first and second stages such as step-down power converters. Liu discloses a capacitor as part of a power absorption circuit between cascaded power converters. Adding these features to Mieth's system to supply power would have been obvious, and yields the alleged invention claimed in the '848 patent.

In sum, as demonstrated by a preponderance of the evidence herein, including the Declaration of Dr. Doug Holberg (Ex.1007), the '848 patent claims are unpatentable as being anticipated and/or obvious in view of the cited prior art.

VI. IDENTIFICATION OF CHALLENGE PURSUANT TO 37 C.F.R.

§ 42.104(B) AND STATEMENT OF THE RELIEF REQUESTED

A. Claims for Which Review is Requested and Grounds on Which Challenge is Based

Petitioner requests review on the following grounds under 35 U.S.C. §§ 102 and 103.

Ground	Prior Art	Claims Challenged
A	Mieth	1, 4, 5, 7-10, 13, 14, 16-18
B	Mieth in view of Balogh	1, 4, 5, 7-10, 13, 14, 16-20
C	Mieth in view of Liu, or Mieth-Balogh in view of Liu	2, 3, 6, 11, 12, 15

B. How Claims Are to Be Construed and Level of Skill

1. How Claims Are to Be Construed

A claim subject to *inter partes* review shall be given its ordinary and customary meaning to a PHOSITA, consistent with the prosecution history, as it would be given in a civil action under 35 U.S.C. § 282(b). 37 C.F.R. § 42.100(b). All claim terms should be construed according to their ordinary and customary meaning at the time of invention to a PHOSITA.

No prosecution history exists that addresses the construction of the claim language at issue. Ex.1006.

Therefore, based on the ordinary and customary meaning of the terms, common usage in the art, and a consistent usage of the terms in the detailed description of the '848 patent, the terms “first stage power converter” and “second stage power converter,” as they are not defined in the detailed description, mean “one or more circuit components” that operate alone or together to provide the

specified function set forth in the claim. Furthermore, the phrase “stable for a predetermined period of time” is not defined in the detailed description, and in the context of the claims is indefinite. For purposes of this petition, “stability” is interpreted to mean that a voltage output reaches an upper threshold of a hysteresis window (*e.g.*, of a comparator) for a period of time. Ex.1007,¶208.

2. Level of Skill

A PHOSITA would have had a bachelor’s degree in electrical engineering, or a similar discipline and at least two years of design experience with circuit design. Ex.1007,¶31.

VII. SPECIFIC GROUNDS FOR UNPATENTABILITY

A. Ground A: Anticipation of claims 1, 4, 5, 7-10, 13, 14, and 16-18 in view of Mieth

1. Independent Claim 1

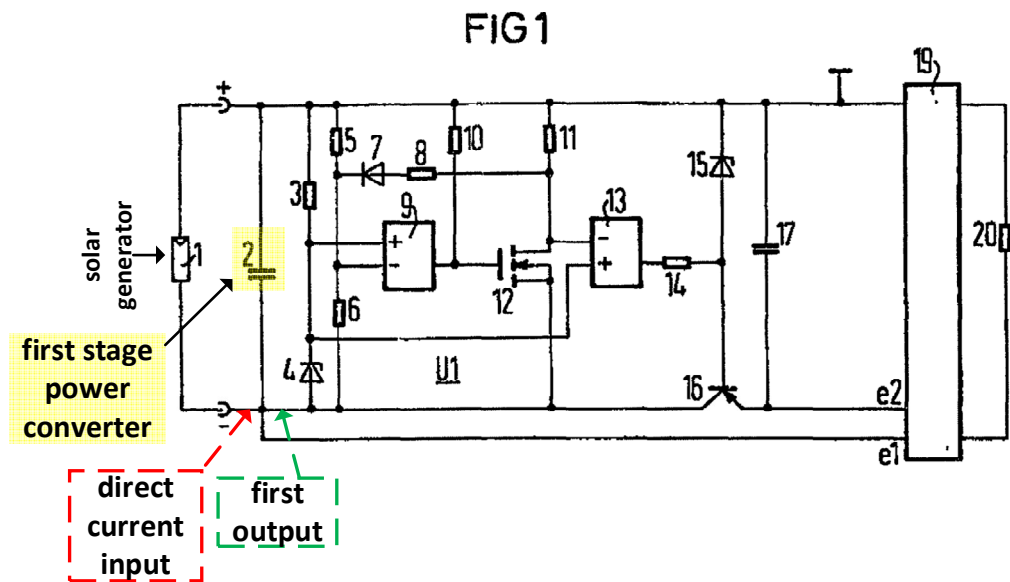
With reference to the claim listing appendix, Mieth discloses Elements [1A]-[1H]. As explained below, a PHOSITA would have been motivated by Mieth to arrive at the alleged invention of claim 1.

i. [1A]: “An apparatus, comprising”

Mieth (Ex.1002) discloses a circuit that supplies power to an electrical load from a solar generator. Ex.1002(Mieth),8:8-9. A PHOSITA would understand that a circuit is an apparatus. Ex.1007,¶96. Thus, Mieth teaches [1A].

ii. [1B]: “a first stage power converter to generate a first output from a direct current input”

Mieth discloses a circuit with a capacitor 2 (yellow) in parallel with a solar generator. Ex.1002,9:5-9;Ex.1007,¶97. A PHOSITA would understand that solar generators generate a direct current. Ex.1007,¶97;Ex.1013,¶21. As such, the solar generator 1 of Mieth supplies the *direct current input* (dashed-red) to the capacitor 2 as shown in Fig.1(annotated-1B) below. The first stage of Mieth is a parallel capacitor 2 which a PHOSITA would understand converts power associated with the direct current input into a *first output* (dashed-green), and thus the parallel capacitor 2 is analogous to the claimed *first stage power converter*. Ex.1007,¶97.



Ex.1002, Fig.1(annotated-1B)

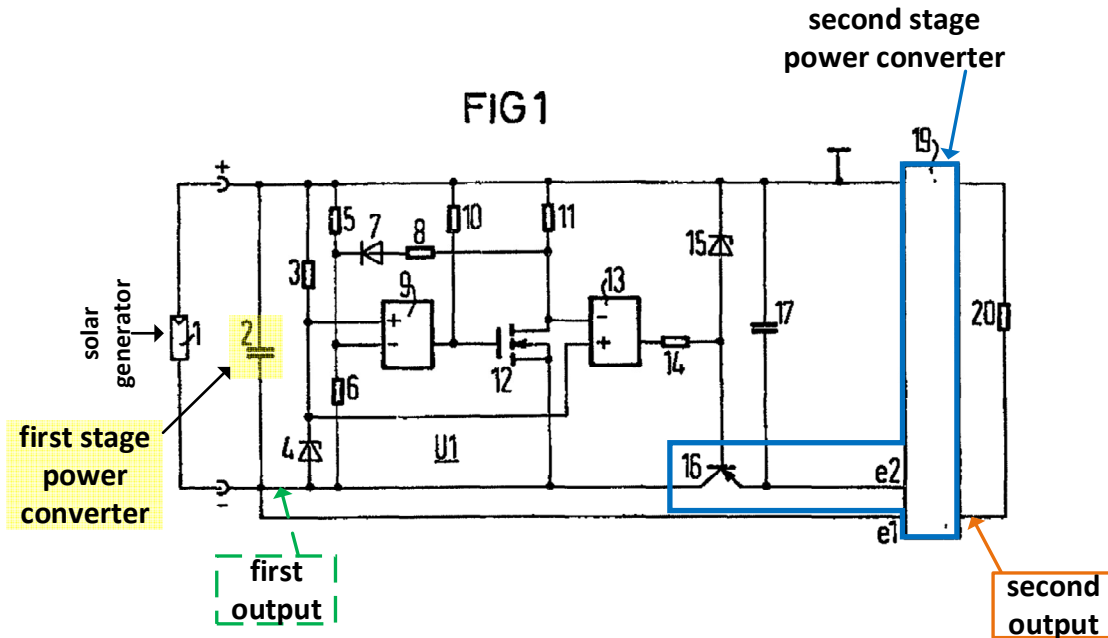
Thus, Mieth teaches [1B]. Additionally, the combination of Mieth and Balogh disclose the features of [1B] as discussed in further detail in §VII.B.1.

- iii. [1C]: “a second stage power converter connected to the first stage power converter to convert the first output to a second output”

Mieth discloses power supply apparatus 19 connected to a bipolar transistor (blue). Ex.1002,11:14-16;Ex.1007,¶99. The power supply apparatus 19 is a DC-DC voltage converter and thus the power supply apparatus 19 and bipolar transistor are analogous to the claimed *second stage power converter*.

Ex.1002,8:29-33;Ex.1007,¶99. The power supply apparatus 19 connected to the bipolar transistor 16 is *connected to the first stage power converter* (capacitor 2) through the first output (dashed-green). Specifically, the power supply apparatus 19 is connected by way of auxiliary voltage input e2 which is associated with the first output when bipolar transistor 16 is conducting. Ex.1002,8:29-

35;Ex.1007,¶100. The power supply apparatus 19 is a DC-DC voltage converter and outputs a voltage and current to power a load 20. *Id.* The output of power supply apparatus 19 is analogous to the claimed *second output* (orange) as shown in Fig.1(annotated-1C) below. Ex.1007,¶100. Since the power supply apparatus 19 is powered by the first output, the power supply apparatus 19 is configured to *convert the first output to a second output*. Ex.1007,¶100.

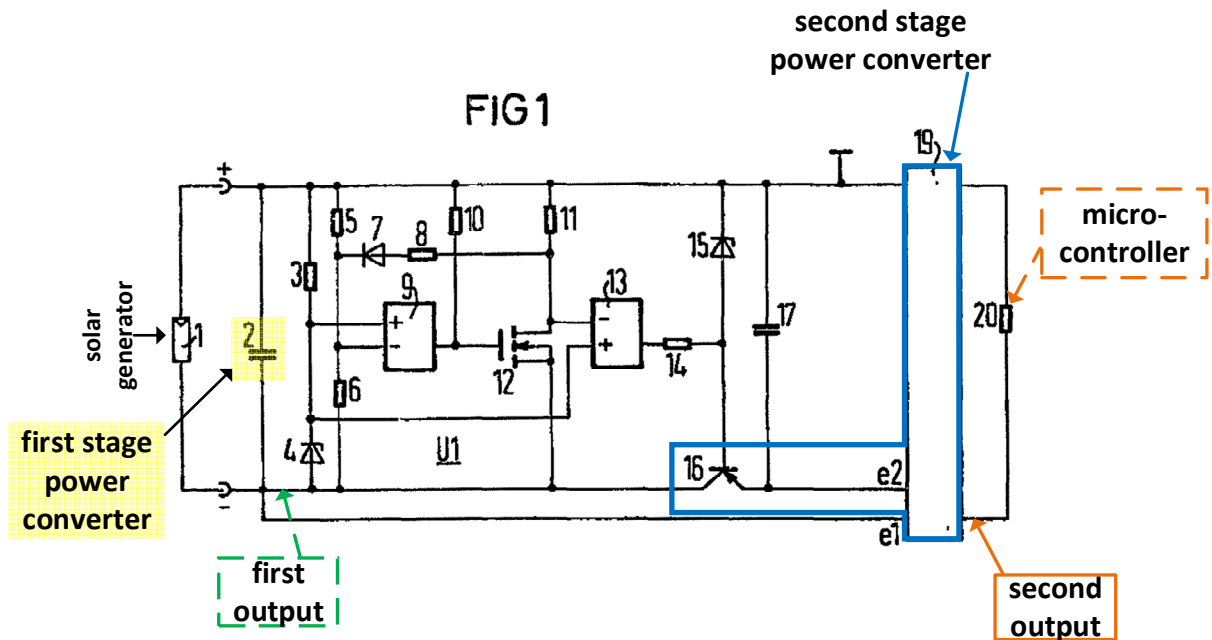


Ex.1002, Fig.1(annotated-1C)

Thus, Mieth teaches [1C].

iv. [1D]: “a micro-controller;”

Mieth discloses a load 20 that is powered by the second output of the power supply apparatus 19 (second stage power converter). A PHOSITA would understand that a load in a circuit can be or include a micro-controller, as such the load 20 is analogous to the claimed *micro-controller* (dashed-orange), as shown in Fig.1(annotated-1D) below. Ex.1007, ¶¶ 102-103; Ex.1014, 1180, Fig.5.

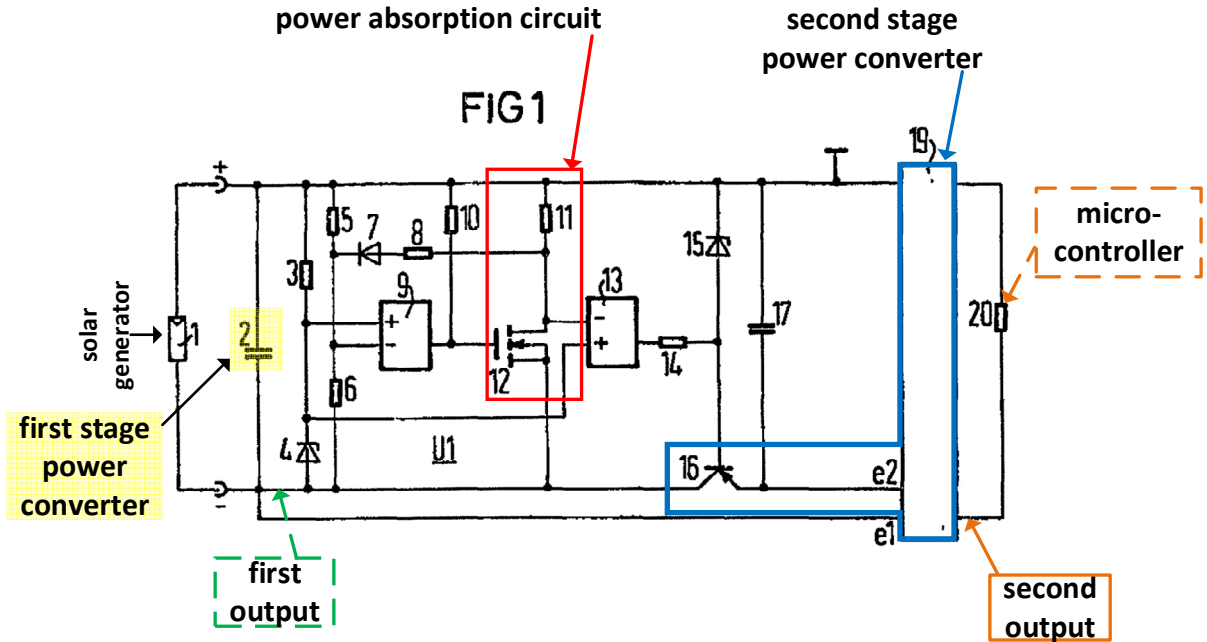


Ex.1002, Fig.1(annotated-1D)

Thus, Mieth teaches [1D].

v. **[1E]: “a power absorption circuit”**

Mieth discloses that the first output (dashed-green) of capacitor 2 is connected to a field-effect transistor 12 that is connected to a preliminary load 11 as shown in Fig.1(annotated-1E). Ex.1002,10:5-14;Ex.1007,¶105.



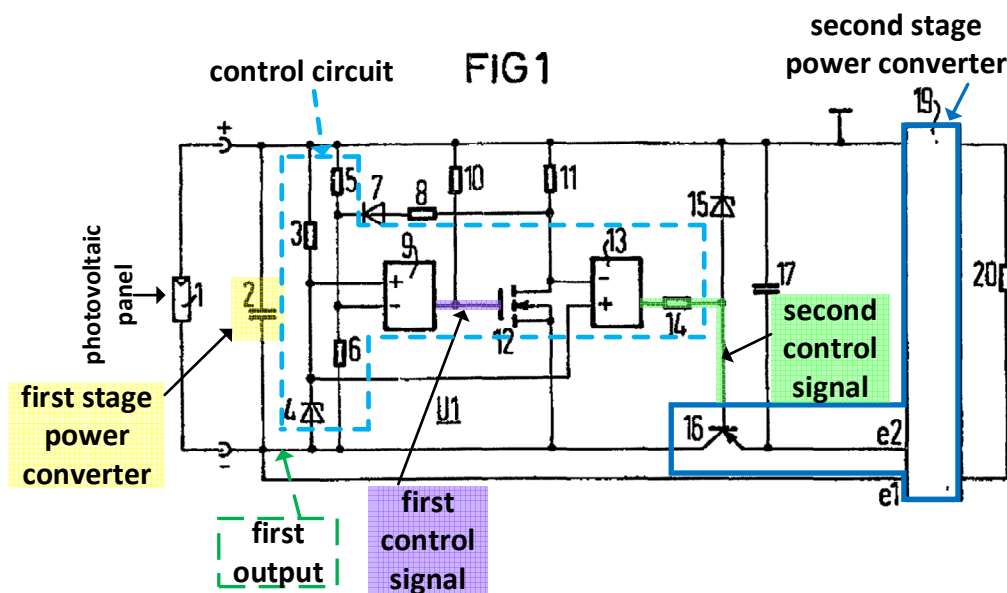
Ex.1002, Fig.1(annotated-1E)

Mieth describes the preliminary load 11 as consuming power from the solar generator 1, and thus a PHOSITA would understand that the preliminary load absorbs power. Ex.1002, 11:14-25; Ex.1007, ¶106. Thus, the field-effect transistor 12, which operates as a switch, and the preliminary load 11 in combination are analogous to the claimed *power absorption circuit* (red). Ex.1007, ¶106.

Thus, Mieth teaches [1E].

- vi. [1F]: “a control circuit coupled with the first stage power converter and the second stage power converter, the control circuit powered by the first output to control the second stage power converter”

Mieth discloses a first comparator 9 that turns the transistor 12 “on” or “off” via a first control signal, as shown in Fig.1(annotated-[1F]). Ex.1002,9:34-10-14;Ex.1007,¶108.



Ex.1002, Fig.1(annotated-[1F])

First comparator 9 compares a reference voltage from a reference voltage generator to a representative voltage from a voltage divider. Ex.1002,9:34-10:3;Ex.1007,¶255. The reference voltage generator is defined by the Zener diode 4. *Id.* The voltage divider is defined by the voltage divider of resistors 5 and 6 and the representative voltage is representative of the first output (dashed-green) of capacitor 2 (first stage power converter-yellow). *Id.* First comparator 9 compares

the representative voltage and the reference voltage to determine if the representative voltage exceeds a value defined by the reference voltage, and outputs a first control signal (highlighted-purple) to transistor 12 based on the comparison. Ex.1002,12:12-26,Ex.1007,¶109.

A PHOSITA understands that a control circuitry (dashed-blue) that controls transistor 12, which includes first comparator 9, voltage divider 5, 6 and reference input generator 3, 4, which are powered by the first output from the capacitor 2, is analogous to the claimed **a control circuit coupled with the first stage power converter** and the claimed **the control circuit powered by the first output**.

Ex.1002,9:34-10:3,Ex.1007,¶110.

The first control signal output from first comparator 9 controls transistor 12, and the output of transistor 12 is used by second comparator 13 to generate a second control signal (highlighted-green). Ex.1002,11:4-12,12:12-19;Ex.1007,¶111. The second control signal output from second comparator 13 operates transistor 16, turning the transistor “on” or “off” which connects or disconnects power supply apparatus 19 to or from the first output. *Id.* When the first control signal is low, transistor 12 is “off” and second comparator 13 outputs a low voltage which turns transistor 16 “on,” connecting the power supply apparatus 19 to the first output of capacitor 2. Ex.1002,12:12-30;Ex.1007,¶111. When the first control signal is high, transistor 12 is “on” which connects preliminary load 11

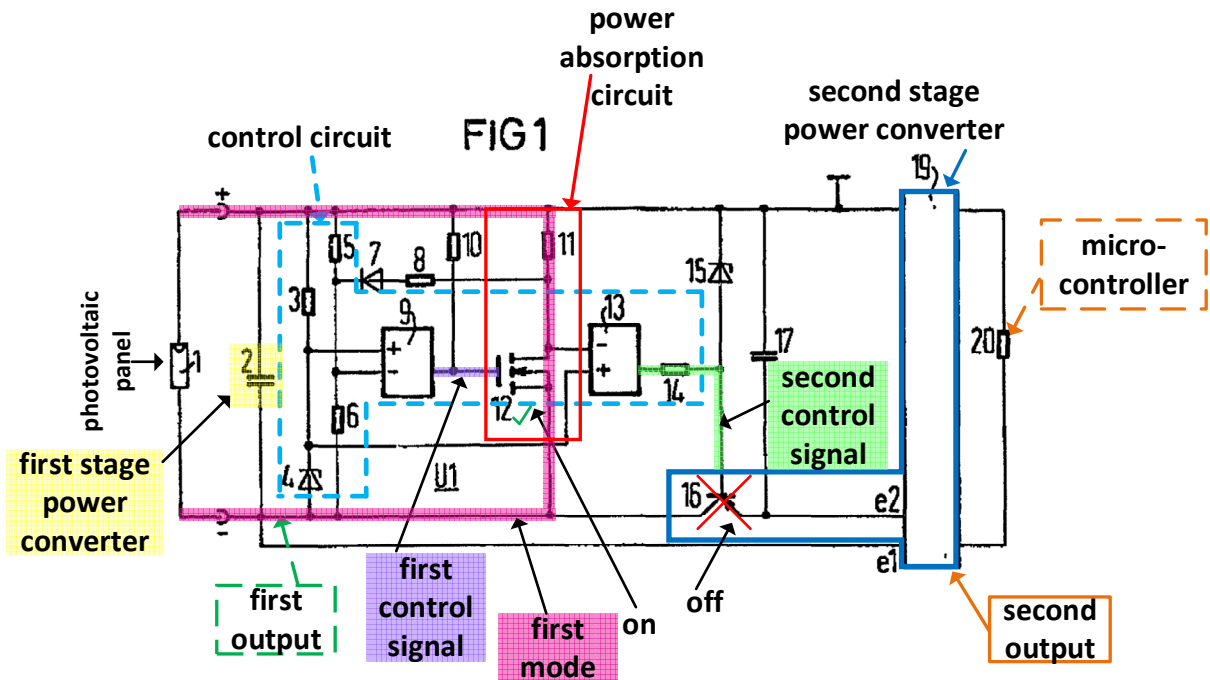
to the first output of capacitor 2, and second comparator 13 outputs a high voltage which turns transistor 16 “off,” disconnecting power supply apparatus 19 from the first output of capacitor 2. Ex.1002,9:15-23,12:12-30;Ex.1007,¶111.

Since first comparator 9 generates the first control signal that controls transistor 12 and second comparator 13 to then control transistor 16/power supply apparatus 19 by the second control signal, Mieth discloses the claimed *to control the second stage power converter*. Ex.1007,¶112. Furthermore, the first comparator 9 couples to transistor 16/power supply apparatus 19 through transistor 12 and the second comparator 13, and is analogous to the claimed *a control circuit coupled with . . . the second stage power converter*. Ex.1007,¶112.

Thus, Mieth teaches [1F].

- vii. [1G]: “wherein; when the second stage power converter is in a first mode of not providing the second output to power the micro-controller, the control circuit monitors a voltage of the first output powering the power absorption circuit and signals the second stage power converter to remain in the first mode during a time period in which the voltage is below a threshold”

As shown in Fig.1(annotated-[1G]), Mieth can be configured in a first mode (highlighted-pink) where transistor 16 is “off” and power supply apparatus 19 (second stage power converter-blue) is disconnected from the first output of capacitor 2 (first stage power converter-highlighted-yellow). Ex.1002,12:12-30;Ex.1007,¶114.



Ex.1002, Fig.1(annotated-[1G])

When transistor 16 is “off,” power supply apparatus 19 is disconnected from the first output (dashed-green) of capacitor 2, and load 20 (micro-controller-dashed-orange) is not powered by the second output (orange). Ex.1002,8:29-35;9:9-13,9:23-32;Ex.1007,¶115. Transistor 16/power supply apparatus 19 being off and disconnected from the first output of capacitor 2, which results in load 20 not powered by the second output is analogous to the claim feature *when the second stage power converter is in a first mode of not providing the second output to power the micro-controller*. Ex.1007,¶115.

Furthermore, in the first mode, transistor 12 is turned “on” and the first output powers preliminary load 11 (power absorption circuit-red). Ex.1002,10:5-14;Ex.1007,¶116. First comparator 9 (part of the control circuit-dashed-blue) turns

transistor 12 “on” based on a comparison of a reference voltage (*i.e.*, reference voltage generator defined by Zener diode 4 and resistor 3) and a representative voltage (voltage at the junction of resistors 5, 6) representative of the first output voltage. Ex.1002,9:34-10:3,Ex.1007,¶116. First comparator 9 that connects preliminary load 11 (*i.e.*, the power absorption circuit) to the first output through control of transistor 12 based on the representative voltage of the first output is analogous to the claimed ***the control circuit monitors a voltage of the first output powering the power absorption circuit.*** Ex.1007,¶116.

The representative voltage at first comparator 9 is compared to a “predefined minimum value,” (*e.g.*, associated with a threshold voltage) and during a time period when the representative voltage is lower than the predefined minimum value, the first control signal from first comparator 9 is a high voltage which turns transistor 12 “on.” Ex.1002,11:4-12,12:12-26;Ex.1007,¶117. The time period when the representative voltage is lower than the predefined minimum value is analogous to the claimed ***during a time period in which the voltage is below a threshold.*** Ex.1007,¶117.

When transistor 12 is “on,” preliminary load 11 is connected to the first output of capacitor 2, which signals a high voltage to second comparator 13, which signals a high voltage to transistor 16, turning power supply apparatus 19 “off,” which disables the second output from powering load 20. Ex.1002,9:15-23,12:12-

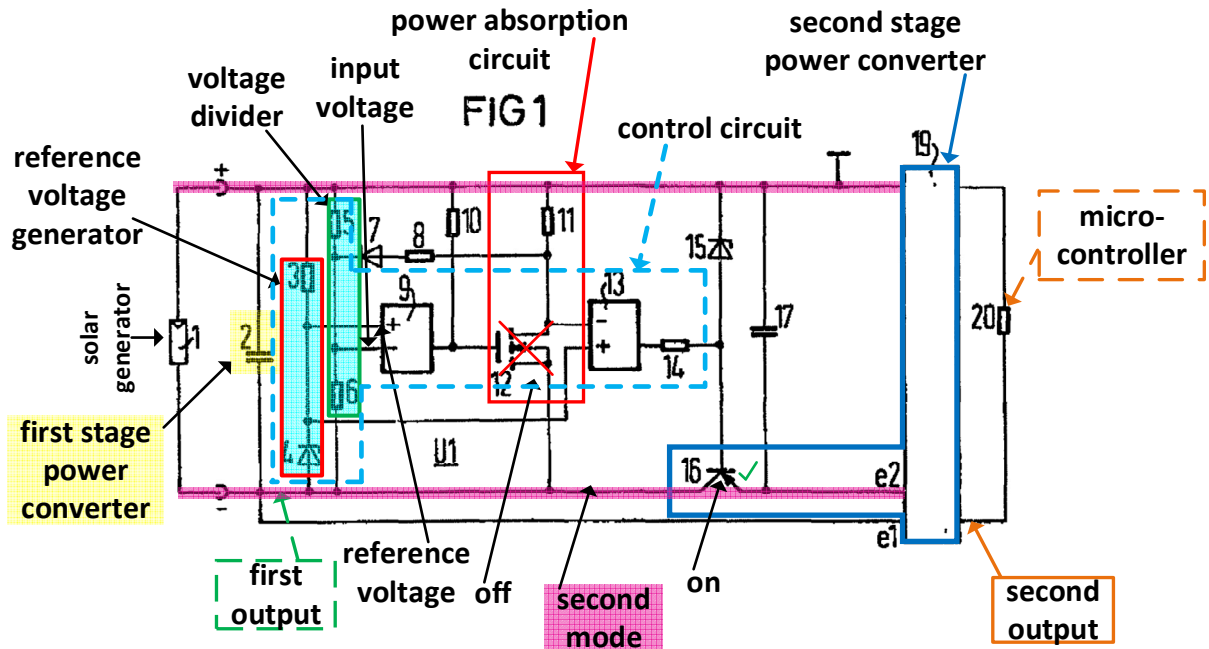
30;Ex.1007,¶118. Therefore, first comparator 9 turning transistor 12 “on” signals power supply apparatus 19 to be turned “off” through transistor 16, thereby disabling the second output from powering the load, which is analogous to the claimed *signals the second stage power converter to remain in the first mode*. Ex.1007,¶118.

Thus, Mieth discloses [1G].

viii. [1H]: “when the voltage is above the threshold, the control circuit signals the second stage power converter to enter a second mode of providing the second output to power the micro-controller”

As discussed in accordance with [1G] in §VII.A.1.vii., in the first mode, the preliminary load 11 and the field-effect transistor 12 (*i.e.*, power absorption circuit-**red**) are powered by the first output of capacitor 2 (*i.e.*, first stage power converter-**highlighted-yellow**). Mieth further discloses that when voltages from the solar generator 1 (as represented at the negative input terminal of first comparator 9) are above a predefined minimum value (as represented at the positive input terminal of first comparator 9), the auxiliary voltage input e2 of the power supply apparatus 19 is connected to the first output of the solar generator 1. Ex.1002,9:23-26. As shown in Fig.1(annotated-1H) below, when the predefined minimum value is satisfied, the circuit of Mieth operates in a *second mode* (**highlighted-pink**) where the bipolar transistor 16 is “on” or conducting, causing the first output (**dashed-**

green) of capacitor 2 to be connected to e2, thereby powering the power supply apparatus 19. Ex.1002,10:16-29;Ex.1007,¶120.



Ex.1002, Fig.1(annotated-1H)

Furthermore, in the second mode, the field-effect transistor 12 is “off” or non-conducting, thereby disconnecting the preliminary load 11 from the first output. *Id.* As discussed in §VII.A.1.vii., the first comparator 9 of the control circuit compares a reference voltage from a reference voltage generator (highlighted-teal-outlined-red) to a representative voltage from a voltage divider (highlighted-teal-outlined-green) to determine if the representative voltage exceeds a value defined by the reference voltage. Ex.1002,12:12-26,Ex.1007,¶121. While in the first mode, when the first output of capacitor 2 rises and the representative voltage at the output voltage divider 5,6 is above the value (*i.e.*, “predefined

minimum value” as quoted by Mieth), the circuit disconnects the preliminary load 11 from the first output by configuring the field-effect transistor 12 to an “off” state. *Id.* The output of voltage divider 5, 6 rising above the value is analogous to the claimed *when the voltage is above the threshold*.

The bipolar transistor 16 connecting the power supply apparatus 19 to the first output, resulting in the second output of the power supply apparatus 19 powering the load 20, is analogous to the claimed *the control circuit signals the second stage power converter to enter a second mode of providing the second output to power the micro-controller*. Ex.1007,¶122.

As such, Mieth teaches [1H], and every feature of claim 1 and thus anticipates claim 1.

2. Dependent Claim 4

Claim 1 is disclosed by Mieth. *Supra*,§VII.A.1. Claim 4 depends from claim 1 and requires, “wherein the power absorption circuit comprises a switchable load.” Ex.1001, claim 4.

As discussed in §VII.A.1.v. Mieth discloses a preliminary load 11 and a field-effect transistor 12 which operates as a switch as shown in FIG.1(annotated-1E). Ex.1002,10:5-14;Ex.1007,¶126. The preliminary load 11 is a resistor which is a load. Ex.1007,¶126. Since the preliminary load 11 is connected or disconnected from the first output based on the first mode or the second mode by the field-effect

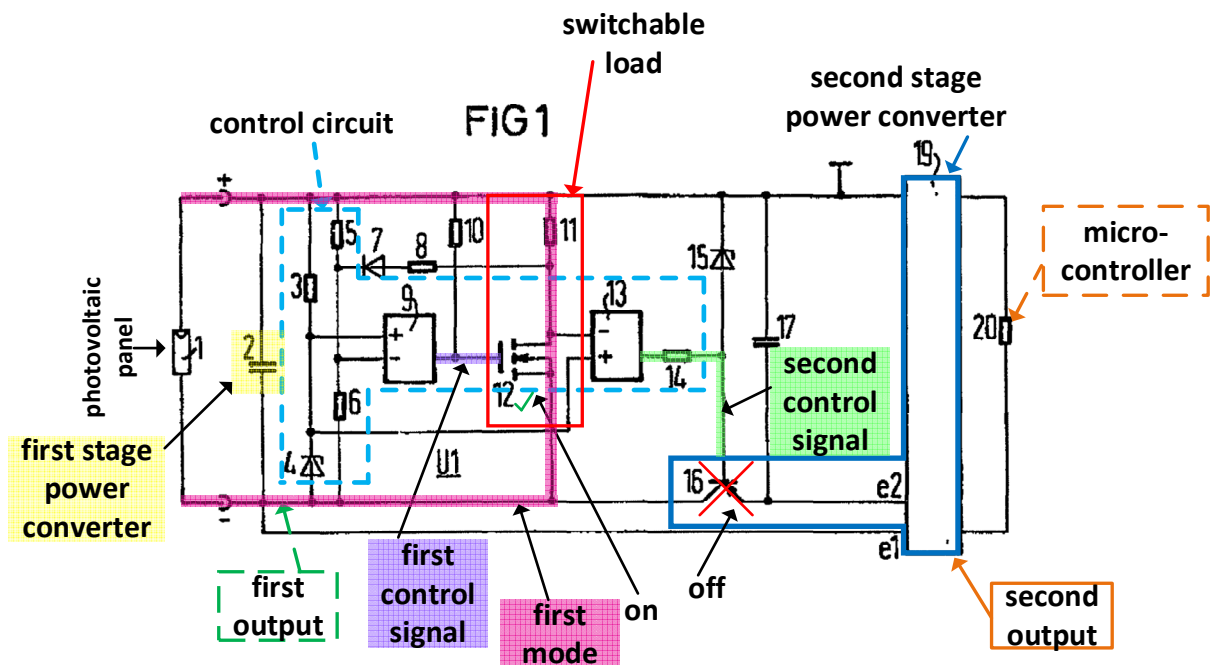
transistor 12, as discussed in §VII.A.1.vii.-§VII.A.1.viii., the preliminary load 11 and the field-effect transistor 12 are analogous to the claimed *switchable load*.

Thus, Mieth teaches claim 4.

3. Dependent Claim 5

Claim 4 is disclosed by Mieth. *Supra*, §VII.A.2. Claim 5 depends from claim 4 and requires [5A], “wherein the control circuit signals the switchable load to be in a first state to consume the first output when the second stage power converter is in the first mode.” Ex.1001, claim 5.

As described in §VII.A.1.vii. and shown in Fig.1(annotated-[5A]), Mieth teaches the claimed *first mode* where the power supply apparatus 19 (*i.e.*, second stage power converter-blue) is disconnected from the claimed *first output*.



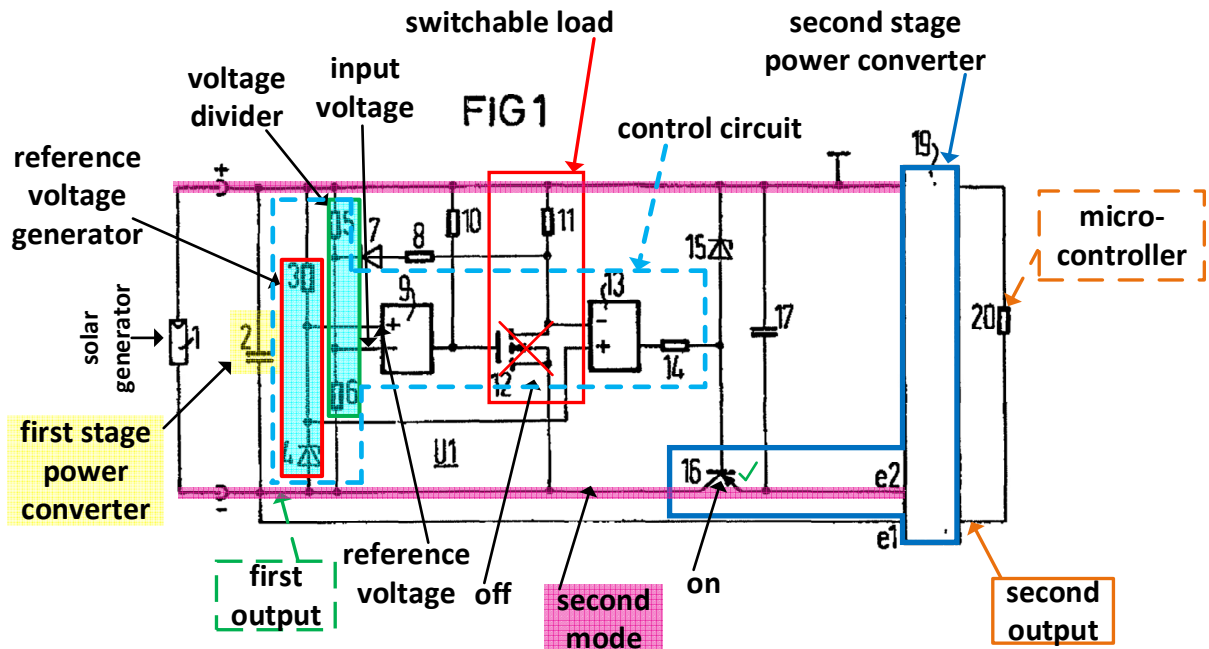
Ex.1002, Fig.1(annotated-[5A])

In the first mode, the first comparator 9 of the control circuit turns transistor 12 “on” by a first control signal (highlighted-purple) associated with the voltage comparison performed by comparator 9. Ex.1002,9:34-10:3,11:4-12,12:12-26;Ex.1007,¶130. When the transistor 12 is “on,” the preliminary load 11 is connected to the first output to consume the first output. *Id.* As discussed in §VII.A.2., the transistor 12 and preliminary load 11 are analogous to the claimed **switchable load**, and the condition where the preliminary load 11 is connected to the first output is analogous to the claimed **first state**. *Id.* Thus, the first control signal from comparator 9 that turns transistor 12 “on” thereby connecting the preliminary load 11 to the first output is analogous to the claimed **the control circuit signals the switchable load to be in a first state to consume the first output**. Ex.1007, ¶130. The preliminary load 11 is connected to the first output while the power supply apparatus 19 is disconnected from the first output during the first mode which is analogous to the claimed **when the second stage power converter is in the first mode**. §VII.A.1.vii.;Ex.1007,¶130.

Thus, Mieth teaches [5A].

Claim 5 further requires [5B], “*and to be in a second state not to consume the first output when the voltage is above the threshold.*” Ex.1001, claim 5. As shown in Fig.1(annotated-[5B]), Mieth teaches the claimed **second state**, where the preliminary load 11 and transistor 12 are disconnected from, and thus not

consuming, the first output when the voltage at the output of voltage divider 5, 6 is above the claimed *threshold*.



Ex.1002, Fig.1(annotated-[5B])

Mieth discloses that when voltages from the solar generator 1 are above a predefined minimum value (which is analogous to the claimed *threshold*), the auxiliary voltage input e2 of the power supply apparatus 19 is connected to the first output of the solar generator 1, described previously as the second mode.

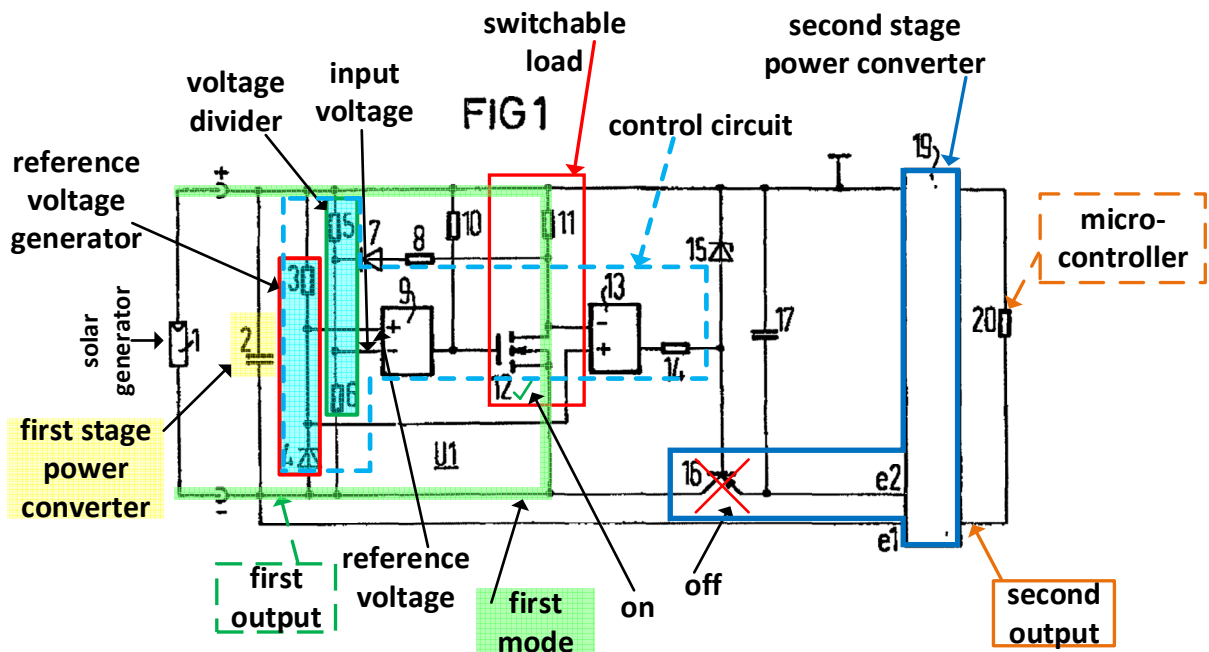
Ex.1002,9:23-26;§VII.A.1.viii. The first comparator 9 of the control circuit compares a reference voltage from a reference voltage generator (highlighted-teal-outlined-red) to a representative voltage from a voltage divider (highlighted-teal-outlined-green) to determine if the representative voltage exceeds the predetermined minimum value defined by the reference voltage. Ex.1002,12:12-

26,Ex.1007,¶133. When the first output of capacitor 2 rises and the representative voltage at the output of voltage divider 5, 6 rises above the predefined minimum value, the control circuit disconnects the preliminary load 11 from the first output by configuring the field-effect transistor 12 to an “off” state. *Id.* The transistor 12 turning “off” and disconnecting the preliminary load 11 from the first output is analogous to the claimed *to be in a second state not to consume the first output*. The voltage at the output of voltage divider 5, 6 rising above the value is analogous to the claimed *when the voltage is above the threshold*. Ex.1007,¶133.

Thus, Mieth teaches claim [5B] and every element of claim 5.

4. Dependent Claim 7

Claim 5 is disclosed by Mieth. *Supra*,§VII.A.3. Claim 7 depends from claim 5 and requires [7A], “wherein the switchable load comprises: a resistive device.” Ex.1001, claim 7. As shown below in Fig.1(annotated-Claim-7.1) of Mieth, preliminary load 11 can be a resistor. Ex.1002,12:14-20(“preliminary load formed by the resistor 11”);Ex.1007,¶135. Since the preliminary load 11 can be a resistor, and a resistor is a resistive device, preliminary load 11 of Mieth is analogous to element [7A] *the switchable load comprises: a resistive device*. Ex.1007,¶135.



Ex.1002, Fig.1(annotated-Claim-7.1)

Claim 7 further requires [7B], “a switching device connected to the resistive device.” Ex.1001, claim 7. As shown in Fig.1(annotated-Claim-7.1), the field-effect transistor 12 is connected to the preliminary load 11. *Supra*, §VII.A.3. Mieth describes the field-effect transistor 12 as an electronic switch, and thus a PHOSITA would understand that the field-effect transistor 12 is a switching device. Ex.1002, 10:5-14; Ex.1007, ¶136. As such, the field-effect transistor 12 connected to resistor 11 is analogous to the claimed, ***switching device connected to the resistive device*** of [7B]. Ex.1007, ¶136.

Claim 7 further requires [7C] further recites, “wherein the switching device is turned on in the first state to connect the resistive device to the first output and

turned off in the second state to disconnect the resistive device from the first output.” As discussed above in §IV.A.1.vii, §VII.A.1.viii, and §VII.A.3, the control circuit of Mieth is configured to operate in two different modes: (1) a first mode associated with “low” first output voltages, where the switchable load is connected to and consumes the first output, and the second output is not powered, and (2) a second mode associated with “high” first output voltages, where the switchable load is disconnected, and power from the first output connects to the second power converter which, in response, powers the micro-controller via the second output.

As stated in VII.A.1.vii, feature [1G], in the first mode, for “low” first output voltages, transistor 12 is turned “on” by the first comparator 9 and loads the first output with the preliminary load 11 (analogous to the switchable load-red).

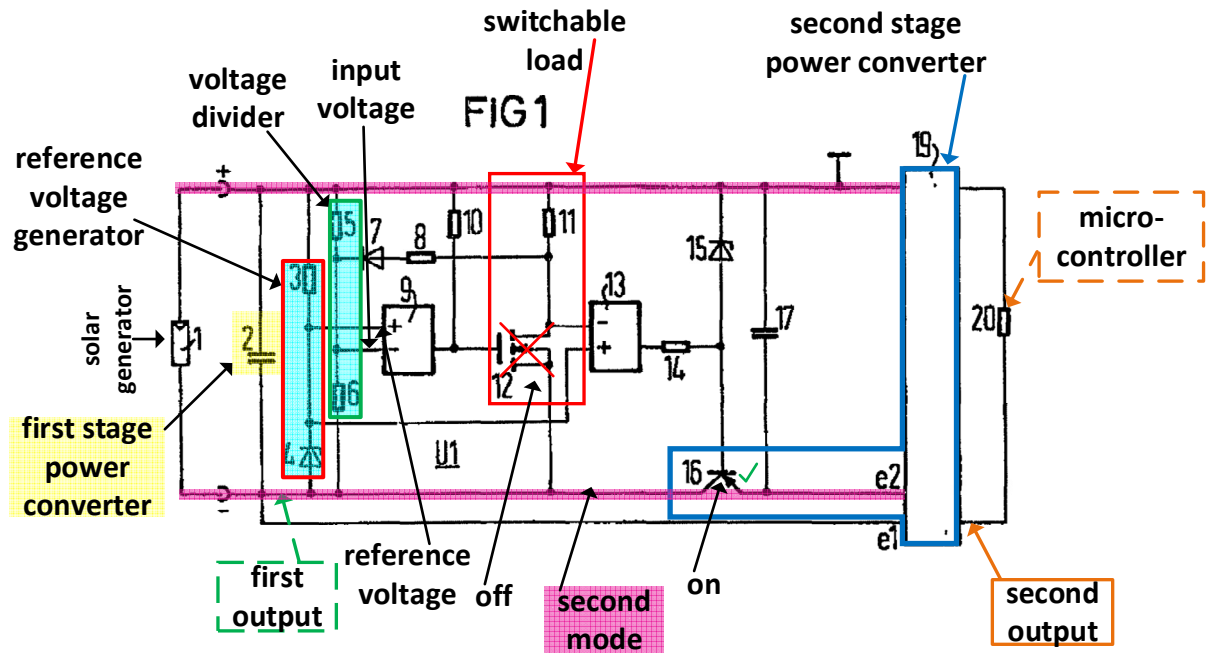
Ex.1002,9:15-32,10:5-14;Ex.1007,¶138. In the first mode, the first comparator 9 compares the reference voltage at the positive terminal of the first comparator 9 to the representative voltage at the negative terminal of the first comparator 9.

Ex.1002,9:34-10:3;Ex.1007,¶138.

In the first mode, the representative voltage is less than the reference voltage in magnitude (*i.e.*, a “low” voltage condition at the first output), and the first comparator 9 turns on the transistor 12 and powers the preliminary load 11 and field-effect transistor 12 by the first output. Ex.1002,12:12-19;Ex.1007,¶139.

Thus, the control circuit and transistor 12 are analogous to feature [7C], *wherein the switching device is turned on in the first state to connect the resistive device to the first output.*

Mieth further discloses that when voltages from the solar generator 1 (as represented at the negative terminal of first comparator 9) are above a predefined minimum value (*i.e.*, relatively “high” first output voltages), the control circuit transitions the circuit to the second mode, where the auxiliary voltage input e2 of the power supply apparatus 19 is connected to the first output of the solar generator 1. Ex.1002,9:23-26. As shown in Fig.1(annotated-Claim-7.2) below, when the predefined minimum value is exceeded, the circuit of Mieth operates in the second mode (highlighted-pink) where the first output (dashed-green) is connected to e2 to power the power supply apparatus 19. Ex.1002,10:16-29;Ex.1007,¶140.



Ex.1002, Fig.1(annotated-Claim-7.2)

Furthermore, in the second mode, the field-effect transistor 12 is “off” or non-conducting, thereby disconnecting the preliminary load 11 from the first output. *Id.* As discussed in §VII.A.1.vii and §VII.A.1.vii., the first comparator 9 compares the reference voltage to the representative voltage to determine if the representative voltage exceeds a threshold defined by the reference voltage. Ex.1002,12:12-26,Ex.1007,¶141. While in the first mode, when the first output rises in magnitude and the representative voltage exceeds the threshold (*i.e.*, “predefined minimum value” as quoted by Mieth), the time period of the first mode ends, and the control circuit disconnects the preliminary load 11 from the first output by configuring the field-effect transistor 12 to an “off” state, which results in the preliminary load 11 (*i.e.*, the switchable load) not consuming the first

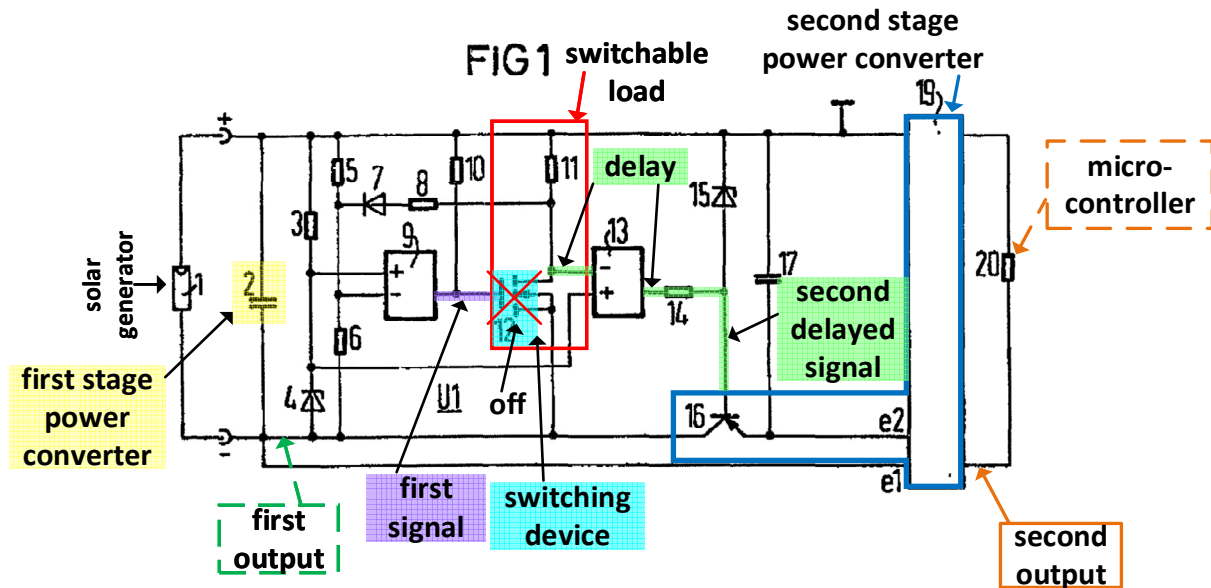
output in the second state. Thus, the control circuit of Mieth teaches the remaining claim feature [7C] *wherein the switching device is... turned off in the second state to disconnect the resistive device from the first output. Id.*

Thus, Mieth teaches all the features of claim 7.

5. Dependent Claim 8

Claim 5 is disclosed by Mieth. *Supra*, §VII.A.3. Claim 8 depends from claim 5 and requires “wherein the control circuit delays a first signal instructing the switching device to change from the first state to the second state to generate a second delayed signal that instructs the second stage to change from the first mode to the second mode.” Ex.1001, claim 8. It is noted that there is no antecedence for the feature “first stage” rendering claim 8 indefinite. Further analysis is provided construing the feature “first stage” as the “first stage power converter” from claim 1.

In the first mode, the output of the first comparator 9 (*i.e.*, the claimed first signal-highlighted-purple), which controls the field-effect transistor 12 (switching device-highlighted-teal), is “high,” turning transistor 12 “on” (*i.e.*, the claimed first state for the switchable load) Ex.1002,12:21-30;Ex.1007,¶114;Ex.1002,Fig.1(annotated-Claim-8).



Ex.1002, Fig.1(annotated-Claim-8)

When the first output reaches a high voltage, the output of the first comparator 9 turns the transistor 12 “off” (*i.e.*, when the output voltage at the first output reaches the desired level, the representative voltage at the comparator input exceeds the predefined minimum value – analogous to the claimed second state).

Ex.1002,10:16-29,12:21-30;Ex.1007,¶145. The circuit signal from the first comparator 9 that feeds the gate of the transistor 12 of Mieth is analogous to **the first signal** of claim 8.

Mieth discloses delaying the first signal from the first comparator 9 to generate a second delayed signal at the output of the second comparator 13 to enable the second stage power converter to power the load 20. Ex.1007,¶146. Mieth discloses that the field-effect transistor 12 and the second comparator 13 delays the first signal from the first comparator 9 to generate a second delayed

signal (highlighted-green) that turns on the bipolar transistor 16. More particularly, the second comparator 13 outputs the second delayed signal based on an output from the field-effect transistor 12, where the output from the field-effect transistor 12 (*i.e.*, the drain terminal thereof) is itself based on the first signal. *Id.* As such, the state of the second delayed signal is dictated by the state of the first signal, and the transition of the second delayed signal to activate bipolar transistor 16 is delayed with respect to the transition of the first signal by the propagation delays of the transistor 12 and the second comparator 13 which is analogous to the claimed *delays the first signal*. Ex.1007,¶146. The second comparator 13 generates the second delayed signal based on the first signal which is analogous to the claimed *to generate a second delayed signal*, and the second delayed signal controls the bipolar transistor 16 which operates as a switch to selectively pass the first output to the second stage power converter 19 at the e2 terminal. Ex.1007,¶146. Upon the second stage power converter 19 being powered by the first output via bipolar transistor 16 at e2, the second stage power converter 19 provides the second output that powers the load 20, which is the micro-controller. This circuit functionality is analogous to claim 8 that recites, *instructing the switching device to change from the first state to the second state . . . that instructs the second stage to change from the first mode to the second mode*.

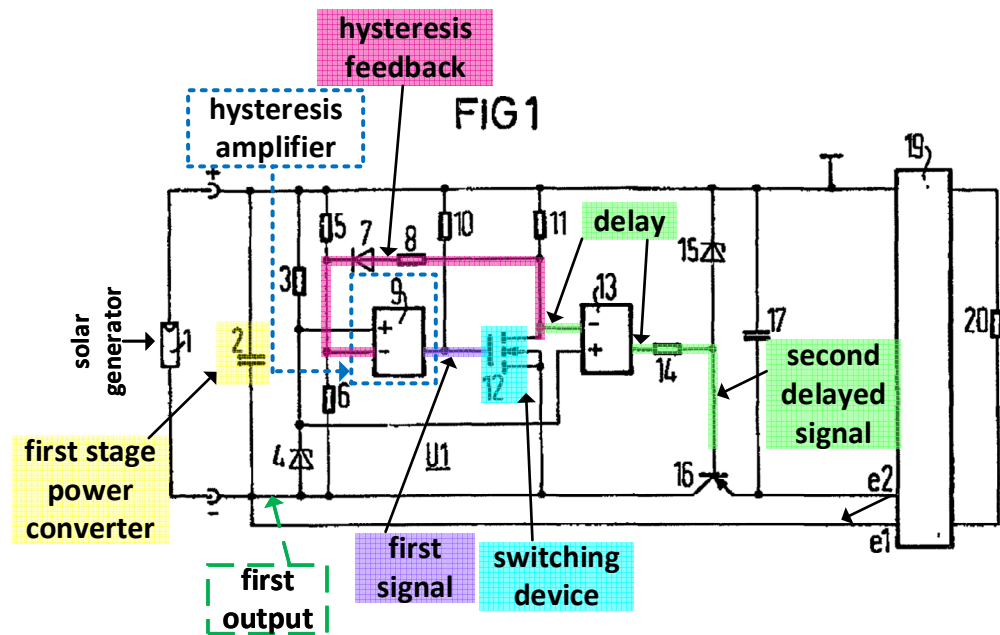
Furthermore, if it is contended that the *delaying the first signal* should be defined by a specific delay circuitry rather than the intrinsic switching and delay characteristics of comparator 13 and switch 12, a PHOSITA would have known to add a capacitor (optionally with a series resistor) parallel to resistor 11 according to customary practices in the art at the time of filing. Further, or in alternative, one or more buffer circuits or delay elements could be interposed between the second comparator output and the base of bipolar transistor 16 to define a larger delay period, as is well known and customary in the general knowledge of a PHOSITA. Ex.1007,¶147;Ex.1015,3:53-63,Fig.3.

Thus, Mieth teaches all the features of claim 8.

6. Dependent Claim 9

Claim 8 is taught by Mieth. *Supra*,§VII.A.5. Claim 9 depends from claim 8 and requires [9A], “wherein the control circuit comprises: a hysteresis amplifier coupled to the first output to generate the first signal.” Ex.1001, claim 9. A PHOSITA understands hysteresis is a positive feedback loop between the output of a device and an input of a device, such as an amplifier or comparator, to mitigate instability in switched signals. Ex.1007,¶150. A PHOSITA would further understand that an amplifier can be configured as a comparator, and thus the first comparator 9 can be an amplifier. Ex.1007,¶150.

As shown in Fig.1(annotated-9) below, Mieth discloses a capacitor 2 (highlighted-yellow) that outputs a first output (dashed-green) analogous to the claimed first output, and the first comparator 9 (dashed-blue) that is analogous to the claimed hysteresis amplifier that outputs a first signal (highlighted-purple) analogous to the claimed first signal of [9A] as discussed further below.



Ex.1002, Fig.1(annotated-9)

The first comparator 9 is configured with hysteresis where the hysteresis feedback path (highlighted-pink) from the output of the switching device (field-effect transistor 12) is connected to the negative input of the first comparator 9 through resistor 8 and diode 7. Ex.1002,9:34-38;Ex.1007,¶152. Furthermore, Mieth recites that “[h]ysteresis is achieved by means of the resistor 8.” Ex.1002,12:26-27. Specifically, when the switch 12 is off, the series circuit

comprising resistors, 8, 11 and diode 7 are in parallel with resistor 5 forming a voltage divider with resistor 6. When the switch 12 is on, diode 7 is off and no current flows through resistor 8 leaving only resistors 5 and 6 to form the voltage divider. In this way the first comparator 9 and associated circuitry exhibit hysteretic behavior. Ex.1007,¶152. Since the first comparator 9 can be an amplifier with a positive feedback loop, the first comparator 9 is the same as the claimed ***hysteresis amplifier***. Ex.1007,¶152. The first output of the capacitor 2 is represented at the negative input of the first comparator 9 through a voltage divider defined by resistors 5 and 6 in addition to resistors 8 and 11 and diode 7 when first comparator 9 output is low, and the first comparator 9 outputs the first signal, which is analogous to the claimed ***hysteresis amplifier coupled to the first output to generate the first signal***. Ex.1002,9:34-38;Ex.1007,¶152.

Thus, Mieth teaches [9A].

Claim 9 further requires [9B], “a delay circuit coupled to the first signal to generate the second delayed signal.” Fig.1(annotated-9) further illustrates the field-effect transistor 12 (switching device-highlighted-teal) and the second comparator 13 that delays the first signal (highlighted-purple) from first comparator 9 to generate a second delayed signal (highlighted-green).

Ex.1002,Fig.1,11:4-12;Ex.1007,¶154.

The delay circuit operates when the first signal goes low, causing transistor 12 to turn “off,” and pulling the drain terminal thereof high due to lack of current flowing through resistor 11. With the drain terminal connected to the negative input terminal of the second comparator 13, the drain terminal going high causes the output of the second comparator 13 to go low (*i.e.*, the second delayed signal), which activates the bipolar transistor 16. The propagation delays from the first signal through the transistor 12 and the second comparator 13 constitute *a delay circuit* that delays the second signal with respect to the first signal. That is, when the first signal goes low, the second signal goes low thereafter by a delay time period dictated by the transistor 12 and the second comparator 13. Ex.1007,¶155.

Since, the field-effect transistor 12 and the second comparator 13 are coupled together and delay the first signal to generate the second signal at the output of the second comparator 13, the field-effect transistor 12 and the second comparator 13 are analogous to the claimed *delay circuit coupled to the first signal to generate the second delayed signal*. However, if it is argued that the *delay circuit* should be defined by further specific circuitry rather than the intrinsic switching characteristics of second comparator 13 and switch 12, delay elements discussed in accordance with claim 8 in §VII.A.5 can be implemented.

Thus, Mieth teaches [9B] and all elements of claim 9.

7. Independent Claim 10

With reference to the claim listing appendix, Mieth discloses Elements [10A]-[10H]. As explained below, a PHOSITA would have been motivated by Mieth to arrive at the alleged invention of claim 10.

i. [10A]: “A method to supply power, the method comprising:”

Mieth (Ex.1002) discloses a circuit that supplies power to an electrical load from a solar generator 1. Ex.1002(Mieth),8:8-9. A PHOSITA would understand that when the circuit of Mieth supplies power to the electrical load, the circuit is performing a method to supply power to the electrical load. Ex.1007,¶159. Thus, Mieth teaches [10A].

ii. [10B]: “providing a first stage power converter to generate a first output from a direct current input”

[10B] is analogous to [1B], and thus Mieth discloses [10B] for at least the same reasons Mieth discloses [1B] as described in §VII.A.1.ii. Ex.1007,¶160.

iii. [10C]: “wherein the first stage power converter is coupled to a power absorption circuit”

The power absorption circuit of [10C] is analogous to the power absorption circuit of [1E], and thus Mieth discloses the power absorption circuit of [10C] for at least the same reasons Mieth discloses the power absorption circuit of [1E] as described in §VII.A.1.v. Ex.1007,¶161. [10C] requires that the *first stage power converter is coupled to the power absorption circuit*. As described in §VII.A.1.v.,

Mieth discloses that the first output of the capacitor 2 (first stage power converter) is connected to the field-effect transistor 12 and preliminary load 11 (power absorption circuit), which is analogous to the claimed *first stage power converter is coupled to a power absorption circuit*. As such, Mieth teaches [10C] for the same reasons described in §VII.A.1.v. Ex.1007,¶161.

iv. [10D]: “providing a second stage power converter connected to the first stage power converter to convert the first output to a second output”

[10D] is analogous to [1C], and thus Mieth discloses [10D] for at least the same reasons Mieth discloses [1C] as described in §VII.A.1.iii. Ex.1007, ¶162.

v. [10E]: “wherein the second stage power converter is coupled to a micro-controller;”

The micro-controller of [10E] is analogous to the micro-controller of [1D], and thus Mieth discloses the micro-controller of [10E] for at least the same reasons Mieth discloses the micro-controller of [1D] as described in §VII.A.1.iv. Ex.1007,¶163. [10E] requires *wherein the second stage power converter is coupled to a micro-controller*. As described in §VII.A.1.iv. and §VII.A.1.viii., Mieth discloses that the power supply apparatus 19 (second stage power converter) is coupled to a load 20 (micro-controller) and provides a second output to the micro-controller, which is the same as the claimed *second stage power converter is coupled to a micro-controller*. As such, Mieth teaches [10E] for the same reasons described in §VII.A.1.iv. and §VII.A.1.viii. Ex.1007,¶163.

- vi. **[10F]: “powering, by the first output, a control circuit that is coupled with the first stage power converter and the second stage power converter”**

[10E] is analogous to [1F], and thus Mieth discloses [10E] for at least the same reasons Mieth discloses [1F] as described in §VII.A.1.vi. Ex.1007,¶164.

- vii. **[10G]: “controlling, by the control circuit powered by the first output, the second stage power converter, by: when the second stage power converter is in a first mode of not providing the second output to power the micro-controller, monitoring a voltage of the first output powering the power absorption circuit and signaling the second stage power converter to remain in the first mode during a time period in which the voltage is below a threshold; and”**

[10G] is analogous to [1G], and thus Mieth discloses [10G] for at least the same reasons Mieth discloses [1G] as described in §VII.A.1.vii. Ex.1007,¶165.

- viii. **[10H]: “when the voltage is above the threshold, signaling the second stage power converter to enter a second mode of providing the second output to power the micro-controller”**

[10H] is analogous to [1H], and thus Mieth discloses [10H] for at least the same reasons Mieth discloses [1H] as described in §VII.A.1.viii. Ex.1007,¶166.

As such, Mieth teaches every feature of claim 1 and thus anticipates claim 1.

8. Dependent Claim 13

Claim 13 is taught by Mieth. *Supra*,§VII.A.7. Claim 13 depends from claim 10 and requires, “further comprising: providing, in the power absorption circuit, a switchable load.” Ex.1001, claim 13. Claim 13 is analogous to claim 4,

and thus Mieth discloses claim 13 for at least the same reason Mieth discloses claim 4 as described in §VII.A.2. Ex.1007,¶167.

9. Dependent Claim 14

Claim 13 is taught by Mieth. *Supra*,§VII.A.8. Claim 14 depends from claim 13 and requires, “wherein the control circuit signals the switchable load to be in a first state to consume the first output when the second stage power converter is in the first mode and to be in a second state not to consume the first output when the voltage is above the threshold.” Ex.1001, claim 14. Claim 14 is analogous to claim 5, and thus Mieth discloses claim 14 for at least the same reason Mieth discloses claim 5 as described in VII.A.3. Ex.1007,¶168.

10. Dependent Claim 16

Claim 14 is taught by Mieth. *Supra*,§VII.A.9. Claim 16 depends from claim 14 and requires, “further comprising: providing, in the switchable load: a resistive device; and a switching device connected to the resistive device, wherein the switching device is turned on in the first state to connect the resistive device to the first output and turned off in the second state to disconnect the resistive device from the first output.” Ex.1001, claim 16. Claim 16 is analogous to claim 7, and thus Mieth discloses claim 16 for at least the same reason Mieth discloses claim 7 as described in VII.A.4. Ex.1007,¶169.

11. Dependent Claim 17

Claim 14 is taught by Mieth. *Supra*, §VII.A.9. Claim 17 depends from claim 14 and requires, “further comprising: delaying, by the control circuit, a first signal instructing the switching device to change from the first state to the second state to generate a second delayed signal that instructs the second stage to change from the first mode to the second mode.” Ex.1001, claim 17. Claim 17 is analogous to claim 8, and thus Mieth discloses claim 17 for at least the same reason Mieth discloses claim 8 as described in VII.A.5. Ex.1007, ¶170.

12. Dependent Claim 18

Claim 17 is taught by Mieth. *Supra*, §VII.A.11. Claim 18 depends from claim 17 and requires, “further comprising: providing, in the control circuit, a hysteresis amplifier coupled to the first output to generate the first signal; and providing a delay circuit coupled to the first signal to generate the second delayed signal.” Ex.1001, claim 18. Claim 18 is analogous to claim 9, and thus Mieth discloses claim 18 for at least the same reason Mieth discloses claim 9 as described in VII.A.6. Ex.1007, ¶171.

B. Ground B: Obviousness of claims 1, 4, 5, 7-10, 13, 14, and 16-20 in view of Mieth and Balogh

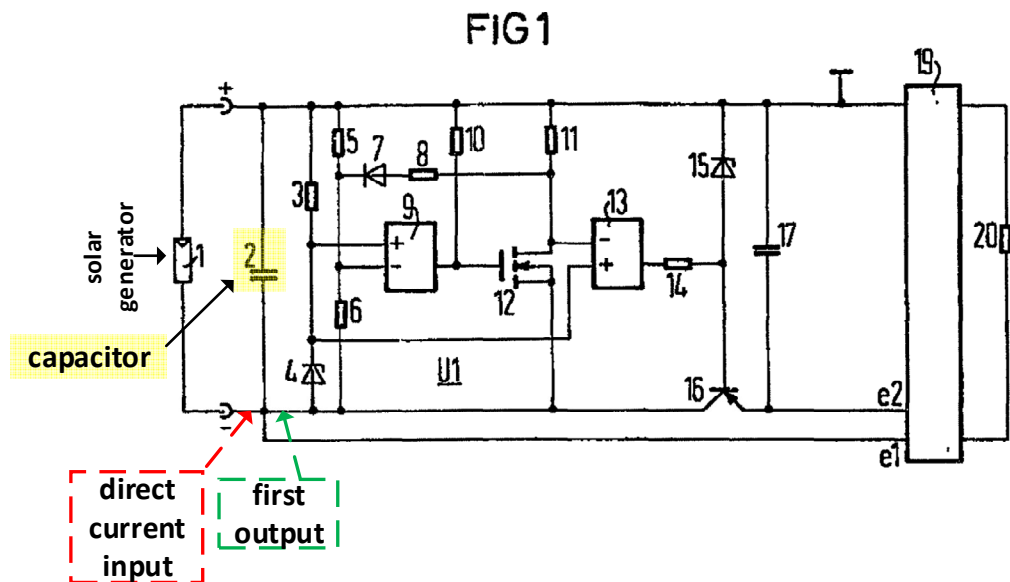
With reference to the claim listing appendix, Mieth is believed to disclose all the elements of claims 1, 4-5, 7-10, 13-14, and 16-18. To the extent it is argued that Mieth does not teach the first stage power converter (e.g., elements [1B] and

[10B]), Balogh discloses a first stage power converter as set forth in elements [1B] and [10B]. Further, as explained below, a PHOSITA would have been motivated to combine together Mieth and Balogh to arrive at the alleged invention of claims 1, 4, 5, 7-10, 13, 14, and 16-20.

1. Independent Claim 1

- i. [1B]: “a first stage power converter to generate a first output from a direct current input”

A PHOSITA understands that solar generators generate a direct current. Ex.1007,¶173;Ex.1013,¶21. As such, the solar generator 1 of Mieth supplies a *direct current input* (dashed-red) to the capacitor 2 as shown in Fig. 1 (annotated-1B.1) below, and generates a first output. Ex.1007,¶173.



Ex.1002, Fig.1 (annotated-1B.1)

Balogh discloses cascaded converter arrangements (*e.g.*, Ex.1003(Balogh),Figs.1B-1D), and states that cascaded arrangements using first and second buck converters are employed in circuit applications that require large input/output conversion ratios. Ex.1003,1:21-27. It is known to a PHOSITA that photovoltaic panels or modules can realize high input voltages, and such high input voltages need large input/output conversion ratios to step down the input voltage. Ex.1003,1:21-27,Ex.1007,¶174. Even a single photovoltaic module can see a voltage as high as 80V, which may necessitate a large input/output conversion ratio. Ex.1007,¶174;Ex.1010;Ex.1011. Balogh teaches, in Fig 1D, a cascaded converter arrangement using *a first stage transformer-coupled input power converter that steps down an input voltage to an intermediate voltage*, followed by a second stage buck output power converter that further steps down the intermediate voltage to a final voltage. Ex.1003,1:62-66. Thus, Balogh clearly discloses *a first stage power converter*, as recited in element [1B] and shown in Fig.1D(annotated-1B.2) below.

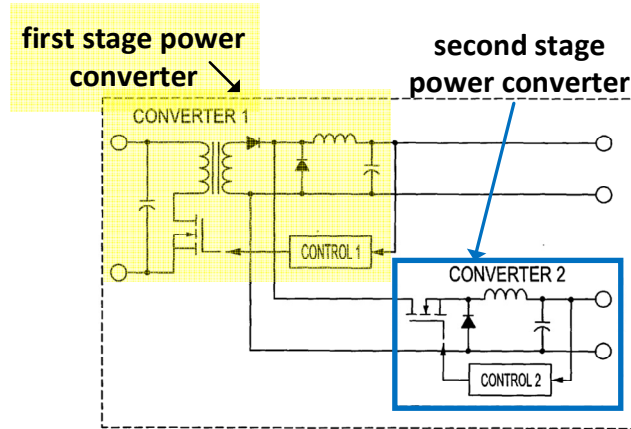


FIG. 1D
PRIOR ART

Ex.1003, Fig.1D(annotated-1B.2)

Mieth states that applications having photovoltaic energy sources or wind energy sources often provide varying levels of input voltage that can create difficulties when serving as an input to a power converter. Ex.1002,5:22-38. Mieth further teaches the use of a switchable load in situations where an input voltage to a power converter varies, such as the voltage from a photovoltaic system that will vary depending upon the time of day, or weather conditions. *Id.*

A PHOSITA is motivated to combine the cascaded power converter architecture of Balogh with Mieth. Balogh discloses the first stage power converter to replace the capacitor 2 of Mieth and configure two cascaded power converters with the switchable load feature of Mieth for DC applications with high input voltages. Ex.1007,¶176. Mieth is directed towards solar generators that generate up to 36 volts. Ex.1002,12:21-26. Balogh discloses higher DC voltages relative to Mieth, for example, 48V with large step-down ratios, for example, 48V

to 1.5V. Ex.1003,10:45-52. In other prior art examples, solar panel modules can have 80V output voltages requiring large step-down ratios. Ex.1010;Ex.1011; Ex.1007,¶176. As such, a PHOSITA would have known and been motivated to combine the cascaded power converter architecture of Balogh with Mieth for high DC applications (e.g., 48V or 80V solar panel modules) to realize an appropriate intermediate voltage for the power supply apparatus 19 (*i.e.*, second stage power converter) of Mieth. Ex.1007,¶176.

The combination of Mieth-Balogh involves combining known prior-art elements (Mieth's switchable load and step-down converter and Balogh's cascaded step down converter architecture) according to known methods to yield predictable results, *i.e.*, a cascaded step-down power converter having a switchable load at the second power converter input that is selectively employed based on the output voltage of the first stage step-down power converter. A PHOSITA would have had the skills, knowledge, and motivation to carry out the combination. Ex.1007,¶177. A PHOSITA would have reasonably expected success in combining Mieth and Balogh as no significant modifications are required to implement. *Id.* A PHOSITA would have appreciated the benefit of adapting the high DC voltage stepped down to an intermediate voltage of Balogh to situations with a variable input voltage to a power converter as shown in Mieth. *Id.* As understood by a PHOSITA, there are no undue technical hurdles to applying Mieth with Balogh or

vice-versa, as such a combination would have been a simple modification to Mieth's system, readily accomplished by a PHOSITA. *Id.* Accordingly, Mieth in combination with Balogh is proper and teaches element [1B]. *Id.*

Specifically, while the capacitor 2 discussed in §VII.A.1.ii (see Fig. 1(annotated-1C.1) above) provides the recited function of the first stage power converter as recited in the claims, and the bipolar transistor 16/power supply apparatus 19 is analogous to the claimed second stage power converter, Balogh discloses a cascaded converter arrangement having an isolated DC-DC converter in its first stage that is explicitly set forth as a first stage power converter.

Ex.1003,10:45-52;Ex.1007,¶178.

Balogh's isolated DC-DC converter (analogous to the first stage power converter-yellow) and post regulator circuit are cascaded step-down converters and are shown in Fig.1D(annotated-1B.2). Ex.1003,2:61-64;Ex.1007,¶179.

Based on Balogh, a PHOSITA would understand that cascaded converters are commonly used to provide input to output power conversion that is not optimally implemented in a single converter. Ex.1003,1:25-28.Ex.1007,¶180. Thus, the purpose of the first stage power converter and the second stage power converter was previously described by Balogh, that is, to provide input-to-output power conversion that is not optimally implemented in a single converter, for example, in high DC voltage applications. Ex.1003,10:45-52. Balogh's DC-DC

converter can replace the capacitor 2 of Mieth to provide a first output to be consumed by the switchable load or to power the second stage power converter, and the claimed second stage power converter uses the first output from the first stage to power the micro-controller, which is not optimally implemented by a single converter (e.g. the first stage power converter or the second stage power converter alone). Ex.1007,¶180. As such, a PHOSITA, at the time of filing, would know that the capacitor 2 of Mieth could be replaced by the DC-DC converter of Balogh, and combined with the power supply apparatus 19 of Mieth to form a cascaded converter architecture as disclosed by Balogh. *Id.*

In addition, it is well known in the art that improved efficiency can be achieved by cascading buck power converters when there is a large ratio of input to output voltage as described in Patent application: US 2007/0001653 (hereafter “Xu”). Ex. 1012. Xu states: “The present invention provides a two-stage power delivery system that employs cascaded buck stages. For high input-to-output voltage ratios, each cascaded buck stage has a more suitable (*i.e.*, larger) duty cycle that results in a much lower total power loss than in a single-stage buck.” Ex.1012,¶6.

Xu reflects further general knowledge of a PHOSITA that cascaded converters advantageously improve circuit efficiency. Ex.1012. Xu states that in some applications where there is a lower input-to-output voltage ratio, for example,

like in Mieth, the first stage power converter can be configured with a duty cycle of one that operates as a well-known L-C filter for the subsequent second stage, thereby being substantially similar to Mieth's capacitor 2 input stage. For at least these reasons, it would have been obvious for a PHOSITA to combine Balogh with Mieth in view of the general knowledge of a PHOSITA, as shown by the teaching of Xu, where large output/input ratios are more efficient when implemented with cascaded buck converters.

Thus, Xu provides a teaching that a PHOSITA would readily consider a cascaded converter arrangement in various solar applications, such as the application taught in Mieth. As such, a PHOSITA, at the time of filing, would know that the capacitor 2 of Mieth could be replaced readily by the first stage power converter of Balogh, and combined with the power supply apparatus 19 of Mieth to form a cascaded converter architecture as disclosed by Balogh.

Ex.1007,¶183.

Thus, Balogh discloses [1B] in combination with Mieth.

ii. [1A]-[1H] are disclosed by Mieth-Balogh

As discussed in §VII.A.1 Mieth discloses claim 1. As discussed in §VII.B.1.i, Mieth in combination with Balogh disclose feature [1B], thus Mieth-Balogh also teach all the elements [1A]-[1H] of claim 1. Additionally, for the same reasons, Mieth-Balogh teach all of claims 4, 5, and 7-9.

2. Independent Claim 10

- i. [10B]: “providing a first stage power converter to generate a first output from a direct current input”**

[10B] is analogous to [1B], and thus Mieth-Balogh disclose [10B] for at least the same reasons Mieth-Balogh disclose [1B] as described in §VII.B.1.

- ii. [10A]-[10H] are disclosed by Mieth-Balogh**

As discussed in §VII.A.7 Mieth discloses claim 10. As discussed in §VII.B.2.i, Mieth in combination with Balogh discloses feature [10B], thus Mieth-Balogh also teach all the elements [10A]-[10H] of claim 10. Additionally, Mieth teaches claims 13-14, and 16-18 as discussed in §VII.A.8-§VII.A.12; therefore for the same reasons, Mieth-Balogh teaches claims 13-14, and 16-18.

3. Independent Claim 19

With reference to the claim listing appendix, Mieth and Balogh disclose elements [19A]-[19J]. As explained below, a PHOSITA would have been motivated to combine together Mieth and Balogh to arrive at the alleged invention of claim 19.

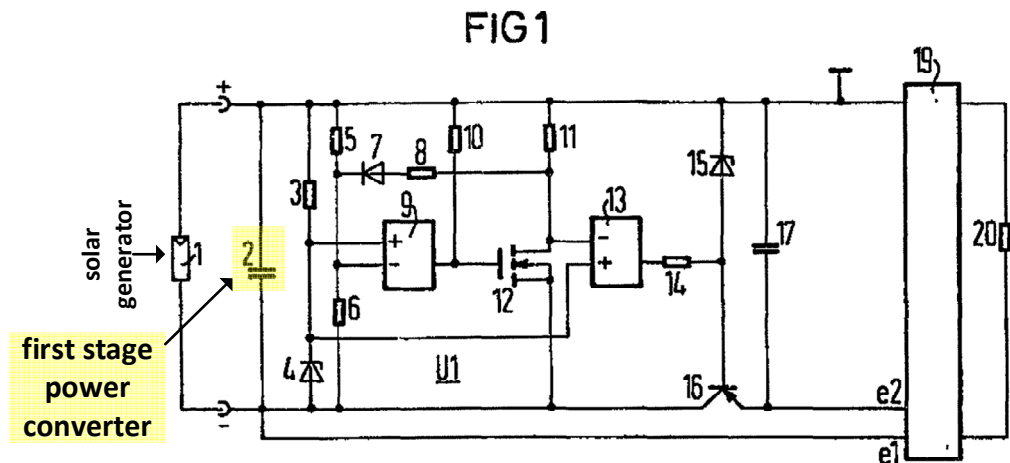
- i. [19A]: “A power supply for use in a solar electric production system”**

Mieth (Ex.1002) discloses a circuit that supplies power to an electrical load from a solar generator. Ex.1002,8:8-9. A PHOSITA would understand that a solar

generator is a solar electric production system. Ex.1007,¶189. Thus, Mieth teaches [19A].

ii. [19B]: “the power supply comprising: a first stage power converter”

Mieth discloses a circuit with a capacitor 2 (yellow) in parallel with a solar generator. Fig.1(annotated-19B);Ex.1002,9:5-9;Ex.1007,¶190. As discussed in accordance with [1B], the capacitor 2 is analogous to the claimed *first stage power converter*. §VII.A.1.ii.

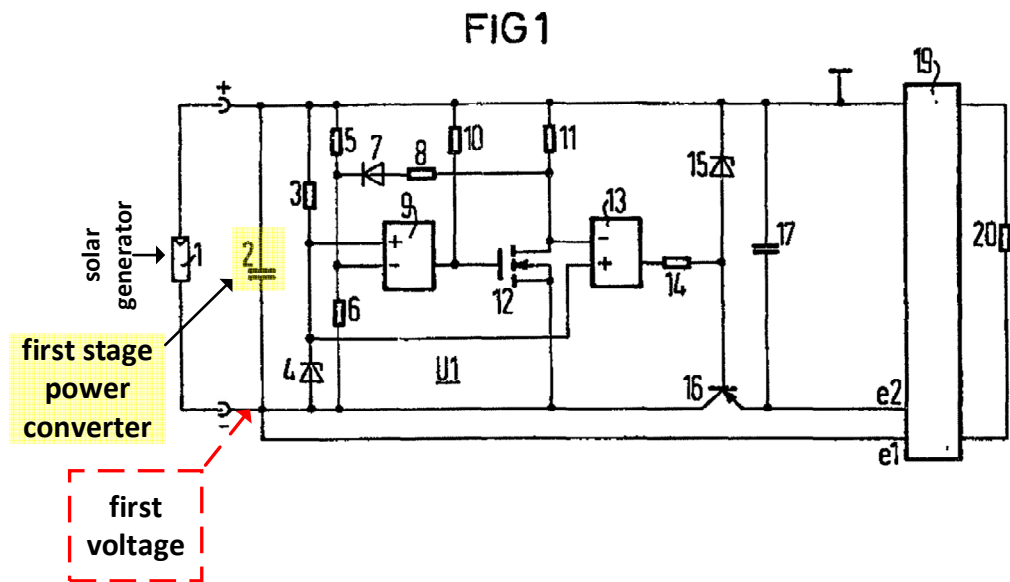


Ex.1002, Fig.1(annotated-19B)

Thus, Mieth teaches [19B]. Additionally, the combination of Mieth and Balogh disclose the first stage power converter of [19B] as discussed in further detail in §VII.B.3.iv.

iii. [19C]: “having: an input connected to a first voltage from a photovoltaic panel”

Mieth discloses a solar generator 1 which a PHOSITA would understand includes the claimed *photovoltaic panel*. Ex.1007,¶192. Mieth further discloses that the solar generator 1 provides an output voltage which is analogous to the claimed *a first voltage from a photovoltaic panel*. Ex.1002,4:37-5:7,Ex.1007,¶192. Furthermore, as seen in Fig.1(annotated-19C), the capacitor 2 is connected to the solar generator 1 and thus *an input* of the capacitor 2 (*i.e.*, first stage power converter) is connected to the output voltage (*i.e.*, first voltage) of the solar generator 1. Ex.1007,¶192.



Ex.1002, Fig.1(annotated-19C)

Thus, Mieth teaches [19C]. Additionally, the combination of Mieth and Balogh disclose the features of [19C] as discussed in further detail in §VII.B.3.iv.

iv. [19D]: “an output providing a second voltage different from the first voltage from the photovoltaic panel”

Mieth does not disclose that the capacitor 2 (first stage power converter) outputs a second voltage that differs from the first voltage. However, Balogh discloses cascaded converter arrangements (*e.g.*, FIG.1D(annotated-19D)), where converter 1 is analogous to the claimed first stage power converter. Ex.1003,2:54-64;Ex.1007,¶194.

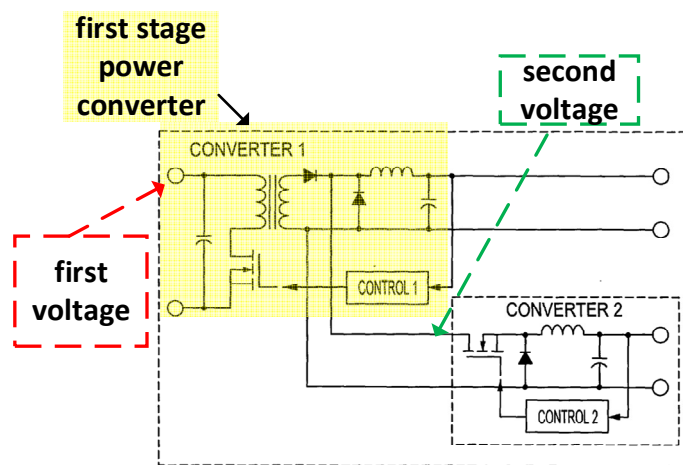


FIG. 1D
PRIOR ART

Ex.1003, Fig.1D(annotated-19D)

Converter 1 of Balogh is a DC/DC converter that converts a first voltage at the input of converter 1 to a second voltage at the output of converter 1 that is different than the first voltage, which is analogous to the claimed *an output providing a second voltage different from the first voltage from the photovoltaic panel*. Ex.1007,¶195. Specifically, the first voltage input to converter 1 passes

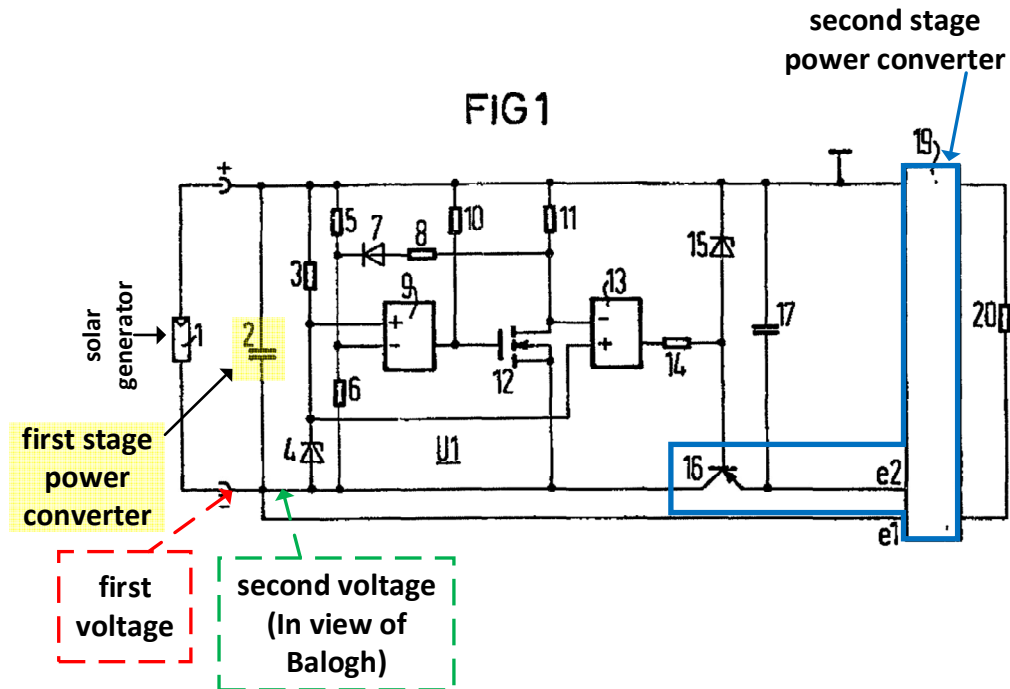
through the transformer of converter 1 which can step down the voltage to the second voltage seen at the output of converter 1. *Id.*

A PHOSITA is motivated to combine the cascaded power converter architecture of Balogh with Mieth as described in accordance with claim 1 in §VII.B.1. That is, Balogh discloses converter 1 which is a first stage power converter than can replace the capacitor 2 of Mieth and configure two cascaded power converters with the switchable load features of Mieth for DC applications with high input voltages for solar generator applications. Ex.1007,¶196.

Thus, Mieth-Balogh teach [19D].

v. **[19E]: “a second stage power converter connected to the output of the first stage power converter,”**

[19E] is analogous to the features of [1C] that recite, “a second stage power converter connected to the first stage power converter.” [19E] differs in reciting that the second stage power converter is connected to the ***output*** of the first stage power converter. Mieth, as seen in Fig.1(annotated-19E), discloses that the power supply apparatus 19 (analogous to the second stage power converter, or see also converter 2 of Balogh’s Fig. 1D) is connected at the output of capacitor 2 (analogous to the first stage power converter, or see also converter 1 of Balogh’s Fig. 1D). Ex.1007,¶198.



Ex.1002, Fig.1(annotated-19E)

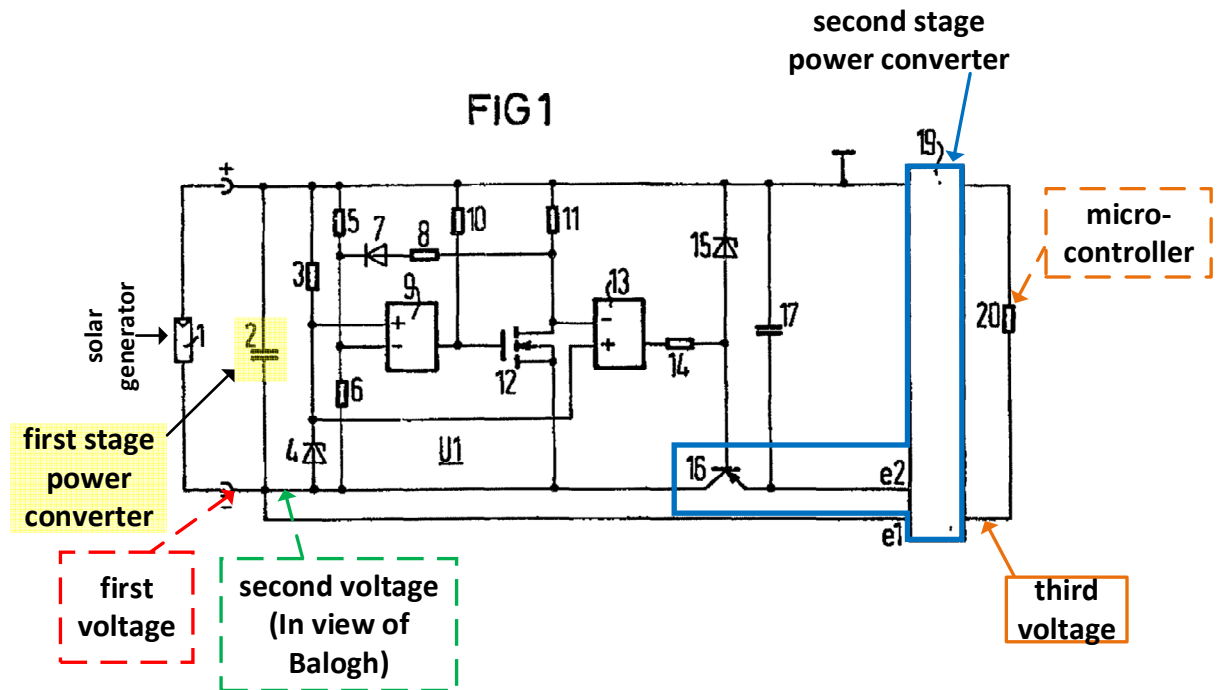
Thus Mieth discloses [19E] for at least the same reasons Mieth discloses [1C] as described in VII.A.1.iii.

- vi. [19F]: “the second stage power converter supplying power at a third voltage to a micro-controller of the photovoltaic panel; and”

Mieth discloses that the power supply apparatus 19 connected to the bipolar transistor 16 (blue-second stage power converter) generates an output voltage to a load 20. Ex.1002,11:14-16,12:21-30;Ex.1007,¶200. As shown in Fig.1(annotated-19F), the output of the power supply apparatus 19 is analogous to the claimed *supplying power at a third voltage*. Ex.1002,8:29-35;Ex.1007,¶200. The load 20 of Mieth receives the output of the power supply apparatus 19. *Id.* A PHOSITA

would understand that a load in a circuit can be or include a micro-controller, as such, the load 20 is analogous to the claimed *micro-controller* (dashed-orange).

Ex.1007,¶200.



Ex.1002, Fig.1(annotated-19F)

A PHOSITA would understand that the micro-controller can reside with or be connected to circuitry associated with the solar generator 1 of Mieth which includes the claimed photovoltaic panel, which is analogous to the claimed *a micro-controller of the photovoltaic panel*. Ex.1007,¶201.

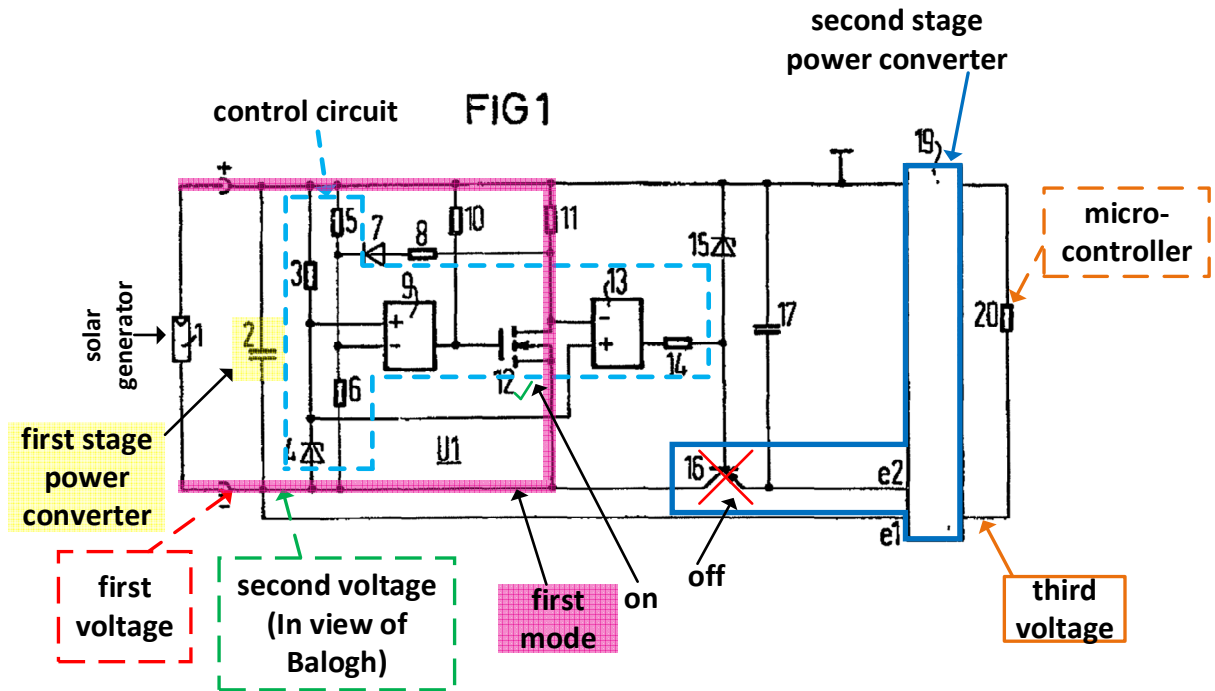
Thus Mieth discloses [19F].

- vii. [19G]: “a control circuit coupled to the first stage power convert and the second stage power converter and powered by the output of the first stage power converter”

[19G] is analogous to [1F], and thus Mieth discloses [19G] for at least the same reasons Mieth discloses [1F] as described in §VII.A.1.vi. Ex.1007,¶203.

- viii. [19H]: “wherein after the first stage power converter is turned on, the control circuit instructs the second stage power converter to: not supply the power at the third voltage to the micro-controller before a determination that the output of the first stage power converter has been stable for a predetermined period of time; and”

Mieth-Balogh disclose a first stage power converter, either the capacitor 2 of Mieth or converter 1 of Balogh (*e.g.*, as discussed in §VII.B.2.ii., VII.B.2.iv). The first stage power converter of Mieth or Balogh are ***turned on*** when connected to and receiving the first voltage from the solar generator 1 as seen in Fig.1(annotated-19H). Ex.1007,¶204. A PHOSITA would understand the claimed “turned on” condition can be met when the solar generator 1 is generating DC power that powers the first stage power converter. *Id.* As such, Mieth-Balogh disclose the claimed ***wherein after the first stage power converter is turned on.*** *Id.*



Ex.1002, Fig.1(annotated-19H)

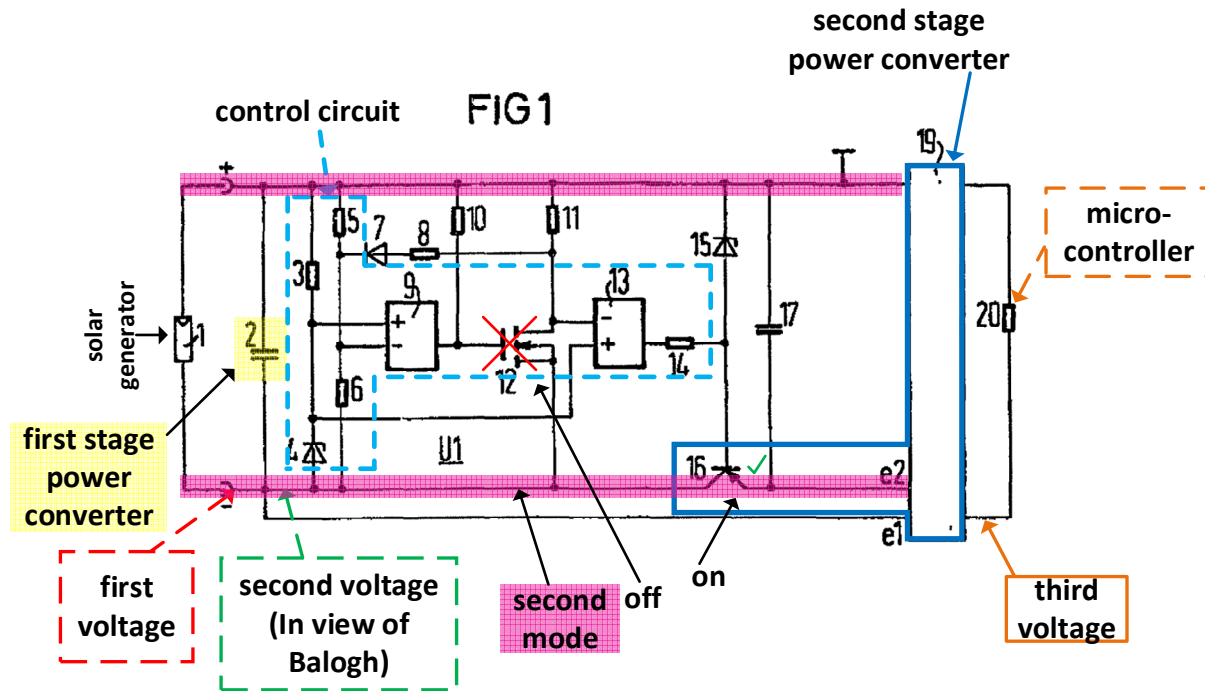
Mieth discloses a switchable load between the first stage and second stage power converter that is connected to the first stage power converter when the output of the first stage power converter does not meet a stable criteria according to a voltage threshold Ex.1002,5:22-38;Ex.1007,¶205. Details regarding the switchable voltage threshold of Mieth are discussed in accordance with §VII.A.1.vi.-§VII.A.1.vii above. Based on the operation of Mieth, a PHOSITA would understand that when the first stage power converter powers on, the circuit of Mieth is configured for the first mode of [1G]. Ex.1007,¶205. Thus, the power supply apparatus 19 does not supply power to the load 20 which is analogous to the claimed *not supply the power at the third voltage to the micro-controller. Id.*

Mieth discloses hysteresis by the circuit configuration of the first comparator 9, to mitigate instability in switching signals as discussed in §VII.A.6. The operation of hysteresis within Mieth is analogous to the claimed *a determination that the output . . . has been stable*. Ex.1007,¶206-210. Furthermore, as shown in Fig.1(annotated-9) above, the feedback from the output of the first comparator 9 back to the input of first comparator 9 through resistor 8 and diode 7, and the time it takes the first comparator 9 to compare its inputs define a period of time that is analogous to the claimed *stable for a predetermined period of time*. *Id.* That is, the predetermined period of time in Mieth is intrinsic to delays of the circuit elements associated with hysteresis for the first comparator 9.

Thus Mieth discloses [19H].

- ix. [19I]: “supply the power at the third voltage to the micro-controller after the determination that the output of the first stage power converter has been stable for the predetermined period of time”

Mieth discloses a second mode that is analogous to feature [19I] as discussed in accordance with [1H]. §VII.A.1.viii. As shown in Fig.1(annotated-19I), in the second mode, the second stage power supply provides power at the third voltage to the load 20 (*i.e.*, micro-controller).



Ex.1002, Fig.1(annotated-19I)

As described in §VII.A.1.viii., in the second mode, the bipolar transistor 16 is “on” causing the output of the power supply apparatus 19 to power the load 20, which is analogous to the claimed *supply the power at the third voltage to the micro-controller*. Ex.1007, ¶213.

As discussed in §VII.B.3.viii, the output of Mieth’s first stage power converter (either capacitor 2 or in view of Balogh’s converter 1) is determined to be stable by the hysteresis of comparator 9 for a predetermined period of time when the representative voltage at the first comparator 9 meets or exceeds the predefined minimum value. Ex.1007, ¶214.

Thus Mieth discloses [19I], and Mieth-Balogh disclose every feature of claim 19.

4. Dependent Claim 20

Claim 19 is taught Mieth and Balogh. *Supra*, §VII.B.3. Claim 20 depends from claim 19 and requires, “wherein the first stage power converter is a first step-down converter, and the second stage power converter is a second step-down converter.” Ex.1001, claim 20. As discussed in *Supra*, §VII.B.1., a PHOSITA would have been motivated to combine the cascaded power converter architecture of Balogh with the switchable load features of Mieth. As discussed in *Supra*, §VII.B.3.ii.- §VII.B.3.v., and Fig.1(annotated-19B), Mieth-Balogh disclose a capacitor 2 (highlighted-yellow) which is analogous to the claimed *first stage power converter* and disclose power supply apparatus 19 connected to the bipolar transistor 16 (blue) which is analogous to the claimed *second stage power converter*. The power supply apparatus 19 is a DC-DC voltage converter or charging converter which a PHOSITA would understand can step-down DC power and is analogous to the claimed *second stage power converter is a second step-down converter*. Ex.1002,8:29-35;Ex.1007,¶216. Balogh teaches a first stage power converter and a second stage power converter that can each comprise step-down converters as seen in Fig.1D(annotated-19D) above. Ex.1003,1:29-36;Ex.1007,¶216. Balogh teaches that a cascaded arrangement can include a first

buck converter and a second buck converter where a buck converter steps an input voltage down to an output voltage that is lower than the input voltage. *Id.* It would be obvious to a PHOSITA to modify the capacitor 2 of Mieth with the step-down converter from Balogh to realize the claimed *first stage power converter is a first step-down converter*. Thus, Mieth-Balogh disclose claim 20.

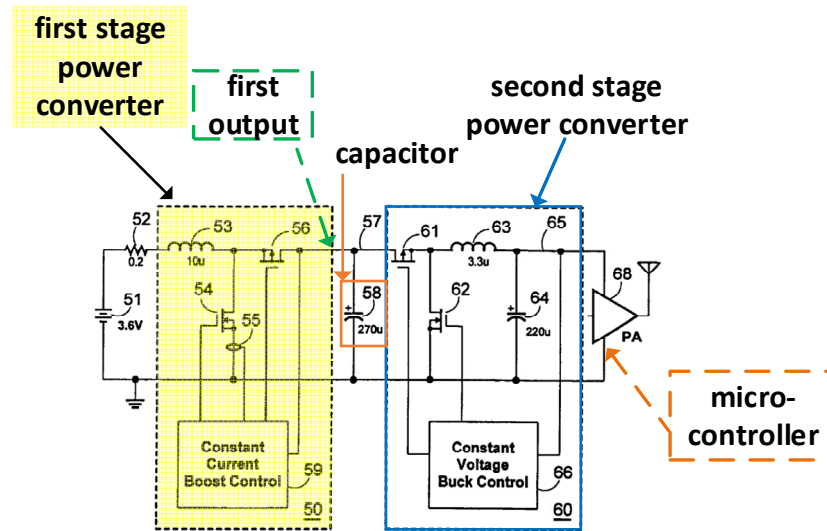
C. Ground C: Obviousness of claims 2, 3, 6, 11, 12, and 15 in view of Mieth and Liu, or over Mieth-Balogh, and further in view of Liu

1. Dependent Claim 2

Claim 1 is taught by Mieth. *Supra*, §VII.A.1. Claim 2 depends from claim 1 and requires, “wherein the power absorption circuit includes a capacitor coupled to the first output.” Ex.1001, claim 2

Mieth discloses transistor 12 connected to preliminary load 11 to form the claimed *power absorption circuit coupled to the first output* as discussed in §VII.A.1.vii. Ex.1007, ¶218. Additionally, Liu (Ex.1005) discloses a capacitor as a power absorption circuit coupled to the first output, and a PHOSITA is motivated to combine Mieth and Liu for the following reasons.

As shown in Fig.5(annotated-Claim-2), Liu discloses cascaded DC voltage converters with an input stage 50 separated from an output stage 60 by a reservoir capacitor 58. Ex.1005,4:25-35;Ex.1007, ¶219.



Ex.1005, Fig.5(annotated-Claim-2)

Input stage 50 up-converts the voltage from battery 51 to charge reservoir capacitor 58, and output stage 60 down converts the voltage of reservoir capacitor 58 to power a power amplifier (“PA”) 68. Ex.1005,4:36-43;Ex.1007,¶220. Since input stage 50 (highlighted-yellow) converts an input voltage to an output voltage, input stage 50 is analogous to the claimed first stage power converter of claim 1, and the output (dashed-green) of input stage 50 is analogous to the claimed *first output* of claim 2. Ex.1007,¶220. Since reservoir capacitor 58 (orange) is charged from the first output of input stage 50, reservoir capacitor 58 absorbs the first output of input stage 50 and is analogous to the claimed *power absorption circuit includes a capacitor coupled to the first output*. *Id.* Thus, Mieth-Liu or Mieth-Balogh-Liu teach claim 2.

The combination of Mieth-Liu involves combining known prior-art elements (combining Mieth's resistive load between converters with Liu's capacitive load between converters) according to known methods to yield predictable results, a cascaded power converter having a capacitive load at the second power converter input. A PHOSITA has the skills, knowledge, and motivation to carry out the combination. Ex.1007,¶221. A PHOSITA would reasonably expect success in combining Mieth and Liu, and there is no undue technical hurdles in combining Mieth with Liu, as the combination is a simple modification to Mieth's system. *Id.*

2. Dependent Claim 3

Claim 2 is taught by Mieth. *Supra*,§VII.C.1. Claim 3 depends from claim 2 and requires, “wherein the voltage above the threshold allows the capacitor to power the second stage to operate the micro-controller for at least a predetermined period of time in absence of power input from the first stage during the predetermined period of time.” Ex.1001, claim 3. Neither claims 3, 2, or 1 provide antecedence for “first stage” or “second stage” and thus the terms are indefinite. For purposes of analysis, “first stage” and “second stage” are interpreted to mean “first stage power converter” and “second stage power converter,” respectively.

The claimed ***voltage above the threshold*** is analogous to feature [1H] discussed in §VII.A.1.viii., and thus is disclosed by Mieth. Ex.1007,¶223.

Liu (see Fig.5(annotated-Claim-2) above) teaches that reservoir capacitor 58 provides most of the energy to PA 68 through output stage 60 for a period of time when battery 51 cannot supply power to the PA 68. Ex.1005,1:8-12,4:43-51;Ex.1007,¶224. A PHOSITA understands that capacitor 58 provides power to the PA 68 for a predetermined period of time by sizing the capacitor appropriately. Ex.1007,¶224. Furthermore, while Liu shows PA 68 powered by reservoir capacitor 58 through output stage 60, a PHOSITA understands that reservoir capacitor 58 and output stage 60 could power another load such as the claimed *micro-controller* through a second stage power converter. *Id.* Thus, capacitor 58 that can provide power to the PA 68 for a period of time is analogous to the claimed *capacitor to power the second stage to operate the micro-controller for at least a predetermined period of time in absence of power input from the first stage during the predetermined period of time. Id.*

Liu discloses cascaded power converters with a capacitor that provides power to a load through a second power converter for a period of time without incoming power from a first power converter. Ex.1005,4:36-43;Ex.1007,¶301. Mieth teaches use of a power absorption circuit when an input voltage to a power converter varies, such as the voltage from a photovoltaic system that varies depending upon time of day, or weather conditions. *Supra*,§VII.A.1.;Ex.1002,5:22-38. Mieth disconnects the switchable load between

first stage and second stage power converters when the input voltage to the first stage power converter meets a stable criteria according to a voltage threshold. *Id.* A PHOSITA is motivated to combine the two-stage converter and capacitor of Liu with the power absorption circuit of Mieth, as the capacitor provides a more stable power source to Mieth's load for a predetermined time period when the power absorption circuit is disconnected from the circuit or voltage from the photovoltaic system is varying due to dynamic conditions. *Id.* Additionally or alternatively, a PHOSITA would be motivated to combine the two-stage converter of Balogh with the capacitor of Liu and power absorption circuit of Mieth. *Id.*

A PHOSITA is motivated to employ known means in the art, as taught in Liu, to modify the circuit of Mieth (e.g., Fig.1(annotated-1H) above) such that when the representative voltage connected to comparator 9 is below the predefined minimum value according to the first output, the capacitor of Liu powers load 20 (*i.e.*, micro-controller) through power supply apparatus 19 (*i.e.*, the second stage power converter) for a predetermined period of time, ***which is analogous to claim 3.*** Ex.1007,¶226. Therefore, both Mieth-Liu or Mieth-Balogh-Liu provide an express motivation to combine together to improve a cascaded power converter system by including a capacitor in the power absorption circuit. *Id.*

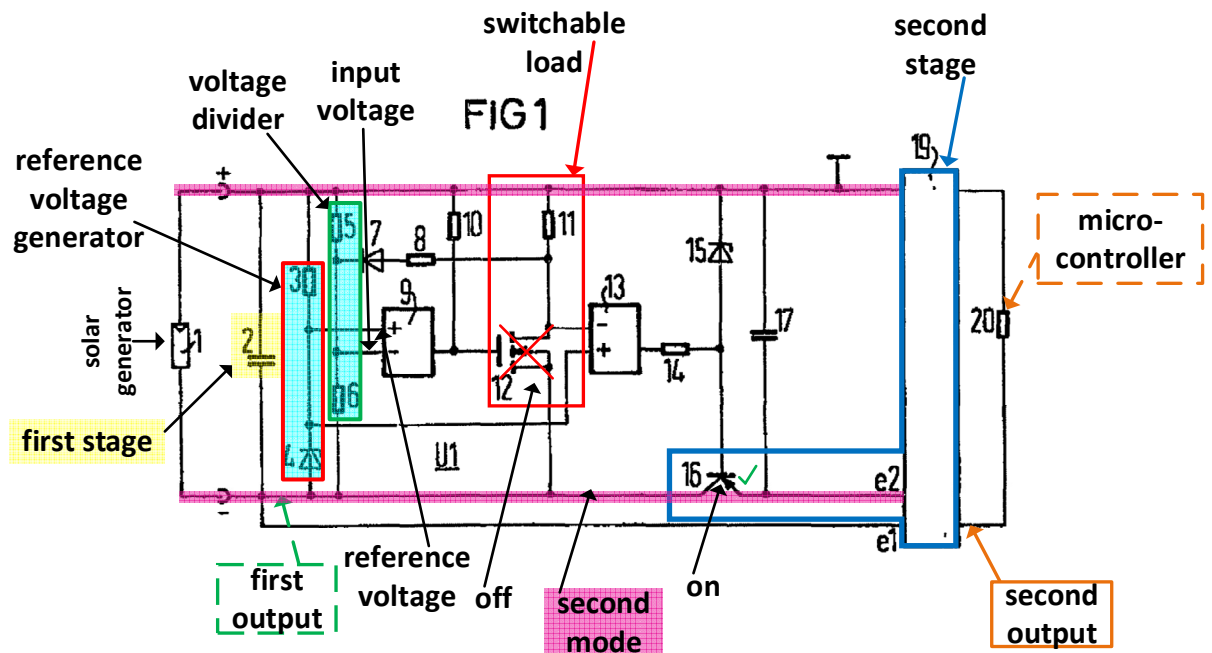
Thus, Mieth-Liu or Mieth-Balogh-Liu disclose claim 3.

3. Dependent Claim 6

Claim 5 is taught by Mieth alone, or by a combination of Mieth-Balogh. *Supra*, §VII.A.3; §VII.B.1. Claim 6 depends from claim 5 and requires, “wherein, when the switchable load is in the second state, the voltage above the threshold is sufficient to power the second state to operate the micro-controller for at least a predetermined period of time during which the direct current input to the first stage power converter has diminishing power.” Ex.1001, claim 6. It is unclear what the claim means by reciting *power the second state to operate the micro-controller*, as the second state described by claims 5-6 is related to the claimed switchable load and not the micro-controller. In fact, in the second state, the switchable load does not consume the first output and is conceivably disconnected from the first output. Thus claim 6 is indefinite. For purposes of analysis the feature is interpreted as powering the second stage rather than powering the second state, to operate the micro-controller.

Fig.1(annotated-Claim-6) below illustrates Mieth in the second mode. As taught by Mieth, when voltages from the solar generator 1 (as represented at the negative terminal of first comparator 9) are above a predefined minimum value (as represented at the positive terminal of first comparator 9)(*i.e.*, relatively “high” first output voltages), the control circuit transitions the circuit to the second mode, wherein the auxiliary voltage input e2 of the power supply apparatus 19 is

connected to the first output of the solar generator 1. Ex.1002,9:23-26. As shown in Fig.1(annotated-Claim-6) below, when the predefined minimum value is satisfied (*i.e.*, the voltage associated with the first output exceeds the claimed threshold), the circuit of Mieth operates in the second mode (highlighted-pink) where the field-effect transistor 12 is “off” or non-conducting, thereby disconnecting the preliminary load 11 from the first output. *Id.*



Ex.1002, Fig.1(annotated-Claim-6)

As discussed in §VII.A.1.viii., the first comparator 9 compares the reference voltage from the reference voltage generator (highlighted-teal-outlined-red) to the representative voltage from the voltage divider (highlighted-teal-outlined-green) to determine if the representative voltage exceeds a threshold defined by the reference voltage. Thus, according to Mieth, *the design of the reference voltage generator*

dictates the magnitude of the threshold that triggers the exit from the first state and entry into the second state. Ex.1002,12:12-26,Ex.1007,¶230.

As shown above, upon the control circuit of Mieth causing the circuitry to exit the first mode and enter the second mode, the first output is large enough that the threshold defined by the reference voltage generator is exceeded, and the first output is passed to the e2 terminal of the second stage power converter 19.

More particularly, when the voltage representative of the first output exceeds the threshold, the transistor 12 is shut “off,” pulling its output node (connected to the negative input terminal of the second comparator 13) high due to resistor 11. This causes the output of the second comparator 13 to go low, thus turning bipolar transistor 16 “on,” and passing the first output to the e2 terminal to power the second stage power converter 19, which, in turns provides the second output to the load 20.

Claim 6 requires that when the direct current input to the first stage power converter has diminishing power, the threshold is sufficient for the second stage power converter to operate the micro-controller for at least a predetermined period of time. Ex.1001, claim 6. The ‘848 patent does not define or provide any context for what constitutes the predetermined period of time for the claim feature. In the second state (or second mode), when the direct current input to the first stage power converter has diminishing power, the first output will begin to decrease. As

the second stage power converter has a range of input voltages at which it may operate effectively to provide the second output to the load 20 (micro-controller), Mieth's control circuit is operable to allow the second stage power converter 19 to operate the load for a predetermined period of time despite a decreasing first output voltage, as no minimum time period is set forth by the claim, nor provided as an example in the detailed description of the '848 patent. Ex.1007,¶233. Thus, Mieth discloses this feature.

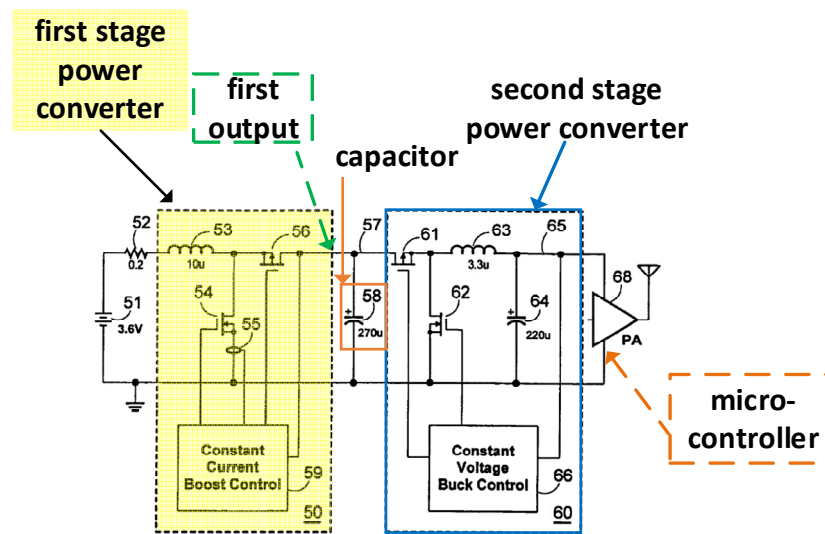
If Mieth standing alone is not deemed to provide adequate support for the feature of claim 6, Liu discloses use of a reservoir capacitor 58 between first and second stage power converters, so that if the first stage power converter is inoperable or otherwise deficient (*e.g.*, diminishing power), the capacitor provides auxiliary power to the second stage power converter to power the micro-controller for the predetermined period of time. Ex.1007,¶234.

Mieth discloses transistor 12 connected to preliminary load/resistor 11 to form a power absorption circuit coupled to the first output, as, during the first mode, power from the first output is at least partially consumed by the preliminary load/resistor 11. Ex.1002,9:34-10:3,11:4-12,12:12-26;Ex.1007,¶235. Mieth does not disclose that preliminary load/resistor 11 includes a capacitor. However, Liu discloses a capacitor as a power absorption circuit coupled to the first output and

feeding a second stage power converter, and a PHOSITA is motivated to combine Mieth and Liu for at least the following reasons.

As shown in Fig.5(annotated-Claim-6), Liu discloses cascaded DC voltage converters with an input stage (or first stage power converter) 50 separated from an output stage (or a second stage power converter) 60 by a reservoir capacitor 58.

Ex.1005,4:25-35;Ex.1007,¶236.



Ex.1005, Fig.5(annotated-Claim-6)

The output (dashed-green) of first stage power converter 50 (highlighted-yellow) of Liu is analogous to the claimed *first output* of claim 3. Ex.1007,¶237.

While Liu shows PA 68 powered by reservoir capacitor 58 through the second stage power converter 60, a PHOSITA understands that reservoir capacitor 58 and output stage 60 could power another load (as opposed to the PA 68) such as the claimed *micro-controller*. Ex.1007,¶237-238. Thus, capacitor 58 that can provide

power to the PA 68 for a period of time is analogous to the claimed *voltage above the threshold is sufficient to power the second state to operate the micro-controller for at least a predetermined period of time during which the direct current input to the first stage power converter has diminishing power.*

A PHOSITA is motivated to employ known means in the art, as taught in Liu, to modify the circuit of Mieth (e.g., Fig. 1(annotated-Claim-6)) such that when Mieth is in the second state and the monitored voltage connected to first comparator 9 falls below the predefined minimum value (*i.e.*, the “predefined threshold”) according to the first output, the capacitor of Liu powers load 20 (*i.e.*, micro-controller) through power supply apparatus 19 (*i.e.*, the second stage power converter) for a predetermined period of time, *which is analogous to claim 6.* Ex.1007,¶240. Therefore, both Mieth and Liu provide an express motivation to combine together to improve a cascaded power converter system by including a capacitor in the power absorption circuit. *Id.*

If it is argued that Mieth does not teach a first stage power converter, Mieth may be combined with Balog to provide such feature, as set forth in §VII.B.1.i. Further, Liu may be combined with a combination of Mieth-Balogh for at least the reasons above in §VII.C.1.

Thus, Mieth-Liu, or alternatively Mieth-Balogh-Liu disclose claim 3.

4. Dependent Claim 11

Claim 10 is taught by Mieth alone, or by a combination of Mieth-Balogh. *Supra*,§VII.A.7.;§VII.B.2. Claim 11 depends from claim 10 and requires, “further comprising: providing, in the power absorption circuit, a capacitor coupled to the first output” Ex.1001, claim 11. Claim 11 is analogous to claim 2, and thus Mieth-Liu or Mieth-Balogh-Liu discloses claim 11 for at least the same reasons Mieth-Liu or Mieth-Balogh-Liu discloses claim 2 as described in VII.C.1. Ex.1007,¶243.

5. Dependent Claim 12

Claim 11 is taught by Mieth-Liu or Mieth-Balogh-Liu. *Supra*,§VII.C.4. Claim 12 depends from claim 11 and requires, “wherein the voltage above the threshold allows the capacitor to power the second stage to operate the micro-controller for at least a predetermined period of time in absence of power input from the first stage during the predetermined period of time.” Ex.1001, claim 12. Claim 12 is analogous to claim 3, and thus Mieth-Liu or Mieth-Balogh-Liu discloses claim 12 for at least the same reasons Mieth-Liu or Mieth-Balogh-Liu discloses claim 3 as described in VII.C.2. Ex.1007,¶244.

6. Dependent Claim 15

Claim 14 is taught by Mieth alone, or by a combination of Mieth-Balogh. *Supra*,§VII.A.9;§VII.B.2. Claim 15 depends from claim 14 and requires,

“wherein, when the switchable load is in the second state, the voltage above the threshold is sufficient to power the second state to operate the micro-controller for at least a predetermined period of time during which the direct current input to the first stage power converter has diminishing power.” Ex.1001, claim 15. Claim 15 is analogous to claim 6, and thus Mieth-Liu or Mieth-Balogh-Liu discloses claim 15 for at least the same reasons Mieth-Liu or Mieth-Balogh-Liu discloses claim 6 as described in VII.C.3. Ex.1007,¶245.

D. CONCLUSION

Inter partes review of claims 1-20 should be instituted and the claims cancelled.

Respectfully submitted,

July 11, 2023

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VIII. CERTIFICATE OF COMPLIANCE WITH WORD COUNT

Pursuant to 37 C.F.R. § 42.24(a)(1)(i), I certify that this paper includes 13,845 words. In accordance with 37 C.F.R. § 42.24(a)(1), this word count does not include a count of the words in a table of contents, a table of authorities, mandatory notices under § 42.8, a certificate of service or word count, or appendix of exhibits or claim listing. Furthermore, in accordance with 37 C.F.R. § 42.24(d), this word count is the word count of the word-processing system used to prepare the paper.

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IX. CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. § 42.105, I hereby certify that I caused a true and correct copy of the Petition for *Inter Partes* Review in connection with U.S. Patent No. 9,966,848 and supporting evidence to be served via FedEx Priority Overnight on July 11, 2023, on the following:

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X. CLAIM LISTING APPENDIX

U.S. Patent No. 9,966,848 - Avrutsky	
Claim Element Designation	Claim Element
Claim 1	
[1A]	An apparatus, comprising:
[1B]	a first stage power converter to generate a first output from a direct current input;
[1C]	a second stage power converter connected to the first stage power converter to convert the first output to a second output;
[1D]	a micro-controller;
[1E]	a power absorption circuit; and
[1F]	a control circuit coupled with the first stage power converter and the second stage power converter, the control circuit powered by the first output to control the second stage power converter,
[1G]	wherein; when the second stage power converter is in a first mode of not providing the second output to power the micro-controller, the control circuit monitors a voltage of the first output powering the power absorption circuit and signals the second stage power converter to remain in the first mode during a time period in which the voltage is below a threshold; and
[1H]	when the voltage is above the threshold, the control circuit signals the second stage power converter to enter a second mode of providing the second output to power the micro-controller
Claim 2: The apparatus of claim 1, wherein the power absorption circuit comprises a capacitor coupled to the first output.	
Claim 3: The apparatus of claim 2, wherein the voltage above the threshold allows the capacitor to power the second stage to operate the micro-controller for at least a predetermined period of time in absence of power input from the first stage during the predetermined period of time.	
Claim 4: The apparatus of claim 1, wherein the power absorption circuit comprises a switchable load.	
Claim 5	
[5A]	The apparatus of claim 4, wherein the control circuit signals the switchable load to be in a first state to consume the first output when the second stage power converter is in the first mode

[5B]	and to be in a second state not to consume the first output when the voltage is above the threshold.
Claim 6: The method of claim 5, wherein, when the switchable load is in the second state, the voltage above the threshold is sufficient to power the second state to operate the micro-controller for at least a predetermined period of time during which the direct current input to the first stage power converter has diminishing power.	
Claim 7	
[7A]	The apparatus of claim 5, wherein the switchable load comprises: a resistive device; and
[7B]	a switching device connected to the resistive device
[7C]	wherein the switching device is turned on in the first state to connect the resistive device to the first output and turned off in the second state to disconnect the resistive device from the first output.
Claim 8: The apparatus of claim 5, wherein the control circuit delays a first signal instructing the switching device to change from the first state to the second state to generate a second delayed signal that instructs the second stage to change from the first mode to the second mode.	
Claim 9:	
[9A]	The apparatus of claim 8, wherein the control circuit comprises: a hysteresis amplifier coupled to the first output to generate the first signal; and
[9B]	a delay circuit coupled to the first signal to generate the second delayed signal.
Claim 10	
[10A]	A method to supply power, the method comprising:
[10B]	providing a first stage power converter to generate a first output from a direct current input,
[10C]	wherein the first stage power converter is coupled to a power absorption circuit;
[10D]	providing a second stage power converter connected to the first stage power converter to convert the first output to a second output,
[10E]	wherein the second stage power converter is coupled to a micro-controller;
[10F]	powering, by the first output, a control circuit that is coupled with the first stage power converter and the second stage power converter; and

[10G]	controlling, by the control circuit powered by the first output, the second stage power converter, by: when the second stage power converter is in a first mode of not providing the second output to power the micro-controller, monitoring a voltage of the first output powering the power absorption circuit and signaling the second stage power converter to remain in the first mode during a time period in which the voltage is below a threshold; and
[10H]	when the voltage is above the threshold, signaling the second stage power converter to enter a second mode of providing the second output to power the micro-controller.
Claim 11: The method of claim 10, further comprising: providing, in the power absorption circuit, a capacitor coupled to the first output.	
Claim 12: The method of claim 11, wherein the voltage above the threshold allows the capacitor to power the second stage to operate the micro-controller for at least a predetermined period of time in absence of power input from the first stage during the predetermined period of time.	
Claim 13: The method of claim 10, further comprising: providing, in the power absorption circuit, a switchable load.	
Claim 14: The method of claim 13, wherein the control circuit signals the switchable load to be in a first state to consume the first output when the second stage power converter is in the first mode and to be in a second state not to consume the first output when the voltage is above the threshold.	
Claim 15: The method of claim 14, wherein, when the switchable load is in the second state, the voltage above the threshold is sufficient to power the second state to operate the micro-controller for at least a predetermined period of time during which the direct current input to the first stage power converter has diminishing power.	
Claim 16: The method of claim 14, further comprising: providing, in the switchable load: a resistive device; and a switching device connected to the resistive device, wherein the switching device is turned on in the first state to connect the resistive device to the first output and turned off in the second state to disconnect the resistive device from the first output.	
Claim 17: The method of claim 14, further comprising: delaying, by the control circuit, a first signal instructing the switching device to change from the first state to the second state to generate a second delayed signal that instructs the second stage to change from the first mode to the second mode.	
Claim 18: The method of claim 17, further comprising: providing, in the control circuit, a hysteresis amplifier coupled to the first output to generate the first	

signal; and providing a delay circuit coupled to the first signal to generate the second delayed signal.	
Claim 19	
[19A]	A power supply for use in a solar electric production system,
[19B]	the power supply comprising: a first stage power converter
[19C]	having: an input connected to a first voltage from a photovoltaic panel; and
[19D]	an output providing a second voltage different from the first voltage from the photovoltaic panel;
[19E]	a second stage power converter connected to the output of the first stage power converter,
[19F]	the second stage power converter supplying power at a third voltage to a micro-controller of the photovoltaic panel; and
[19G]	a control circuit coupled to the first stage power converter and the second stage power converter and powered by the output of the first stage power converter
[19H]	wherein after the first stage power converter is turned on, the control circuit instructs the second stage power converter to: not supply the power at the third voltage to the micro-controller before a determination that the output of the first stage power converter has been stable for a predetermined period of time; and
[19I]	supply the power at the third voltage to the micro-controller after the determination that the output of the first stage power converter has been stable for the predetermined period of time.
Claim 20: The power supply of claim 19, wherein the first stage power converter is a first step-down converter, and the second stage power converter is a second step-down converter.	