UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

VOLTAGE, LLC,
NINGBO VOLTAGE SMART PRODUCTION CO.
Petitioners

v.

SHOALS TECHNOLOGIES GROUP, LLC
Patent Owner

Inter Partes Review No.: To Be Assigned
U.S. Patent No. 12,015,376

PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 12,015,376 UNDER 35 U.S.C. § 311 AND 37 C.F.R. § 42.100

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LIST OF EXHIBITS

Exhibit No.	Description of Exhibit
1001	U.S. Patent No. 12,015,376
1002	Notice of a Commission Final Determination Finding No Violation of Section 337; Termination of the Investigation, Certain Photovoltaic Connectors and Components Thereof, Inv. No. 337-TA-1365 (Jan. 14, 2025, Doc. ID 841065).
1003	File History for U.S. Patent No. 12,015,376
1004	U.S. Provisional Patent Application No. 62/047,773
1005	Original Japanese Patent Publication No. JPH10-135499A
1006	Certified English Translation of Japanese Patent Publication No. JPH10-135499A ("Machida")
1007	U.S. Patent Publication No. 2011/0011642 A1 ("Solon")
1008	Order No. 20: Construing Claim Terms, Certain Photovoltaic Trunk Bus Cable Assemblies and Components Thereof, Inv. No. 337-TA-1438 (July 23, 2025, EDIS Doc. ID 858239).
1009	U.S. Patent Publication No. 2014/0272293 A1 ("Saitou")
1010	Wikipedia entry for "American wire gauge" (archived on Wayback Machine on July 13, 2014)
1011	Webpage "The Original MC4 DC PV connector offers a unique high contact quality" (https://www.staubli.com/global/en/electrical-connectors/industries/renewable-energy/the-originalmc4.html)
1012	Original Korean Patent No. 10-1428689
1013	Certified English Translation of Korean Patent No. 10-1428689 ("Kim")

1014	Original Japanese Patent Publication No. JPS52-135081A
1015	Certified English Translation of Japanese Patent Publication No. JPS52-135081A ("Sakatani")

Pursuant to 35 U.S.C. § 311 and 37 C.F.R. § 42.100, Voltage, LLC and Ningbo Voltage Smart Production Co. (collectively, "Petitioners") request *inter partes* review ("IPR") of claims 1-6, 8-10, and 12-13 ("the Challenged Claims") of U.S. Patent No. 12,015,376 ("the '376 Patent") (EX1001). The '376 Patent is purportedly assigned to Shoals Technologies Group, LLC ("Patent Owner") per USPTO assignment records.

I. INTRODUCTION

The '376 Patent is the result of a continuation patent application claiming priority to two patents that Patent Owner previously asserted, unsuccessfully, against Petitioners at the United States International Trade Commission ("ITC"). *See* EX1002; EX1008 at 1-2.[1] While the investigation was pending, Patent Owner pursued additional claims as an apparent contingency plan: on the eve of the Commission's adverse determination, Patent Owner filed suit against Petitioners again at the ITC and in U.S. District Court for the Middle District of North Carolina

[1] Patent Owner initially asserted the parent, U.S. Patent No. 10,992,254 ("the '254 patent") in May 2023 and added the first issued continuation upon issuance, U.S. Patent No. 11,689,153 ("the '153 patent") in July 2023 against Petitioners. Patent Owner terminated the investigation as to the '254 Patent and the Commission found no section 337 violation of the '153 Patent.

alleging infringement of the ’376 Patent and another issued continuation (U.S. Patent No. 12,015,375 (“the ’375 Patent”)[2]. The ’376 Patent and the new suits alleging infringement of the ’376 Patent represent Patent Owner’s second bite at the apple to obtain an infringement ruling based on claims from the same limited specification directed to technology Petitioners have already been found not to practice.

However, Patent Owner continues to overreach. The claims of the ’376 Patent capture the prior art. For example, the primary reference relied upon in this Petition, Machida (EX1005-EX1006)—a Japanese Patent Publication that was not considered during prosecution of the ’376 Patent—explicitly discloses transmitting power by connecting the outputs of solar cell modules to the inverter using connectors in the same configuration recited in many claims of the ’376 Patent.

As an example showing the similarity between Machida and the ’376 Patent, FIG. 1 below reproduces Figure 7 of the ’376 Patent showing a cross section of the “joint 17” identifying the following features: a drop line 12 (in red), a feeder cable 14 (in blue), and exposed wire 18 (in orange) within compression lug 20 (in purple) located within a mold (in grey). The reproduced Figure 7 is annotated and flipped for ease of comparison to Machida’s Figure 3.

[2] Petitioners have filed IPR2025-01443 challenging certain claims of the ’375 Patent.

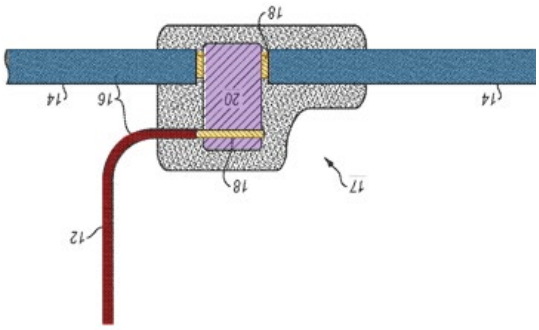

FIG. 1[3]: Figure 7 of '376 Patent (flipped and annotated)

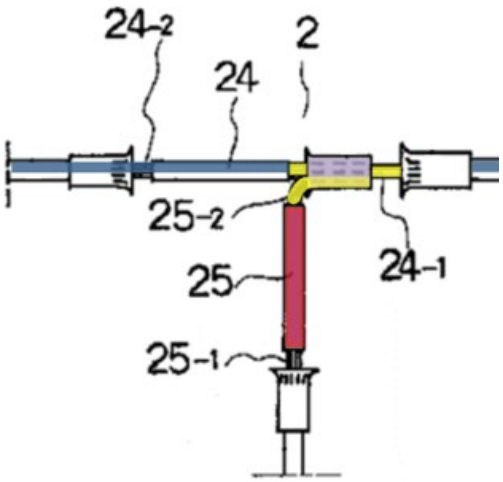

FIG. 2: Figure 3 of Machida (annotated)

FIG. 2 reproduces Figure 3 of Machida, showing a front view of "wire processing product 2" identifying the following features: an electrical wire 25 (in red), an electrical wire 24 (in blue), and exposed portions 24-1 and 25-2 (in yellow) with soldering component (in purple). Figure 2 of Machida (reproduced as FIG. 3 below) further shows a mold that encapsulates this wiring, like the mold (in grey) in FIG. 1.

[3] "FIG" used throughout this Petition refers to the Petition Figure numbers—often times representing a demonstrative illustration of aspects of the challenged patent or the prior art. "Figure" used throughout this petition refers to the Figures included in those underlying documents.

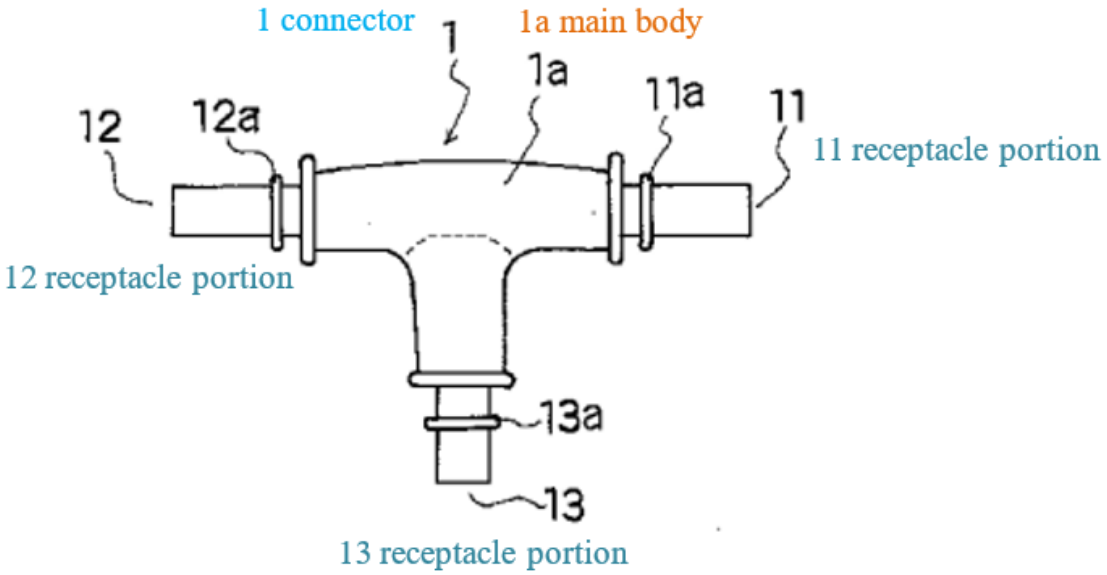

FIG. 3: Machida, Figure 2 (annotated)

As shown in FIGS. 1 and 2, the technical solutions of the '376 Patent and Machida are the same, both aiming to electrically couple the drop line to the feeder cable at the nexus inside a joint encapsulated by a mold. While the Figure of Machida does not additionally disclose a second drop line, using a second drop line within joints for solar panel assemblies was well known—as shown in secondary references such as Solon (*see* Section V.B, *infra*) and Kim (*see* Section V.C, *infra*)—and it would be a trivial modification well within the skill of a POSA to add a second drop line to the assembly of Machida. Likewise, while Machida does not expressly disclose that its wire harness has a **plurality** of branches, that too was well known in the prior art, as shown in Sakatani. Thus, in 1998, 16 years earlier than the earliest identified priority date of the '376 Patent, the technical solution claimed in the '376

Patent was essentially disclosed. Therefore, the challenged claims are invalid as obvious over Machida in view of either Solon (Ground 1) or Kim (Ground 2), prior art references that both disclose similar dual drop wire arrangements, and further in view of Sakatani.

II. OVERVIEW OF THE '376 PATENT

A. The Specification and the Challenged Claims

The '376 Patent specification purports to provide assemblies for connecting solar panel arrays to an inverter without the use of a combiner box. *See* EX1001, 1:26-29. Figure 3 of the '376 Patent, reproduced as FIG. 4 below, shows one such embodiment, with a plurality of wire harnesses 34 coupled to a lead assembly 10 that connects to an inverter 38.

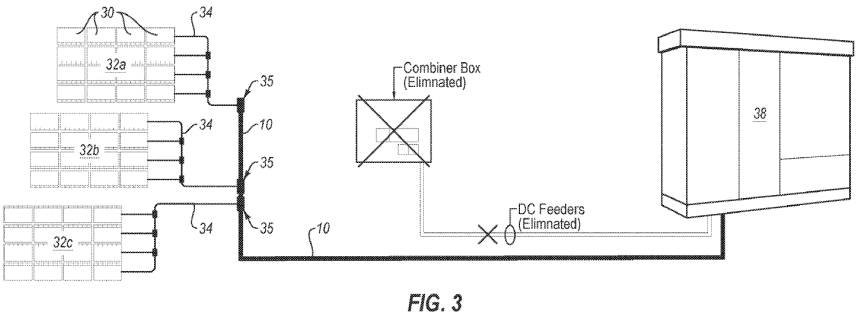

FIG. 4: Figure 3 of the '376 Patent

The bulk of the '376 Patent specification is directed to a lead assembly with at least one drop line that is joined to a feeder cable within a joint. Figure 7 (reproduced as FIG. 5 and annotated below) includes a cross section of a joint 17 including a single drop line. *See id.,* 2:43-44. It depicts a drop line 12 (in red), a feeder cable 14

(in blue), and exposed wire 18 (in orange) within compression lug 20 (in purple). *See id.*, 4:17-39.

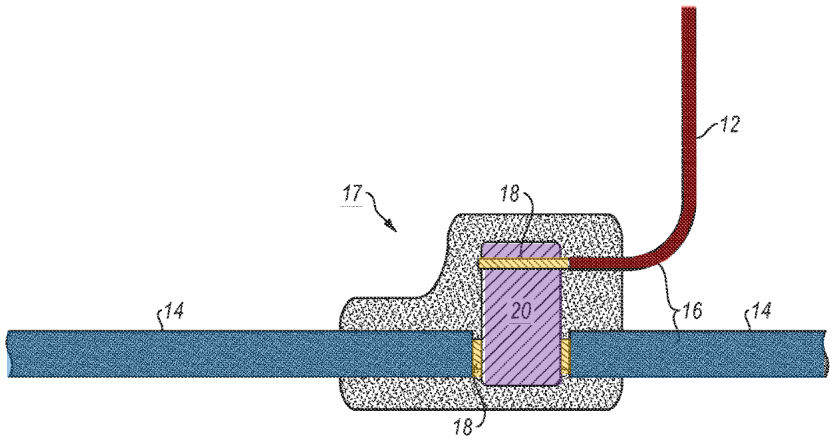

FIG. 7

FIG. 5: Figure 7 of the '376 Patent (annotated)

The specification describes that the joint is surrounded by a mold that may be applied by injection molding. *See* EX1001, 6:4-16, 4:60-62.

Figure 8, reproduced as FIG. 6 below, provides a schematic view of the single drop joint shown in FIG. 5. *See id.*, 4:17-39. It depicts the feeder cable 14 and the drop line 12, both exiting the joint, as well as the drop line connector 13.

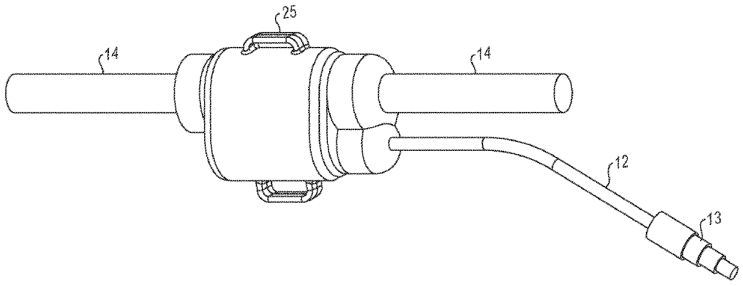

FIG. 8

FIG. 6: Figure 8 of the ’376 Patent

Figures 33-38 depict an embodiment that includes two drop lines (which are required by the claims of the ’376 Patent). Figure 37, reproduced and annotated as FIG. 7 below, shows the drop line 12 (in red) on the right, a second drop line (not numbered) on the left, and feeder cable 14 (in blue) with exposed wires 18 (in orange) electrically coupled at nexus 19. *See* EX1001, 5:63-65.

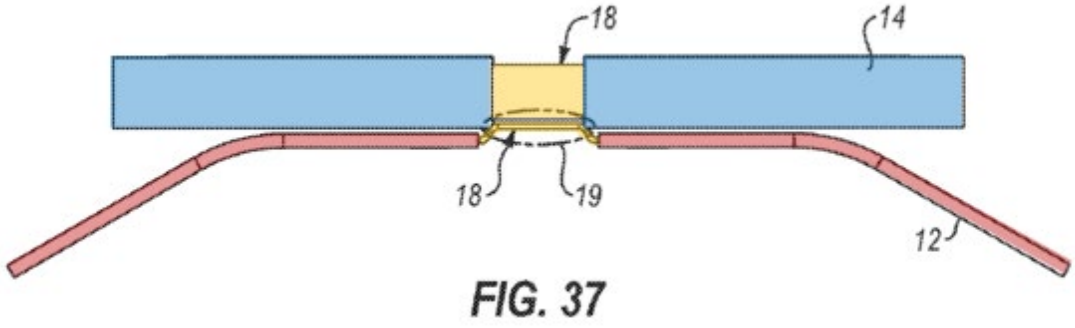

FIG. 37

FIG. 7: Figure 37 of the ’376 Patent (annotated)

The specification describes that the drop lines and feeder cable shown in Figure 37 are held together by compression lug 20 (in purple)—as shown in Figure 35 reproduced as FIG. 8 below. *See* EX1001, 4:60-63.

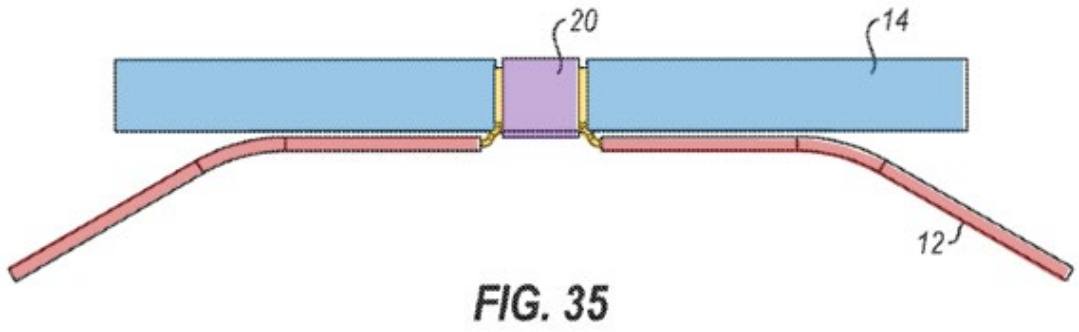

FIG. 8: Figure 35 of the '376 Patent (annotated)

That joint is surrounded by undermold 22, shown in Figure 33 reproduced as FIG. 9 below. *See* EX1001, 4:60-63.

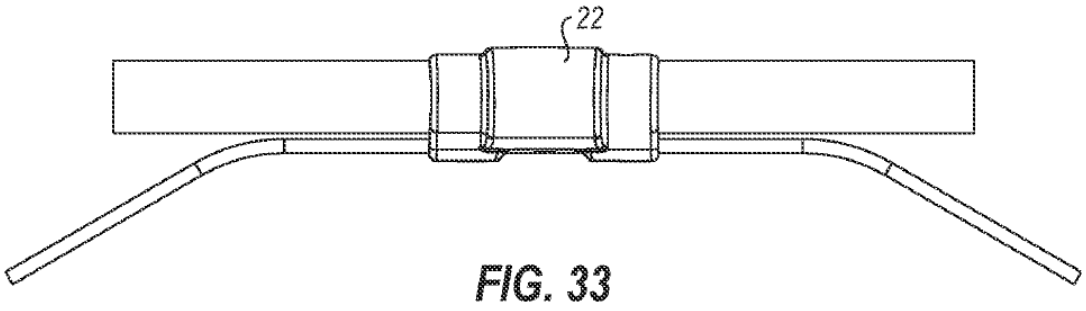

FIG. 9: Figure 33 of the '376 Patent

Independent claim 1 generally relates to the embodiment requiring two drop lines. The challenged dependent claims recite additional features of the wiring connections.

B. The Prosecution History of the ’376 Patent

U.S. Provisional Patent Application No. 62/047,773 (EX1004) was filed on September 9, 2014. U.S. Patent Application No. 14/849,458 (“the ’458 application”) was then filed on September 9, 2015, claiming priority to the provisional application, and eventually matured into the ’254 Patent. U.S. Patent Application No. 17/301,609 was filed on April 8, 2021, as a continuation of the ’458 application, and matured into the ’153 Patent.

U.S. Patent Application No. 18/523,464, which issued as the ’376 Patent, was filed on November 29, 2023, as a continuation of U.S. Patent Application No. 18/341,655 (the ’655 application)[4]. The ’376 Patent was originally filed with 20 claims in total, where claims 1 and 14 were independent.

A non-final rejection, issued January 29, 2024, stated that claims 1-12 and claims 13-20 lack unity because claims 1-12 were drawn to a solar power system and claims 13-20 were drawn to a method of forming a lead assembly. The Examiner further rejected claims 1-12 without reviewing claims 13-20. The Examiner cited U.S. Patent No. 6,268,559 alleging claims 1, 2, 5, 8, and 12 were anticipated under 35 U.S.C. § 102(a). *See* EX1003 at 100-102.

[4] The ‘655 Application eventually issued as the ‘375 Patent.

On February 16, 2024, Patent Owner amended independent claim 1 (corresponding to issued claim 1) and added new claim 22 (corresponding to issued claim 14). *See* EX1003 at 84.

On February 28, 2024, the Examiner and Patent Owner conducted an interview. The Examiner proposed amendments to independent claims 1 and 22 to bring the application into condition for allowance. *See* EX1003 at 61.

As reflected in the Interview summary dated March 6, 2024, Patent Owner accepted and then further altered the Examiner's proposed amendments to the claims. *See* EX1003 at 52-53.

In response to Patent Owner's counter-proposals, the Examiner issued a Notice of Allowance. *See* EX1003 at 13-20.

C. Person of Ordinary Skill in the Art ("POSA")

A POSA would have had at least a bachelor's degree in mechanical or electrical engineering, or a related scientific field, and at least two years of experience with electrical wiring and connectors, including significant experience with electrical wiring in photovoltaic systems, in which more education could substitute for experience, and that experience combined with training could substitute for formal education. *See* EX1008 at 5-6.

III. CLAIM CONSTRUCTION

In an *inter partes* review, claims shall be construed using the same claim construction standard that would be used to construe the claims in a civil action under 35 U.S.C. § 282(b), including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent. 37 C.F.R. § 42.100(b); *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (*en banc*). The Board construes claims only to the extent necessary to resolve the underlying controversy. *See Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) ("[O]nly those terms need be construed that are in controversy, and only to the extent necessary to resolve the controversy.").

On July 23, 2025, a Claim Construction Order was issued by the Administrative Law Judge ("ALJ") in the parallel ITC litigation. EX1008. For purposes of this proceeding, Petitioners propose this Board adopt the interpretation of the challenged claims in the ITC Claim Construction Order. *See Apple Inc. v. Geoscope Techs.*, IPR2024-00259, Paper 32 at 12, 2025 Pat. App. LEXIS 2229. (PTAB May 7, 2025) ("A petition need only include how the challenged claims are to be construed. 37 C.F.R. § 42.104(b)(3)"). Here, Petitioners meet this requirement by identifying the proposed interpretations of the claim terms.

A chart showing the ALJ's construction in the ITC Claim Construction Order for adoption in this IPR is reproduced below. *See* EX1008 at 6-40.

Disputed Claim Term	**ALJ's Construction**
"lead assembly"	Likely "an assembly for electrically coupling a solar panel array" or "a plurality of solar panel arrays." Deferred construction to determine whether the "lead assembly" should exclude a combiner box. EX1008 at 6-13.
"feeder cable"	Plain and ordinary meaning, which is "a cable that feeds electrical current." *Id.* at 14-17.
"drop line"	"line that electrically couples a solar array to a feeder cable." *Id.* at 13-14.
"opposite direction(s)" claims 1, 2	Plain and ordinary meaning, which does not require precisely 180 degrees of separation. *Id.* at 21-24.
"wherein the . . . [line / line pathway] and the . . . [cable / cable pathway] extend parallel to one another within the [region of electrical interconnection / nexus]" claim 1 "wherein, in the region of electrical interconnection, the first . . . line and the second . . . line extend in opposite directions along a longitudinal axis that is parallel to a longitudinal axis of the feeder cable" claim 1	"wherein the . . . [line / line pathway[s]] and the . . . [cable / cable pathway] extend parallel to one another within the [region of electrical interconnection / nexus] considered as a whole" *Id.* at 25-29.

Alternatively, the Board need not construe any of these claim terms, since the differences between the ITC constructions and the plain and ordinary meaning

should be insignificant with respect to the invalidity Grounds presented herein. *See Huawei Techs. Co. v. WSOU Invs., LLC*, IPR2021-00228, Paper 9 at 20 (PTAB June 10, 2021) ("we find it unnecessary to construe any claim term expressly to resolve the disputed issues before us"). In other words, the claims are also invalid under 35 U.S.C. §103 under the plain and ordinary meaning of the terms. Petitioners reserve the right to address any construction proposed by Patent Owner or the Board.

IV. STATUTORY GROUNDS OF CHALLENGES

Ground	References	Basis	Claims Challenged
1	Machida in view of Solon and in further view of Sakatani	§ 103	1-6, 8-10, 12-13
2	Machida in view of Kim and in further view of Sakatani	§ 103	1-6, 8-10, 12-13

V. OVERVIEW OF THE PRIOR ART REFERENCES

A. MACHIDA

Machida is a Japanese Patent Application Publication No. JPH10-135499A, titled "Method for Connecting Solar Cell Module Wiring." It is prior art under 35 U.S.C. § 102(a)(1) because it was published on May 22, 1998, before the earliest possible priority date of the '376 Patent. Machida was not cited or applied during prosecution of the '376 Patent. EX1005 is the original publication; EX1006 is a certified translation. Machida discloses the wiring of solar cell modules to an inverter by using a connector 1 with an injection molded plug 3. An object of the

invention is to complete the task of connecting electrical wires (drop lines) from solar cell modules to the base wires (feeder cables). *See* EX1006, ¶ [0006].

B. SOLON

U.S. Patent Application Publication No. 20110011642A1 ("Solon") was filed July 14, 2009 and published January 20, 2011. *See* EX1007. Solon was cited and relied on as a secondary reference in combination with another prior art reference, Fujimoto (that is not relied on in this Petition), during the prosecution of the '376 Patent. *See* EX1003 at 100-103. However, Patent Owner did not present any specific argument to distinguish Solon in its response, but relied on its amendment to the independent claims, including with respect to Fujimoto, to overcome the obviousness rejections. *Id.* at 16, 34, 63, 77. The Examiner did not consider Solon as a secondary reference modifying Machida.

Solon is prior art under 35 U.S.C. § 102(a)(1) because it was published before the earliest possible priority date of the '376 Patent. Solon "relates generally to electrical components and, more particularly, low-leakage electrical joints and wire harnesses for simplifying the electrical infrastructure associated with solar energy utilities." *See* EX1007, ¶ [0002].

C. KIM

Korean Patent No. 10-1428689B1 ("Kim") was granted and published on August 11, 2014. EX1012 is the original Korean patent; EX1013 is a certified

translation. Kim was identified by Patent Owner but not relied on by the Examiner to reject any claim during the prosecution of the ’376 Patent. See EX1003 at 80. It is prior art under 35 U.S.C. § 102(a)(1) because it was published before the earliest possible priority date of the ’376 Patent. Kim relates to a cable connecting apparatus to “transmit power, such as power generated by photovoltaic modules.” EX1013, ¶ [0001]. Kim explains electrically coupling a plurality of cables in an X-shape, Y-shape, or T-shape. *Id.*, Summary, Figures 1, 4, 5.

D. SAKATANI

Sakatani is a Japanese Patent Application Publication No. JPS52-135081A, titled “Prefabricated Cable Unit with Branch Lines.” It is prior art under 35 U.S.C. § 102(a)(1) because it was published on November 11, 1977, before the earliest possible priority date of the ’376 Patent. Sakatani was not cited or applied during prosecution of the ’376 Patent. EX1015 is a certified translation; the original publication is EX1014. Sakatani discloses a prefabricated cable unit with branch lines that is suitable for use at construction sites, such as in buildings, for drawing power for construction work and lighting. Sakatani further closes the electricity is transmitted by connecting the drop line connector to the central trunk. *See* EX1015 at 371.

VI. DETAILED EXPLANATION OF THE CHALLENGE

For ease of reference, all claims and sub-parts discussed below are reproduced in the "Claim Appendix of Challenged Claims."

A. Ground 1—Claims 1-6, 8-10, and 12-13 Would Have Been Obvious over Machida in view of Solon and in further view of Sakatani

1. Motivation to Combine Machida and Solon

Solon expressly discloses at least two branch wires (drop lines) branching off from a single lead assembly. A POSA would have been motivated to modify the wiring harnesses and solar array configurations of Machida in view of the teachings of Solon—including to incorporate a dual "drop line" arrangement—for multiple reasons. First, Solon discloses information regarding a multiple drop line arrangement that allows for the connection of additional solar panels to a single connector, providing a POSA with additional guidance for designing and fabricating a variety of such connectors. Second, Solon teaches that "low leakage electrical joints and wire harnesses [can be used] for simplifying the electrical infrastructure associated with solar energy utilities." EX1007, ¶ [0002]; *see also* discussion of claim 6 below. Third, Solon describes a "wire harness 10 constructed of a plurality of joints" which "can be shaped as T's, crosses or Y's, and be fitted with various lengths of insulated wire" (EX1007, ¶¶ [0012], [0025], [0026]), while Machida describes a "three-way connectors [that] may be T-shaped" (EX1006, ¶ [0008]). Indeed, Solon emphasizes that "a multitude of electrical configurations may be

achieved by varying the number and choice of connectors and joint types." EX1007, ¶ [0025]. That is, Solon starts with, but does not limit itself, to using the described examples of "tee joint 20," "cross joint 22" and "y joint 24."

Both Machida and Solon are analogous prior art to each other, as well as to the '376 Patent, since they disclose components and methods for wiring connections in solar power systems. "[The aim of this invention is to] make wiring connecting work for solar cell modules less time-consuming and safer." EX1006, Front Page. Solon "relates generally to electrical components and, more particularly low leakage electrical joints and wire harnesses for simplifying the electrical infrastructure associated with solar energy utilities." EX1007, ¶ [0002]. Machida explains that conventional methods for "connecting electrical wires from solar cell modules to the base wires" are "time-consuming and involves the risk of electric shock due to a long working period." EX1006, ¶ [0006]. Solon explains that conventional wiring methods require "extensive wiring" which "often further requires the labor and expense of troubleshooting and repairing." EX1007, ¶ [0005]. Solon explains that a need exists "for components that decrease electrical leakage," and "[i]deally, these low leakage components are relatively simple, safe and inexpensive to manufacture, transport and use." *See id.*, [0010]. Further, both Machida and Solon are analogous prior art because they are in the same field as the '376 Patent. *See* EX1001 at 1:24-2:21.

Finally, a POSA would have an expectation of success in modifying the connector disclosed by Machida in view of the teachings of Solon because both references are directed to connectors or joints used for solar power installations and aim to achieve their stated common goal of minimizing working time for safe and reliable wiring connection for solar cell modules. *See* EX1006, ¶¶ [0006], [0008]; EX1007, ¶¶ [0005], [0012], [0025], [0026]. Specifically, Solon discloses that "[p]referably insulated wire 30 includes copper, and most preferably is a 8, 10 or 12 AWG photovoltaic wire" and that "[a] branch wire may be the next smaller size of wire as it will not carry as much current." EX1007, ¶ [0028]. A 12 AWG wire has a cross-sectional area of 3.31 mm^2, which is very similar to the CV 3.5 mm^2 cable used for photovoltaic power generation disclosed by Machida. *See* EX1010 at 2; EX1006, ¶ [0016]. Moreover, a "commercially available and suitable insulated wire 30" is a "preferred example" of the invention of Solon. EX1007, ¶ [0028]. Therefore, such modification would be readily made as of the time of the filing of the '376 Patent with a reasonable expectation of success, as this is a simple substitution of structures known to a POSA to yield a predictable result.

2. Motivation to Combine Sakatani with Machida and Solon

Sakatani expressly discloses the sockets (the claimed "drop line connector") connecting to the trunk cables (the claimed "central trunk"). A POSA would have been motivated to modify the wiring connections for solar cell panels of Machida

(as modified in view of Solon) further in view of the teaching of Sakatani—including connecting the drop line connector to the central trunk—for multiple reasons.

Sakatani discloses one of the benefits of its described invention is that it provides for "insulation and waterproofing of the connection points." EX1015 at 370. Sakatani focuses on "complete insulation and waterproofing of the branch connection points" to combat "environments where dust, oil, and rainwater are present." *Id.* at 370. Sakatani emphasizes that the claimed invention eliminates the problems "by providing a useful and economical prefabricated cable unit with branch lines that is durable against mechanical external forces, unaffected by dust and oil, and highly waterproof against rainwater, etc." *Id.* at 370. Machida aims to solve the same problem. Machida provides a method for connecting solar cell module wiring, which makes "wiring connecting work less consuming and safer." EX1006, Abstract. Machida discloses that "56 and 57 are the connection points at which the electrical wires 51 and 52 from the solar cell modules are connected to the base wires 53, 54" and "insulating tape is wrapped around [] to provide insulation and waterproofing and complete the connection points 56, 57." EX1006, ¶ [0004].

Both Machida and Sakatani are analogous prior art to the '376 Patent because they are in the same field as the '376 Patent. Indeed, both Machida and Sakatani (and the '376 Patent) are in the field of electrical wiring, which was adopted by the ITC as part of the defined level of ordinary skill in the art for the '376 Patent. EX1008 at

5-6. Moreover, both references are even more specifically directed to "prefabricated" arrangements of such electrical wiring. For example, Sakatani relates to a "prefabricated cable unit with branch lines that is suitable for use at construction sites …." EX1015 at 369. Specifically, Sakatani mentions the claimed "prefabricated cable unit with branch lines … is delivered to a construction site … where it is used by connecting or disconnecting the required number of cable units. EX1015 at 371. Machida discloses "a long electrical wire measuring 20 to 40 meters must be brought to the construction site," and is cut to "the required length to make base wires 53, 54." EX1006, ¶ [0004].

Finally, a POSA would have an expectation of success in modifying the wiring connections disclosed by Machida (as modified in view of Solon) with the teachings of Sakatani because both references are directed to wiring connections with means of sealing the connection points from external environments. EX1006, ¶¶ [0006], [0008]; EX1015 at 369-370. A POSA would have known that electricity flows both ways in a conductor and that a conductor used for delivering electricity can also be used to receive electricity. Although Sakatani's system is disclosed to be used for transmitting electricity to appliances from a trunk cable, the same system can also be used to collect electricity from electric sources to the trunk cable. Therefore, such modification would be readily made as of the time of the filing of the '376 Patent with a reasonable expectation of success, as this is a simple substitution of structures

known to a POSA to yield a predictable result.

3. Claim 1

Preamble

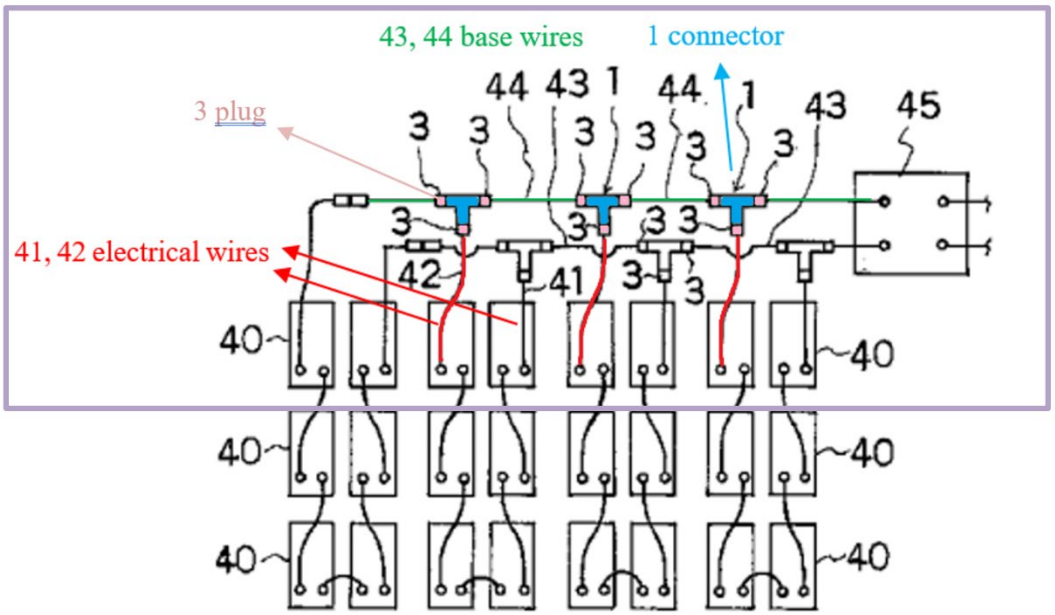

FIG. 10: Machida, Figure 1 (annotated)

Machida relates to "a method for connecting the wiring of solar cell modules used in solar power generation." *See* EX1006, ¶ [0001]. Machida Figure 1 (reproduced as FIG. 10 and annotated above) shows "a configuration diagram of the wiring connections [(in purple box)] for solar cell modules using a connector [(in blue)]." *Id.*

With reference to FIG. 2 above (Machida, Figure 3), the electric wire 25 is connected to an electrode of "a block formed by connecting a plurality of solar cell modules 40 in series" via the electrical wire 41 (or 42) (depicted in red above). *Id.*, Abstract, ¶¶ [0016], [0026], [0027]. The electric wire 25 is the claimed "drop line"

(*i.e.*, a "line that electrically couples a solar array to a feeder cable"), as it electrically couples a solar array (solar cell modules 40) to a feeder cable (base wire 24, *See* discussion below). *See* EX1006, Abstract; ¶ [0016], FIGS. 1-4.[5]

Machida discloses that the "electrical wires that supply power from the solar cell modules to the power supply destination are called base wires." *Id.*, ¶ [0010]. With reference to FIG. 10 above, Machida shows two base wires 43, 44 (in green) that are "connected to a terminal box 45 leading to an inverter (not shown)." *Id.*, ¶¶ [0010], [0026], [0027], Abstract.[6] With reference to FIG. 2 above (Machida, Figure 3), the electric wire 24 "is the electrical wire corresponding to the portion constituting the horizontal segment of the T-shape." *Id.*, ¶ [0016]. Thus, the electric wire 24 is a portion of the base wire 43 or 44 within the connector 1. The base wire 24 is the claimed "feeder cable" (*i.e.*, "a cable that feeds electrical current"), as it

[5] To the extent that the Board determines that it need not construe this term, this disclosure is consistent with the plain and ordinary meaning of the term as shown by the usage in the specification: "In use, the drop line is connected to solar arrays, and the feeder cable is connected to an inverter…." EX1001 at 2:2-3.

[6] Machida uses the terms "wire" and "cable" interchangeably. *See id.*, ¶ [0016].

feeds electric current to an inverter.[7] Also, as illustrated in FIG. 10, the base wires 43, 44 (the claimed "feeder cable," in green) attach to the terminal box 45. The terminal box 45 functions as an electric connector that relays the base wires 43, 44 directly to the inverter.[8]

To the extent the preamble is limiting, the connector 1 depicted and described above is the claimed "lead assembly" (*i.e.*, "an assembly for electrically coupling a solar panel array" or "a plurality of solar panel arrays"), as it is an assembly for electrically coupling a solar panel array (*i.e.*, solar cell modules 40), which can be seen in FIG. 10.

[7] To the extent that the Board determines that it need not construe this term, this disclosure is consistent with the plain and ordinary meaning of the term as shown by the usage in the specification: "feeder cable is connected to an inverter…" EX1001 at 2:3.

[8] Notably, the terminal box 45 is not a combiner because it does not combine solar energy. FIG. 10 illustrates two wires going into the terminal box 45 and two wires leaving it. This is in sharp contrast to what a combiner looks like shown by the '376 Patent—a plurality of wires input into the combiner, and a single wire outputs from the combiner. *See* EX1001, Figure 1.

a. Part[a]

Machida discloses that the base wire 24 can use "[a] cable of approximately CV 3.5 mm^2 or CV 2.0 mm^2." EX1006, ¶ [0016], Figure 3. Thus, the base wire 24 (*i.e.*, the claimed "feeder cable") has a first diameter (*i.e.*, approximately CV 3.5 mm^2 or CV 2.0 mm^2).

b. Part[b]

As discussed above, Machida discloses the claimed "one or more drop lines." *See* Section VI.A.3, *supra.* Specifically, with reference to FIG. 2 above, the electrical wire 25 is a "first drop line."

Part[b1]

Machida discloses that the base wire 24 can use "[a] cable of approximately CV 3.5 mm^2 or CV 2.0 mm^2" and that the electric wire 25 "is made of a cable of the same thickness [*i.e.*, the same set of CV 3.5 mm^2 and CV 2.0 mm^2] as above." EX1006, ¶ [0016], Figure 3. That is, Machida suggests an embodiment where the base wire 24 (the claimed "feeder cable") has the first diameter (*i.e.*, approximately CV 3.5 mm^2), and the electrical wire 25 (the claimed "first drop line") has a second diameter (*i.e.*, approximately CV 2.0 mm^2), in which the second diameter is different than the first diameter. Sakatani likewise discloses a trunk cable 1A (the claimed "feeder cable") and branch cable 4A (the claimed "drop line") with different diameters as shown in FIG. 15. *See* discussion of part [b4] *infra*.

Additionally, a POSA would have known that the base wire 24 carries a total electric power that is larger than the portion of the electric power received from the electric wire 25, as the base wire 24 receives electric power from multiple electric wires 25. *See* FIG. 10, *supra*. As a result, the diameter of the electric wire 25 (the claimed "first drop line") would have been smaller than the diameter of the base wire 24 (the claimed "feeder cable"), as the diameter of an electricity-carrying cable is proportionate to the maximum current the cable can carry. This would have been well known within the knowledge of a POSA as defined in Section II.C above, who has at least two years of experience with electrical wiring and connectors.

As evidence of a POSA's general knowledge as of its effective filing date, the '376 Patent states that "drop line 12 is preferably constructed of 18 to 4 gauge wire, and drop line connectors 13 are preferably off-the-shelf connectors such as MC4/PV-KBT4/61-UR & PV-KST4/61-UR from Multi-Contact of Windsor, CA." EX1001, 5:1-4 (emphasis added); *see also id.*, Figure 5 (reproduced below as FIG. 11); *see also* EX1011 at 2. That is, Patent Owner admitted that the connectors 13 in the '376 Patent had been sold or offered for sale before its effective filing date, and thus the connectors as well as the wire sizes connected thereto had been general knowledge to a POSA as of the effective filing date of the '376 Patent.

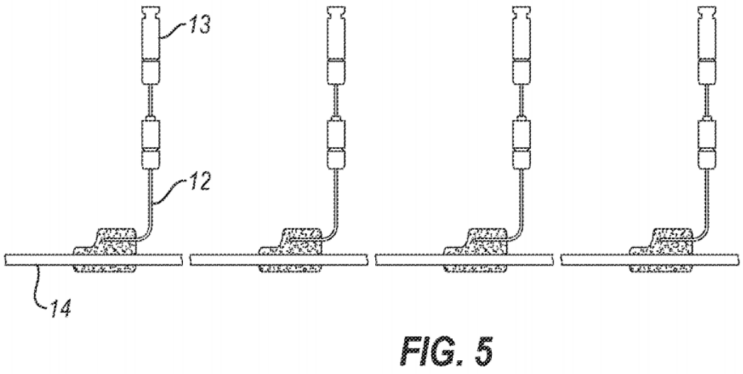

FIG. 5

FIG. 11: ’376 Patent Figure 5

A POSA would have been motivated to select different gauge wires for different current or power requirements so as to lower the cost of the wiring, because small-gauge wires are generally cheaper than large-gauge wires.

Part[b2]

Regarding the claimed “first drop line connector,” Machida discloses that “receptacles and plugs” that are “set in a proper mating position” “constitute a connector.” *Id.*, ¶ [0013]. With reference to FIG. 13, Machida’s sleeve 23a in the receptacle portion 13 discloses the claimed “first drop line connector.” Specifically, Machida Figure 4 (reproduced as FIG. 12 below with annotation) shows “a plug 3 [(in blue)] inserted into a receptacle portion 11 [(in green)].” *Id.*, ¶ [0024]. Plug 3 “is inserted to a predetermined position” such that “the ring-shaped protrusion 11a formed on the outer periphery of receptacle portion 11 engages with the ring-shaped recessed portion 31a provided on the inner diameter portion of the outer sleeve 31.”

Id. By doing so, "[the] contact pin 32 is inserted into the sleeve 21 to maintain electrical contact." *Id.*; *See also* FIG. 13.

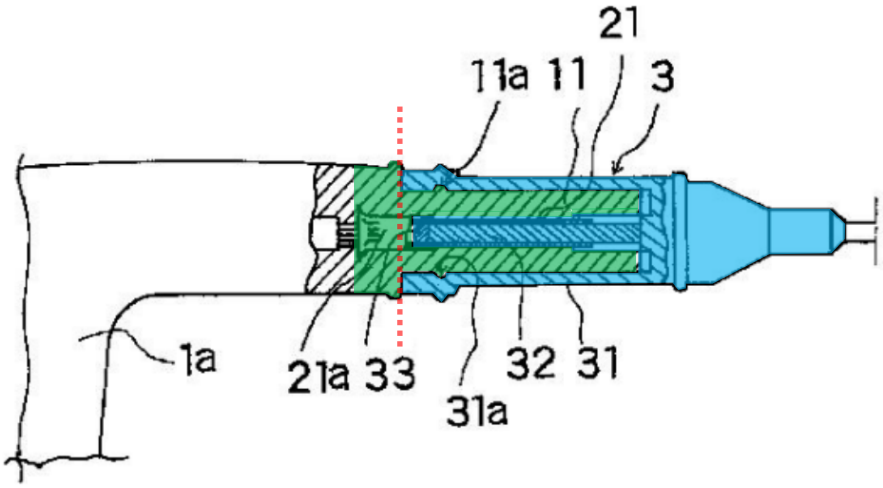

FIG. 12: Machida, Figure 4 (annotated)

Machida Figure 3 (reproduced as FIG. 13 and annotated below) shows a "wire processing product inserted into the connector 1 during molding." *See* EX1006, ¶ [0016]. The product "forms a T-shaped overall" with "24 [being] the electrical wire [(in green)] corresponding to the portion constituting the horizontal segment of the T-shape" and "25 [being] a wire [(in red)] corresponding to the portion that forms the vertical segment of the T-shape." *Id.* Wire 24 has cylindrical sleeves 21 and 22. *Id.*, ¶¶ [0017]-[0018]. Wire 25 has sleeve 23. *Id.* ¶ [0019].

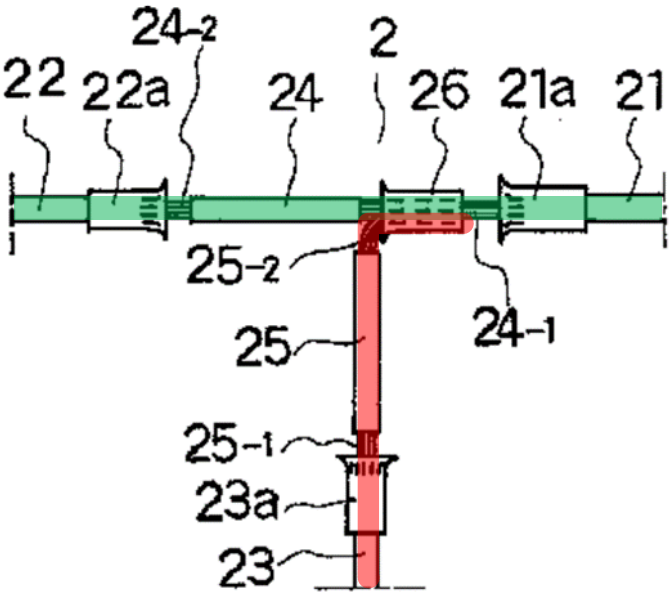

FIG. 13: Machida, Figure 3 (annotated)

With reference to FIG. 13 above, Machida discloses that "21 [or 22] is a cylindrical sleeve formed of phosphor bronze with a nickel-plated surface" with "[o]ne end of the sleeve receives the end portion 24-1 [or 24-2] of electrical wire 24," and that "21a [or 22a] is a ring sleeve for maintaining strength, which is fitted over the outer circumference of the sleeve 21 and has a structure that crimp-connects and reinforces the portion where end portion 24-1 [or 24-2] of electrical wire 24 is connected to the sleeve 21." *Id.*, ¶ [0017]-[0018], Figure 2. The other end of sleeve 21 or 22 "receives the contact pin on the plug side." *Id.* That is, the contact pin of the identified "drop line" terminates the base wire 24. Machida also discloses that "23 and 23a are sleeves and ring sleeves similar to those described above." *Id.*, ¶ [0019]. Thus, similarly, sleeve 23a (the claimed "drop line connector") has a

contact pin that terminates the electric wire 25 (the claimed "first drop line"). *See* FIG. 12. Accordingly, Machida discloses the claimed feature of "the first drop line terminating at a first drop line connector."

Part[b3]

With reference to FIG. 12 above, Machida discloses that the plug 3 and the receptacle portion 11 are locked "in the inserted state." *Id.*, ¶ [0024]. In such a state, "[the] contact pin 32 is inserted into the sleeve 21 to maintain electrical contact." *Id.* Thus, the contact pin 32 and the sleeve 21 are a detachable connection. For example, when the above-described plug 3 is pulled from the receptacle portion 11, the contact pin 32 and the sleeve 21 become detached. Thus, such a drop line connector (*i.e.*, sleeve 23a) is "configured to be capable of detachable connection" as claimed.

Further, with reference to FIG. 10 above, electrical wires 41, 42 connect to a plurality of solar cell modules 40. The solar cell modules 40 discloses the claimed "photovoltaic (PV) panel." Specifically, Machida discloses "a block formed by connecting a plurality of solar cell modules 40 in series" and "a plurality of such blocks." *Id.*, Abstract, ¶ [0003], Figures 1, 5. For example, "[a] plurality of solar cell modules 40 (six in this example) are connected in series to form a single block, a plurality of blocks are formed (five blocks in this example), a plurality of blocks are connected in parallel by connecting electrical wires 41, 42 from solar cell modules forming the two poles of each block to base wires 43, 44, and the two base wires 43,

44 are connected to a terminal box 45 leading to an inverter (not shown)." *Id.*, ¶ [0025], Figure 1. Thus, Machida's solar cell modules 40 or 50, and/or the "single block," disclose the claimed "photovoltaic (PV) panel." Accordingly, the electrical wires 41, 42 of Machida disclose the claimed "wire harness" that is "configured to receive electrical power generated by a corresponding photovoltaic (PV) panel" as claimed.

Also shown in FIG. 10, the electric wire 42 connects to a plug 3 of a connector 1. With reference to FIGS. 10 and 13, the electric wire 42 (the claimed "wire harness") connects to sleeve 23a (the claimed "drop line connector"), where plug 3 and sleeve 23a mate. Indeed, "plugs or receptacles are attached to the electrical wire terminals of both poles of blocks composed of solar cell modules." *Id.*, ¶ [0011]. Machida also discloses that the solar cell modules are connected, via each of the electrical wires 41, 42 (the claimed "one or more drop lines"), to "a base wire [43, 44] for connecting the outputs of the plurality of blocks [of solar cell modules 40] in parallel to transmit power." *Id.*, ¶ [0007], claim 1. Thus, Machida discloses that "the first drop line connector [is] configured to be capable of detachable connection to a wire harness … configured to receive electrical power generated by a corresponding photovoltaic (PV) panel."

Moreover, Machida Figure 1 (reproduced as FIG. 14 and annotated below) shows that power generated by a single block (in purple box) of six solar cell

modules 40 is combined at two connectors 1 (in red circles) on the base wires 43 and 44, respectively. Thus, Machida discloses the feature that "the first drop line connector [is] … configured to receive electrical power generated by a corresponding photovoltaic (PV) panel resulting in combined electrical power at the first drop line connector."

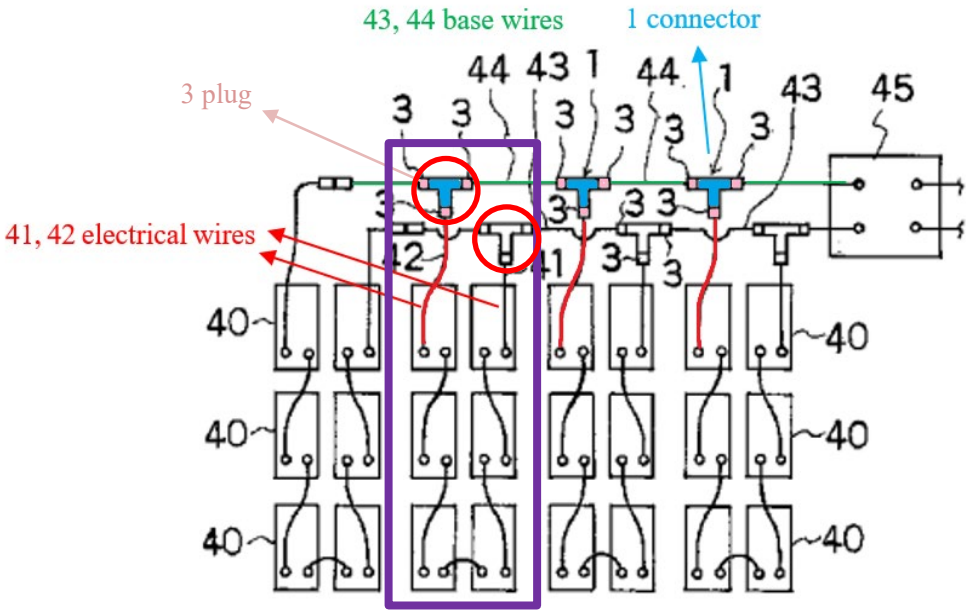

FIG. 14: Machida, Figure 1 (annotated)

Part[b4]

Machida does not expressly disclose that the "wire harness [has] a plurality of branches that are each configured to receive electrical power … resulting in combined electrical power at the first drop line connector." However, that arrangement was well known in the prior art and a POSA would have been motivated to modify Machida's wire harness in view of Sakatani's teachings, which include a

connection configuration where a wire harness has a plurality of branches for the reasons discussed in Section VI.A.2 above.

For example, Sakatani Figures 1A and 1B (reproduced below as FIG. 15 with annotation) discloses a lead assembly and a wire harness thereof, respectively. Specifically, Sakatani discloses a trunk cable 1A (the claimed "feeder cable," annotated in orange) and a branch cable 4A (the claimed "drop line," annotated in aqua). The trunk cable 1A and the branch cable 4A are connected at the branch connecting portion 7 (the claimed "lead assembly," annotated with yellow dotted box). The branch cable 4A terminates at a watertight socket 5A (the claimed first or second "drop line connector," annotated in pink) with a two-way branching structure. The socket 5A would have been similar to Machida's sleeve 23a. *See* FIG. 13. The trunk cable 1B (annotated in green), together with one or more similar cables (such as trunk cable 1C, annotated in dark red), would have been connected to the socket 5A (which is a three-way connector), by which electrical power can flow into or out of the socket 5A. Accordingly, Sakatani discloses or teaches that the wire harness (*i.e.*, the collection of the structures represented by Sakatani's Figure 1B and the structures in the dark-red dash-line box in FIG. 15) includes a plurality of branches. For example, a first branch would have been the structures (*e.g.*, including socket 5B, cable cord 34B , the cable cord 34C, *etc*.) associated with the trunk cable 1B, and a second branch would have been similar structures associated with trunk cable

1C, where each of the branches is configured to receive electrical power (*e.g.*, through the cable cord 34B, the cable cord 34C, and the socket 5B) resulting in combined electrical power at the socket 5A (the claimed "first drop line connector").

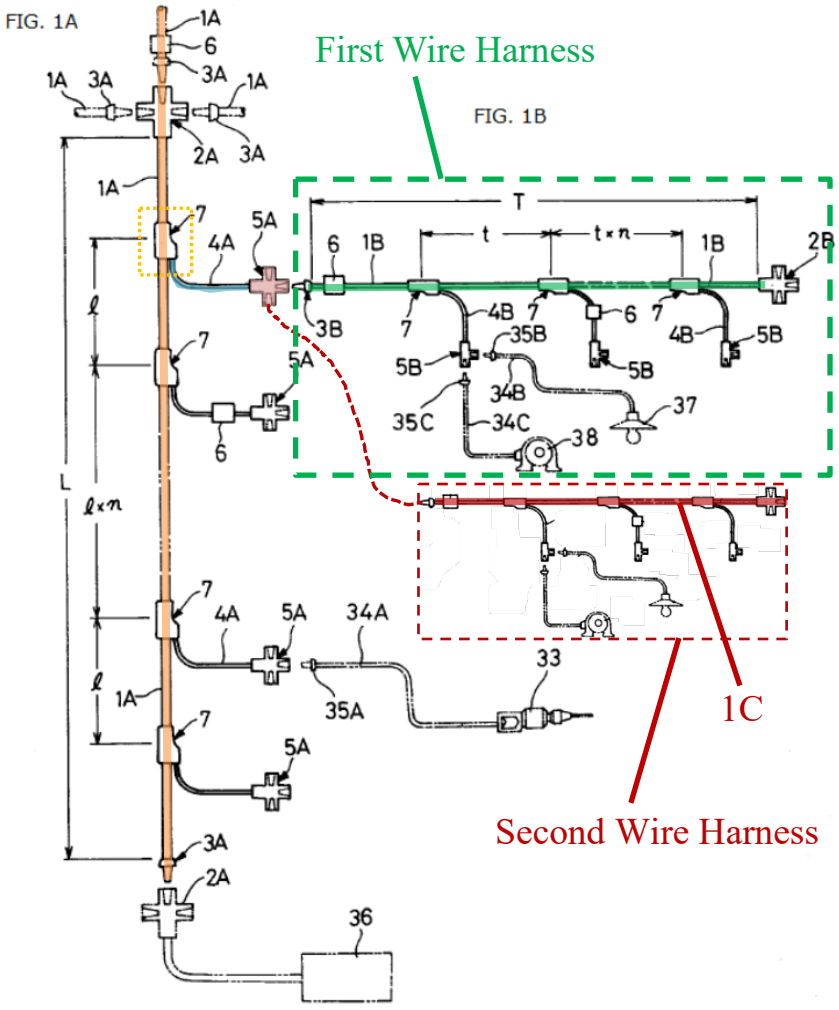

FIG. 15: Sakatani, Figure 1B (annotated and modified)

On the other hand, Machida discloses either "[a] plurality of solar cell modules 50 (six in this example)" or "[a] plurality of solar cell modules 40 (six in this example)" that can be "connected in series to form a single block." EX1006, ¶¶ [0003], [0025] (emphases added). That is, the solar cell modules in the block

would have been any number and are not limited to the example embodiments expressly shown and described in Machida. Therefore, it would have been obvious for a POSA to modify the number of solar cell modules in the block.

In practical cases, the number of solar cell modules in a block may be limited by the terrain or form factors of the solar field. For example, a first block may have four solar cell modules, and a second block may have two solar cell modules. Applying the above teaching of Sakatani, the first and second blocks may be connected to the same connector 1 (*see* FIG. 14). Such an example can be seen as the single block with six solar cell modules 40 being divided into two blocks, one with four solar cell modules and the other one with two solar cell modules, and the resulting combined electrical power at the sleeve 23a (the claimed "first drop line connector") (*see* FIG. 13) of the connector 1 would have been modified with the socket 5A of Sakatani. FIG. 16 shows an example of such modification.

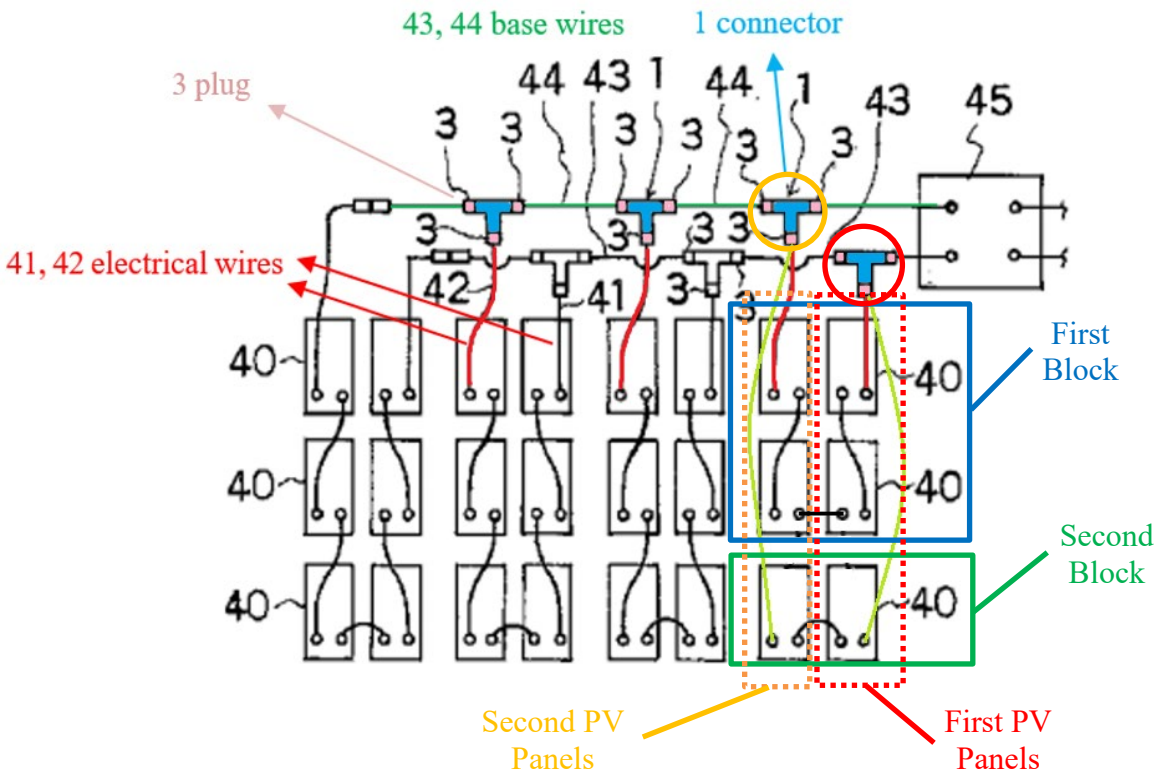

FIG. 16: Machida, Figure 1 (annotated and modified)

As shown in FIG. 16, two connectors 1 at the base wires 43 and 44, respectively, constitute a supply path (or positive pole) (in red circle) and a return path (or negative pole) (in orange circle) of a circuit for receiving electricity generated by PV Panels 40. Two solar cell modules 40 connected in series form a first block (in green box), and four solar cell modules connected in series form a second block (in blue box). The first block and the second block, on the block level, are connected in parallel. For the first block, first electric wires (in light green) are connected to the supply path and return path, respectively, for outputting the electric power generated by the first block to the base wires 43 and 44. For the second block, second electric wires

(in red) are also connected to the supply path and return path, respectively, for outputting the electric power generated by the second block to the base wires 43 and 44. One branch of the first electric wires (similar to the cables and wires connected to the trunk cable 1B in FIG. 15) and one branch of the second electric wires (similar to cables and wires connected to another cable similar to trunk cable 1B) are combined at the plug (in pink) (similar to the socket 5A in FIG. 15) of the supply path. Similarly, the other branch of the first electric wires (similar to the cables and wires connected to the trunk cable 1B in FIG. 15) and the other branch of the second electric wires (similar to cables and wires connected to another cable similar to the trunk cable 1B in FIG. 15) are combined at the plug (in pink) (similar to the socket 5A in FIG. 15) of the return path.

Thus, Machida's sleeve 23a (the claimed "first drop line connector"), which is inside the plug (in pink) as shown in FIG. 16, would have been replaced with Sakatani's socket 5A (also the claimed "first drop line connector") that is "configured to be capable of detachable connection to a wire harness having a plurality of branches" (*i.e.*, having a red branch and a light green branch), where each of the branches is "configured to receive electrical power generated by a corresponding photovoltaic (PV) panel" (the "corresponding PV panel" being the first block in green box and the second block in blue box, respectively). Such a modification "result[s] in combined electrical power at the first drop line connector,"

that is, at the sleeve(s) (the claimed "first drop line connector") of either the supply path or return path, the electrical power from the first block and the second block is combined from the red branch and the light green branch.

c. Part[c]

Part[c1]

Part [c1] would have been obvious to the POSA. Machida discloses that "the three-way connectors may be T-shaped, the three-way connectors may be disk-shaped, or the three-way connectors may be polygonal." EX1006, ¶ [0008]. That is, the form factor of connector 1 would have been modified in various ways and is not limited to the example embodiments expressly shown and described in Machida. Machida further discloses that the plugs 3 corresponding to the connector 1 can also be modified in almost unlimited ways, as long as the plugs can seal the connector 1. Specifically, "[t]he plugs that are used are not necessarily limited to those described above, and any structure may be used as long as the plug has a waterproof structure and a structure that keeps fingertips and tools, etc. from touching the plug tip during connection work, or a structure [that] does not cause an electric shock if accidentally touched." *Id.*, ¶ [0031].

It would have been obvious to modify the joint disclosed in Machida to include a second drop line in view of the teachings in Solon. For example, as shown in Solon Figure 2 (reproduced as FIG. 17 below), Solon discloses two branch wires

(annotated in red) branching off from a single cross joint or t-joint connecting branch wires with the trunk wire 30 (annotated in green).

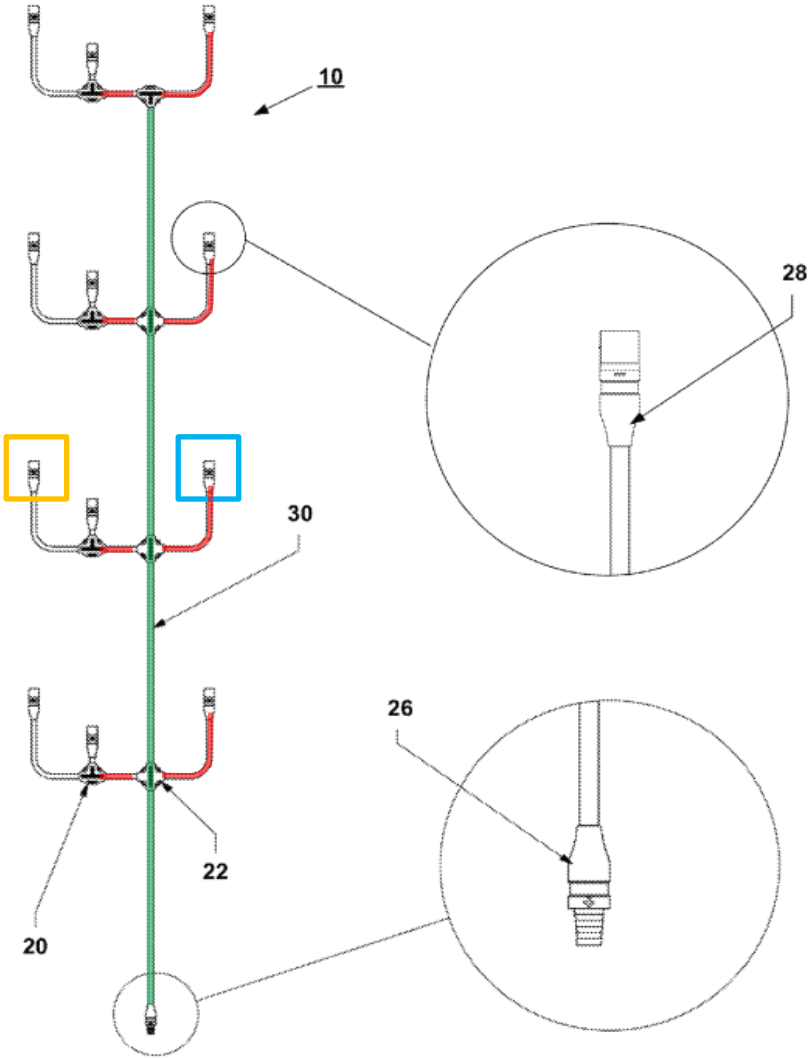

FIG. 2

FIG. 17: Solon, Figure 2 (annotated)

Therefore, it also would have been obvious for a POSA to modify Machida's connector 1 to include two or more drop lines in view of the teachings of Solon. For example, such modification would have been made by: (1) modifying Machida's

wire processing product 2 by including an additional electric wire 28 (which is similar to electric wire 25) (*See* FIG. 18); (2) soldering the additional electric wire 28 to the same base wire 24 at the connection point (*See* FIG. 18). As shown in FIGS. 18-19, similar to the electric wire 25, the electric wire 28 can also have a sleeve 28a (similar to the sleeve 23a) at the end corresponding to the receptacle 13 (*See* FIG. 11).

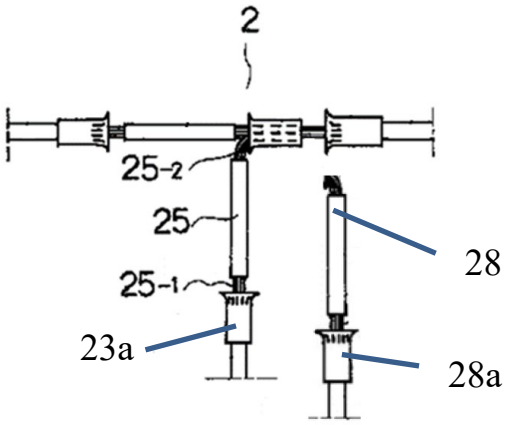

FIG. 18 (modified Machida Figure 3)

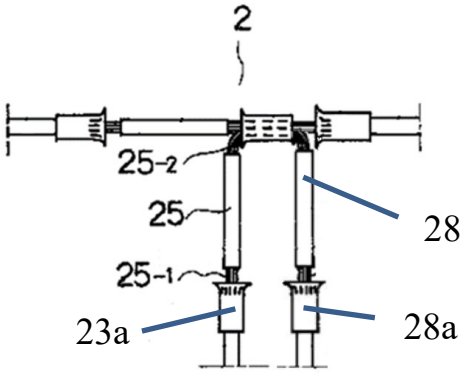

FIG. 19 (modified Machida Figure 3)

Moreover, Machida discloses that the base wire 24 can use "[a] cable of approximately CV 3.5 mm^2 or CV 2.0 mm^2" and that the electric wire 25 "is made of a cable of the same thickness [approximately CV 3.5 mm^2 or CV 2.0 mm^2] as above." EX1006, ¶ [0016], Figure 3. Additionally, with reference to FIGS. 18-19, the electric wire 28 would have been the same or similar to the electric wire 25. That is, Machida suggests an embodiment where the base wire 24 has the claimed "first diameter" of approximately CV 3.5 mm^2, and the electric wire 28 has the claimed "third diameter" of approximately CV 2.0 mm^2 (or another different diameter), in which the third diameter is different than the first diameter. Moreover, Sakatani likewise discloses a trunk cable 1A (the claimed "feeder cable") and branch cable 4A (the claimed "drop line") with different diameters as shown in FIG. 15. *See* EX1015, at Figure 1B. If two such drop lines were used—as would be done in this modification—a POSA would use two of the smaller diameter "drop lines" as compared to the larger trunk cable ("feeder cable"), which would necessarily result in the "second drop line having a third diameter different than the first diameter" as required by the claims.

Part[c2]

With reference to FIG. 17, Solon's branch wires correspond to the claimed "first drop line" and "second drop line." The trunk wire 30 corresponds to the claimed "feeder cable." As shown in FIG. 17, a first branch wire (the "first drop line")

terminates at a first drop line connector (in orange box), and a second branch wire (the "second drop line") terminates at a second drop line connector (in blue box). A POSA would have been motivated to modify the connector and plug assembly of Machida to include a second drop line, as disclosed in Solon for the reasons discussed in Section VI.A.1 above. For the same reason as discussed in Section VI.A.3.b, the electric wire 28 (the claimed "second drop line") also terminates at the sleeve 28a (the claimed "second drop line connector").

d. Part[d]

Machida's "connection point" inside the connector 1 (red circles in FIG. 14) discloses the claimed "region of electrical interconnection between the feeder cable, the first drop line, and the second drop line." The connection point is not explicitly shown in FIG. 14 but is similar to those shown in Machida Figure 5 (reproduced as FIG. 20 and annotated below). FIG. 20 shows "a configuration diagram of conventional wiring connections for solar cell modules" that includes "connection points 56, 57" (in red circles). *Id.*, ¶ [0003]-[0004]. The connection points are where "the electrical wires 41, 42 from the solar module blocks are connected to the base wires 43, 44." *Id.*, ¶ [0026]. The connection points in FIG. 20 are similar to those in FIG. 14.

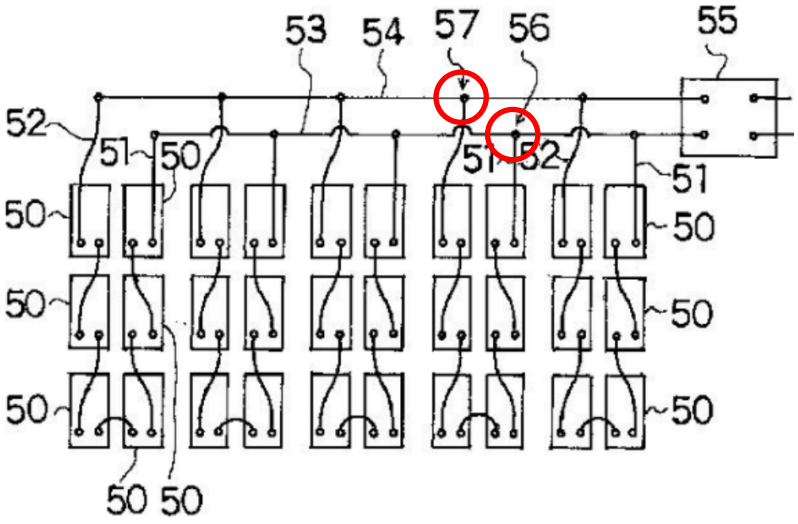

FIG. 20: Machida, Figure 5 (annotated)

Based on the above discussions, FIG. 21 below shows a combined figure of Machida's Figure 2 and FIG. 16 above with annotations. Regarding the claimed "region of electrical interconnection between the feeder cable, the first drop line, and the second drop line," as illustrated in FIG. 21, the red circle is a "region of electrical interconnection" between the base wire 24 (the claimed "feeder cable"), the electric wire 25 (the claimed "first drop line"), and the electric wire 28 (the claimed "second drop line").

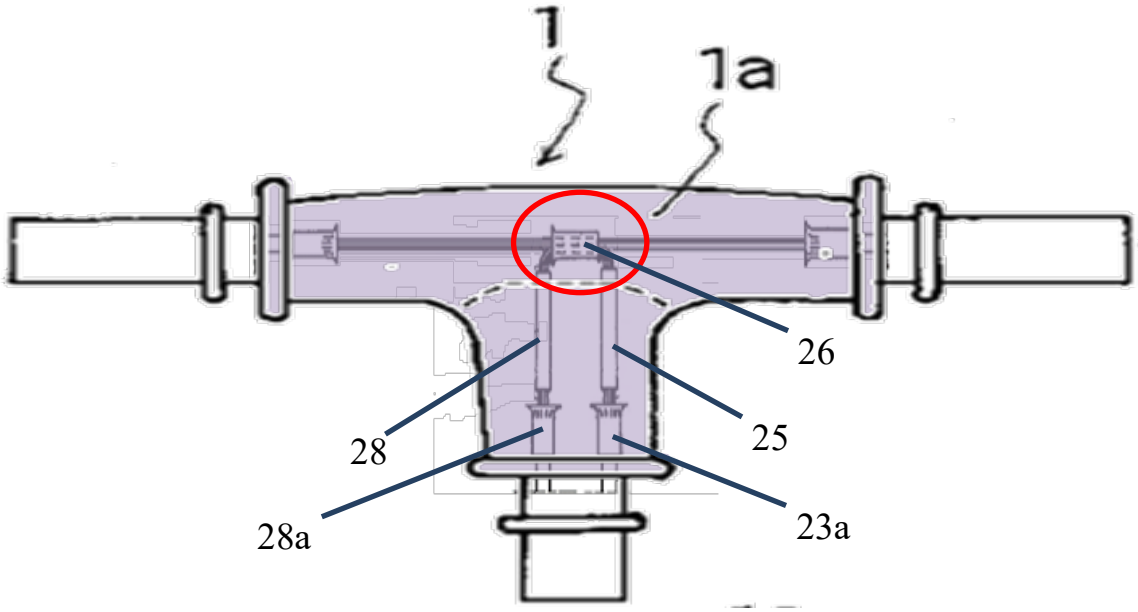

FIG. 21: Combined Figure of Machida Figure 2 and FIG. 16 (annotated)

Referring to FIG. 21, Machida also discloses that Connector 1 is "used at [] parallel connection points [(in red circle)]." *Id.*, ¶ [0010]; *See also id.*, ¶ [0004], [0007], [0009], [0027]. "The connector is used at the connection points at which the electrical wires 41, 42 from the solar module blocks are connected to the base wires 43, 44." *See* EX1006, ¶ [0026], Figure 1.

Regarding the claimed "one or more mold structures," as shown in FIG. 21 above, connector 1 is disposed about and conforming the connection point (the claimed "region of electrical interconnection between the feeder cable, the first drop line, and the second drop line," as shown in the red circle). Machida discloses that connector 1 has an "outer shell formed from a soft vinyl chloride material by insert

molding of the wire processing product." *Id.*, ¶ [0015], Figure 2.[9] Machida further discloses that connector 1 "is formed by insert molding the wire processing product 2." EX1006, ¶ [0021], Figure 2. Specifically, "the wire processing product 2 is inserted and molded using a soft vinyl chloride material." *Id.* Thus, with reference to FIG. 21, the outer shell (in light purple) of connector 1 discloses the claimed "one or more mold structures," which is "disposed about and conforming to" the "region of electrical interconnection between the feeder cable, the first drop line, and the second drop line."

Regarding "the one or more mold structures substantially sealing the region of electrical interconnection from external environmental conditions," Machida discloses that the connector 1 can have receptacles (*e.g.*, receptacles 11, 12, and 13 in FIG. 11) to be mated with plugs "attached on the electrical wire side." *See id.*, ¶¶ [0027], [0032]. Machida also discloses that "the reverse relationship may be used, that is, the connector of the three-way branch may be a plug and the electrical wire side a receptacle." *Id.*, ¶ [0032]. That is, the connector 1 can have plugs to be mated with receptacles attached on the electrical wire side. "[T]he plugs for the connector have a waterproof structure and are designed to keep fingertips and tools, etc. from touching the plug tip during connection work, or to prevent electric shocks even if

[9] Insert molding is a type of injection molding. *See* EX1009, ¶ [0101].

accidentally touched." *Id.*, ¶ [0033] (emphases added). "The plugs that are used are not necessarily limited to those described above, and any structure may be used as long as the plug has a waterproof structure and a structure that keeps fingertips and tools, etc. from touching the plug tip during connection work, or a structure does not cause an electric shock if accidentally touched." *Id.*, ¶ [0030] (emphases added).

Thus, when the connector 1 has plugs instead of receptacles, the plugs that constitute the connector 1 (as part of the claimed "one or more mold structures") keep the connection point (the claimed "region of electrical interconnection") inside connector 1 waterproof and touch-proof. That is, Machida discloses the claim feature of "the one or more mold structures substantially sealing the region of electrical interconnection from external environmental conditions."

e. Part[e]

As discussed in Section VI.A.3.b above, Machida discloses that "the combined electrical power" is received "at the first drop line connector" as a result of "the first drop line connector [being] configured to be capable of detachable connection to a wire harness having a plurality of branches that are each configured to receive electrical power generated by a corresponding photovoltaic (PV) panel."

As shown in FIG. 14 above, electrical power generated by a single block (in purple box) of six solar cell modules 40 is combined at a sleeve 23a (the claimed "first drop line connector") inside either one of the two connectors 1 (in red circles)

that disposed about and conforming two connection points (one serving as positive pole and one as negative pole) on the base wires 43 or 44 (the claimed "feeder cable"), respectively. Each of the two connection points includes the "region of electrical interconnection."

f. Part[f]

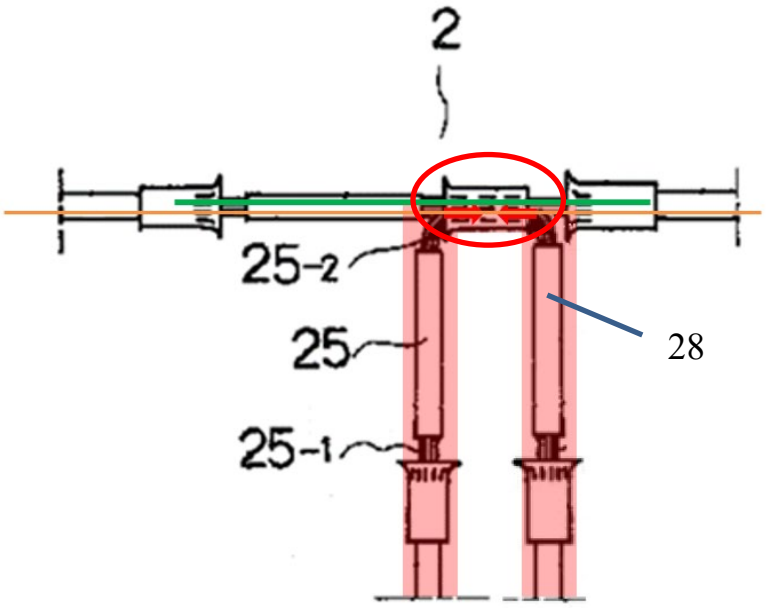

FIG. 22 (Machida Figure 3, modified and annotated)

As discussed in Section VI.A.3.c, the second drop line would have been obvious over the teachings of Machida. *See also* FIGS. 18-19. FIG. 16 is reproduced below as FIG. 22 with more annotations. As shown in FIG. 22, in the red circle (the claimed "region of electrical interconnection"), the electric wire 25 (the claimed "first drop line") and the electric wire 28 (the claimed "second drop line") extend in opposite directions (indicated by two red arrows pointing in opposite directions

inside the red circle) along a longitudinal axis (the orange line) that is parallel to the longitudinal axis (the green line) of the base wire 24 (the claimed "feeder cable").

4. Claim 2

a. Part[a]

With reference to FIG. 12 above, Machida discloses that "3 is a connection plug … and 32 is a contact pin" and that "33 is an insulator … fixed to the tip of the contact pin 32." EX1006, ¶ [0022]. Machida also discloses that "[t]he contact pin 32 is inserted into the sleeve 21 to maintain electrical contact." *Id.*, ¶ [0024]. As shown in FIG. 12, the ring sleeve 21a extends slightly out of outer shell (*See* Section VI.A.3.d, FIG. 21, *supra*), and the tip of the contact pin 32 (as indicated by the insulator 33) is also slightly out of the outer shell, which is indicated by a red-dotted line in FIG. 12. As discussed in Section VI.A.3, the electric wire 24 is a portion of the base wire 43 or 44 within the connector 1, and the base wire 43 or 44 extends through the connector 1. *See* FIG. 10. Thus, Machida discloses that the base wire 24 (the claimed "feeder cable") extends continuously through the outer shell (the claimed "one or more mold structures") such that the base wire 24 extends out of (as indicated by the position of the tip of the contact pin 32) and away from the outer shell in one direction.

FIG. 12 is "a cross-sectional view of the connector during use [] with a plug inserted" (EX1006, ¶ [0022]) and specifically, "a plug 3 inserted into a receptacle

portion 11" (*id.*, ¶ [0024]), because receptacle portions 11, 12, 13 all "have a structure for receiving the appropriate plug" (*id.*, ¶ [0015]), Machida would have rendered it obvious that the receptacle portion 12, which is in an opposite direction to the receptacle portion 11 (*See* FIG. 11 above), would have had the same structure as shown and described in FIG. 12. Thus, with reference to FIG. 21, Machida would also have rendered it obvious that the base wire 24 extends out of and away from the outer shell (the claimed "one or more mold structures") in an opposite direction.

b. Part[b]

As discussed in Section VI.A.3.b above, Machida discloses "the first drop line terminating at a first drop line connector." Machida discloses that the receptacle portions 11, 12, 13 all "have a structure for receiving the appropriate plug" (*id.*, ¶ [0015]) and would have rendered it obvious that the receptacle portion 13 (*See* FIG. 11 above) would have had the same structure as shown and described in FIG. 12. With reference to FIGS. 16 and 22, Machida would have rendered it obvious that the ring sleeve 23a (the claimed "drop line connector") is within the outer shell (the claimed "one or more mold structures").

5. Claim 3

a. Part [a]

Machida discloses that the electric wire 25 has "the insulating sheath removed at both ends to the specified length." EX1006, ¶ [0016], Figure 3. Specifically, "[t]he

[] end 25-2 of electrical wire 25 … has its insulating sheath removed." *Id.*, ¶ [0020]. Machida Figure 3 (reproduced below as FIG. 23 and annotated) clearly shows that the end 25-2 (in orange) of the electric wire 25 (the claimed "the first drop line") has a section of exposed wire at the connection point (the claimed "region of electrical interconnection," in red circle).

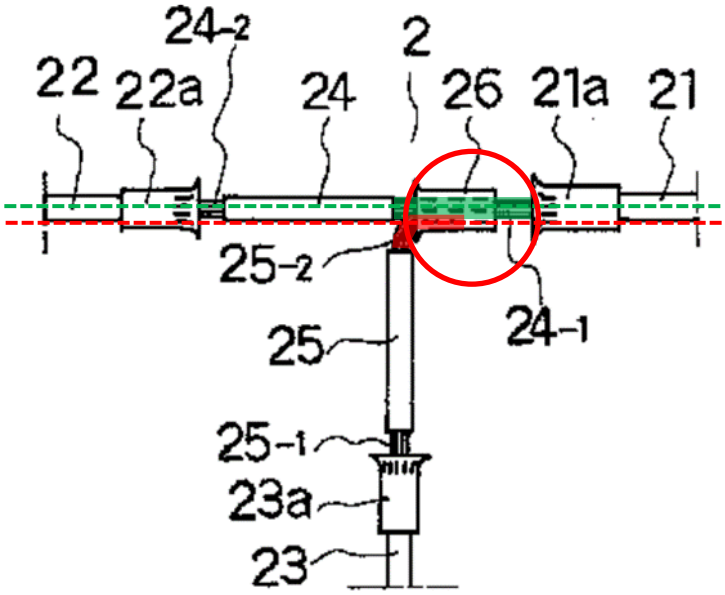

FIG. 23: Machida, Figure 3 (annotated)

b. Part [b]

Machida discloses that the base wire 24 has "the insulating sheath [] removed to the specified dimensions at both ends." *Id.*, ¶ [0016], Figure 3. Specifically, "the end portion 24-1 of electrical wire 24 [has] its insulation coating removed." *Id.*, ¶ [0017], Figure 3. FIG. 23 above clearly shows that the end portion 24-1 (in green)

of the base wire 24 (the claimed "feeder cable") has a section of exposed wire at the connection point (the claimed "region of electrical interconnection," in red circle).

6. Claim 4

Machida discloses that "the electrical wires [*e.g.*, wire 25] and base wires [*e.g.*, wire 24] are connected using soldering or some other specified procedure." EX1006, ¶ [0004] (emphases added). "The two wires [the end 25-2 of the electric wire 25 and the end 24-1 of the base wire 24] are connected by soldering … and reinforced by crimping." *Id.*, ¶ [0020] (emphases added), Figure 3; *See also* FIG. 12. As illustrated in FIG. 23 above, at the connection point (the claimed "region of electrical interconnection," in red circle), the electric wire 25 (the claimed "first drop line") is coupled to the base wire 24 (the claimed "feeder cable") using a solder portion reinforced by crimping.

7. Claim 5

Regarding the claimed "feeder cable connector," Machida discloses that "receptacles and plugs" that are "set in a proper mating position" "constitute a connector." EX1006, ¶ [0013]. Specifically, Machida discloses that "[e]ach sleeve 21, 22, and 23 of the wire processing products 2 is exposed at the opening to each receptacle." *Id.*, ¶ [0021]. Also, "[the] end portion 24-1 of electrical wire 24 is connected to the sleeve 21," and "[the] end portion 24-2 of electrical wire 24 is connected to the sleeve 22." *Id.*, ¶¶ [0017]-[0018]. With reference to FIG. 13 above,

either of Machida's sleeves 21 and 22 in the receptacle portions 12 and 13, respectively, discloses the claimed "feeder cable connector."

Machida further discloses "a terminal box 45" that is "linked to an inverter." *Id.*, Abstract. Also, "the two base wires 53, 54 are connected to a terminal box 55 leading to an inverter (not shown)." *Id.*, ¶ [0003], Figure 5. Moreover, "the two base wires 43, 44 are connected to a terminal box 45 leading to an inverter (not shown)." *Id.*, ¶ [0025], Figure 1. FIG. 24 below is a figure modified from Machida Figure 1 based on the above disclosure. As illustrated in FIG. 24, the base wires 43, 44 (the claimed "feeder cable," in green) attach to the terminal box 45 and further to the inverter (in purple box). The terminal box 45 functions as an electric connector that relays the base wires 43, 44 directly, without any combining or recombining actions, to the inverter.[10] Electricity in each of the base wires 43, 44 runs directly to the inverter without interfering with each other. Thus, the sleeve 21 or 22 (the claimed

[10] Notably, the terminal box 45 is not a combiner because it does not combine solar energy. FIG. 24 illustrates two wires going into the terminal box 45 and two wires leaving it. This is sharp contrast to what a combiner looks like shown by the '376 Patent—a plurality of wires going into the combiner, and a single wire leaves the combiner. *See* EX1001, Figure 1.

"feeder cable connector") is configured to electrically couple the base wire 43 or 44 (the claimed "feeder cable") to an inverter without an intervening combiner box.

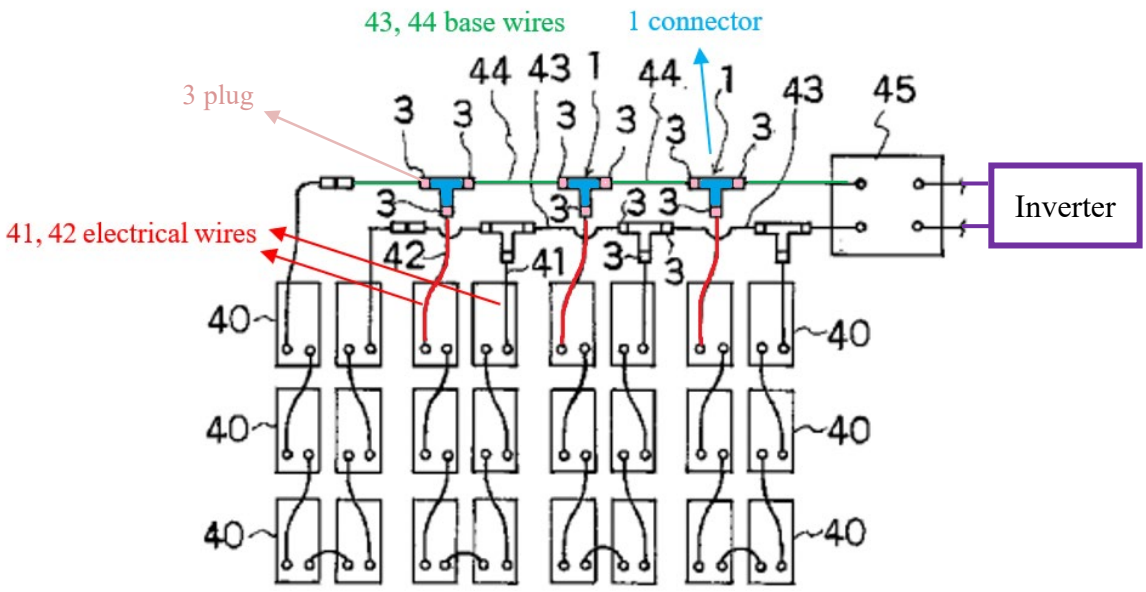

FIG. 24: Machida, Figure 1 (annotated and modified)

8. Claim 6

Machida discloses that "[t]he other end 25-2 of electrical wire 25… has its insulating sheath removed, and is bent so that it runs parallel to the end portion 24-1 of electrical wire 24, which also has its insulating sheath removed." *Id.*, ¶ [0020] (emphasis added), Figure 3. With reference to FIG. 23 above, the bent portion of the end 25-2 (in red) of the electric wire 25 (the claimed "first drop line") with its insulating sheath removed discloses the claimed "at least a portion of the first drop line." The end portion 24-1 (in green) of the base wire 24 (the claimed "feeder cable") with its insulating sheath also removed discloses the claimed "at least a portion of the feeder cable."

As illustrated in FIG. 23, a green dashed line represents a longitudinal axis of the base wire 24, and a red dashed line represents a longitudinal axis of the bent portion of the electric wire 25. As shown, a portion of the end 25-2 of the electric wire 25 is parallel to the base wire 24.

9. Claim 8

As discussed in Section VI.A.3.b above, Machida discloses that the electrical power is combined at the first drop line connector. With reference to FIG. 16 above, the two connectors 1 forming a supply path (in red circle) and a return path (in orange circle) can each use the structure as illustrated in FIG. 21 above to receive a red branch and a light green branch, respectively. Specifically, in FIG. 21, ring sleeves 23a and 28a (the claimed "first and second drop line connectors") can connect the red branch and the light green branch to the electric wires 25 and 28 (the claimed "first and second drop lines"), respectively, for receiving electrical power combined from the first block (*See* FIG. 16, in green box) and the second block (*See* FIG. 16, in blue box). Thus, Machida would have rendered "combined electrical power received through the first and second drop line connectors of first and second drop lines" obvious.

As illustrated in FIG. 21, Machida would have rendered it obvious that, at the connection point (the claimed "region of electrical interconnection," in red circle), the connector 1 (the claimed "lead assembly") is configured to combine, in the base

wire 24 (the claimed "feeder cable") via ring sleeves 26 and 28, the combined electrical power received through the ring sleeves 23a and 28a (the claimed "first and second drop line connectors") of the electric wires 25 and 28 (the claimed "first and second drop lines"), respectively.

Alternatively, even if Machida alone does not render the above features obvious, they would have been obvious over Machida in view of Solon. As discussed in Section VI.A.3.c above, Machida's connector 1 would have been modified to include a second drop line that terminates at a second drop line connector. *See* FIG. 17. With reference to FIG. 17, the cross joint (the claimed "lead assembly") combines, in the trunk wire 30 (the claimed "feeder cable"), electrical power received through the first and second drop line connectors (in orange box and blue box, respectively) of first and second branch wires (in red, the claimed "first and second drop lines").

As discussed in Section VI.A.7, with reference to FIG. 24 above, the base wire 44 is in electrical communication with the inverter. The connector 1 delivers the combined electrical power to the inverter that is in electrical communication with the base wire 44 (the claimed "feeder cable").

10. Claim 9

The "gauge" in Claim 9 refers to American wire gauge, which "is a standardized wire gauge system used since 1857 predominantly in North America for the diameters of round, solid, nonferrous, electrically conducting wire." EX1010

at 1. A wire of gauge 4 has a cross-sectional area of 21.2 mm^2, and a wire of gauge 18 has a cross-sectional area of 0.823 mm^2. *Id.* at 2.

Machida discloses that the base wire 24 can use "[a] cable of approximately CV 3.5 mm^2 or CV 2.0 mm^2" and that the electric wire 25 "is made of a cable of the same thickness [approximately CV 3.5 mm^2 or CV 2.0 mm^2] as above." EX1006, ¶ [0016], Figure 3. That is, the electric wire 25 (the claimed "first drop line") can have cross-sectional areas of 3.5 mm^2 or 2.0 mm^2, which fall between the above claimed value range (0.823-21.2 mm^2). As discussed in Section VI.A.3.c above, the wire 28 (the claimed "second drop line") would have been the same or similar to the wire 25.

11. Claim 10

As evidence of a POSA's general knowledge as of its effective filing date, the '376 Patent states that "the present invention would have been scaled up or down to accommodate any feeder cable size, including the common 250 and 750 MCM cable sizes." EX1001, 6:35-37 (emphases added).[11] That is, Patent Owner admitted that the feeder cable with "250 and 750 MCM cable sizes" in the '376 Patent had

[11] "MCM" is "[a]n older abbreviation for one thousand circular mils," which is used as the unit for wire sizes "larger than 4/0 AWG" "[i]n the North American electrical industry." EX1010 at 2.

been commonly sold or offered for sale before its effective filing date, and thus the "250 and 750 MCM cable sizes" had been general knowledge to a POSA as of the effective filing date of the '376 Patent. The "250 and 750 MCM cable sizes" fall within the claimed size range "between 250 MCM to 1000 MCM."

Notably, the '376 Patent does not specify any benefits of using or shortcomings of not using the claimed value range for feeder cables. *See* EX1001. Instead, it expressly admitted that "the present invention can be scaled up or down to accommodate any feeder cable size." EX1001, 6:35-36 (emphasis added). Moreover, the '376 Patent discloses that "[a]n embodiment of the present invention preferably has the following specifications: … Maximum branch current of 30 amps per string; Maximum overcurrent protection of 30 amps per string; maximum trunk cable size of 750 MCM…" *Id.*, 6:23-27. Similarly, Machida discloses that its solar cell modules can have "a maximum output current of 20A for the output circuitry, … and a maximum current of 30A." EX1006, ¶ [0002]. The electrical specifications are similar and comparable between the systems of the '376 Patent and Machida.

A POSA would have been motivated to modify the connector 1 of Machida to receive a base wire 24 having a size of 250 and 750 MCM because such cable size is "common" in the U.S. market. It would have been apparent to the POSA that such modification would have been readily made, with a reasonable expectation of

success, and would be done for adaptation to the U.S. market, to accomplish the same result as the embodiment described in Machida.

12. Claim 12

Claim 12 depends on claim 1. Machida discloses all elements of claim 12 except that the drop line connector connects to the central trunk. However, a POSA would have been motivated to modify Machida's wiring connections for solar cell panels in view of Sakatani's teaching of a connection configuration where the drop line connector connecting to the central trunk for the reasons discussed in Section VI.A.2 above.

a. Part [a]

Part [a] would have been obvious over Machida in view of Solon. *See* Sections VI.A.3.a to VI.A.3.f, *supra*.

b. Part [b]

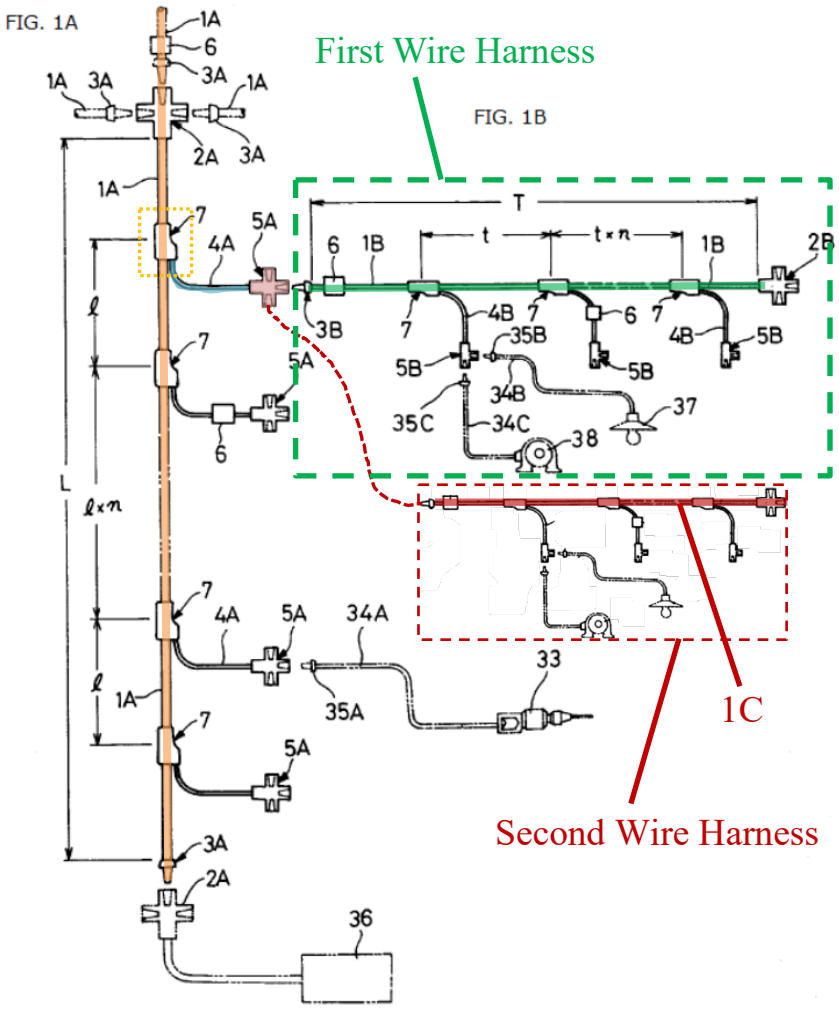

FIG. 15: Sakatani, Figure 1B (annotated and modified)

Sakatani discloses "the wire harness further including a first central trunk." With reference to FIG. 15 (reproduced above), the trunk cable 1B discloses the claimed "first central trunk," and it is connected to the socket 5A, by which electrical power can flow into or out of the socket 5A. Accordingly, Sakatani discloses that the structures (*e.g.*, including the socket 5B, the cable cord 34B, the cable cord 34C, *etc*.)

(the claimed "first wire harness") associated with the trunk cable 1B includes the trunk cable 1B (the claimed "first central trunk").

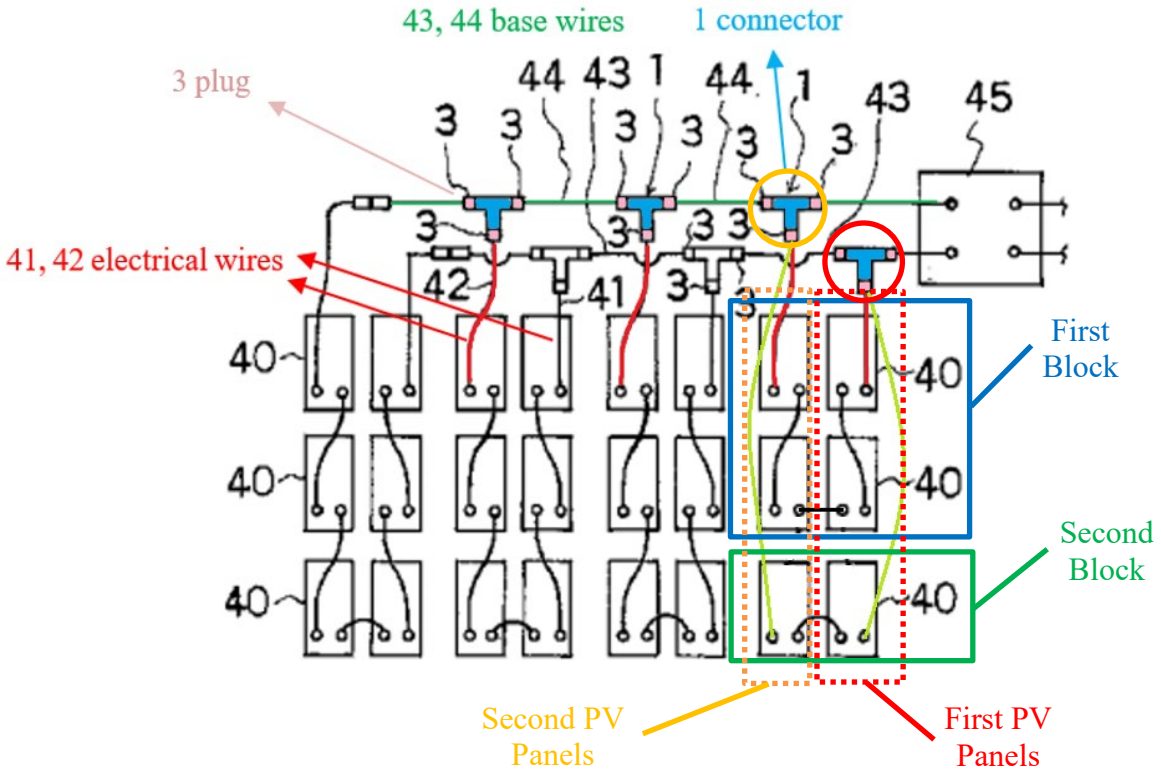

FIG. 16: Machida, Figure 1 (annotated and modified)

Machida's wire harness, shown by the red branches and light green branches in the first and second blocks in FIG. 16 (reproduced above), would have been modified to provide for a mating connection with Sakatani's trunk cable 1B (the claimed "first central trunk"). With reference to FIG. 16, for the first block (in green box), a first electric wire (in light green) would have been connected to a plug similar to Sakatani's trunk cable 1B (*i.e.*, the claimed "first central trunk," not shown in FIG. 16), as a supply path, that is further coupled to Machida's sleeve 23a (the claimed

"first drop line connector") inside the red circle of FIG. 16. For the second block (in blue box), a second electric wire (in red) can also be connected to the first central trunk that is further coupled to Machida's sleeve 23a inside the red circle of FIG. 16. The first electric wire (in light green) and the second electric wire (in red) are combined at the first central trunk.

Thus, it would have been obvious to modify Machida in view of Sakatani to teach or suggest the claimed "wire harness," which includes the first central trunk and a plurality of branches, including the first electric wire (the claimed "first branch") and the second electric wire (the claimed "second branch"). *See* FIG. 16 and FIG. 15. With reference to FIG. 16, three solar panels 40 in the red-dotted box (the claimed "first plurality of PV panels") are electrically coupled by the first electric wire (in light green) and the second electric wire (in red), as part of the claimed "wire harness," to form "a first solar array." Each of the first electric wire and the second electric wire electrically couples a different one of the solar panels 40 in the red-dotted box (the claimed "a different one of the first plurality of PV panels") to the first central trunk.

A POSA would have been motivated to modify Machida's ring sleeve 23a (the claimed "first drop line connector") to mate with Sakatani's trunk cable 1B (the claimed "first central trunk") that further couples with a plurality of branches,

including Machida's electric wire 40, for the reasons discussed in Section VI.A.2 above. *See also* FIG. 16.

c. Part [c]

Sakatani discloses "the second wire harness including a second central trunk." With reference to FIG. 15 above, the trunk cable 1C discloses the claimed "second central trunk," and it is connected to the socket 5A (the claimed first or second "drop line connector") together with the trunk cable 1B, by which electrical power can flow into or out of the socket 5A. Accordingly, Sakatani teaches that the structures (*e.g.*, structures similar to the socket 5B, the cable cord 34B, and the cable cord 34C, *etc*.) associated with the trunk cable 1C (the claimed "second wire harness") includes the trunk cable 1C (the claimed "second central trunk").

As discussed in Section VI.A.12.b, in view of Sakatani, with reference to FIG. 16, the orange circle in FIG. 16 would have been modified to mate with the trunk cable 1C (the claimed "second central trunk"). With reference to FIG. 16, for the first block (in green box), a third electric wire (in light green) would have been connected to a plug similar to the trunk cable 1C (*i.e.*, the claimed "second central trunk"), as a supply path, that is further coupled to Machida's sleeve 23a (the claimed "first drop line connector") inside the orange circle of FIG. 16. For the second block (in blue box), a fourth electric wire (in red) can also be connected to the second central trunk that is further coupled to Machida's sleeve 23a inside the orange circle

of FIG. 16. The third electric wire (in light green) and the fourth electric wire (in red) are combined at the second central trunk. Thus, it would have been obvious to modify Machida in view of Sakatani to teach or suggest the claimed "second wire harness," which includes the second central trunk and a "second plurality of branches," including the third electric wire (the claimed "third branch") and the fourth electric wire (the claimed "fourth branch"). *See* FIG. 16 and FIG. 15. With reference to FIG. 16, three solar panels 40 in the orange-dotted box (the claimed "second plurality of PV panels") are electrically coupled by the third electric wire (in light green) and the fourth electric wire (in red), as part of the claimed "second wire harness," to form "a second solar array." Each of the third electric wire and the fourth electric wire electrically couples a different one of the solar panels 40 in the orange-dotted box (the claimed "a different one of the second plurality of PV panels") to the second central trunk.

A POSA would have been motivated to modify Machida's ring sleeve 28a (the claimed "second drop line connector") to mate with Sakatani's trunk cable 1C (the claimed "second central trunk") that further couples with a plurality of branches, including Machida's electric wire 40, for the reasons discussed in Section VI.A.2 above. *See* FIG. 16.

d. Part [d]

As shown in FIG. 15, the socket 5A, which corresponds to Machida's sleeve 23a (the claimed "first drop line connector") (*see* FIG. 13), connects to the trunk cable 1B (the claimed "first central trunk"). A POSA would have been motivated to modify Machida's wiring connections for solar cell panels with Sakatani's wiring configuration, for the reasons discussed in Section VI.A.2 above.

e. Part [e]

Part [e] is disclosed by Machida. *See* Section VI.A.3.b and Section VI.A.8, *supra*.

f. Part [f]

As shown in FIG. 15, the socket 5A, which also corresponds to Machida's sleeve 28a (the claimed "second drop line connector") (*see* FIG. 13), would have been connected to the trunk cable 1C (the claimed "second central trunk"). Accordingly, for similar reasons as discussed in VI.A.12.d above, Sakatani discloses Part [f].

g. Part [g]

Part [g] is disclosed by Machida. *See* Sections VI.A.3.b and VI.A.9, *supra*.

13. Claim 13

Claim 13 depends from claim 1. Machida discloses all elements of claim 13 except that the drop line connector connects to the central trunk. However, a POSA

would have been motivated to modify Machida's wiring connections for solar cell panels with Sakatani's connection configuration where the drop line connector connecting to the central trunk. *See* Section VI.A.2, *supra*.

a. Part [a]

Part [a] would have been obvious over Machida in view of Sakatani. *See* Section VI.A.12.d, *supra*.

b. Part [b]

Part [b] is disclosed by Machida in view of Sakatani. *See* Section VI.A.12.b, *supra*.

c. Part [c]

Part [c] is disclosed by Machida in view of Sakatani. *See* Section VI.A.12.b, *supra*.

d. Part [d]

Part [d] is disclosed by Machida. *See* Section VI.A.12.e, *supra*.

e. Part [e]

Part [e] would have been obvious over Machida in view of Sakatani. *See* Section VI.A.12.f, *supra*.

f. Part [f]

Part [f] is disclosed by Machida in view of Sakatani. *See* Section VI.A.12.c, *supra*.

g. Part [g]

Part [g] is disclosed by Machida in view of Sakatani. *See* Section VI.A.12.c, *supra*.

h. Part [h]

Part [h] is disclosed by Machida. *See* Section VI.A.12.g, *supra*.

B. Ground 2—Claims 1-6, 8-10, and 12-13 Would Have Been Obvious over Machida in view of Kim and Sakatani

1. Motivation to Combine Machida and Kim

Kim expressly discloses at least two cables (drop lines) branching off from a single lead assembly. A POSA would have been motivated to modify the T-shaped connector of Machida with the teachings of Kim—including a dual "drop line" arrangement—for multiple reasons. First, Kim discloses information regarding a multiple drop line arrangement that allows for the connection of additional solar panels to a single connector, providing a POSA with additional guidance for designing and fabricating a variety of such connectors. *See* EX1013, summary, Figure 1. Second, Kim teaches a cable connection device that can electrically couple cables in X-shape, Y-shape, or T-shape (EX1013, summary, Figures 1, 4, 5), while Machida describes a "three-way connectors [that] may be T-shaped" (EX1006, ¶ [0008]). Third, Kim describes that a "sealing portion (300) can strengthen the environmental adaptability of the connection area by sealing the core portion (110) area," so that "the sealing portion (300) can prevent the cable (100) connection area from becoming vulnerable to external environments." EX1013, ¶ [0024]. Machida

expressly states that the connector can use various structure for its plug as long as "the plug has a waterproof structure and a structure that keeps fingertips and tools, etc. from touching the plug tip during connection work." EX1006, ¶ [0031].

Both Machida and Kim are analogous prior art to the '376 Patent because they are in the same field as the '376 Patent. *See* EX1001 at 1:24-2:21. Kim "pertains to a cable connection device and method, and more particularly to a cable connection device and method for cables that transmit power, such as power generated by photovoltaic modules." EX1013, ¶ [0001]. Kim identifies a problem that "photovoltaic cables are [] located outdoors and are exposed to harsh external environments for long periods, that is, at least 10 years or more." EX1013, ¶ [0002]. Kim explains that a need exists to manufacture photovoltaic cables "under conditions that can withstand harsh external environments." *Id.* Kim provides a solution for "a cable connection device and method" that "can seal cable connection portions so that they have no problems even in external environments." *Id.*, ¶¶ [0005], [0012]. Specifically, Kim discloses a cable connection device to "transmit power, such as power generated by photovoltaic modules." *Id.*, ¶ [0001]. Kim explains electrically coupling a plurality of cables in an X-shape, Y-shape, or T-shape. *Id.*, summary, Figures 1, 4, 5. On the other hand, Machida's invention "relates to a method for connecting the wiring of solar cell modules used in solar power generation" and discloses a connector that uses receptacles and plugs for easy

installation. EX1006, ¶¶ [0001], [0033]. Therefore, a POSA designing or fabricating a solar power system would have been aware of and motivated to consider both Machida and Kim.

Finally, a POSA would have an expectation of success in modifying the connector disclosed by Machida with the teachings of Kim because both references are directed to connectors or joints used for solar power installations and aim to achieve their stated common goal of sealing the wire connection portion from external environments. *See* EX1006, ¶¶ [0006], [0008]; EX1013, ¶¶ [0002], [0005], [0012]. Specifically, Kim discloses that "[t]he cables are connected in X-shaped, Y-shaped, or T-shaped configurations." EX1013, ¶ [0010]. Machida also discloses that its connectors may be T-shaped, disk-shaped, or polygonal. *See* EX1006, ¶ [0008]. Therefore, such modification would be readily made as of the time of the filing of the '376 Patent with a reasonable expectation of success, as this is a simple substitution of structures known to a POSA to yield a predictable result.

2. Motivation to Combine Sakatani with Machida and Kim

Sakatani expressly discloses the sockets (the claimed "drop line connector") connecting to the trunk cables (the claimed "central trunk"). A POSA would have been motivated to modify the wiring connections for solar cell panels of Machida (as modified in view of Kim) further in view the teaching of Sakatani—including

connecting the drop line connector to the central trunk for the same reasons discussed above. *See* Sections VI.A.2, VI.A.12, *supra.*

3. Claim 1

The preamble of claim 1 is disclosed by Machida. *See* Section VI.A.3, *supra.*

a. Part[a]

Part [a] is disclosed by Machida. *See* Section VI.A.3.a, *supra*.

b. Part[b]

Part [b] is disclosed by Machida in view of Sakatani. *See* Section VI.A.3.b, *supra.* As discussed in *Part [c1], infra,* Kim also discloses that the "second diameter [of the first drop line] being different than the first diameter [of the feeder cable]."

c. Part[c]

Part[c1]

It would also have been obvious to modify the joint disclosed in Machida to include a second drop line in view of the teachings in Kim. For example, as shown in Kim Figures 1 and 2 (reproduced as FIGS. 25-26 below with annotation), Kim discloses two cables 102 (the claimed "drop lines") branching off from a joint with a sealing portion 300. Kim describes a cable 102 in FIG. 25, and FIG. 26 shows that each of the drop lines extend at least partially through the sealing portion 300. EX1013, Figures 1, 2, ¶ [0018]; *see also id.*, ¶ [0029]. The joint also includes a cable 101 (the claimed "feeder cable") extending completely through the joint.

Accordingly, Kim discloses two cables 102 (the claimed two drop lines) on both sides of the sealing portion 300. A POSA would have been motivated to modify the connector and plug assembly of Machida to include a second drop line, as disclosed in Kim for the reasons discussed in Section VI.B.1 above.

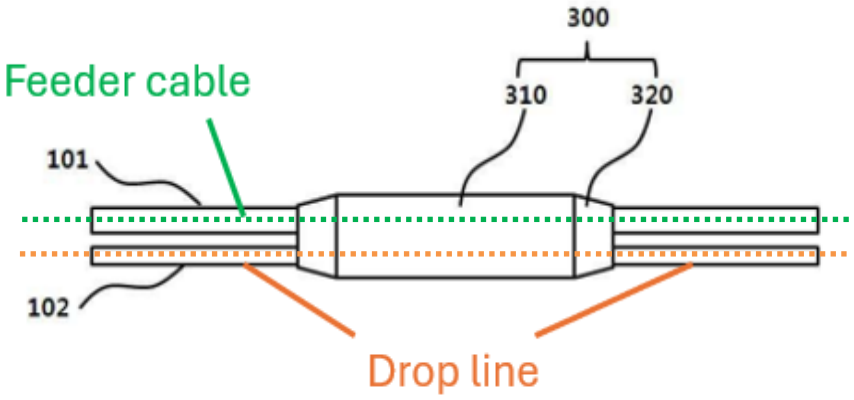

FIG. 25: Kim Figure 1 (annotated)

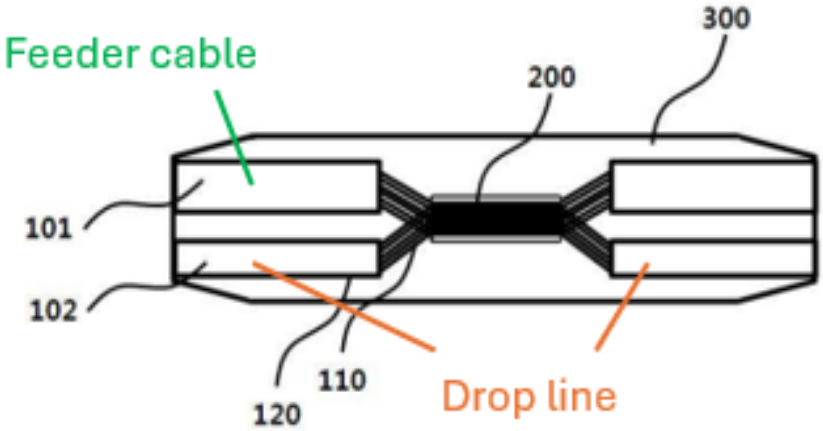

FIG. 26: Kim Figure 2 (annotated)

As shown with the annotations on FIG. 25, Kim discloses that the "second diameter" (for first drop line) is different from the "first diameter" (of the feeder cable), and

that the "third diameter" (for the second drop line) is different from the first diameter (for the feeder cable). *See* EX1013 at Abstract, [0017]-[0018].

Part[c2]

As discussed above, it would have been obvious to modify Machida to include two drop lines. FIG. 19. Both drop lines would have terminated at the sleeves 23a and 28a (the claimed "second drop line connector"), respectively. *See also* Section VI.A.3.c, *supra.*

d. Part[d]

Part [d] is disclosed by Machida. *See* Section VI.A.3.d, *supra.*

e. Part[e]

Part [e] is disclosed by Machida. *See* Section VI.A.3.e, *supra.*

f. Part[f]

Part [f] is disclosed by Machida. *See* Section VI.A.3.f, *supra*. Alternatively, it would have been obvious over Machida in view of Kim because Kim discloses portions of the first and second drop lines that extend in opposite directions along a longitudinal axis (the orange dotted line in FIG. 25) that is parallel to a longitudinal axis (the green dotted line in FIG. 25) of the feeder cable. *See* Section VI.B.3.c, *supra*; FIGS. 25-26.

4. Claim 2

Claim 2 is disclosed by Machida. *See* Section VI.A.4, *supra.*

5. Claim 3

Claim 3 is disclosed by Machida. *See* Section VI.A.5, *supra*.

6. Claim 4

Claim 4 is disclosed by Machida. *See* Section VI.A.6, *supra*.

7. Claim 5

Claim 5 is disclosed by Machida. *See* Section VI.A.7, *supra*.

8. Claim 6

Claim 6 is disclosed by Machida. *See* Section VI.A.8, *supra*.

9. Claim 8

The limitations of claim 8 would have been obvious over Machida. *See* Section VI.A.9, *supra.* Moreover, as discussed in Section VI.B.3.c above, Machida's connector 1 would have been modified in view of Kim to include a second drop line. *See* FIGS. 25-26. With reference to FIG. 26, the joint (the claimed "lead assembly") with a sealing portion 300 combines, in the cable 101 (the claimed "feeder cable"), electrical power received through the first and second drop line connectors (Machida's sleeves 23a and 28a, *see* FIG. 16) of the two cables 102 (the claimed "first and second drop lines").

10. Claim 9

Claim 9 is disclosed by or would have been obvious over Machida. *See* Section VI.A.10, *supra*.

11. Claim 10

Claim 10 would have been obvious over Machida. *See* Section VI.A.11, *supra*.

12. Claim 12

Claim 12 would have been obvious over Machida in view of Sakatani. *See* Section VI.A.12, *supra*.

13. Claim 13

Claim 13 would have been obvious over Machida in view of Sakatani. *See* Section VI.A.13, *supra*.

VII. MANDATORY NOTICES

A. Real Parties-in-Interest (37 C.F.R. § 42.8(b)(1))

Other than the Petitioners, there are no real parties-in-interest.

B. Related Matters (37 C.F.R. § 42.8(b)(2))

The ’376 Patent is involved in the following legal matters.

Matter	Case Name	Case No.
Civil Action	Shoals Technologies Group, LLC *v.* Voltage, LLC *et al*	1-25-cv-00026 (M.D.N.C.)
ITC	Certain Photovoltaic Trunk Bus Cable Assemblies and Components Thereof	337-TA-1438

C. Identification of Counsel (37 C.F.R. § 42.8(b)(3))

Lead Counsel	Back-Up Counsel
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Please direct all correspondence to lead and backup counsel at the address identified above. Petitioners consent to electronic service by e-mail. Concurrently filed herewith are Powers of Attorney pursuant to 37 C.F.R. § 42.10(b).

VIII. GROUNDS FOR STANDING AND PROCEDURAL STATEMENT

Petitioners certify that the '376 Patent is available for *inter partes* review and that Petitioners are not barred or estopped from requesting an *inter partes* review of the patent on the grounds identified herein.

IX. PAYMENT OF FEES (37 C.F.R. §§ 42.103 AND 42.15(A)(1))

The *inter partes* review fee accompanies this Petition. Petitioners authorize the PTO to charge any additional fees to Deposit Acct. No. 05-1323 (Reference No. 125063.0000001).

X. CONCLUSION

The Challenged Claims are unpatentable for the reasons set forth above.

Respectfully submitted,

DATED: October 16, 2025

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Claim Appendix of Challenged Claims

Independent Claim 1

[pre] A lead assembly for electrically coupling one or more drop lines to a feeder cable, the lead assembly comprising:

[a] a feeder cable having a first diameter;

[b] **[b1]** a first drop line having a second diameter different than the first diameter,

[b2] the first drop line terminating at a first drop line connector,

[b3] the first drop line connector configured to be capable of detachable connection to a wire harness [having a plurality of branches that are each] configured to receive electrical power generated by a corresponding photovoltaic (PV) panel resulting in combined electrical power at the first drop line connector;

[b4] [… a wire harness] having a plurality of branches that are each [configured to receive electrical power …]

[c] **[c1]** a second drop line having a third diameter different than the first diameter,

[c2] the second drop line terminating at a second drop line connector; and

[d] one or more mold structures disposed a bout [*sic*] and conforming to a region of electrical interconnection between the feeder cable, the first drop line, and the second drop line, the one or more mold structures substantially sealing the region of electrical interconnection from external environmental conditions;

[e] wherein the combined electrical power received at the first drop line connector is delivered to the feeder cable at the region of electrical interconnection; and

[f] wherein, in the region of electrical interconnection, the first drop line and the second drop line extend in opposite directions along a longitudinal axis that is parallel to a longitudinal axis of the feeder cable.

Claim 2

[a] The lead assembly of claim 1, wherein:
the feeder cable extends continuously through the one or more mold structures such that the feeder cable extends out of and away from the one or more mold structures in one direction and out of and away from the one or more mold structures in an opposite direction; and

[b] the first drop line includes one end that terminates within the one or more mold structures.

Claim 3

[a] The lead assembly of claim 1, wherein in the region of electrical interconnection:
the first drop line includes a section of exposed wire; and

[b] the feeder cable includes a section of exposed wire.

Claim 4

[4] The lead assembly of claim 1, wherein in the region of electrical interconnection, the first drop line is coupled to the feeder cable using at least one of a compression lug, a solder portion, a splice, or a crimp.

Claim 5

[5] The lead assembly of claim 1, further comprising a feeder cable connector at an end of the feeder cable, the feeder cable connector configured to electrically couple the feeder cable to an inverter without an intervening combiner box.

Claim 6

[6] The lead assembly of claim 1, wherein in the region of electrical interconnection, at least a portion of the first drop line is arranged parallel to at least a portion of the feeder cable.

Claim 8

[8] The lead assembly of claim 1, wherein the lead assembly is configured to combine, in the feeder cable, combined electrical power received through the first and second drop line connectors of first and second drop lines and to deliver the combined electrical power to an inverter that is in electrical communication with the feeder cable.

Claim 9

[9] The lead assembly of claim 1, wherein each of the first and second drop lines includes a wire of between four (4) gauge to eighteen (18) gauge.

Claim 10

[10] The lead assembly of claim 1, wherein the feeder cable includes a wire of between 250 MCM to 1000 MCM.

Claim 12

[a] A solar power system comprising:
the lead assembly of claim 1;

[b] a first plurality of PV panels electrically coupled by the wire harness to form a first solar array, the wire harness further including a first central trunk, each branch of the plurality of branches electrically coupling a different one of the first plurality of PV panels to the first central trunk; and

[c] a second plurality of PV panels electrically coupled by a second wire harness to form a second solar array, the second wire harness including a second central trunk and a second plurality of branches, each branch of the second plurality of branches electrically coupling a different one of the second plurality of PV panels to the second central trunk,

[d] wherein:

the first drop line connector connects to the first central trunk;

[e] the first drop line connector and the first drop line electrically couple the first solar array to the feeder cable;

[f] the second drop line connector connects to the second central trunk; and

[g] the second drop line connector and the second drop line electrically couple the second solar array to the feeder cable.

Claim 13

[a] The lead assembly of claim 1, wherein:

the first drop line connector connects to a first central trunk of the wire harness;

[b] each branch of the plurality of branches of the wire harness couples a different one of a first plurality of PV panels to the first central trunk;

[c] the first plurality of PV panels electrically coupled by the wire harness form a first solar array;

[d] the first drop line connector and the first drop line electrically couple the first solar array to the feeder cable;

[e] the second drop line connector connects to a second central trunk of a second wire harness;

[f] each branch of a plurality of branches of the second wire harness couples a different one of a second plurality of PV panels to the second central trunk;

[g] the second plurality of PV panels electrically coupled by the second wire harness form a second solar array; and

[h] the second drop line connector and the second drop line electrically couple the second solar array to the feeder cable.

Certification of Word Count

Pursuant to 37 C.F.R. § 42.24(d), Petitioners hereby certify, in accordance with and reliance on the word count provided by the word-processing system used to prepare this Petition, that the number of words in the Petition is 13,984. Pursuant to 37 C.F.R. § 42.24(a), this word count excludes the table of contents, mandatory notices, the certificates of service and word count, claim appendix of challenged claims and the appendix of exhibits.

Respectfully submitted,

Dated: October 16, 2025

/Scott L. Bittman/
Scott L. Bittman

Certificate of Service

Pursuant to 37 C.F.R. § 42.6(e)(4), I certify that the foregoing Petition, along with the accompanying exhibits, is being served on the following correspondence address of record for the subject patent via Federal Express on this October 16, 2025:

Maschoff Brennan
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Courtesy copies are also being served via e-mail on Patent Owners' litigation counsel of record at the following address:

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Respectfully submitted,

Dated: October 16, 2025

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