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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte YEHUI HAN and JIYAO WANG

Appeal 2019-003134
Application 14/181,085
Technology Center 2800

Before DONNA M. PRAISS, MICHELLE N. ANKENBRAND, and JEFFREY R. SNAY, *Administrative Patent Judges*.

ANKENBRAND, *Administrative Patent Judge*.

DECISION ON APPEAL

Appellant[1] appeals under 35 U.S.C. § 134(a) from the Examiner's decision[2] finally rejecting claims 1, 2, 4–13, and 15–22. We have jurisdiction under 35 U.S.C. § 6(b).

We affirm in part.

[1] Appellant identifies Wisconsin Alumni Research Foundation as the real party in interest. Appeal Brief, filed July 6, 2018 ("Appeal Br.") 3.
[2] Final Action, mailed February 7, 2018 ("Final Act.").

STATEMENT OF THE CASE

Background

The subject matter on appeal relates to a converter that can convert DC power to AC power, which can be supplied to an electric machine. Specification, filed February 14, 2014 ("Spec.") ¶¶ 3, 29, 32. We reproduce Appellant's Figure 7 below.

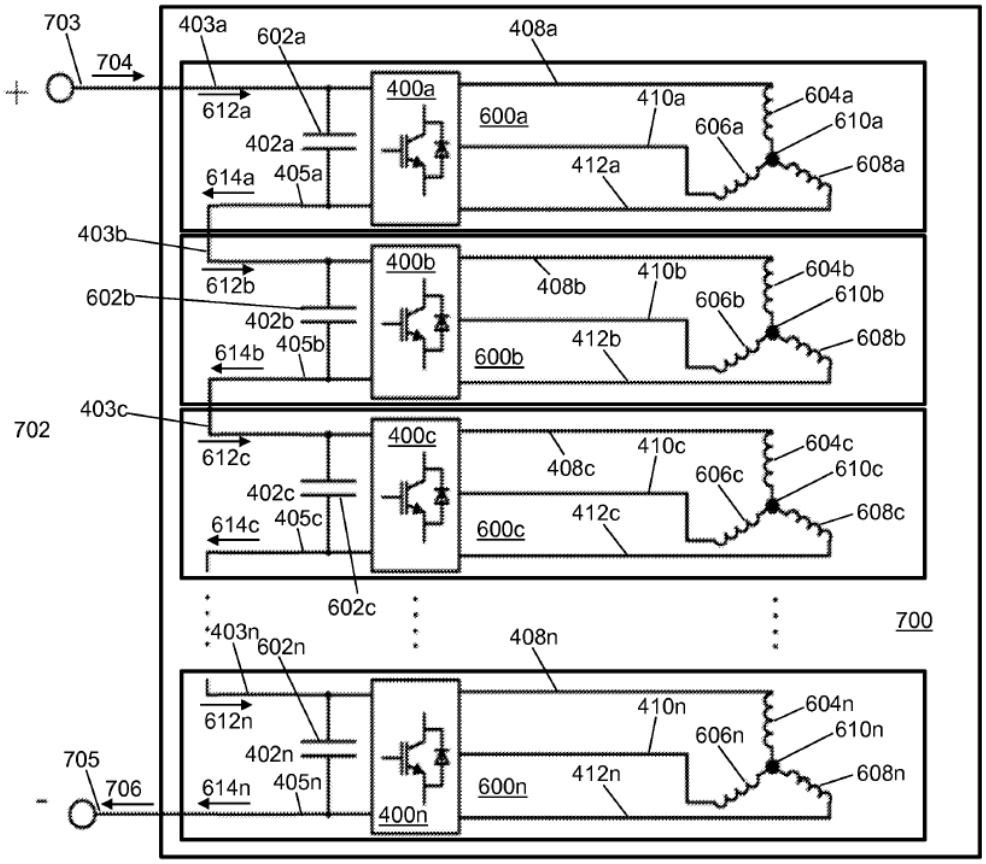

Fig. 7

Figure 7 depicts a multi-level converter module.

Multi-level converter module 700 includes first single converter module 600a having first capacitor 602a and first multi-phase inverter 400a. *Id.* ¶¶ 44–45. Multi-level converter module 700 further includes second single converter module 600b having second capacitor 602b and second multi-phase inverter 400b. *Id.* ¶¶ 44, 46. Multi-phase inverters 400a, 400b are

connected to the windings of an electric machine. *Id.* ¶¶ 45–46. The single converter modules are connected in series to reduce an input voltage across each single converter module, which reduces the voltage stress on the single converter modules and allows the use of low-voltage, less expensive circuit components. *Id.* ¶ 54. Multi-level converter module 700 also can accommodate a wide range of voltage levels and power ratings. *Id.*

Of the appealed claims, claims 1, 12, and 20 are independent. Claim 1 is representative of the subject matter on appeal, and is reproduced below:

1. A converter comprising:

a first multi-phase inverter comprising

a first plurality of switch-diode circuits for each phase of the first multi-phase inverter;

a first direct current (DC) positive line;

a first DC negative line, wherein the first plurality of switch-diode circuits are connected between the first DC positive line and the first DC negative line; and

a first plurality of alternating current (AC) lines, wherein a first end of each AC line of the first plurality of AC lines is connected between a pair of the first plurality of switch-diode circuits for a respective phase of each AC line of the first plurality of AC lines, wherein each AC line of the first plurality of AC lines is configured to be connected at a second end to a single phase winding of an electric machine;

a second multi-phase inverter comprising

a second plurality of switch-diode circuits for each phase of the second multiphase inverter;

a second DC positive line;

a second DC negative line, wherein the second plurality of switch-diode circuits are connected between

the second DC positive line and the second DC negative line; and

a second plurality of AC lines, wherein a first end of each AC line of the second plurality of AC lines is connected between a pair of the second plurality of switch-diode circuits for a respective phase of each AC line of the second plurality of AC lines, wherein each AC line of the second plurality of AC lines is configured to be connected at a second end to a second single phase winding of the electric machine;

a first capacitor connected in parallel with the first multi-phase inverter between the first DC positive line and the first DC negative line; and

a second capacitor connected in parallel with the second multi-phase inverter between the second DC positive line and the second DC negative line,

wherein the first DC negative line is electrically coupled to the second DC positive line to connect the first multi-phase inverter and the second multi-phase inverter in series.

Appeal Br. 28–29 (Claims App'x).

The References

Barza US 2014/0002002 A1 Jan. 2, 2014

Rodriguez et al., *Multilevel Inverters: A Survey of Topologies, Controls, and Applications*, IEEE Transactions on Industrial Electronics, vol. 49, no. 4, 724–38 (2002).

The Rejection

The Examiner maintains the rejection of claims 1, 2, 4–13, and 15–22 under 35 U.S.C. § 103 as unpatentable over Barza in view of Rodriguez. Examiner's Answer, mailed January 14, 2019 ("Ans."), 2–6.

OPINION

Appellant argues claims 1, 12, and 20 as a first group, claim 5 as a second group, and claims 6–8 and 16–18 as a third group. Appeal Br. 16–26. Appellant does not present separate arguments for claims 2, 4, 9–11, 13, 15, 19, 21, and 22, each of which stands or falls with the independent claim from which it ultimately depends. *See* 37 C.F.R. § 41.37(c)(1)(iv).

Claims 1, 2, 4, 9–13, 15, 19–22

The Examiner finds that Barza discloses a first multi-phase inverter and a second multi-phase inverter, as claim 1 requires, and that the multi-phase inverters are connected in series. Final Act. 4–8 (citing Barza Figs. 3, 4, ¶ 61).

The Examiner finds Barza does not disclose first and second capacitors connected in parallel with the multi-phase inverters, as claim 1 requires. *Id.* at 7. The Examiner further finds that a flying capacitor multilevel inverter is a well-known topology and that Rodriguez's Figure 4 and Figure 5 show a "[c]ascaded inverter with three-phase cells with three flying capacitors at each level." *Id.* at 7–8. The Examiner concludes it would have been obvious to modify Barza in view of Rodriguez to use a capacitor at each level, i.e., in parallel, in order to provide voltage balancing or voltage regulation control. *Id.* at 8.

Appellant contends Rodriguez's Figure 4 shows a nine-level cascaded inverter but not a multi-phase inverter, Figure 4 does not teach connecting multi-phase inverters in series with a capacitor connected across each multi-phase inverter, and, if one were to modify Barza in view of Rodriguez, Rodriguez's nine-level inverter would replace each single current branch of Barza's device. Appeal Br. 16–18; Reply Brief, filed March 12, 2019

("Reply Br."), 16–18. Appellant also argues that, although "Fig. 5 of Rodriguez shows multi-phase inverters," because Figure 5 "shows three separate three-phase inverters with their own power sources" and "[s]eparate capacitors are connected across each multi-phase inverter," "[t]he inverters are not connected in series as recited in Claims 1, 12, and 20." Appeal Br. 18–19 (emphases omitted); Reply Br. 18–19. Appellant also argues that the Figure 5 inverters are connected to separate DC sources and that modifying Barza in view of Figure 5 would replace Barza's entire circuit with Rodriguez's circuit and change Barza's circuit's principle of operation. Appeal Br. 19–20; Reply Br. 19–20.

"The test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference." *In re Keller*, 642 F.2d 413, 425 (CCPA 1981). "Rather, the test is what the combined teachings of the references would have suggested to those of ordinary skill in the art." *Id.* Appellant's arguments are not persuasive because they fail to consider what Barza's and Rodriguez's combined teachings would have taught or suggested to one of ordinary skill in the art.

Barza's Figure 3 is reproduced below.

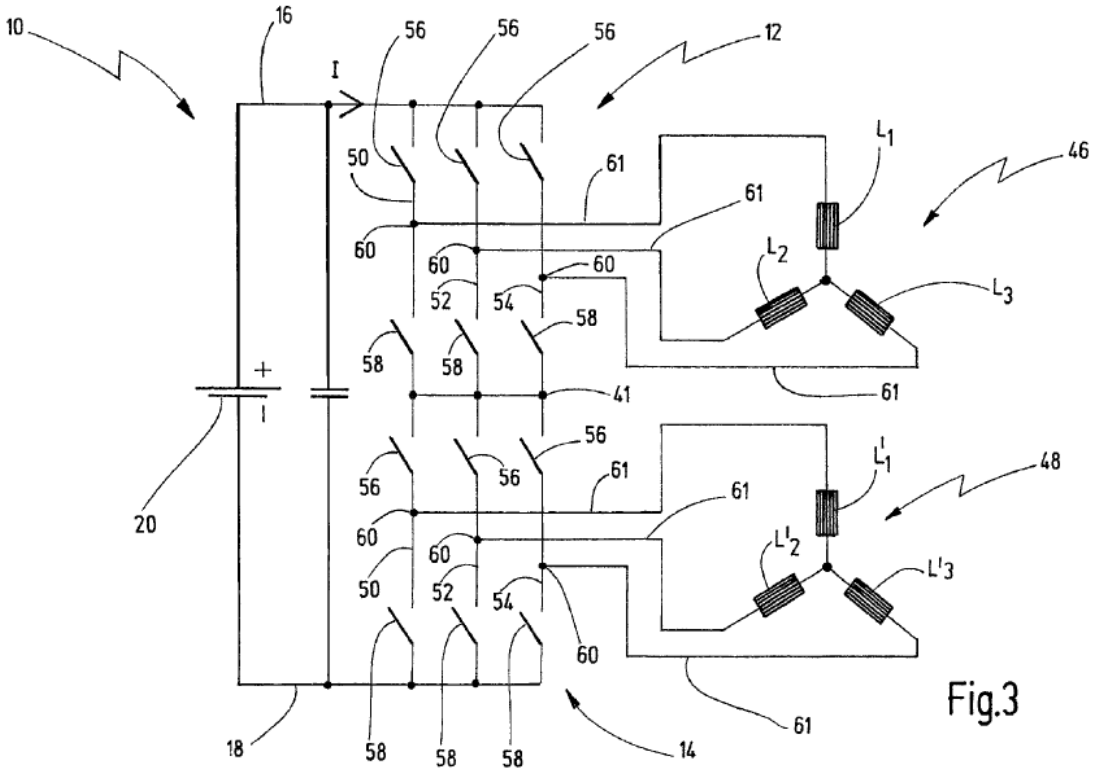

Figure 3 is a schematic circuit diagram of a control unit for controlling two coil arrangements of an electric drive

Barza's control unit 10 includes first control arrangement 12 and second control arrangement 14 respectively connected to electric loads 46, 48 (i.e., coil systems of an electric machine) to provide multi-phase current. Barza ¶¶ 60, 61, 73. Barza teaches "control arrangements 12, 14 are connected in series between the voltage connections 16, 18" and each of control arrangements 12, 14 has three current branches 50, 52, 54, which each have two controllable switches 56, 58. *Id.* ¶ 73.

Barza discloses a similar embodiment in Figure 4, which we reproduce below.

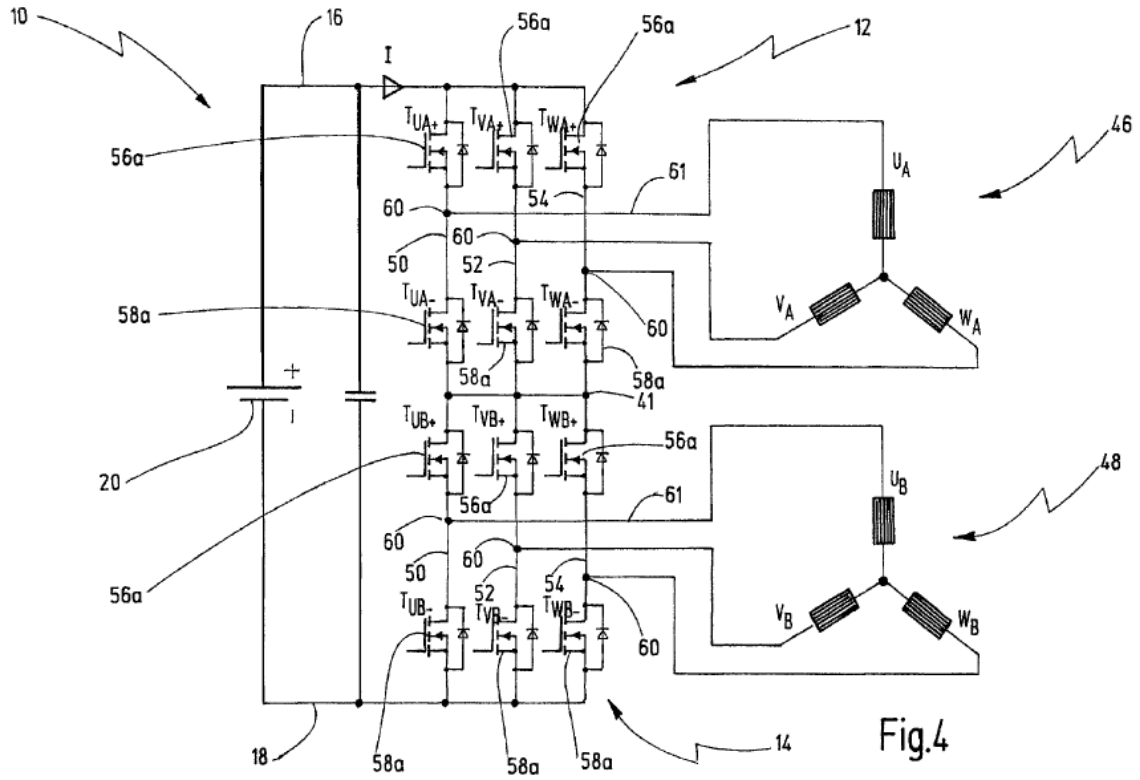

Fig.4

Figure 4 is a schematic circuit diagram of a control unit having controllable semiconductor switches

In Figure 4's embodiment, Barza teaches controllable switches 56, 58 are formed by semiconductor switches 56a, 58a. *Id.* ¶ 77. Therefore, Barza's disclosure supports the Examiner's findings that Barza teaches or suggests first and second multi-phase inverters that are connected in series, as claims 1, 12, and 20 recite.

We reproduce below a copy of Rodriguez's Figure 5 with our annotations.

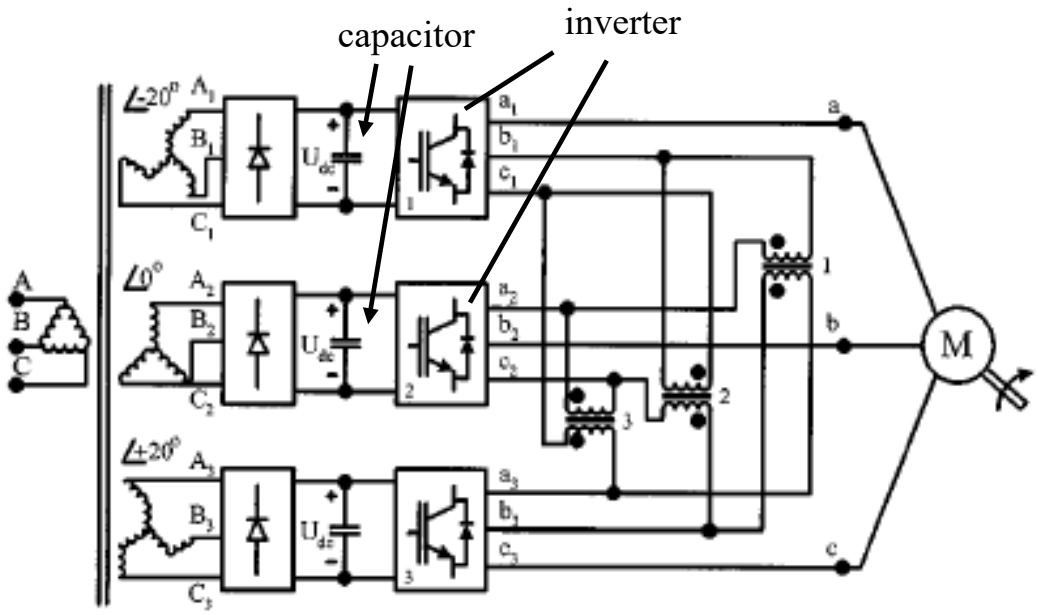

Fig. 5. Cascaded inverter with three-phase cells.

Figure 5 depicts a cascaded multilevel inverter

Rodriguez discloses cascaded multicell inverters and teaches that Figure 5 uses "standard three-phase two-level inverters." Rodriguez, 726. As shown in annotated Figure 5 above, capacitors are connected in parallel with the inverters. Also, as noted above, Appellant concedes Figure 5 shows multi-phase inverters and separate capacitors connected across each multi-phase inverter. Appeal Br. 19.

Rather than focusing on what the combined teachings of Barza and Rodriguez would have taught or suggested to those of ordinary skill in the art, Appellant's arguments focus on the individual teachings of Barza and Rodriguez. But, as we explain above, the test for obviousness does not require either Barza or Rodriguez to teach or suggest both serial first and

second inverters and a capacitor in parallel with each inverter, as claims 1, 12, and 20 recite.

Here, as discussed above, Barza's and Rodriguez's disclosures support the Examiner's findings that Barza discloses serial first and second inverters and that Rodriguez's Figure 5 teaches a capacitor at each level of an inverter, i.e., a capacitor connected in parallel with the inverter. Appellant's argument that the ordinary artisan would have replaced Barza's circuit with Rodriguez's circuit appears to rely upon bodily incorporating Rodriguez's device into Barza's without properly considering what the combined teachings of these references would have taught or suggested to one of ordinary skill in the art.

Further, to the extent Appellant is arguing that differences between Barza's circuit and Rodriguez's circuit would have made their combination nonobvious, Appellant's arguments are insufficiently developed. For instance, Appellant's argument that the combination would have changed the principle of operation of Barza's circuit is based on wholly incorporating Rodriguez's circuit into Barza's circuit and does not explain why using a capacitor in parallel with each of Barza's inverters, as Rodriguez teaches, would have changed Barza's principle of operation.

Appellant also contends the Examiner's rationale for modifying Barza in view of Rodriguez is insufficient because: (1) a flying capacitor at each level of an inverter is inapplicable to Barza, which supplies two loads with multi-phase power and does not contemplate using Rodriguez's inverter; (2) flying capacitors are a topology for multilevel inverters but not multi-phase inverters like those disclosed in Rodriguez's Figures 4 and 5; and

(3) the issues and solution Rodriguez teaches or suggests would not have been relevant to Barza. Appeal Br. 21–22; Reply Br. 21–25.

These arguments are also unpersuasive. To the extent that Appellant's first argument points to differences between Barza's circuit and Rodriguez's circuit, Appellant does not explain sufficiently why those differences undermine the Examiner's rationale.

As to the second argument, Appellant's own Specification contradicts Appellant's assertion that flying capacitors are not a topology for multi-phase inverters. Spec. ¶ 62 ("Third multi-phase inverter 1200 is similar to multi-phase inverter 400 except that each phase 1202 of third multi-phase inverter 1200 is formed using a flying capacitor topology as understood by a person of skill in the art.").

Further, to the extent Appellant refers only to the Examiner's statements in the rejection and the Answer regarding flying capacitors, the Examiner also specifically refers to Rodriguez's Figure 5 when discussing that it was known to use capacitors at each level of an inverter (i.e., in parallel with the inverter). *See* Final Act. 7–8; Ans. 4. And Appellant agrees that Figure 5 discloses a cascaded multi-phase inverter. Appeal Br. 19, 21–22. For the reasons discussed above, we agree with the Examiner that Rodriguez's Figure 5 teaches capacitors in parallel with inverters.

We also find unpersuasive Appellant's argument that the issues and solution Rodriguez teaches or suggests would not have been relevant to Barza. Specifically, Appellant contends that Rodriguez teaches a voltage balancing problem for diode-clamped multilevel inverters and capacitor-clamped multilevel inverters in comparison to the cascade inverters depicted in Rodriguez's Figures 4 and 5. Appeal Br. 22. Appellant argues "[t]hese

issues/solutions are not relevant to the circuit taught by Barza." *Id.* (emphasis omitted). In that regard, Appellant contends that Barza's circuit "is designed to achieve a multi-phase signal not a multilevel signal." Reply Br. 23. These arguments are not developed sufficiently to explain why Rodriguez's issues and solution would not have been relevant or why it would not have been obvious to apply Rodriguez's solution, which is embodied in Rodriguez's Figure 5, to Barza's circuit.

Further, Appellant's own arguments regarding an insufficient rationale highlight how Rodriguez's disclosure supports the Examiner's rationale. Although Rodriguez discloses that cascaded inverters (e.g., the embodiment depicted in Rodriguez's Figure 5) can experience a slight voltage imbalance that "[a] simple control scheme" can correct, Rodriguez also states that "the cascaded inverter has an inherent self-balancing characteristic." Rodriguez 732. Thus, Rodriguez teaches or suggests that using a cascaded inverter such as the one in Figure 5 would provide some degree of voltage balancing, which supports the Examiner's reason to modify Barza in view of Rodriguez. Final Act. 8.

As discussed above, the Examiner's rejection modifies Barza in view of Rodriguez to add a capacitor in parallel with each of Barza's control arrangements. Ans. 4–5 (annotating Barza's Figure 3 to add a capacitor in parallel with each control arrangement). Appellant's arguments fail to explain sufficiently why this modification would not result in the improvement (i.e., voltage balancing) that Rodriguez suggests. Accordingly, we affirm the Examiner's rejection of claims 1, 2, 4, 9–13, 15, and 19–22 under 35 U.S.C. § 103.

Claim 5

Claim 5 depends from claim 4, which depends from claim 1. Claim 4 recites "wherein a phase of a current input to the second multi-phase inverter is shifted relative to a current input to the first multi-phase inverter." Appeal Br. 29 (Claims App'x). Claim 5 recites "wherein the phase is determined based on a number of multi-phase inverters forming the converter." *Id.*

In the rejection, the Examiner finds Barza discloses the limitations of claim 4. Final Act. 8 (citing Barza ¶ 61). The Examiner determines claim 5 "includes similar features as those discussed above in connection with claim 4" and rejects claim 5 for the same reasons. *Id.*

Appellant asserts that the cited portion of Barza does not teach the limitations of claim 5 because "[s]tating an arbitrary phase shift fails to teach anything whatsoever related to the phase being determined based on the number of multi-phase inverters." Appeal Br. 23–24.

In response, the Examiner maintains that Barza's paragraph 61 suggests the limitations of claim 5. The Examiner also explains that Barza's device includes a control system with multi-phase inverters and the system can supply an electric machine with current in multiple phases that are shifted according to the number of phases because, in general, phases are determined by dividing 360° by the number of phases in a machine. Ans. 5.

Appellant replies by repeating the arguments set forth in the Appeal Brief, further arguing "the passage of Barza states an arbitrary phase shift not a phase determined based on a number of multi-phase inverters forming the converter," and generally asserting that the cited passage of Barza does not teach the limitations of claim 5. Reply Br. 26–27 (emphasis omitted). These arguments are limited to Barza's teachings in paragraph 61 and do not

address the Examiner's explanation in the Answer as to how a machine can produce multiple phases. As a result, Appellant's arguments are insufficient to identify a reversible error in the Examiner's rejection of claim 5.

Claims 6–8 and 16–18

Claims 6–8 depend from claim 1. Claim 6 recites "wherein each phase of the first multi-phase inverter is a first multilevel inverter, and each phase of the second multiphase inverter is a second multilevel inverter." Appeal Br. 29 (Claims App'x). Claim 7 depends from claim 6 and recites that the first and second multilevel inverters of each phase are neutral point clamped inverters. *Id.* at 30 (Claims App'x). Claim 8 depends from claim 6 and recites that the first and second multilevel inverters of each phase are flying capacitor inverters. *Id.* (Claims App'x). Claims 16–18 depend from claim 12 and recite limitations similar to those of claim 6–8. *Id.* at 33 (Claims App'x).

In rejecting claim 6, the Examiner states only "[s]ee Fig. 3."[3] Final Act. 8. For claims 7 and 8, the Examiner finds that Appellant's Specification acknowledges that using a neutral point clamped topology was a well-known feature and further finds that Rodriguez's Figures 4 and 5 teach that well-known topology. *Id.* at 8–9.

Appellant argues the references do not support the rejection because Barza does not suggest replacing each phase of its control arrangements 12,

[3] Although Appellant refers to Barza's Figure 3 in the arguments responding to this rejection, it not clear to us whether the Examiner is citing Barza's Figure 3 or Rodriguez's Figure 3 because only the statement "[s]ee Fig. 3" appears in the rejection of claim 6. The claim rejections are presented in a claim chart containing findings for each claim limitation, but the Examiner does not always accompany those findings with a statement identifying whether a citation is to Barza or Rodriguez.

14 with multilevel inverters and because Rodriguez's Figures 4 and 5 do not teach neutral point clamped or flying capacitor inverters. Appeal Br. 24–26.

The Examiner responds that the "Examiner believes that the multilevel power converter of Barza modified with the implementation of flying Capacitors topology of multilevel inverter taught in Rodriguez, has a similar structure circuit constituted of the same claimed elements having similar functionality." Ans. 6. This statement is conclusory and does not explain how modifying Barza in view of Rodriguez provides the same structure with similar functionality or how the proposed modification otherwise would have rendered claims 6–8 and 16–18 obvious.

"[T]he examiner bears the initial burden, on review of the prior art or on any other ground, of presenting a prima facie case of unpatentability." *In re Oetiker*, 977 F.2d 1443, 1445 (Fed. Cir. 1992) (emphasis omitted). The rejection lacks sufficient factual findings and explanation as to why claims 6–8 and 16–18 would have been obvious. As a result, the Examiner has not set forth a prima facie case of obviousness for claims 6–8 and 16–18.

CONCLUSION

The Examiner's rejection of claims 1, 2, 4, 5, 9–13, 15, and 19–22 under 35 U.S.C. § 103 over Barza and Rodriguez is affirmed.

The Examiner's rejection of claims 6–8 and 16–18 under 35 U.S.C. § 103 over Barza and Rodriguez is reversed.

In summary:

Claim(s) Rejected	35 U.S.C. §	References/Basis	Affirmed	Reversed
1, 2, 4–13, 15–22	103	Barza, Rodriguez	1, 2, 4, 5, 9–13, 15, 19–22	6–8, 16–18
Overall Outcome			1, 2, 4, 5, 9–13, 15, 19–22	6–8, 16–18

TIME PERIOD FOR RESPONSE

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a). *See* 37 C.F.R. § 1.136(a)(1)(iv).

AFFIRMED IN PART