

For: **Preconditioned Air Unit with Variable Frequency Driving**

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 9,771,169**

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Exhibit List

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1001	U.S. Patent No. 9,771,169 B2 (“169 patent”)
1002	File History of U.S. Patent No. 9,771,169 B2 (“169 FH”)
1003	Declaration of Steven B. Leeb, Ph.D. (“Leeb Decl.”)
1004	<i>Curriculum Vitae</i> of Steven B. Leeb
1005	U.S. Patent No. 5,715,701 (“Kreymer”)
1006	International Patent Publication No. WO 2007/046794 A1 (“Taras”)
1007	U.S. Patent No. 5,351,498 (“Takahashi”)
1008	German Patent Utility Model No. DE 296 22 089 U 1 (“Lechmotoren”) (English version of Exhibit 1021)
1009	Carrier Corp., <i>Variable Frequency Drive: Operation & Application of Variable Frequency Drive (VFD) Technology</i> (Oct. 2005), https://www.shareddocs.com/hvac/docs/1001/Public/0B/WP_VARFREQDRIVE.pdf (last visited Jan. 4, 2025)
1010	Am. Soc’y of Heating, Refrigerating & Air-Conditioning Eng’rs, Inc. (ASHRAE), <i>2008 ASHRAE Handbook: HVAC Systems & Equipment</i> (2008) (“ASHRAE 2008 Handbook”)
1011	Ross Montgomery & Robert McDowall, <i>Fundamentals of HVAC Control Systems</i> , ASHRAE (2008) (excerpts)

Exhibit	Description
1012	Katherine B. Preston et al., <i>Airport Coop. Rsch. Program (ACRP) Rep. No. 207: Optimizing the Use of Electric Preconditioned Air (PCA) & Ground Power Systems at Airports</i> (2019), available at https://nap.nationalacademies.org/catalog/25623/optimizing-the-use-of-electric-preconditioned-air-pca-and-ground-power-systems-for-airports (“ACRP Rep. 207”)
1013	Benjamin Cromie, <i>What is a Pre-Conditioned Air Unit</i> ,” PHL.org (July 6, 2023), https://www.phl.org/newsroom/PCAs (last visited Dec. 11, 2024, 5:40 p.m.)
1014	U.S.P.T.O. Assignment Abstract of Title for [U.S. Patent No. 9,771,169 B2 (’169 patent)] Application No. 13257669 (recorded Sept. 20, 2011), Docket No. 22664
1015	Solomon S. Turkel, “ <i>Understanding Variable Speed Drives (Part 2): A Thorough Understanding of How to Match the VFD to the Driven Load is the Key to a Successful Application</i> ,” EC&M (Apr. 1, 1999), https://www.ecmweb.com/basics/article/20897058/understanding-variable-speed-drives-part-2
1016	U.S. Patent No. 3,971,972 (“Stich”)
1017	U.S. Patent No. 4,272,967 (“White”)
1018	U.S. Patent No. 5,383,335 (“Anderson”)
1019	U.S. Patent No. 5,797,729 (“Rafuse”)
1020	U.S. Patent Application Publication No. US 2008/0174257 A1 (“Schnetzka”)
1021	German Patent Utility Model No. DE 296 22 089 U 1 (Lechmotoren) (German version of Exhibit 1008)
1022	Declaration of Ingrid Hsieh-Yee

Exhibit	Description
1023	<i>Curriculum Vitae</i> of Ingrid Hsieh-Yee
1024	Carrier Corp., White Papers, Internet Archives Wayback Machine searches (Dec. 1, 2007, Dec. 16, 2007 & July 18, 2009), https://web.archive.org/web/20071201093321/http://www.commercial.carrier.com/commercial/hvac/technical_literature/1%2C3063%2CCCLI1_CNT1_DIV12_ETI8627_MID4337_QRYY%2C00.html (last visited Dec. 6, 2024, 4:33 p.m.) (regarding Carrier Corp., <i>Variable Frequency Drive: Operation & Application of Variable Frequency Drive (VFD) Technology</i> (Oct. 2005) (Ex. 1040))
1025	Carrier Corp., White Papers, Internet Archives Wayback Machine searches (Jan. 3, 2008 & July 18, 2009, respectively), https://web.archive.org/web/20080103002120/http://www.commercial.carrier.com/commercial/hvac/technical_literature/1%2C3063%2CCCLI1_CNT1_DIV12_ETI8627_MID4337_QRYY%2C00.html (last visited Dec. 6, 2024, 4:35 p.m.) (regarding Carrier Corp., <i>Variable Frequency Drive: Operation & Application of Variable Frequency Drive (VFD) Technology</i> (Oct. 2005) (Ex. 1040))
1026	Carrier Corp., White Papers, Internet Archives Wayback Machine searches (Feb. 7, 2008 & July 18, 2009, respectively), https://web.archive.org/web/20080207173830/http://www.commercial.carrier.com/commercial/hvac/technical_literature/1%2C3063%2CCCLI1_CNT1_DIV12_ETI8627_MID4440_QRYY%2C00.html (last visited Dec. 10, 2024, 1:03 p.m.) (regarding Carrier Corp., <i>Variable Frequency Drive: Operation & Application of Variable Frequency Drive (VFD) Technology</i> (Oct. 2005) (Ex. 1040))
1027	<i>Link About Starting & Protecting AC Motors [Archive]</i> , Refrigeration-Engineer Forums (Apr. 20, 2007 & May 20, 2007, respectively), https://www.refrigeration-engineer.com/forums/archive/index.php/t-7742.html (last visited Oct. 16, 2024, 11:00 a.m.)

Exhibit	Description
1028	Refrigeration-Engineer.com, Internet Archives Wayback Machine searches (Oct. 12, 2007 & Feb. 13, 2004, respectively), https://web.archive.org/web/20071012021115/http://www.refrigeration-engineer.com/ ; and archived on February 13, 2004, available at https://web.archive.org/web/20040213191227/http://www.refrigeration-engineer.com/chat/ (last visited Dec. 22, 2024, 10:01 p.m.)
1029	Carrier Corp., Internet Archives Wayback Machine searches (Feb. 23, 2006–Jan. 24, 2013), https://web.archive.org/web/*/http://www.xpedio.carrier.com/idc/* (last visited Jan. 7, 2025) and white paper archived on January 24, 2013, available at https://web.archive.org/web/20130124022403/http://www.xpedio.carrier.com:80/idc/groups/public/documents/marketing/wp_varfreqdrive.pdf (last visited Jan. 7, 2025)
1030	Index of /idc/groups/public/documents/marketing, Internet Archives Wayback Machine search results (Nov. 22, 2007), https://web.archive.org/web/20071122161731/http://www.xpedio.carrier.com/idc/groups/public/documents/marketing/ (last visited Dec. 6, 2024, 6:08 p.m.)
1031	Index of /idc/groups/public/documents/marketing, Internet Archives Wayback Machine search results (Feb. 7, 2009), https://web.archive.org/web/20090207000247/http://www.xpedio.carrier.com/idc/groups/public/documents/marketing/#expand (last visited Dec. 6, 2024, 6:09 p.m.)
1032	Declaration of Tanya Zeif (pertaining to Exhibits 1024, 1025, 1030)
1033	Declaration of Tanya Zeif (pertaining to Exhibits 1026, 1031)
1034	A.E. Fitzgerald, Charles Kingsley, Jr., Stephen D. Umans, <i>ELECTRIC MACHINERY</i> (6th ed. 2003) (excerpt)

Exhibit	Description
1035	Declaration of Irina Hinrichs (translation of German Patent Utility Model No. DE 296 22 089 U 1 (“Lechmotoren”) from German (Ex. 1021) to English (Ex. 1008))
1036	Am. Soc’y of Heating, Refrigerating & Air-Conditioning Eng’rs, Inc. (ASHRAE), <i>2019 ASHRAE Handbook: Heating, Ventilating & Air-Conditioning Applications</i> (Inch-Pound ed. 2019) (“ASHRAE 2019 Handbook”) (excerpts)
1037	AM. SOC’Y OF HEATING, REFRIGERATING & AIR-CONDITIONING ENG’RS, INC. (ASHRAE), About ASHRAE, https://www.ashrae.org/about (last visited Jan. 2, 2024)
1038	U.S. Patent No. 5,467,606 (“Sasaki”)
1039	<i>Link About Starting & Protecting AC Motors</i> , Refrigeration-Engineer Forums (Apr. 20, 2007 & May 20, 2007, respectively), https://www.refrigeration-engineer.com/forum/technical-refrigeration/electrical/6602-link-about-starting-protecting-ac-motors (last visited Jan. 3, 2025, 1:32 p.m.)
1040	Carrier Corp., <i>Variable Frequency Drive: Operation & Application of Variable Frequency Drive (VFD) Technology</i> (Oct. 2005) (“Carrier”), https://web.archive.org/web/20090718111829/http://www.docs.hvacpartners.com/idc/groups/public/documents/marketing/wp_varfreqdrive.pdf (last visited Jan. 4, 2025)
1041	Screenshot of portion of Exhibit 1040 as appears on browser, https://web.archive.org/web/20090718111829/http://www.docs.hvacpartners.com/idc/groups/public/documents/marketing/wp_varfreqdrive.pdf

Exhibit	Description
1042	Screenshot of portion of Exhibit 1029 as appears on browser, https://web.archive.org/web/20130124022403/http://www.xpedio.carrier.com:80/idc/groups/public/documents/marketing/wp_varfreqdrive.pdf

Claim Listing

1. 1[pre] A preconditioned air unit for supplying preconditioned air to an aircraft parked on the ground, the preconditioned air unit comprising **1[a]** a housing accommodating a flow duct with an air inlet for ambient air and an air outlet for connection to the parked aircraft, a blower connected with the flow duct for generation of an air flow from the air inlet toward the air outlet,

1[b] a plurality of refrigeration systems, each of which includes

at least one compressor,

at least one condenser,

at least one expansion valve,

at least one evaporator connected in a flow circuit containing a refrigerant, and wherein the at least one evaporator interacts with the air flow in the flow duct, and

1[c] at least one variable frequency driver for power supply of the at least one compressor, and

1[d] a central controller that is configured for controlling the operation of the preconditioned air unit including variable frequency drivers of the plurality of refrigeration systems,

1[e] wherein the central controller has a power sharing control input for control of the preconditioned air unit power consumption.

2. 2[pre] A preconditioned air unit for supplying preconditioned air to an aircraft parked on the ground, the preconditioned air unit comprising

2[a] a housing accommodating a flow duct with an air inlet for ambient air and an air outlet for connection to the parked aircraft, a blower connected with the flow duct for generation of an air flow from the air inlet toward the air outlet,

2[b] a plurality of refrigeration systems, each of which includes

at least one compressor,

at least one condenser,

at least one expansion valve,

at least one evaporator connected in a flow circuit containing a refrigerant, and wherein the at least one evaporator interacts with the air flow in the flow duct, and

2[c] at least one variable frequency driver for power supply of the at least one compressor, and

2[d] a central controller that is configured for controlling the operation of the preconditioned air unit including variable frequency drivers of the plurality of refrigeration systems,

2[e] wherein the central controller automatically adjusts the cooling performed by the preconditioned air unit according to at least one of: the selected

type of aircraft, the ambient temperature, the humidity, the cabin temperature, or the outgoing airflow from the preconditioned air unit.

3. A preconditioned air unit according to claim 2, wherein the housing further accommodates at least one condenser fan positioned for generation of an airflow interacting with at least one of the condensers of the plurality of refrigeration systems.

4. A preconditioned air unit according to claim 2, wherein the housing further accommodates at least one variable frequency driver connected for power supply of at least one condenser fan for generation of an airflow interacting with at least one of the condensers of the plurality of refrigeration systems.

5. A preconditioned air unit according to claim 2, wherein the housing further accommodates a variable frequency driver connected for electrical power supply of the blower.

6. A preconditioned air unit according to claim 2, wherein at least one variable frequency driver has a controller that is configured for variation of the output frequency of the at least one variable frequency driver.

7. A preconditioned air unit according to claim 6, wherein the controller is configured for variation of the output frequency of the at least one variable frequency driver above the frequency of the mains supply of the preconditioned air unit.

8. A preconditioned air unit according to claim 6, wherein the controller is configured for variation of the output frequency of the at least one variable frequency driver above the frequency of the mains supply of the preconditioned air unit.

9. A preconditioned air unit according to claim 2, wherein the housing further accommodates a rectifier connected to a mains supply input of the air unit for generation of a power DC voltage supply.

10. A preconditioned air unit according to claim 9, wherein the rectifier is selected from the group consisting of a 12-pulse rectifier, an 18-pulse rectifier, and a 24-pulse rectifier.

11. A preconditioned air unit according to claim 2, further comprising at least one of: a user interface panel with input keys and a display, a remote control, a computer interface, a network interface, or a loudspeaker.

12. A preconditioned air unit according to claim 2, further comprising a heater in the flow duct.

13. A preconditioned air unit according to claim 2, wherein the central controller has a power sharing control input for control of the preconditioned air unit power consumption.

14. A preconditioned air unit according to claim 2, wherein each refrigeration system of the plurality of refrigeration systems is configured for failure

detection so that, in the event that one of the refrigeration systems fails, the failing refrigeration system transmits a failure signal to the central controller.

15. A preconditioned air unit according to claim 2, wherein:

15[a] at least one variable frequency driver has a controller that is configured for variation of the output frequency of the at least one variable frequency driver;

15[b] the controller is configured for variation of the output frequency of the at least one variable frequency driver above the frequency of the mains supply of the preconditioned air unit;

15[c] at least one variable frequency driver is configured to keep the ratio between the output voltage and the frequency substantially constant;

15[d] each refrigeration system of the plurality of refrigeration systems is configured for failure detection so that, in the event that one of the refrigeration systems fails, the failing refrigeration system transmits a failure signal to the central controller; and

15[e] the central controller is further configured to automatically adjust the required amount of cooling among the remaining properly operating refrigeration systems of the plurality of refrigeration systems in response to the failure signal.

16. 16[pre] A preconditioned air unit for supplying preconditioned air to an aircraft parked on the ground, the preconditioned air unit comprising

16[a] a housing accommodating a flow duct with an air inlet for ambient air and an air outlet for connection to the parked aircraft, a blower connected with the flow duct for generation of an air flow from the air inlet toward the air outlet,

16[b] a plurality of refrigeration systems, each of which includes

at least one compressor,

at least one condenser,

at least one expansion valve,

at least one evaporator connected in a flow circuit containing a refrigerant, and wherein the at least one evaporator interacts with the air flow in the flow duct, and

16[c] at least one variable frequency driver for power supply of the at least one compressor, and

16[d] a central controller that is configured for controlling the operation of the preconditioned air unit including variable frequency drivers of the plurality of refrigeration systems,

16[e] wherein each refrigeration system of the plurality of refrigeration systems is configured for failure detection so that, in the event that one of the refrigeration systems fails, the failing refrigeration system transmits a failure signal to the central controller.

17. A preconditioned air unit according to claim 16, wherein the central controller is further configured to automatically adjust the required amount of cooling among the remaining properly operating refrigeration systems of the plurality of refrigeration systems in response to the failure signal.

18. A preconditioned air unit according to claim 16, wherein at least one variable frequency driver has a controller that is configured for variation of the output frequency of the at least one variable frequency driver.

19. A preconditioned air unit according to claim 18, wherein the controller of the variable frequency driver is further configured for adjustment of the output frequency in response to a sensor output connected to the controller.

20. A preconditioned air unit according to claim 18, wherein the central controller is connected to at least one controller of at least one voltage frequency driver.

21. A preconditioned air unit according to claim 16, wherein at least one variable frequency driver keeps the ratio between the output voltage and the frequency substantially constant to maintain a high motor torque throughout the entire output frequency range.

22. A preconditioned air unit according to claim 16, wherein the central controller is further configured to automatically adjust the required amount of

cooling among the remaining properly operating refrigeration systems of the plurality of refrigeration systems in response to the failure signal.

I. Introduction

Petitioner Dabico Airport Solutions Inc. (“Dabico”) requests *inter partes* review of all claims of the U.S. Patent 9,771,169, titled “Preconditioned Air Unit with Variable Frequency Driving” (Ex.1001 (“’169 patent”)).

The ’169 patent discloses air-conditioners for cooling parked aircraft. These air-conditioners are called preconditioned air (“PCA”) units because they condition (e.g., heat or cool) the air within a housing outside of an aircraft before pushing the conditioned air into the aircraft’s cabin. PCAs can be powered by an airport’s electrical supply, saving the aircraft from having to use jet fuel to power the onboard air-conditioning systems. The ’169 patent acknowledges that PCAs were well-known and used conventional refrigeration techniques.

The ’169 patent discloses and claims PCAs with (1) variable-frequency drivers (all claims), (2) a power sharing input (claim 1), (3) automatic cooling adjustment (claim 2), and (4) failure detection (claim 16). The use of variable frequency drives (“VFD”) to drive compressors in a refrigeration system was a well-known solution with well-known benefits in the field of heating, ventilating, air-conditioning, and refrigeration (“HVAC&R”) engineering and was disclosed in several prior art references, including an International Patent Application by Taras et al. Power sharing inputs, automatic cooling adjustment, and failure detection were

also known in the art and were disclosed in, for example, a German patent by Lechmotoren, and in U.S. patents to Kreymer and Takahashi.

The dependent claims do not add any patentable limitations, either. In view of the combinations detailed below, which are obvious to a POSITA, the Board should institute *inter partes* review and cancel claims 1-22 of the '169 patent.

II. Identification of Challenges (37 C.F.R. § 42.104(b))

Ground	Claims	Basis	References
1	2-9, 11-12	§ 103	Kreymer and Taras
2	14-22	§ 103	Kreymer, Taras, and Takahashi
3	9-10	§ 103	Kreymer, Taras, and Carrier
4	1, 2, and 13	§ 103	Lechmotoren and Taras
5	14-22	§ 103	Lechmotoren, Taras, and Takahashi

III. Background

A. The '169 Patent (Ex.1001)

The '169 Patent, filed September 20, 2011, derives from PCT Application No. PCT/IB2010/051189, filed March 18, 2010, which itself claims priority to Danish Patent Application 2009/00392, filed March 20, 2009. The '169 patent was on September 26, 2017. According to USPTO records, the '169 patent is assigned to AXA Power APS. Ex.1014.

1. The '169 Patent Applies Known Variable-Frequency Drives to Known Preconditioned Air Units.

The '169 patent, entitled “Preconditioned Air Unit with Variable Frequency Driving” is directed to “preconditioned air units.” '169 patent Cover, 1:13-15.

PCAs supply “preconditioned air, i.e., heated air or cooled air, to an aircraft parked on the ground.” *Id.* 1:13-15. PCAs are employed as an alternative to the aircraft’s use of its auxiliary power unit (“APU”) engine to heat or cool the aircraft cabin. *Id.* 1:16-19. PCAs can be powered with electricity available at the airport, allowing conservation of jet fuel. *Id.* 1:19-31

The disclosed PCA is an air-conditioner that employs well-known refrigeration system methods to precondition (e.g., cool) air within its housing, and push that preconditioned air to the aircraft cabin. Ex.1003 (“Leeb Decl.”) ¶¶41, 71-75. This is exemplified in Figure 1 of the ’169 patent, reproduced below. The disclosed PCA has a flow duct going from an air inlet 22 to an air outlet 25, which is connected to a parked aircraft through a hose. ’169 patent 5:58-6:2. “A blower 30 is connected with the flow duct 20 for generation of the required air flow from the air inlet 22 toward the outlet 25.” *Id.* 6:8-10. “The direction of the air flow is illustrated by arrows 26a, 26b, 26c, 26d, 26e.” *Id.* 5:66-67.

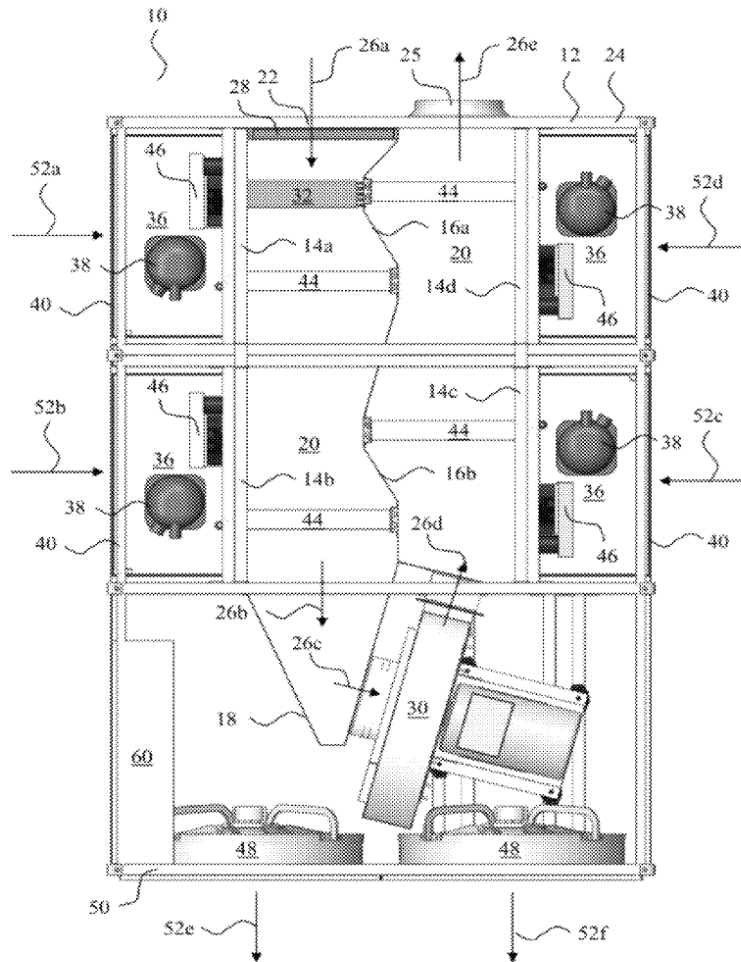


Fig. 1

The air flowing in the flow duct 20 is refrigerated by a “self-contained cooling module[] 36 [that] operates in accordance with *well-known refrigerator principles*.”¹ *Id.* 6:31-33; *see also id.* 3:37-40. Specifically, each self-contained cooling module 36 includes “a compressor 38, a condenser 40, an expansion valve 42, and an evaporator 44 connected in series in a refrigerant flow circuit.” *Id.* 6:23-

¹ All emphases are added unless noted otherwise.

30. “[T]he evaporator 44 of each self-contained cooling module 36 is positioned inside the flow duct 20” for performance of heat exchange “as is *well-known in the art of refrigeration systems.*” *Id.* 7:49-58. The PCA may “operate with any number of self-contained cooling modules 36 installed.” *Id.* 6:52-63.

Various components of the PCA can be driven using VFDs, including compressors (*id.* 8:6-22), condenser fans (*id.* 8:56-62), and the blower (*id.* 9:1-10). The VFDs are controlled “in a way well-known in the art of variable frequency drivers.” *Id.* 8:23-25.

The PCA has a “central controller 60 that is configured for controlling the operation of the preconditioned air unit 10.... The central controller 60 is connected with all of the VFD-controllers.” *Id.* 9:23-46. The central controller can automatically adjust cooling based on input such as a “selected type of aircraft, the ambient temperature, the humidity, the cabin temperature, the outgoing airflow from the preconditioned air unit 10, etc.” *Id.* 10:18-22. An input interface for selecting aircraft is illustrated in Figure 7, reproduced below.



Fig. 7

The '169 patent also describes a failure response where a “failing cooling module transmits a failure signal to the central controller 60 and shuts down if required.” *Id.* 9:40-42. In response, the central controller can “automatically adjust the required amount of cooling among the remaining properly operating self-contained cooling modules 36.” *Id.* 9:39-46.

The '169 patent also describes a “power sharing control input” that can be used when the PCA “share[s] a mains power outlet with other equipment at the parked aircraft.” *Id.* 10:27-50. The power sharing control input can be used to adjust the PCA’s “power consumption during high load operation of the ground power

unit,” for example, “by lowering the cooling capacity provided by the preconditioned air unit 10.” *Id.*

2. Prosecution History

Patent application 13/257,669, issued as the '169 patent, was filed on September 20, 2011, claiming priority to a Danish application filed March 20, 2009. The as-filed application included independent claim 13, which would form the base limitations for issued independent claims 1, 2, and 16. Ex.1002 (“’169 FH”) 002. For convenience, Petitioner refers to as-filed claim 13 as the “Base Claim” and reproduces it in the table below.

The Base Claim was directed to a PCA with a plurality of conventional refrigeration systems having, each, VFD-powered compressors. The Examiner repeatedly rejected the Base Claim as obvious, and the Applicant added additional features to gain allowance. Specifically, the claim was repeatedly rejected because modifying a PCA to use a variable frequency driver to drive the compressor would have been obvious. As an example, the last Final Office Action relied on a combination of “Anderson” (Ex.1018) disclosing PCAs without VFDs with “UVSD” (Ex.1015) that “teaches that the variable frequency drive is the most effective motor controller in the industry.” ’169 FH 502-504, 516-519; *see also id.* 189-190, 269-271, 309-310, 361, 363, 432-434, 443-444, 551.

The applicant eventually amended the Base Claim to form three separate claims that issued as independent claims 1, 2, and 16. *See id.* 586-587, 590-592 (claim amendments leading to issuance). Each independent claim included a distinct final limitation, detailed in the table below.

Base Claim	A preconditioned air unit for supplying preconditioned air to an aircraft parked on the ground, the preconditioned air unit comprising a housing accommodating a flow duct with an air inlet for ambient air and an air outlet for connection to the parked aircraft, a blower connected with the flow duct for generation of an air flow from the air inlet toward the air outlet, a plurality of refrigeration systems, each of which includes at least one compressor, at least one condenser, at least one expansion valve, at least one evaporator connected in a flow circuit containing a refrigerant, and wherein the at least one evaporator interacts with the air flow in the flow duct, and at least one variable frequency driver for power supply of the at least one compressor, and a central controller that is configured for controlling the operation of the preconditioned air unit including variable frequency drivers of the plurality of refrigeration systems.
Additional limitation specific to cl. 1	wherein the central controller has a power sharing control input for control of the preconditioned air unit power consumption

Additional limitation specific to cl. 2	wherein the central controller automatically adjusts the cooling performed by the preconditioned air unit according to at least one of: the selected type of aircraft, the ambient temperature, the humidity, the cabin temperature, or the outgoing airflow from the preconditioned air unit
Additional limitation specific to cl. 16	wherein each refrigeration system of the plurality of refrigeration systems is configured for failure detection so that, in the event that one of the refrigeration systems fails, the failing refrigeration system transmits a failure signal to the central controller.

B. State of the Art

HVAC&R systems have long employed a refrigerant circuit to heat or cool air. The circuit includes four main parts: (1) a compressor that pumps refrigerant through the circuit; (2) a condenser that condenses the refrigerant to a liquid form, thereby releasing heat to surrounding air; (3) an expansion valve that removes pressure from the refrigerant; and (4) an evaporator that evaporates the refrigerant to gas form, thereby absorbing heat from surrounding air (i.e., cooling the air). Leeb Decl. ¶¶60-61, 65-66.

PCAs are large air-conditioners that condition air within a housing outside parked aircraft cabins before blowing the preconditioned air inside the cabin. *See* Ex.1013 1 (“[PCA] is an external heating, cooling, and dehumidifying device that provides fresh preconditioned air to the aircraft and jet bridges between flights.... The air is ‘preconditioned’ because it is filtered and treated for temperature and humidity before it enters the aircraft.”); *see also* Ex.1012 15 (“[A]n air-conditioning

unit—referred to as a PCA unit—is necessary to provide efficient heating and cooling to the aircraft [on the ground].”). PCAs were known for decades before the ’169 patent. For example, U.S Patent No. 4,272,967 (Ex.1017 (“White”)), issued in 1981, described a self-contained air-conditioning system for supplying air-conditioned air to aircraft on the ground through a duct. White Abstract. White employed well-known refrigeration technology for conditioning the air, including compressors, condensers, expansion valves, and evaporators connected in a refrigerant circuit. *See id.* 4:32-5:2. Various others advanced PCA technology in the decades before the ’169 patent, continuously incorporating technological advances in HVAC&R engineering. Leeb Decl. ¶¶71-75 (listing other published designs). Several of these designs, including White, employed a plurality of refrigeration systems—a well-known technique to provide PCA with flexibility to cool different-sized aircrafts. *See, e.g.*, White 4:32-4:51; Anderson 2:6-17, 2:40-65; *see also* Leeb Decl. ¶73.

VFDs were also well-known by 2009. VFDs use power electronics to vary the frequency of input power to a motor to control motor speed. Ex.1040 (“Carrier”) 2. VFDs work by using a rectifier, dc bus, and inverter to produce an AC signal at a desired frequency from an AC mains supply. *See id.* 2-3; Leeb Decl. ¶77. Using VFDs to control capacity in refrigeration systems was advantageous as it provided, for example, energy savings, low motor starting current, reduction of thermal and

mechanical stresses on motors and belts during starts, simple installation, high power factor, and lower KVA[kilo-volt-amperes]. Carrier 4. By 2009, use of VFDs in refrigeration systems was commonplace knowledge available in textbooks and industry manuals. *E.g.*, Ex.1011 52 (describing VFDs as “[o]ne of the most important developments in recent years” and describing “VFDs used in HVAC applications”); Ex.1010 42.9-42.10 (use of VFD to drive compressors); *id.* 4.13 (use of VFD to drive air handlers); *id.* 44.9-44.14 (detailed description on the electrical implementation of VFDs in HVAC systems); *see also id.* 3.2-3.4, 3.8, 5.3, 39.8-39.9 (other applications).

VFDs were used in HVAC&R devices that operated in the same “conventional” manner as the refrigeration units in a PCA. Leeb Decl. ¶79; ’169 patent 6:23-33. For example, Ex.1006 (“Taras”) provides an example disclosure of the use of VFDs in a refrigeration system using “power electronics... known in the art.” Taras ¶19. Taras discloses air-conditioning and refrigeration systems operating using well-known refrigeration techniques. *Id.* ¶16 (“Such refrigerant system components are known by a person of ordinary skill in the art.”). The system includes a motor-operated compressor, a condenser, an expansion device, and an evaporator connected in a refrigerant circuit—the exact same architecture as described in the ’169 patent. *Compare id.* ¶17, with ’169 patent 6:23-33. Taras

further discloses the use of several VFDs to drive the compressor motors, condenser fans, and evaporator fans in such systems. Taras ¶31; Leeb Decl. ¶79.

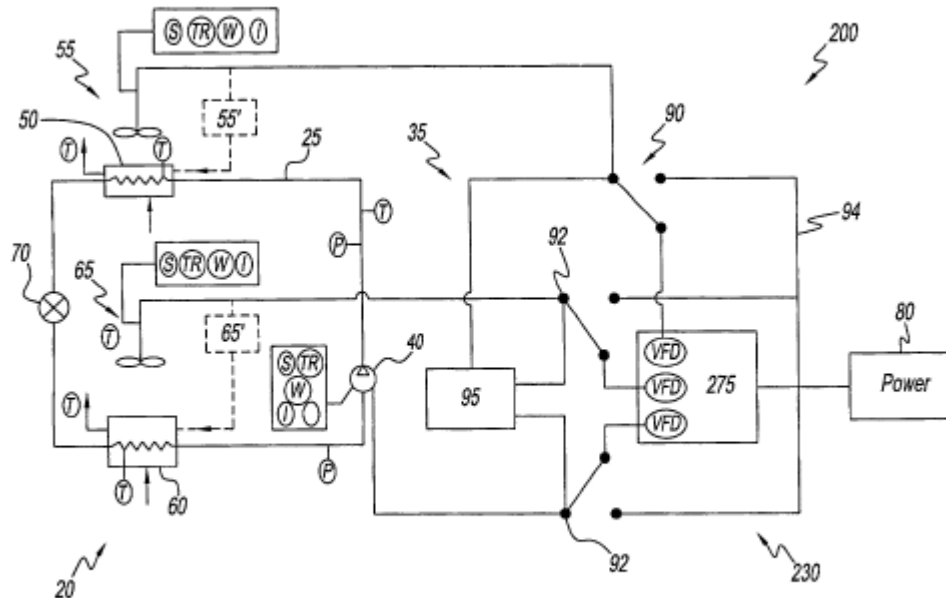


Fig. 3

Taras, Fig. 3

C. Person of Ordinary Skill in the Art

A POSITA would have had at least a Bachelor's degree in Mechanical or Electrical Engineering or related field, and two years of work experience in HVAC&R engineering. Leeb Decl. ¶36. Additional graduate education could substitute for work experience. *Id.*

D. Claim Construction

The prior art relied on in this Petition discloses the subject matter of the challenged claims under any reasonable construction, including their plain meaning.²

IV. Ground 1: Kreymer in view of Taras (Claims 2-9 and 11-12)

A. Overview of Kreymer (Ex.1005)

U.S. Patent 5,715,701 (“Kreymer”) was filed on October 1, 1996, and issued on February 10, 1998. It is, thus, prior art under pre-AIA §§102(a), (b), and (e).

Kreymer, titled “Double Blower Air Conditioning Unit,” discloses “[a] method and apparatus for providing conditioned air to an aircraft parked at an airport.” Kreymer Abstract. Kreymer discloses an “invention to provide sufficient amounts of conditioned air to a variety of aircraft sizes by cooling, heating, air moving means, which is a single air conditioning unit.” *Id.* 1:24-27. Figure 1, reproduced below, illustrates a side view of the PCA 10 mounted on a passenger boarding bridge.

² Petitioner reserves the right to argue alternative constructions in other proceedings, and where such a defense is available, that the claims are indefinite.

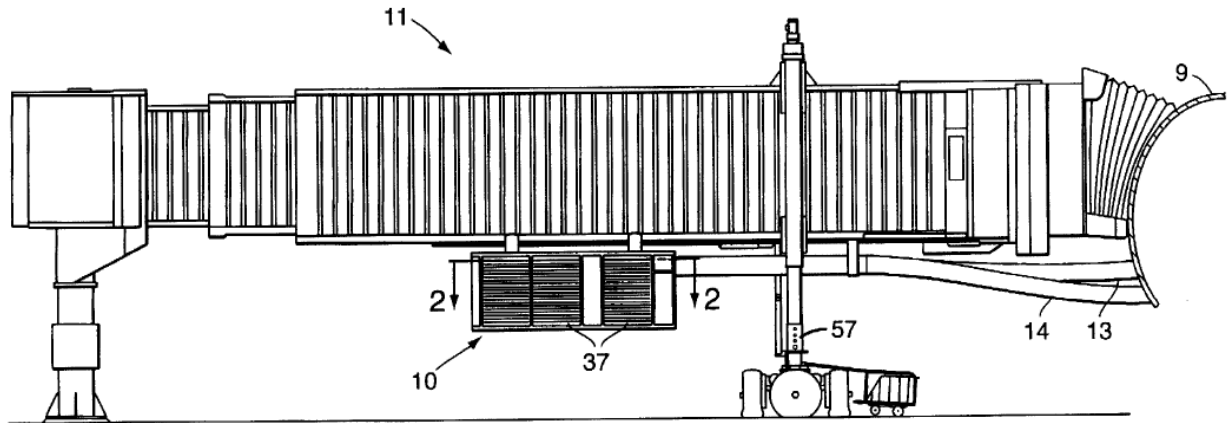


FIG 1

Figure 3 (reproduced below), is a schematic view of PCA 10. Kreymer 1:47-48. The PCA 10 comprises four refrigerant circuits, each with a compressor (compressors 21-24), evaporator coil (27-30), and condenser coil (16-19). *Id.* 1:44-2:10; *see also id.* Figs. 1-2. Each refrigerant circuit further includes an expansion device. *Id.* Fig. 3; Leeb Decl. ¶137. The use of multiple compressors allows for some adjustment in the amount of cooling provided (i.e., by turning individual units off or on to provide less or more cooling). Kreymer 2:63-3:13; *see also* Leeb Decl. ¶¶84, 124-126.

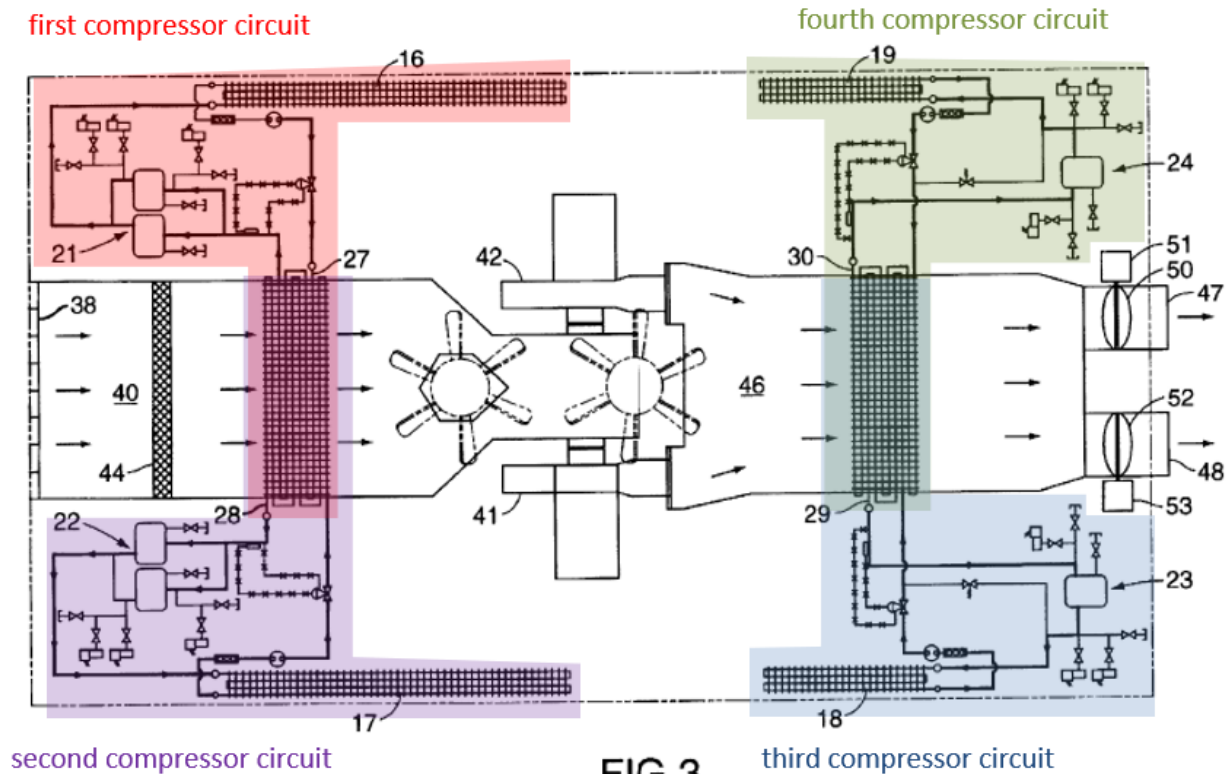


FIG 3

Kreymer, Fig. 3 (annotated)

“The air conditioning unit is able to accommodate various aircraft sizes.”

Kreymer Abstract. A “mode selector switch” in a remote control can be used to adjust operation (including the number of operating compressors) for a specific aircraft type. *Id.* 2:35-40, 3:14-27 (automatic configuration for “narrow body aircraft”), 3:28-44 (automatic configuration for “wide body aircraft”), 3:45-61 (automatic configuration for “jumbo body aircraft”).

B. Overview of Taras (Ex.1006)

International Patent Publication No. 2007/046794 (Taras) is a PCT application published on April 26, 2007. It is therefore prior art under §§102(a) and (b).

Taras relates to “machinery driven by variable speed drives and, more particularly, to systems for heating, ventilation, air-conditioning and refrigeration application with variable speed components.” Taras ¶1. In particular, Taras discloses an HVAC system having VFDs driving a compressor, a condenser fan, and an evaporator fan. An example of this system is illustrated in Figure 3, reproduced below. The system includes a conventional coolant circuit 25 comprising compressor 40, condenser 50, an evaporator 60, and an expansion device 70 between the condenser and evaporator. *Id.* ¶17. Thus, Taras applies VFDs to the well-known air refrigeration system that employs a vapor compression cycle. Leeb Decl. ¶¶86-88. The system further includes fans 55 and 65 for condenser 50 and evaporator 60, respectively. Taras ¶17.

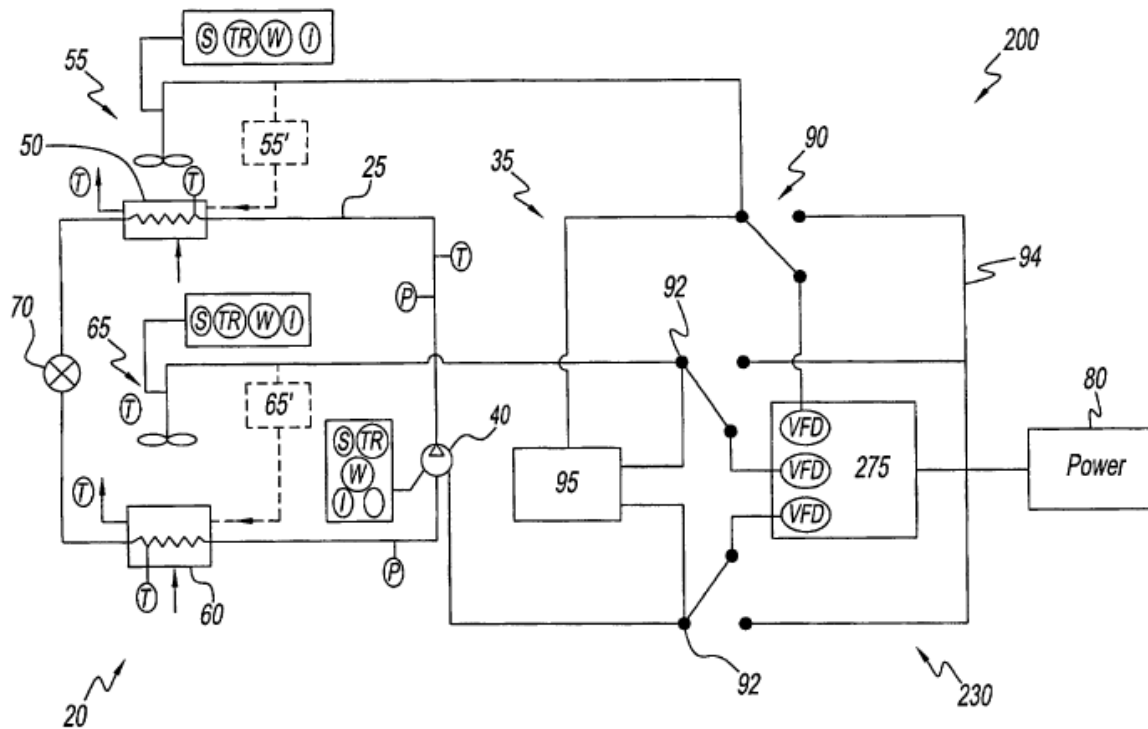


Fig. 3

Taras's VFDs 275 drive the compressor 40, the condenser fan 55, and the evaporator fan 65. Taras ¶31. VFDs 275 are “operated by the system controller.” *Id.*

C. Motivation to Combine

Kreymer and Taras are analogous art at least because they are in the same field of endeavor as the '169 patent, which includes air refrigeration systems. Leeb Decl. ¶124. For example, the '169 patent is directed to a PCA system that preconditions air using “self-contained cooling modules 36 [that] operate[] in accordance with well-known refrigerator principles.” '169 patent 6:23-33.

Similarly, Kreymer discloses air refrigeration systems that each include compressors, condensers, evaporators, and expansion devices that are connected in a refrigerant circuit. Kreymer 2:63-3:13. Taras, likewise, discloses the same type of air refrigeration system, with compressors, condenser, evaporators, and expansion devices in a refrigerant circuit. Taras ¶17. In addition, Kreymer is further analogous to the '169 patent as both patents are directed to PCA systems for parked aircraft. Leeb Decl. ¶124; *compare* '169 patent 1:13-15, with Kreymer Abstract (discussing supply of conditioned air to parked aircrafts).

A POSITA would have been motivated to combine Kreymer and Taras. Kreymer discloses a PCA system that adjusts cooling capacity by enabling or disabling refrigerant flow in individual refrigerant circuits. *See* Kreymer 2:63-3:13; Leeb Decl. ¶¶82, 84, 126. Kreymer describes this approach as “more efficient” than “cycling an entire cooling system on and off.” Kreymer 3:11-13. Kreymer, however, was filed in 1996. By 2009, a POSITA would have understood that VFDs offered an even more efficient approach. Leeb Decl. ¶126; Carrier 4 (VFDs offered “greatest operational savings” including “energy savings”). For example, in 2005, HVAC leader Carrier published a white paper describing that “[VFD] usage has increased dramatically in HVAC applications,” such that “VFDs are now commonly applied to air handlers, pumps, chillers and tower fans.” Carrier 2. A POSITA, thus, would have sought the energy savings of VFDs in Kreymer’s PCA and would have

sought prior art describing the use of PCAs in similar systems. The POSITA would have found Taras, and recognized that Taras' VFD-driven compressors provide such benefits.

For these reasons, a POSITA would have been motivated to add Taras's VFDs, and related control system, to Kreymer, obtaining a PCA with multiple refrigeration units that employ VFDs to drive its various motors, including its compressors, with the objective of improving the efficiency of the overall system. Leeb Decl. ¶¶126-189; *see* Carrier 4 (providing benefits from use of VFD in refrigeration systems). For further example, a POSITA would have recognized that Taras's solution could and would improve efficiency of the similar air refrigeration systems in Kreymer's PCA by adding VFDs. Leeb Decl. ¶¶126-128; *see* Taras ¶19. For example, it was known to a POSITA that use of speed to adjust the capacity maximizes energy savings and allows a refrigeration system to operate more efficiently when adjustments of the output capacity are desired. Leeb Decl. ¶126; *see* Taras ¶19 (“[VFD] adjustment allows the motor of compressor 40 to run at lower or higher than normal operating speed.... [S]uch a speed adjustment will improve system performance under circumstances when thermal load in the conditioned space or environmental conditions for the refrigerant system change[s] or a user alters the conditioned space setpoint.”). As a further example, Carrier states that use of VFDs for capacity control is more efficient than alternatives. Carrier 4. In the combination,

each of Kreymer's compressors is driven by a VFD to maximize the energy gains of VFDs. Leeb Decl. ¶126; Ex.1019 ("Rafuse") Fig. 1; *see* Taras cl. 16 ("adjusting frequency... of power supplied to... a plurality of electric motors, and wherein each of said plurality of electric motors drives a refrigerant component selected from... a compressor"). A POSITA would also be motivated to add a VFD to a system with multiple refrigeration circuits, such as Kreymer, because Kreymer teaches that there are benefits to having redundant cooling systems in case of failure of one refrigeration circuit. Leeb Decl. ¶¶125-126; Kreymer 3:67-4:2.

Finally, a POSITA had a reasonable expectation of success in combining Kreymer with Taras to obtain adjustable outputs in a multi-compressor PCA using VFDs for aircraft. Taras's refrigerant circuit includes the same four conventional refrigeration components as Kreymer's. In fact, VFDs had already been successfully applied to conventional refrigeration systems similar to the refrigeration circuits of Kreymer. *See* Leeb Decl. ¶129 (citing examples); *see also* Rafuse Fig. 1 (disclosing multiple VFDs driving multiple compressors); Section VIII.A.3. Taras further states that the "power electronics used to adjust or control the frequency and voltage via VFD 75 are known in the art." Taras ¶19. Thus, any modification of Kreymer to accommodate VFDs as detailed in Taras would be implemented using well known methods that yield predictable results. Leeb Decl. ¶¶128-129; *see also* Carrier 5 (noting the "Easy Installation" of VFDs in refrigeration systems).

D. Claim 2

- 1. 2[pre]: A preconditioned air unit for supplying preconditioned air to an aircraft parked on the ground, the preconditioned air unit comprising**

To the extent the preamble is limiting, Kreymer discloses and renders obvious this limitation. Leeb Decl. ¶¶130-131. For example, Kreymer discloses “[a] method and apparatus for providing conditioned air to an aircraft parked at an airport.” Kreymer Abstract; *see also id.* 2:41-51.

- 2. 2[a]: a housing accommodating a flow duct with an air inlet for ambient air and an air outlet for connection to the parked aircraft, a blower connected with the flow duct for generation of an air flow from the air inlet toward the air outlet**

The combination of Taras and Kreymer discloses and renders obvious this limitation. Leeb Decl. ¶¶132-134. For example, Kreymer discloses an “air conditioning unit 10 [that] has a frame 15.” Kreymer 1:47-48, Fig. 3 (annotated below).

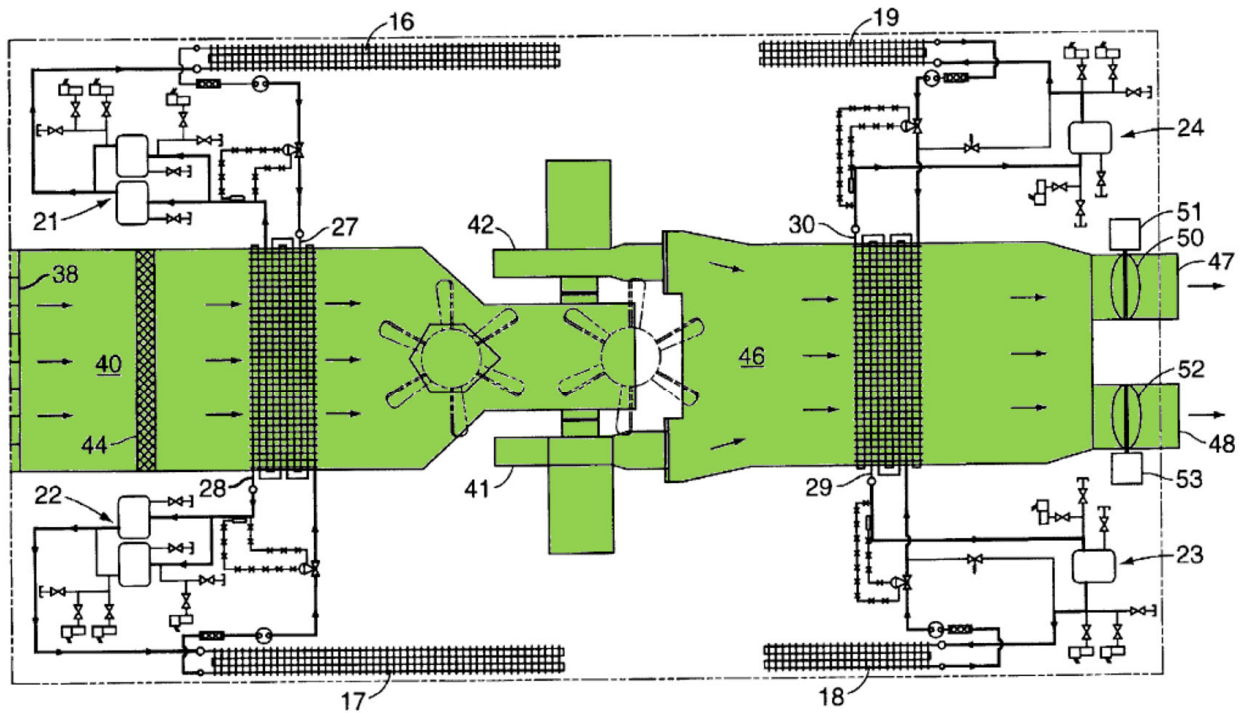


FIG 3

The air-conditioning unit has a flow duct formed by connected chambers that include blowers inducing an air flow from an air inlet to an air outlet. “A first chamber 40 is in fluid connection between [] the inlet grill 38 and a first blower 41 and a second blower 42.” Kreymer 2:11-15. “A second chamber 46 is in fluid connection between the first blower 41 and the second blower 42 and a first outlet 47 and a second outlet 48.” *Id.* 2:22-24. The blowers generate flow from the air inlet to the air outlet. *See, e.g., id.* 3:18-26 (“The first blower 41 draws air in through the inlet grill to the first chamber 40.... The air passes through the first blower 41 to the second chamber 46.... The air then passes through... the first outlet 47.”); *see also id.* 3:28-62. The outlet can be connected to an aircraft, e.g., through hoses. *Id.* 2:31-47.

Kreymer's disclosure is compatible with Taras, which also discloses a blower in the form of the evaporator fan. Taras ¶17. Specifically, in the context of a refrigeration system, a POSITA would have understood an evaporator fan is the same as a blower because it moves ambient air to flow through the evaporator, thereby cooling it, and delivering it to the conditioned area. Leeb Decl. ¶¶88, 154.

3. **2[b]: a plurality of refrigeration systems, each of which includes at least one compressor, at least one condenser, at least one expansion valve, at least one evaporator connected in a flow circuit containing a refrigerant, and wherein the at least one evaporator interacts with the air flow in the flow duct, and**

Kreymer discloses and renders obvious this limitation. Leeb Decl. ¶¶135-137. For example, Kreymer discloses a PCA with four refrigeration systems, each with a flow circuit containing a refrigerant. The refrigerant circuits are annotated in the reproduction of Figure 3, below. Each refrigerant circuit includes a compressor (21-24), a condenser (16-19), an expansion valve (not labeled), and an evaporator (27-30). *See* Kreymer 2:63-3:10.

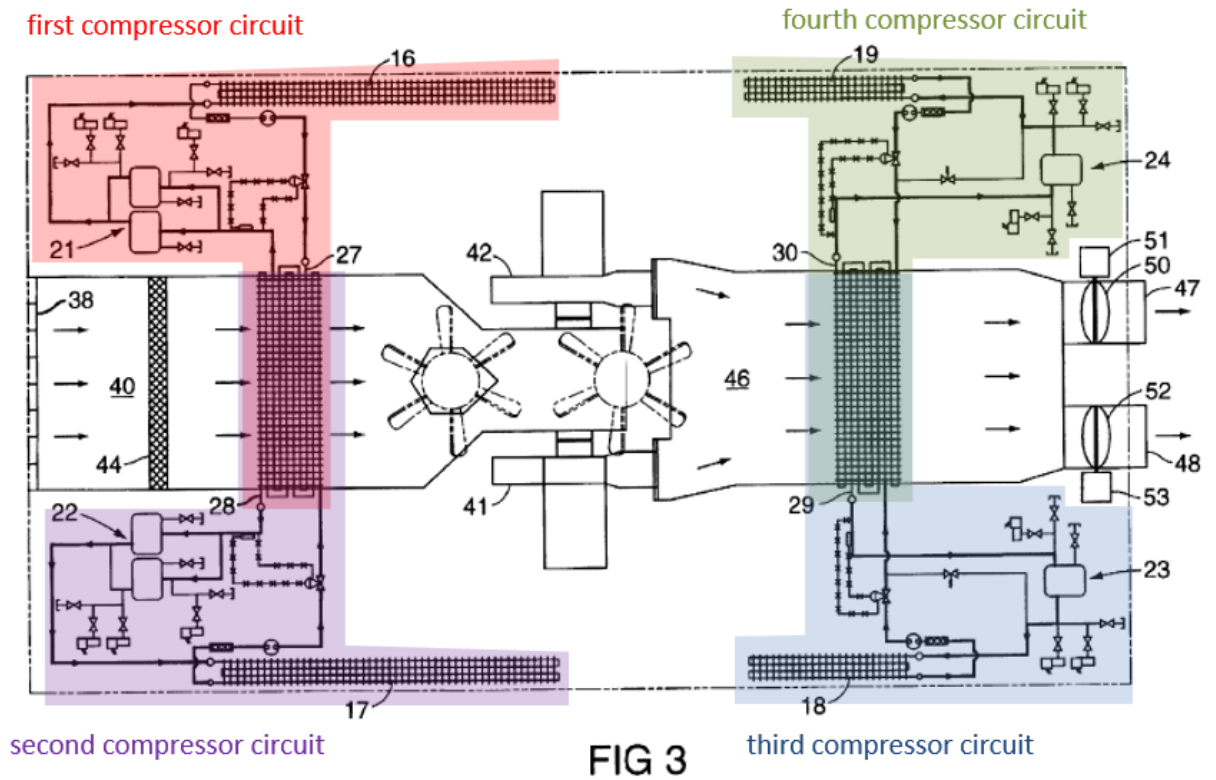
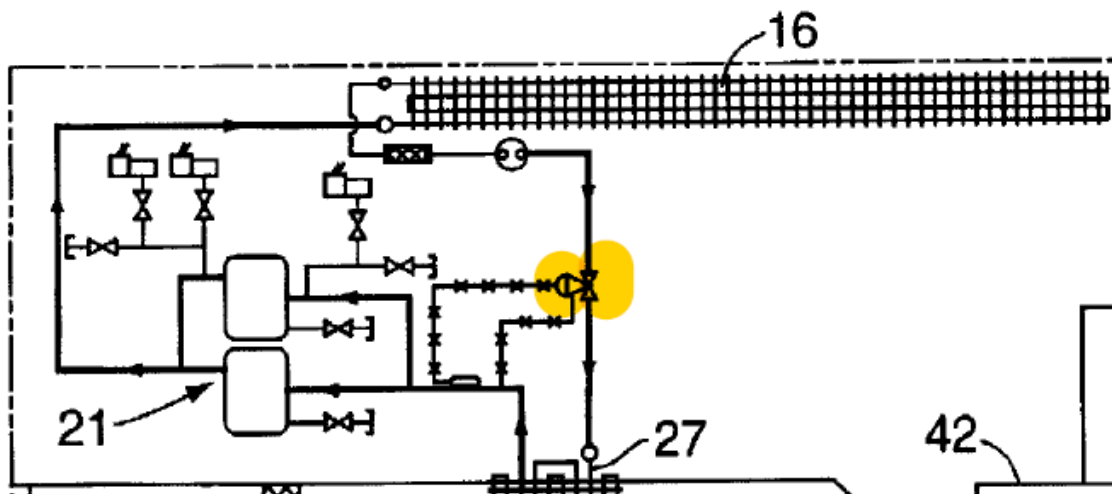


Figure 3 (annotated below) illustrates the expansion valve in its conventional location between the condenser 16 and evaporator 27. Leeb Decl. ¶¶137. It also would have been obvious to a POSITA to employ an expansion valve, as it was well-known to be one of the four components of typical refrigeration circuits. *Id.*



Kreymer also discloses the evaporator interacting with the air flow in the flow duct. “The primary evaporator coil 32 extends across a cross section of [the flow duct]... so that air... must pass through the primary evaporator coil 32.” Kreymer 2:14-21; *see also id.* 2:22-33 (discussing the secondary evaporator coil 33). This is also illustrated in Figure 3, above.

4. 2[c]: at least one variable frequency driver for power supply of the at least one compressor

The combination of Taras and Kreymer discloses and renders obvious this limitation. Leeb Decl. ¶¶138-140. For example, Taras discloses a “variable frequency drive 75 (‘VFD’) that is connected to the AC motor of compressor 40 and which is also connected to a power source 80.” Taras ¶18. “VFD 75 adjusts the speed of the motor of compressor 40 by varying the frequency and/or voltage of the power provided to the motor.” *Id.* ¶19. As discussed above, the obvious combination includes each of Kreymer’s compressors driven by a VFD. Leeb Decl. ¶¶125-126.

5. 2[d]: a central controller that is configured for controlling the operation of the preconditioned air unit including variable frequency drivers of the plurality of refrigeration systems,

The combination of Kreymer and Taras discloses and render obvious this limitation in multiple ways. Leeb Decl. ¶¶141-144. In one example, Kreymer discloses the operation of the PCA unit includes a remote control. For example,

Kreymer discloses “a remote control... electrically connected to the air conditioning unit 10. The remote control switches comprise a start switch 60, a stop switch 61, and a mode selector switch 62.” Kreymer 2:34-40. The PCA “is operated automatically after being turned on by the remote control 57.” *Id.* 2:52-53; *see id.* 2:25-3:10. A POSITA would have understood that Kreymer’s PCA comprises a central controller receiving and implementing the instructions from the remote control. Leeb Decl. ¶¶141-142. Specifically, Kreymer’s PCA is operated automatically after being turned on by a single remote control. Kreymer 2:52-53; *see also id.* 3:11-13 (controlling the overall system to add cooling systems “as needed”).

In another example, Taras discloses a “system controller” that explicitly controls the operation of the variable frequency drivers. For example, Taras discloses a “[p]ower/control system 230” that controls multiple components in the refrigeration system. Taras ¶30. “Power/control system 230 has a plurality of variable frequency drives 275 that are operated by the system controller.” *Id.* ¶31. Taras’s system controller is a central controller at least because of its description as controlling the “system.” Leeb Decl. ¶144. It was also within the knowledge of a POSITA that a VFD-driven refrigeration circuit and system would have a central controller because it was within the knowledge of POSITA to use such a controller

with the well-known “power electronics” of a VFD to vary the power to a motor of a compressor and the PCA’s cooling output a result. *Id.* ¶143.

Informed by these teachings, a POSITA would have been motivated to incorporate a central controller to the combined system to perform the automatic operation of Kreymer and to vary the amount of cooling with Taras’s. Leeb Decl. ¶126. Accordingly, the combination of Kreymer and Taras discloses and renders obvious limitation 2[d].

6. **2[e]: wherein the central controller automatically adjusts the cooling performed by the preconditioned air unit according to at least one of: the selected type of aircraft, the ambient temperature, the humidity, the cabin temperature, or the outgoing airflow from the preconditioned air unit.**

The combination of Kreymer and Taras discloses and renders obvious this limitation. Leeb Decl. ¶¶145-147. For example, Kreymer discloses a “mode selector switch 62” that can be used by an operator to select a type of aircraft “such as narrow body, wide body, or jumbo body.” Kreymer 2:52-56. Once the operator selects the type of aircraft, the unit automatically configures itself to provide the amount of cooling and the direct the airflow by adjusting the refrigeration systems, blowers and dampers. *See id.* 2:59-3:62; *see also id.* 2:52-53 (“The air conditioning unit 10 is operated automatically after being turned on.”); Leeb Decl. ¶145. This disclosure matches the ’169 patent’s disclosure of the central controller “automatically

adjust[ing] the cooling performed by the [PCA] to the *selected type* of aircraft” (’169 patent 10:18-22) including “wide body” aircraft (*id.* Fig. 2). Leeb Decl. ¶145.

Moreover, Taras discloses a “[p]ower/control system 230” that drives a “vapor compression system 20” that adjusts the PCA cooling performance based on the required “conditioned space thermal load,” which a POSITA would have understood to include variables such as the ambient temperature, the humidity, the cabin temperature, and the type of aircraft. Leeb Decl. ¶¶146-147; Taras ¶¶30-31. And using a central controller to adjust the cooling by the PCA would have been obvious to a POSITA because controllers were well-known to be used to adjust the motor speed output from the “power electronics” of a VFD and thus the cooling capacity of the PCA based on the cooling requirements of a parked aircraft, which in the combination includes the aircraft type selected by Kreymer’s mode selector switch. Leeb Decl. ¶¶79, 143, 146.

E. Claim 3

The combination of Kreymer and Taras renders claim 3 obvious. Leeb Decl. ¶¶148-150. Kreymer, for example, discloses “[a] first condenser fan 35 and a second condenser fan 36 are placed adjacent to condenser fan outlets in the air conditioning unit 10.” Kreymer 2:6-10. Figures 2 and 3, annotated below, illustrated these condenser fans.

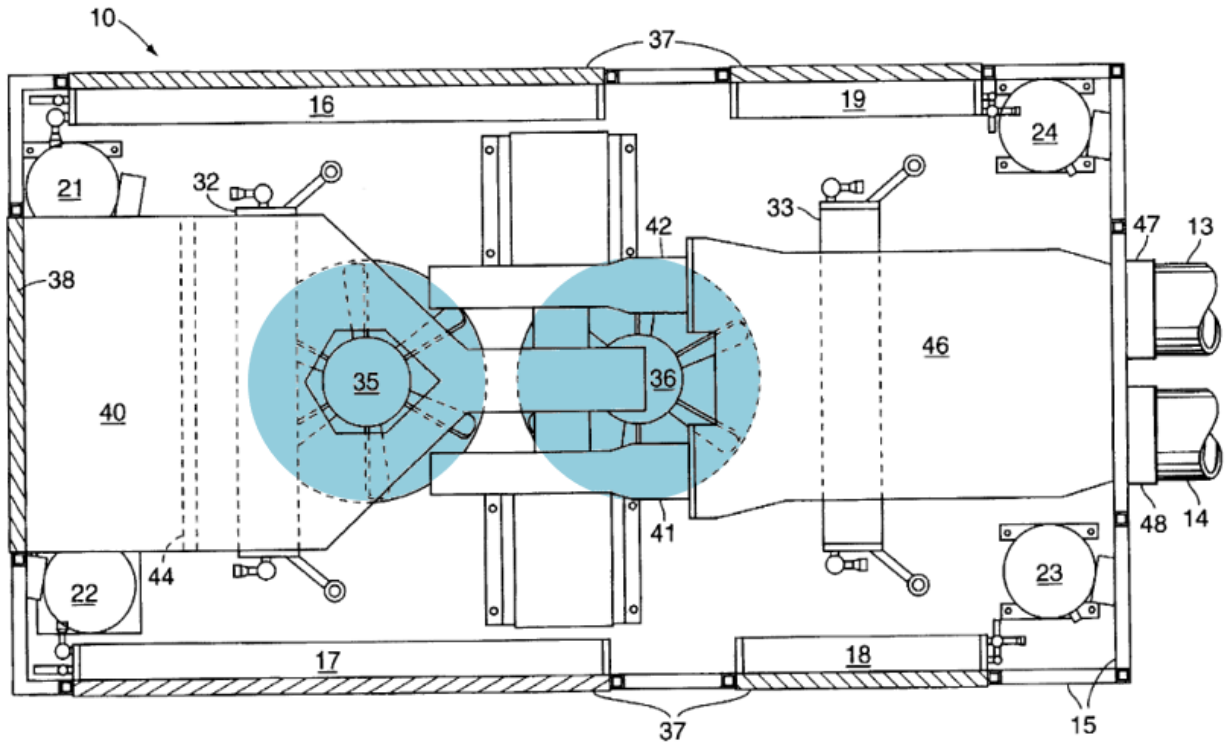


FIG 2

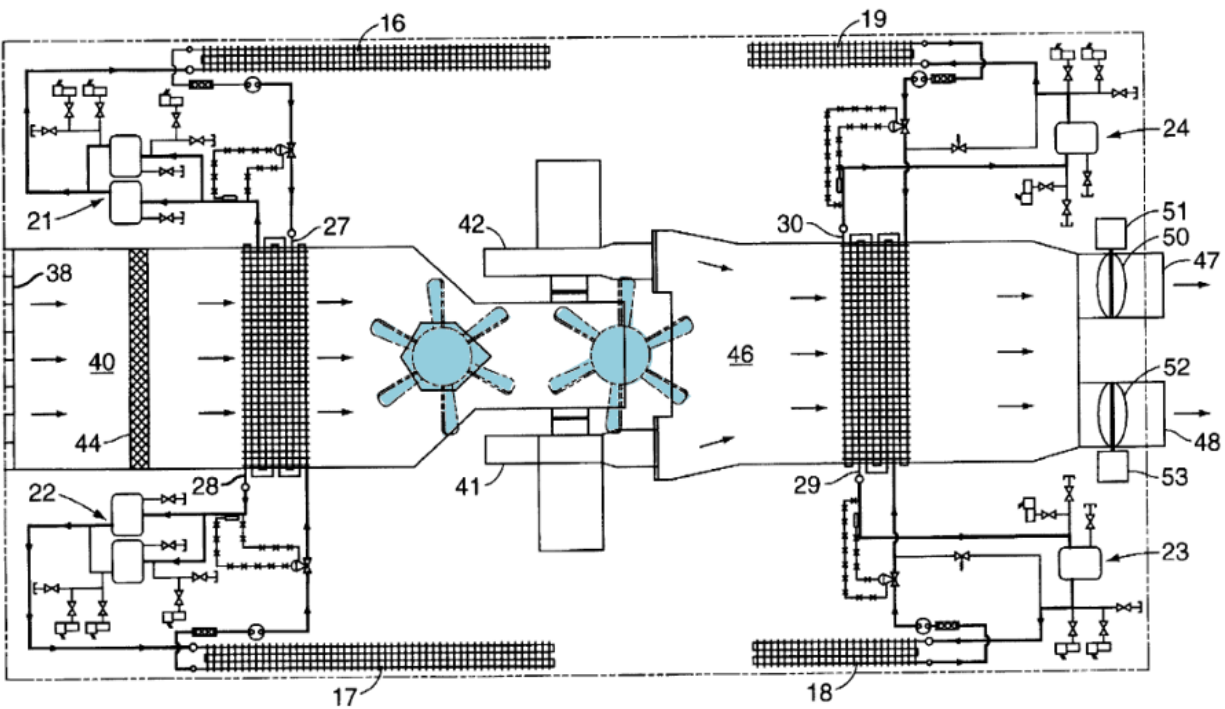


FIG 3

The condenser fans generate an airflow which interacts with at least one of the condensers 16-19. As annotated below, the condenser fans blow air out of an outlet on the bottom of the unit (Figure 1 at red arrows), which draws air through the condenser intakes 37 on the side of the unit to interact with condensers 16-19 (Figure 2 at blue arrows).

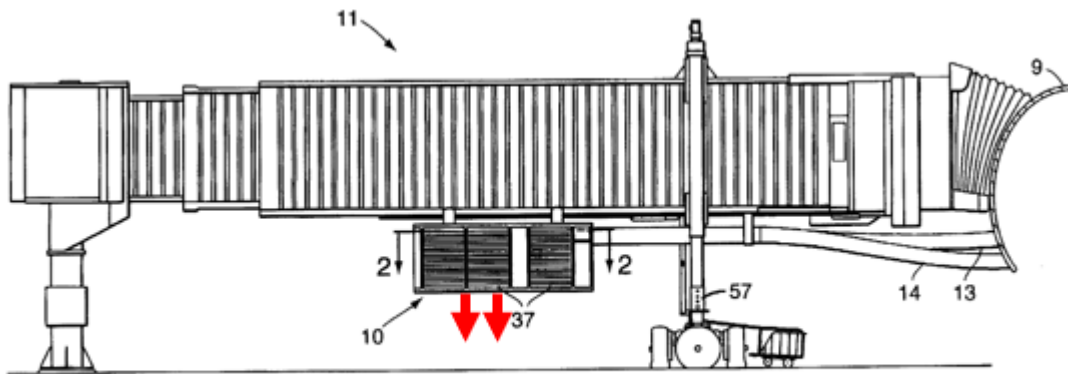


FIG 1

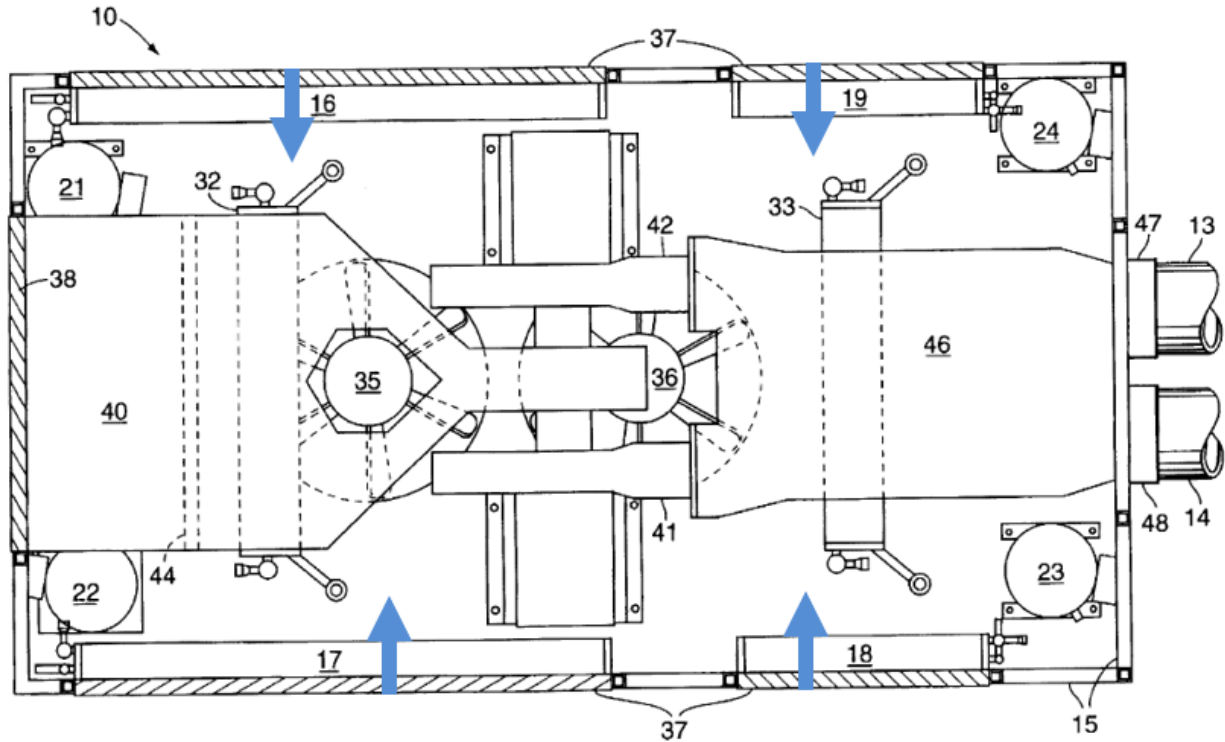


FIG 2

A POSITA also would have understood that condenser fans were conventional, well-known components of air refrigeration systems to generate airflow that interacts with condensers. Leeb Decl. ¶150. In the combined system, Kreymer's use of condenser fans is compatible with Taras, which for example, discloses a condenser fan that generates airflow that interacts with the condenser. Taras ¶17 ("fan[] 55... in fluid communication with the condenser 50"), cl. 9 ("condenser fan 55").

F. Claim 4

The combination renders obvious claim 4, based on at least the additional VFD teachings disclosed in Taras. Leeb Decl. ¶¶151-152. As discussed with respect

to claim 3, the combined system includes condenser fans that generate airflow interacting with a condenser. Kreymer 2:6-10; Taras ¶17. Moreover, Taras discloses a VFD connected to and supplying power to a condenser fan. Taras ¶31 (“Each of the VFD[s] are connected to various components of the refrigerant system 20, such as, for example... the [condenser] fan[] 55.”). A POSITA would have been motivated to incorporate Taras’s VFD to drive the condenser fan of the combined system to obtain an adjustable amount of air flow across the condensers. *See id.* ¶22 (“This allows for selective variable speed control of the fan motors.”); *see also id.* ¶19 (“speed adjustment will improve system performance under circumstances when thermal load in the conditioned space or environmental conditions for the refrigerant system change or a user alters the conditioned space setpoint”); Leeb Decl. ¶152. A POSITA would have understood that a variable-frequency approach offers many benefits including being more energy efficient than an on/off approach, and reducing thermal and mechanical stresses on motors and belts during starts. Carrier 4; Leeb Decl. ¶152.

G. Claim 5

Kreymer and Taras render obvious claim 5. Leeb Decl. ¶¶153-154. For example, Kreymer discloses a system having two blowers 41, 42 that may be enabled or disabled in accordance with the amount of airflow desired by an application. Kreymer 3:63-4:3. This on/off adjustment of airflow provided by the dual blower

system provides two discrete levels of output. Leeb Decl. ¶153. Taras further discloses the use of VFDs for a blower fan. For example, Taras discloses an evaporator 60, and an evaporator fan 65 that is a blower generating air flow through that evaporator. Taras ¶17; *see also* Leeb Decl. ¶154. A POSITA would have understood the blower fan of Kreymer, which generates air flow through the evaporator to be comparable to the condenser fan of Taras, which performs the same function. Kreymer 2:11-21; Taras ¶¶17, 31; Leeb Decl. ¶¶88,155. A POSITA would find obvious to incorporate Taras's VFD to drive the blowers of Kreymer to obtain finer adjustments of the air flow in Kreymer. *See* Taras ¶22 ("This allows for selective variable speed control of the fan motors."); *see also id.* ¶19 ("speed adjustment will improve system performance under circumstances when thermal load in the conditioned space or environmental conditions for the refrigerant system change or a user alters the conditioned space setpoint"); Leeb Decl. ¶154. A POSITA would have understood that a variable-frequency approach offers many benefits including being more energy efficient than an on/off approach, and reducing thermal and mechanical stresses on motors and belts during starts. Carrier 4; Leeb Decl. ¶154.

H. Claim 6

The combination renders obvious claim 6 in light of the additional teachings of Taras's variable frequency drives. Leeb Decl. ¶155. Taras discloses that the

“plurality of variable frequency drives 275... are operated by the system controller.”

Taras ¶31. The VFDs that drive compressor motors “adjust[] the speed of the motor of [the] compressor... by varying the frequency... of the power provided.” *Id.* ¶19.

I. Claims 7 and 8

The combination renders claims 7 and 8 obvious in view of Taras’s VFD teachings. Leeb Decl. ¶¶156-157. Taras discloses that the system controller can provide an output frequency higher than the frequency of the power supply. For example, Figure 3, annotated below, illustrates a system in which the compressor may be powered either by the VFD 275 or directly by the mains supply, i.e., power source 80, depending on the state of the bypass switch 92. Taras ¶31; *see also* Leeb Decl. ¶156.

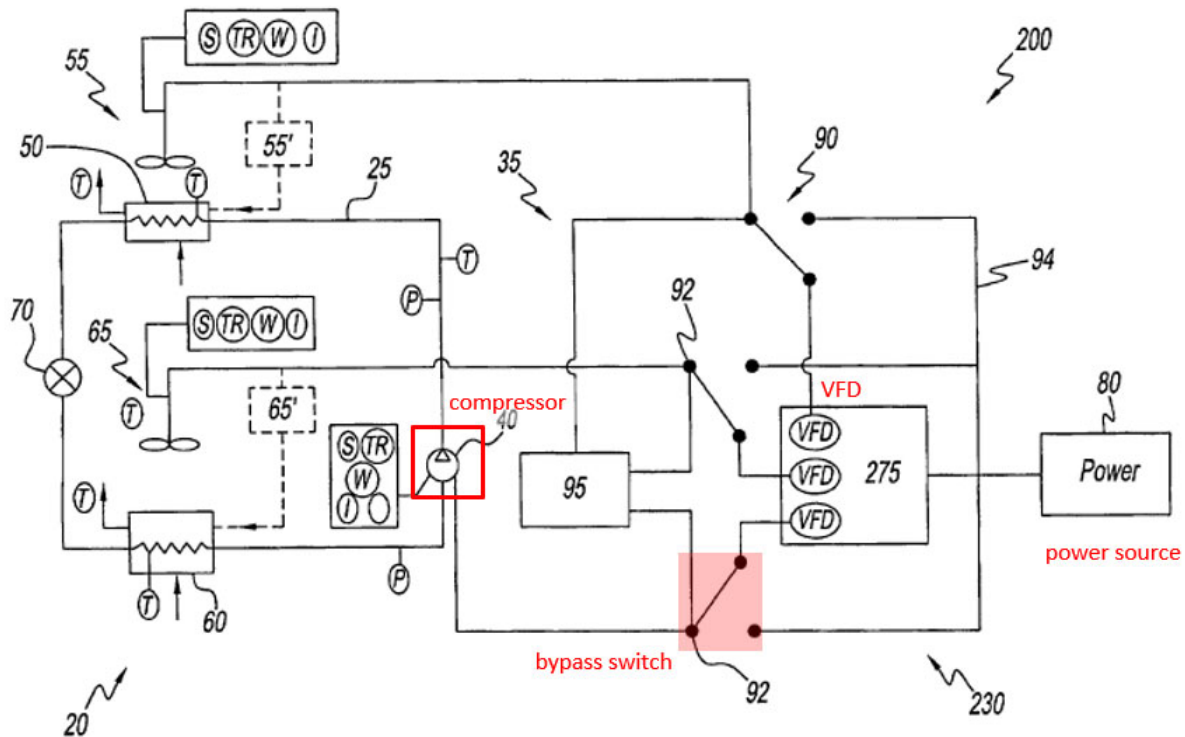


Fig. 3

When the bypass switch is configured such that the compressor is powered directly by the mains supply, the compressor operates at “the normal operating speed.” Taras ¶19. In contrast, when the VFD provides power to the compressor motor, the frequency can be varied such that “the motor of compressor 40 [runs] at lower or *higher than normal operating speed.*” *Id.* Thus, in the combined system, the controller is configured to vary the output frequency of at least one VFD driving a compressor motor to provide an output frequency higher than the frequency of the mains supply. Leeb Decl. ¶157.

J. Claim 9

The combination renders obvious claim 9 in light of Taras's teachings and the knowledge of a POSITA. Leeb Decl. ¶¶158-159. For example, Taras discloses that "[t]he power electronics used to adjust or control the frequency and voltage via VFD 75 are known in the art, such as, for example, rectifiers and inverter bridges." Taras ¶19. A POSITA would have known that Taras's rectifier is one of the "three basic sections" of a VFD. *See, e.g.*, Carrier 3 ("[T]he three basic sections of the VFD: the rectifier, dc bus, and inverter."); Leeb Decl. ¶158. The POSITA would also have known that Taras' rectifiers convert AC power from a mains supply (e.g., power supply 80) to DC voltage. *Id.* ¶159. As a result, it would have been obvious to a POSITA for the rectifier to be connected to the mains power supply of the PCA to generate a power DC voltage supply because rectification of the AC power supply into DC voltage is the first step of the well-known power electronics circuitry used to provide a variable-frequency power supply. Leeb Decl. ¶159.

K. Claim 11

The combination renders claim 11 obvious in light of Kreymer's disclosures. Leeb Decl. ¶160. For example, Kreymer discloses "a remote control 57... with... remote control switches electrically connected to the air conditioning unit 10." Kreymer 2:35-40.

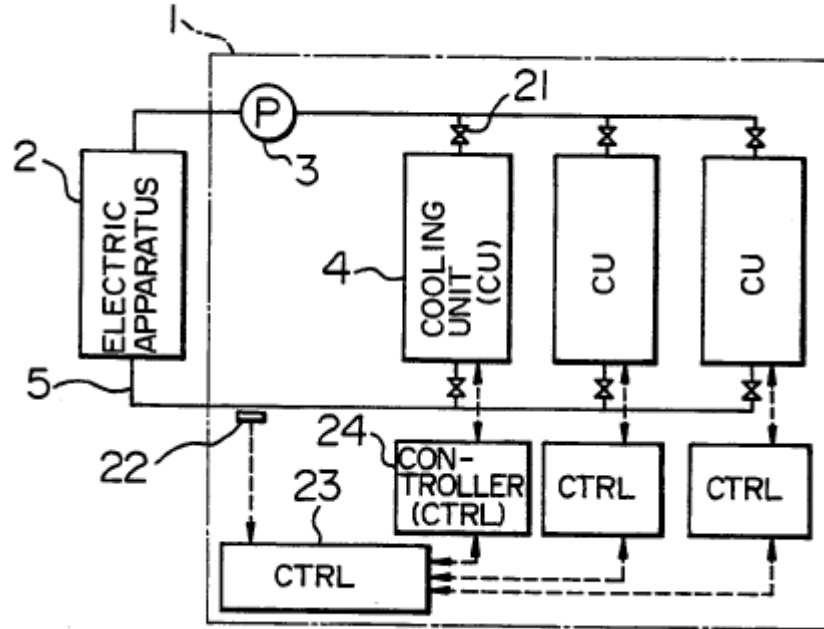
L. Claim 12

The combination renders claim 12 obvious in light of Kreymer's disclosures. Leeb Decl. ¶161. For example, Kreymer discloses a "resistance heating or other types of heating across the first chamber or second chamber." Kreymer 4:4-8.

V. Ground 2: Kreymer in view of Taras and Takahashi (Claims 14-22)

A. Overview of Takahashi (Ex.1007)

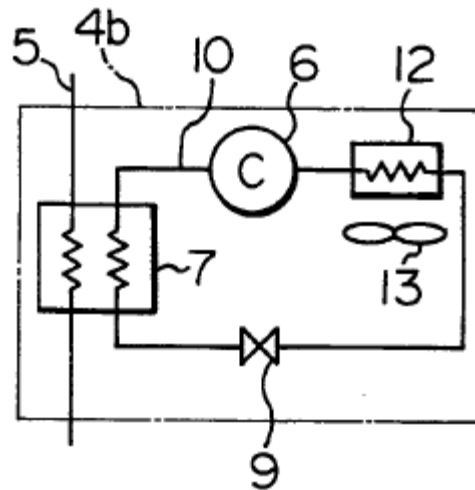
U.S. Patent 5,351,498 ("Takahashi") was filed November 3, 1993, and issued October 4, 1994. It is therefore prior art under pre-AIA §§102(a), (b), and (e). Takahashi, entitled "Cooling System for Electronic Apparatus and Control Method Therefor," discloses "a cooling system having two or more cooling units in which an operation frequency of each cooling unit can be reduced." Takahashi Cover, 1:7-12. An embodiment is illustrated in Figure 1, reproduced below.

FIG. 1

The cooling system in Takahashi includes multiple “cooling units 4.” Takahashi 3:41-4:2. The cooling units are controlled by a “controller 23 for controlling the operation of each cooling unit 4... and a plurality of unit controllers 24 each for performing a variable control of the individual cooling unit 4 based on a command from the controller 23.” *Id.*

The cooling unit is a refrigeration system designed using the well-known thermodynamic cycle. Leeb Decl. ¶93. The cooling unit can be a “air-cooling condenser-type cooling unit,” which is illustrated in Figure 3, below. Takahashi 4:3-8. The cooling unit includes an air-cooling condenser 12, compressor 6, expansion valve 9, and a vaporizer 7. *See id.* 4:9-28.

FIG. 3



Takahashi's compressor motor is driven by a VFD. Takahashi 4:29-47. The motor 31 is connected to an A.C. power supply through an invertor 35 capable of varying the frequency of outputted A.C. power and switching circuit 36 for turning on and off the power supply. *Id.*

The system of Takahashi can detect abnormalities in cooling units. Takahashi 7:17-27. When a cooling unit presents an abnormality, such as a change in pressure or temperature of the coolant, its unit controller can “stop the operation on the cooling unit 4” and transmit a signal to a central controller. *Id.* 7:28-45. “[T]he controller 23 receives the information from the unit controller 24 that one of the three cooling units 4 in operation has been stopped due to the abnormality.” *Id.* 7:46-52. In response, the controller controls the remaining cooling units to operate at a higher capacity to compensate the loss due to abnormality. “[T]he controller 23 controls

the unit controllers 24 to perform a degenerated operation by use of the two cooling units 4 which is still operating.... [T]he controller 23 commands the unit controllers 24 connected to the two operating cooling units 4 to change the operation frequency to [1.5x higher frequency].” *Id.* at 7:46-66.

B. Motivation to Combine

Takahashi is in the same field of endeavor of Kreymer, Taras, and the ’169 patent, which includes refrigeration systems that employ well-known thermodynamic principles. *See, e.g.*, Takahashi 4:9-28 (describing a cooling unit having a compressor, condenser, evaporator, and expansion device); *see* Leeb Decl. ¶162; Section IV.C. Accordingly, Takahashi, Kreymer, and Taras are analogous to each other and the ’169 patent.

A POSITA would have been motivated to combine Takahashi with Kreymer and Taras to obtain a fault-tolerant PCA system. Leeb Decl. ¶¶163-166. As shown above, Kreymer discloses a multi-unit refrigeration system with multiple refrigerant circuits that can be enabled to provide additional cooling when needed. When combined with Taras, the system uses VFDs to control the compressors and adjust the cooling capacity of the system. Kreymer discloses a desire for redundancy in the case of failure, such as in the case of a blower. Kreymer 3:67-4:2. With the application of VFDs, which can vary speed of the refrigeration components, a

POSITA would have been motivated to look for prior art solutions for redundancy that employ VFDs rather than a purely on/off approach.

In analogous art, Takahashi discloses a multi-cooler refrigeration system employing VFDs and controllers that detect operational abnormalities, disable the relevant module in response to those detected abnormalities, and adjust the cooling performance of other modules in response to the failure. *See* Takahashi 7:17-66; *see also id.* 3:41-4:2.

A POSITA would have recognized the fault-tolerant feature as an improvement to a PCA system having multiple refrigerant circuits, such as Kreymer's. Leeb Decl. ¶166. For example, Takahashi's fault-tolerant architecture allows a refrigeration system with multiple refrigerant circuits, such as Kreymer's, to preserve its cooling output upon failure of one of the refrigerant circuits, by increasing the operation of the remaining coolers to compensate the loss resulting from the failure. *See* Takahashi 7:17-66.

Moreover, the POSITA would have been motivated to modify the controller architecture of Kreymer and Taras, discussed above, to obtain the controller architecture of Takahashi, to implement this fault-tolerant feature. Leeb Decl. ¶166. Specifically, the POSITA would have modified the Kreymer-Taras controller with features taught by Takahashi's control system, including use of individual unit controllers to control respective refrigerant circuits. *See, e.g.,* Takahashi Fig. 1

(reproduced above). For example, the unit controllers provide monitoring of sensors relating to their respective refrigerant circuits and can report failures to the central controller. *Id.* 7:17-21. Moreover, when an abnormality is detected, the unit controller may stop operation of the refrigerant circuit and inform the central controller. *Id.* 7:40-45. Finally, the central controller may control working refrigerant circuits to increase its output capacity to compensate the loss from the failed circuit. *Id.* 7:46-66.

Finally, a POSITA would have had a reasonable expectation of success in implementing the modification of the multi-circuit PCA of Kreymer (driven by VFDs when combined with Taras) with the fault-tolerant system of Takahashi. Leeb Decl. ¶¶167-168. The controller architecture of Takahashi employs well-known elements, *i.e.*, controllers, sensors, and communication lines, to perform well-known functions, *i.e.*, monitor, control, measure, exchange information. Leeb Decl. ¶167.

Takahashi's particular application—*i.e.*, cooling for an electronic apparatus—is not a barrier to the obvious combination. Leeb Decl. ¶168. As discussed above, Takahashi employs a conventional refrigerant circuit; the fact that it does so to cool a liquid pipeline rather than cooling air would not have diminished the POSITA's reasonable expectation of success. *See, e.g.*, Takahashi 3:64-4:2. As explained by Taras, a POSITA would have known that technological solutions and benefits for controlling and implementing VFDs in refrigeration systems that refrigerate liquids

would also work with refrigeration systems that refrigerate airflows. Taras ¶16 (“[T]he particular components of the system can be changed to accomplish the specific space conditioning objective. Such refrigerant system components are known by a [POSITA]. For instance, fans moving air across the condenser and evaporator could be replaced by pumps circulating liquid, [e.g.], water or brine, for heat transfer purposes.”); *see also id.* ¶32 (stating “control methodology” applicable to air flow refrigeration can be applied to liquid pumps); Leeb Decl. ¶168; *see* Carrier 4 (providing benefits from use of VFD in refrigeration systems).

C. Claim 16

1. Limitations 16[pre]-16[d]

As discussed above for claim 2, the combination of Kreymer and Taras discloses and renders obvious these limitations. *See* Leeb Decl. ¶¶169-181; Section IV.D.

2. 16[e] wherein each refrigeration system of the plurality of refrigeration systems is configured for failure detection so that, in the event that one of the refrigeration systems fails, the failing refrigeration system transmits a failure signal to the central controller.

Takahashi discloses and renders obvious this limitation. Leeb Decl. ¶¶179-181. For example, Takashi discloses “unit controllers 24 [that] always monitor the cooling units 4 to detect abnormalities by a variety of sensors arranged in the cooling units 4.” Takahashi 7:17-45. The variety of sensors may include a pressure sensor, temperature sensor, etc. *Id.*; Leeb Decl. ¶179. If a pressure abnormality is detected,

“the unit controller 24 turns the switching circuit 36 off to stop the operation of the cooling unit 4.” Takahashi 7:17-45. A POSITA would have understood that stopping a circuit in the midst of a detected abnormality to mean failure of the cooling unit. Leeb Decl. ¶95. As a result of the failure, “the unit controller 24 informs the controller 23 of the stopped operation.” *Id.*

D. Claims 17 and 22

The combination renders obvious claims 17 and 22 in light of Takahashi’s additional teachings. For example, Takahashi describes operation after an abnormality of a cooling unit wherein the remaining operating cooling units compensate the loss. The controller 23 controls the unit controllers 24 to perform what Takahashi calls “a degenerated operation” by increasing operation frequency for the remaining cooling units, such that “each unit controller 24 controls the inverter 35 to change the operation frequency in accordance with the command.” *Id.* 7:46-66.

E. Claim 18

The combination renders claim 18 obvious in view of Taras’s disclosures, as discussed above for claim 6. *See* Section IV.H; *see also* Leeb Decl. ¶185. The combination of Kreymer, Taras, and Takahashi also renders claim 18 obvious in view of the additional teachings of Takahashi, which discloses “a plurality of unit controllers 24 each for performing a variable control of the individual cooling unit 4

based on a command from the controller 23.” Takahashi 3:57-64. Takahashi also discloses “the controller 23 commands the respective unit controllers 24 to change the operation frequency.” Takahashi at 6:38-41. Thus, a POSITA would have combined Takahashi’s unit controllers that vary the output frequency of the combination’s VFDs to change the cooling capacity of the combination’s system. Leeb Decl. ¶185.

F. Claim 19

The combination renders claim 19 obvious in view of Takahashi’s additional disclosures. Leeb Decl. ¶¶186-187. As discussed regarding claim 18, a combination of Kreymer, Taras, and Takahashi includes a controller (e.g., Takahashi’s controller 23) that sends commands to a unit controller (e.g., Takahashi’s unit controller 24), which adjusts individual VFD’s output frequencies based on the commands. Takahashi also teaches that the controller 23 receives output from a connected temperature sensor 22 and controls the operation of each cooling unit “based on the difference between a temperature detected by the temperature sensor 22 and a predetermined set temperature.” Takahashi 3:42-64; *see also id.* Fig. 1 (reproduced below). Additionally, the unit controller 24 monitors its respective cooling unit using a “variety of sensors” such as a pressure or temperature sensor. *Id.* 7:17-25. Takahashi’s unit controllers 24 adjust output frequency of the respective VFDs in response to sensor output. *See id.* 7:28-40 (describing lowering output frequency in

response to pressure sensor output). Based on these teachings and the knowledge of a POSITA, it would have been obvious to a POSITA to incorporate the connected temperature sensor of Takahashi to adjust the speed of the refrigeration system compressors in response to the sensed pressure/temperature. Leeb Decl. ¶187; *see also* Taras ¶19 (discussing adjustment of temperatures to adequate cooling to a thermal load).

G. Claim 20

The combination renders claim 20 obvious. Leeb Decl. ¶188. As discussed in connection with claims 18, a combination of Kreymer, Taras, and Takahashi provides a system with a central controller (e.g., Takahashi's controller 23) that is connected to a unit controller (e.g., Takahashi's unit controller 24) that controls a VFD. *See also* Takahashi Fig. 1 (reproduced above).

H. Claim 21

The combination renders claim 21 obvious in view of the knowledge of a POSITA. Leeb Decl. ¶¶189-190. As an initial matter, it was well-known that, in its rated range, the torque of an AC motor driven by an AC signal is proportional to the ratio between the voltage and the frequency of the signal. Ex.1034 ("Fitzgerald") 580-81 (describing the "constant volts-per-hertz" operation); Leeb Decl. ¶189. As such, keeping a constant ratio between the VFD output's voltage and frequency is a strategy well-known decades before the '169 patent to keep the torque in an AC

motor constant. Leeb Decl. ¶189; *see, e.g.*, Ex.1016 (“Stich”) 1:20-27; Fitzgerald 580-81. In fact, the “volts per Hz control” can “provide substantially constant torque over a wide speed range.” Stich 3:14-21; *see* Leeb Decl. ¶189. This strategy applies whether the motor torque is “high” or not. *See* Stich Fig. 2a; Leeb Decl. ¶189.

A POSITA would have been motivated to operate the VFD using the volts per Hz strategy because, at least, is a well-known way to prevent damage to an AC motor when operating at frequencies different from the motor’s rated frequency. Fitzgerald 579-81 (stating that a reducing the frequency without reducing the voltage in a typical AC motor operating at the rated voltage and frequency “will increase the flux density to the point of potential machine damage” and that “it is typical to operate a machine at constant flux density” using the constant volts-per-hertz operation); Leeb Decl. ¶190. A POSITA would have had a reasonable expectation of success because it could implement this well-known strategy in the Taras’s VFD that is capable of “adjust[ing] the speed of the motor compressor 40 by varying the frequency and/or voltage of the power provided to the motor.” Taras ¶19.

I. Claim 14

As discussed above, Kreymer and Taras disclose and render obvious claim 2. *See* Section IV.D. Takahashi further discloses and renders obvious this limitation, which is identical to claim 16[e]. *See* Section V.C.2.

J. Claim 15

- 1. 15[a]: A preconditioned air unit according to claim 2, wherein: at least one variable frequency driver has a controller that is configured for variation of the output frequency of the at least one variable frequency driver;**

As discussed above, Kreymer and Taras disclose and render obvious claim 2.

Leeb Decl. ¶192. Taras and Takahashi further disclose and render obvious this limitation, which is identical to the limitation of claim 6 and 18. *See* Sections IV.H and V.E.

- 2. 15[b]: the controller is configured for variation of the output frequency of the at least one variable frequency driver above the frequency of the mains supply of the preconditioned air unit;**

Taras discloses and renders obvious this limitation, which is identical to the limitation in claim 7. Leeb Decl. ¶193; *see* Section IV.I.

- 3. 15[c]: at least one variable frequency driver is configured to keep the ratio between the output voltage and the frequency substantially constant;**

The knowledge of POSITA in view of Kreymer, Taras, and Takahashi discloses and renders obvious this limitation, which is broader than the limitation of claim 21. Leeb Decl. ¶194; *see* Section V.H.

- 4. 15[d]: each refrigeration system of the plurality of refrigeration systems is configured for failure detection so that, in the event that one of the refrigeration systems fails,**

the failing refrigeration system transmits a failure signal to the central controller; and

Takahashi discloses and renders obvious this limitation, which is identical to the limitation of claims 14 and 16[e]. Leeb Decl. ¶195; *see* Section V.C.2.

- 5. 15[e]: the central controller is further configured to automatically adjust the required amount of cooling among the remaining properly operating refrigeration systems of the plurality of refrigeration systems in response to the failure signal.**

Takahashi discloses and renders obvious this limitation, which is identical to the limitation of claim 17. Leeb Decl. ¶196; *see* Section V.D.

VI. Ground 3: Kreymer, Taras, and Carrier (Claims 9-10)

A. Overview of Carrier (Ex.1040)

“Variable Frequency Drive—Operation and Application of Variable Frequency Drive (VFD) Technology,” is a white paper published by the Carrier Corporation (Syracuse, NY), in October 2005. This paper was publicly available in Carrier’s website prior to 2009. *See* Ex.1022 (Hsieh-Yee Decl.) ¶¶24-28, 49. Because Carrier was a well-known leader in the field of HVAC&R, interested persons would have looked to Carrier’s website for relevant literature. Leeb Decl. ¶¶119-120. On Carrier’s website, interested persons would have easily been able to find the Carrier white paper, which was indexed and searchable in multiple different ways before 2009. Hsieh-Yee Decl. ¶¶24, 31, 35, 49. Carrier is therefore prior art under §§102(a) and (b).

Carrier teaches how to use VFDs in HVAC applications. It is “intended to provide a basic understanding of... VFD operation, and VFD benefits.” Carrier 2. The paper, from 2005, states that “[VFD] usage has increased dramatically in HVAC applications. The VFDs are now commonly applied to air handlers, pumps, chillers and tower fans.” *Id.*

Carrier also lists as advantages of VFDs. “Variable frequency drives provide the following advantages: energy savings[,] low motor starting current[,] reduction of thermal and mechanical stresses...[,] simple installation[,] high power factor[,] lower KVA.” Carrier 4. These benefits can be seen by implementing VFDs in HVAC&R compressors as well as other air flow handlers such as blowers, and condenser fans. *Id.* (discussing advantages of variable speed capacity control for “centrifugal pumps, fans and compressors”).

B. Motivation to Combine

Carrier is in the same field of endeavor as both Kreymer, Taras, and the '169 patent, as it is also directed to air refrigeration systems that employ well-known HVAC&R techniques. Leeb Decl. ¶197; *see also* Section IV.C. Specifically, Carrier explains how to use VFDs to drive compressors and fans in HVAC&R systems and make refrigeration systems more efficient. *See* Carrier 2.

A POSITA would have been motivated to combine Carrier with Kreymer and Taras to obtain details in the implementation of VFDs as applied to HVAC&R

systems. Carrier provides solutions to certain known challenges in the use of VFDs. Leeb Decl. ¶¶119-120, 198. For example, Carrier explains the role of a rectifier in a VFD. Carrier 3. “A VFD may have multiple rectifier sections, with 6 rectifiers per section, enabling a VFD to be ‘12 pulse,’ ‘18 pulse,’ or ‘24 pulse.’” *Id.* Carrier further explains these multi-pulse VFDs can mitigate potential harms from harmonics generated with VFD. *See id.* 9; *see also id.* 6 (“When evaluating VFDs, it is important to understand how harmonics are provided and the circumstances under which harmonics are harmful.”). A POSITA would have known of the problem of harmonics generated by rectifiers and recognized that the multi-pulse technique to mitigate harmonics described in Carrier would improve the VFDs disclosed in Taras. Leeb Decl. ¶199. Use of Carrier’s technique is, moreover, well within the skill of a POSITA. *Id.*; *see also* Carrier 4.

A POSITA had a reasonable expectation of success when combining Kreymer with Carrier and Taras. In fact, Carrier is, itself, an instructional white paper directed with the goal of instructing a POSITA on how to use VFDs in HVAC&R systems. Carrier 2. Accordingly, a POSITA implementing a rectifier to obtain a multi-pulse VFD as instructed by Carrier would predictably obtain mitigation of harms from harmonics. *Id.* 9.

C. Claim 9: A preconditioned air unit according to claim 2, wherein the housing further accommodates a rectifier connected to a

mains supply input of the air unit for generation of a power DC voltage supply.

As discussed above in Section IV.D, Kreymer and Taras disclose and render obvious claim 2. Carrier further discloses and renders obvious the additional limitation of claim 9. Leeb Decl. ¶201. Carrier explains that a VFD generally includes a rectifier. “[T]he three basic sections of the VFD: the rectifier, dc bus, and inverter.” Carrier 3. The rectifier is connected to a mains supply. “The rectifier in a VFD is used to convert incoming ac power into direct current (dc) power.” *Id.* The rectifier is used to generate a DC voltage supply in a dc bus. “After the power flows through the rectifier it is stored on a dc bus.” *Id.*

D. Claim 10: A preconditioned air unit according to claim 9, wherein the rectifier is selected from the group consisting of a 12-pulse rectifier, an 18-pulse rectifier, and a 24-pulse rectifier.

As discussed above, Kreymer and Taras disclose and render obvious claim 9. Carrier further discloses and renders obvious the additional limitation of claim 10. Leeb Decl. ¶202. For example, carriers discloses that the “VFD may have multiple rectifier sections, with 6 rectifiers per section, enabling a VFD to be ‘12 pulse,’ ‘18 pulse,’ or ‘24 pulse.’” Carrier 3; *see also id.* 9.

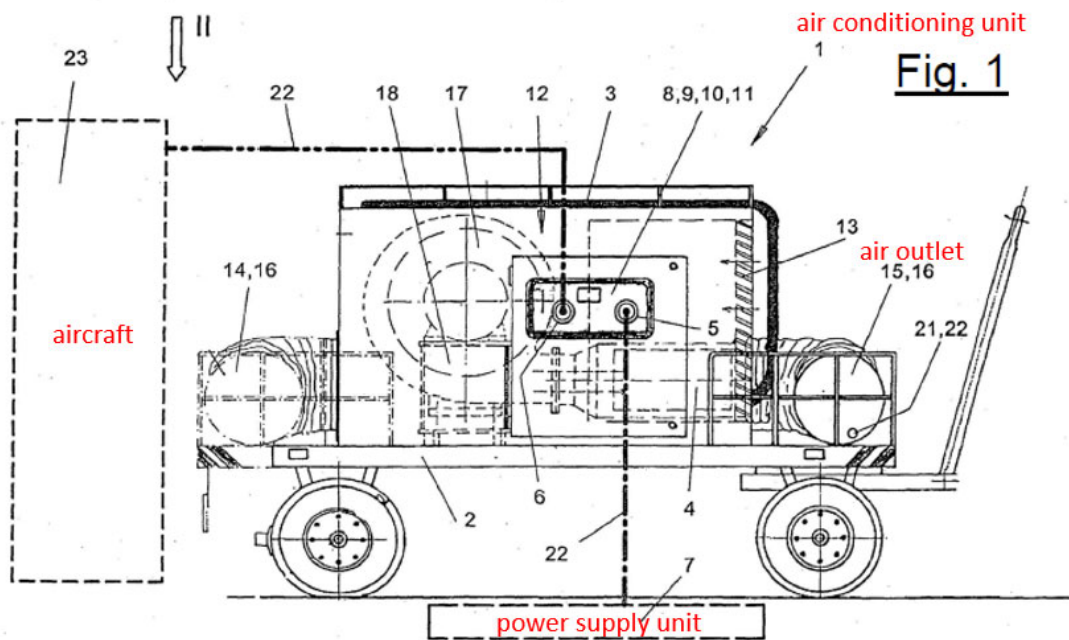
VII. Ground 4: Lechmotoren and Taras (Claims 1, 2, and 13)

A. Overview of Lechmotoren (Exs.1008, 1021)

German Utility Model DE29622089 (“Lechmotoren”) is a German patent issued on April 9, 1998, and published May 20, 1998. It is therefore prior art under

§§102(a) and (b). Exhibit 1008 is an English translation of the German patent (Ex.1021). *See* Ex.1035 (translator declaration).

Lechmotoren is directed to a PCA. Lechmotoren 1:10-14 (“The invention relates to an air conditioning unit for... aircrafts on the ground.”). The Figure 1 embodiment of Lechmotoren is reproduced below, with annotations.



Lechmotoren Fig. 1

The air-conditioning unit operates by preconditioning air in a housing and having the conditioned air blown into the aircraft cabin via an air supply. Lechmotoren 10:27-33; Leeb Decl. ¶¶99,106. “The air circulation device (12)... has one or more fans (17) or similar devices that draw in fresh air or recirculated air, send it... through the air-conditioning pack (4), and blow it into the aircraft (23)

through the air outlet (15) and the supply air hose (16).” Lechmotoren 11:4-9. Embodiments include multiple air-conditioning packs “designed as... cooling device[s]” that “can also work with a thermodynamic cycle with compressor and condenser and can therefore provide heating and/or cooling output as required.” *Id.* 10:3-11.

Lechmotoren’s air-conditioning unit can share power with the aircraft. In that configuration, its controller can receive signals from a device measuring the aircraft’s demands, and that input is used to adjust the air-conditioning unit’s power usage based on the aircraft demands. Leeb Decl. ¶¶112,115-117. To that end, the air-conditioning unit can be placed between a power supply and the aircraft in series. “[T]he series connection makes it possible to adapt to the aircraft’s (23) power demands. The air-conditioning unit (1) only draws as much output from the power supply unit (7) as is not needed by the aircraft (23).” Lechmotoren 8:10-15. The control system (8) has a measuring device (9), which can be “arranged externally” to the control system, for measuring the aircraft’s (23) power or output demands. *Id.* 8:23-31. The control system has a regulating device (10) that “adjusts the output of the air-conditioning pack (4) to the available residual energy.” *Id.*

Lechmotoren also discloses the use of fans with speed that can be regulated by the control system. Fan (17) is “driven directly by an electric motor (18)” which is “connected to the control system (8).” *Id.* 11:15-29. The fan (17) or motor (18)

has “several output levels” and can be “controlled or regulated in speed.” *Id.* The motor (18)... has a speed of approx. 5000 rpm” which can be “reduced to 2500 rpm.” *Id.*

B. Motivation to Combine

Lechmotoren and Taras are analogous to each other and to the ’169 patent at least because both references are in the same field of endeavor as the ’169 patent, which includes air refrigeration systems. Leeb Decl. ¶¶203,205. For example, the ’169 patent is directed to a PCA system that preconditions air using “self-contained cooling modules 36 [that] operate[] in accordance with well-known refrigerator principles.” ’169 patent 6:23-33. Similarly, Lechmotoren discloses an “air conditioning unit for air conditioning... of aircrafts on the ground (Lechmotoren 1:10-14) using “one or more air-conditioning packs” that can “provide both cooling output and heating output” (*id.* 4:9-17). Taras, likewise, discloses the same type of air refrigeration system, with compressors, condenser, evaporators, and expansion devices in a refrigerant circuit. Taras ¶17. In addition, Lechmotoren is further analogous to the ’169 patent as both are directed to PCA systems for parked aircrafts. Leeb Decl. ¶204; *compare* ’169 patent 1:13-15, *with* Lechmotoren 10:27-35.

A POSITA would have been motivated to combine Lechmotoren and Taras to obtain a PCA with multiple refrigeration units that employs VFDs to drive its various motors, including its compressors. Leeb Decl. ¶¶206-210; *see* Carrier 4

(listing benefits from VFDs in refrigeration systems). Taras discloses more detail to a solution that is described in Lechmotoren at a high level. Lechmotoren discloses an “air-conditioning pack [that can] work with a thermodynamic cycle with compressor and condenser” to provide cooling. Lechmotoren 10:6-11. The “air-conditioning pack (4) has a variable and controllable output,” which can be used to “adapt[] to different ambient conditions” or to adapt to the “aircraft’s (23) power demands.” *Id.* 8:3-17. Lechmotoren, however, does not provide details for implementation the of refrigeration systems and variable controllers for individual cooling packs, which are disclosed in Taras. Leeb Decl. ¶208. A POSITA would have sought out such details in the prior art, and would have found Taras, which provides details for such implementation. *Id.* ¶208.

For example, Taras discloses as “typical components for achieving desired characteristics in the conditioned space[,] a refrigerant circuit 25...[,] compressor 40, a condenser 50, and an evaporator 60,” in addition to “an expansion device 70.” Taras ¶17. In view of this explicit disclosure, a POSITA would have found obvious to supplement the air-conditioning packs of Lechmotoren having “compressor and condenser” to also include the refrigerant circuit, the evaporator, and the expansion device.

As another example, Taras explains that its VFD can be used to implement the variable and controllable output to adapt to different conditions discussed in

Lechmotoren. *See* Taras ¶19 (“[VFD] adjustment allows the motor of compressor 40 to run at lower or higher than normal operating speed.... [S]uch a speed adjustment will improve system performance under circumstances when thermal load in the conditioned space or environmental conditions for the refrigerant system changes or a user alters the conditioned space setpoint”).

Finally, a POSITA would have reasonable expectation of success in combining Lechmotoren with Taras to obtain more adjustable output and loads and a more efficient usage using VFDs. Leeb Decl. ¶211. In fact, VFDs had already been successfully applied to conventional refrigeration systems, such as the cooling packs of Lechmotoren. Leeb Decl. ¶129 (citing examples); *see also* Section III.B. Thus, any modification of Lechmotoren to accommodate VFDs as detailed in Taras would be implemented using well known methods that yield predictable results. Leeb Decl. ¶¶129,211; *see also* Carrier 5 (noting the “Easy Installation” of VFDs in refrigeration systems).

C. Claim 1

1. 1[pre]: A preconditioned air unit for supplying preconditioned air to an aircraft parked on the ground, the preconditioned air unit comprising

To the extent the preamble is limiting, Lechmotoren discloses and renders obvious this limitation. Leeb Decl. ¶¶212-214. For example, Lechmotoren discloses “an air conditioning unit for air conditioning... aircrafts on the ground.”

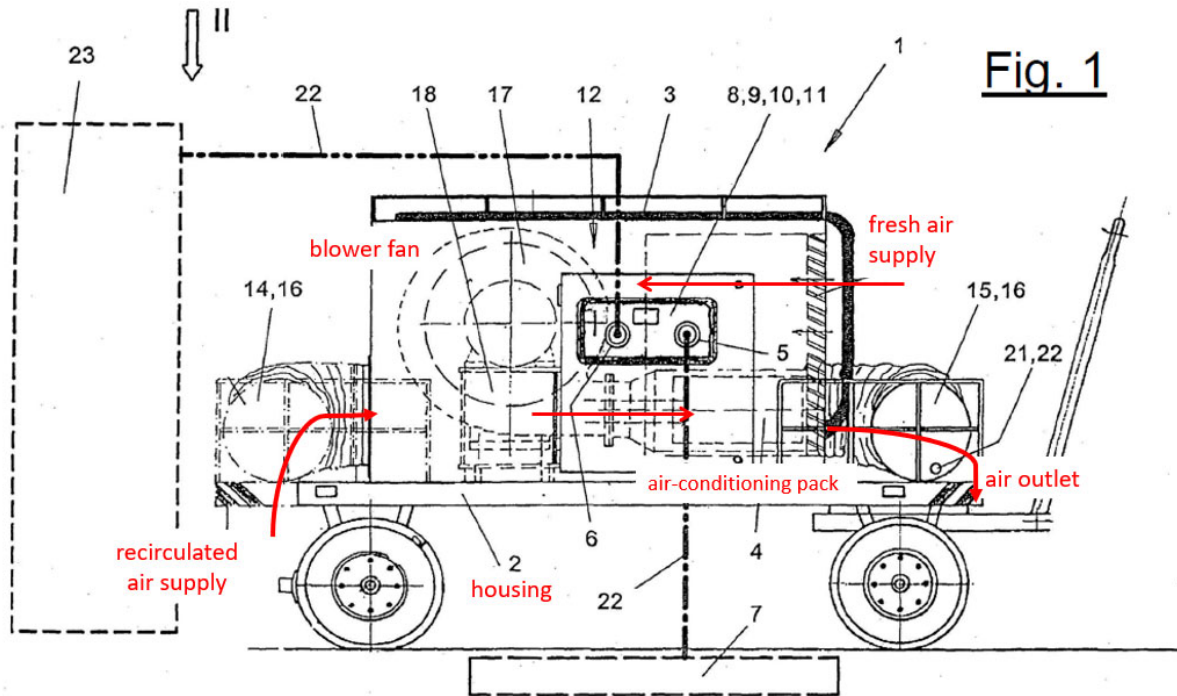
Lechmotoren 1:10-13. The unit operates by blowing into the aircraft fresh or recirculated air treated by multiple air-conditioning packs. *See, e.g., id.* 10:3-11, 10:27-35, 11:4-9. The device is a preconditioned air unit because it preconditions the air before supplying it to the aircraft. *Id.* 11:4-13; Leeb Decl. ¶214.

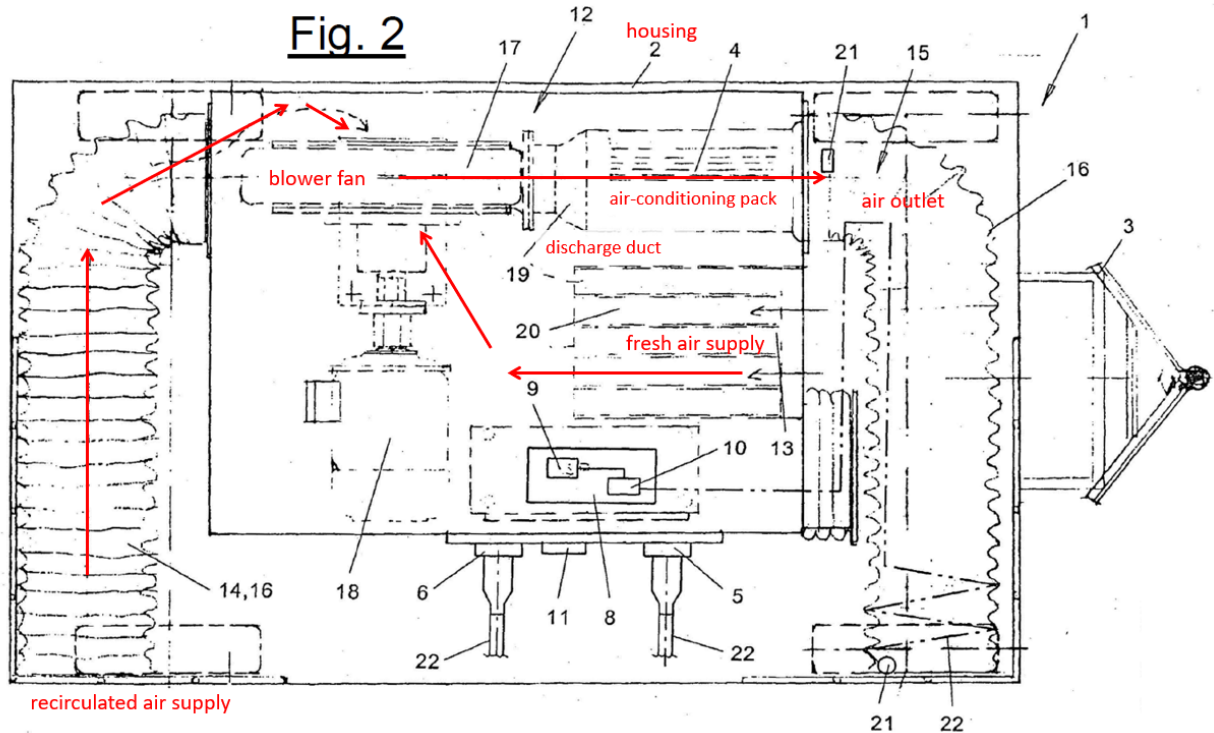
2. 1[a]: a housing accommodating a flow duct with an air inlet for ambient air and an air outlet for connection to the parked aircraft, a blower connected with the flow duct for generation of an air flow from the air inlet toward the air outlet

Lechmotoren discloses this limitation. Leeb Decl. ¶¶215-218. As illustrated in Figures 1 and 2, reproduced below, Lechmotoren discloses a housing accommodating an “an air circulation device” that includes a flow duct connected with a blower. Leeb Decl. ¶¶216-217. “The air conditioning unit (1) has... an air circulation device (12)... in a housing or frame (2).” Lechmotoren 7:32-35. “The air circulation device (12) also has one or more fans (17)... that draw in fresh air or recirculated air, send it through a discharge duct (19) through the air-conditioning pack (4).” *Id.* 11:4-9; Leeb Decl. ¶217.

The air circulation device further includes “at least one air supply (13), which... draws in outside air from the housing (2),” constituting an air inlet for ambient air. Lechmotoren 10:18-21; Leeb Decl. ¶217. The air circulation device also includes “one or more air outlets (15) on the housing (2) with connected supply air hoses (16)..., which lead to the aircraft (23),” constituting the claimed “air outlet

for connection to the parked aircraft.” *Id.* 10:27-32; ’169 patent cls. 1-2, 16. Finally, Lechmotoren discloses that the blower connected with the flow duct generates the flow of air from the inlet to the outlet. Leeb Decl. ¶218. “The air circulation device (12) also has one or more fans (17) or similar devices that draw in fresh air or recirculated air... and blow it into the aircraft (23) through the air outlet (15).” Lechmotoren 11:4-9.





3. **1[b]: a plurality of refrigeration systems, each of which includes at least one compressor, at least one condenser, at least one expansion valve, at least one evaporator connected in a flow circuit containing a refrigerant, and wherein the at least one evaporator interacts with the air flow in the flow duct, and**

The combination of Lechmotoren and Taras discloses and renders obvious this limitation. Leeb Decl. ¶¶219-226. Lechmotoren discloses a plurality of refrigeration systems in the form of “air-conditioning pack[s]” that “can be present... in multiples.” Lechmotoren 10:3-7. Lechmotoren discloses that each of the air-conditioning packs can use a “thermodynamic cycle with a compressor and condenser.” *Id.* 10:7-11. Lechmotoren further discloses that an air flow generated by a fan that sends air through the flow duct and through the air-conditioning pack for refrigeration. *Id.* 11:4-9.

To the extent that Lechmotoren does not explicitly disclose that its air-conditioning packs include an expansion valve, evaporator, or refrigerant circuit, Taras renders these elements obvious, as discussed above. Leeb Decl. ¶¶87,137,222; *see* Section VII.B. Taras discloses a refrigerant system with “a refrigerant circuit 25,” “a compressor 40, a condenser 50, and an evaporator 60 interconnected in the circuit 25,” and “an expansion device 70... positioned between the condenser and evaporator within the circuit 25.” Taras ¶17; *see also id.* ¶16 (“Such refrigerant system components are known by a person of ordinary skill in the art.”).

A POSITA would have been motivated to apply the details of the well-known refrigerant system components described in Taras to each of Lechmotoren’s air-conditioning packs that work with a thermodynamic cycle and includes a compressor and condenser, for the reasons discussed above. *See* Section VII.B. Lechmotoren does not describe the well-known and conventional details of such refrigeration systems. The POSITA would have looked to the prior art for such details and would have found Taras. The combination would have been nothing more than the combination of prior art elements (Taras’ conventional refrigeration system components) according to known methods (the refrigerant circuit, e.g., as disclosed in Taras’ Figure 3) to yield predictable results (e.g., the cooling of air using a thermodynamic cycle as disclosed in Lechmotoren and Taras).

To the extent that the Lechmotoren does not explicitly disclose an interaction between an evaporator and the air flow in the flow duct, Taras renders this element obvious. Lechmotoren discloses that an air flow generated by a fan (17) that sends air through the flow duct and through the air-conditioning pack for refrigeration. Lechmotoren 11:4-9. Taras discloses a fan 65 that generates an air flow through evaporator 60. Taras ¶17. A POSITA would have understood the fan (17) of Lechmotoren to correspond to the evaporator fan 60 and, accordingly, understand that Lechmotoren's fan (17) causes an air flow in the duct to interact with an evaporator, for cooling. Leeb Decl. ¶226; *see, e.g.*, Kreymer 2:14-33.

4. 1[c]: at least one variable frequency driver for power supply of the at least one compressor

Taras discloses and renders obvious this limitation. Leeb Decl. ¶¶227-231. For example, Taras discloses a “variable frequency drive 75 (“VFD”) that is connected to the AC motor of compressor 40 and which is also connected to a power source 80.” Taras ¶18. “VFD 75 adjusts the speed of the motor of compressor 40 by varying the frequency and/or voltage of the power provided to the motor.” *Id.* ¶19. Taras also discloses use of multiple VFDs to drive multiple compressor motors. *See id.* cl. 16 (“adjusting frequency... of power supplied to... a plurality of electric motors, and wherein each of said plurality of electric motors drives a refrigerant component selected from... a compressor”).

As discussed above, it would have been obvious to a POSITA to incorporate the VFDs of Taras to drive the compressor motors for each of Lechmotoren's air-conditioning packs. Leeb Decl. ¶¶210, 231. In fact, Lechmotoren discloses the use of fans with speed that can be regulated by the control system. Lechmotoren 11:19-29.

5. 1[d]: a central controller that is configured for controlling the operation of the preconditioned air unit including variable frequency drivers of the plurality of refrigeration systems

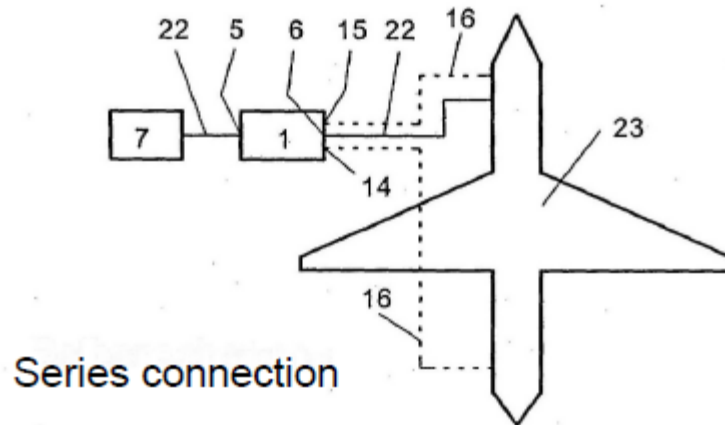
The combination of Lechmotoren and Taras discloses and renders obvious this limitation. Leeb Decl. ¶¶232-237. For example, Lechmotoren discloses a central controller that is configured for controlling the operation of the preconditioned air unit. "The air conditioning unit (1) has a suitable control system (8), which is preferably designed as a programmable logic control system and allows the air conditioning output to be adapted to different ambient conditions." Lechmotoren 8:4-8; *see also id.* 8:8-9:2.

Taras discloses a central controller that is configured to control the operation of the multiple variable frequency drivers. For example, Taras discloses a "[p]ower/control system 230" that controls multiple components in the refrigeration system. Taras ¶30. "Power/control system 230 has a plurality of variable frequency drives 275 that are operated by the system controller." *Id.* ¶31.

As discussed above, a POSITA would be motivated to combine Taras and Lechmotoren to obtain a refrigeration system where the VFDs drive each of the compressors. Section VII.B; Leeb Decl. ¶210. A POSITA incorporating Taras' VFDs into Lechmotoren would have been further motivated to incorporate the system controller of Taras to operate the multiple VFDs, based on the disclosures of the system controller of Taras to adjust the amount of cooling in accordance with the thermal load. Leeb Decl. ¶¶210,235-236. A POSITA would understand that the VFD controllers of Taras are prior art elements combined in accordance with known methods to yield predictable results.

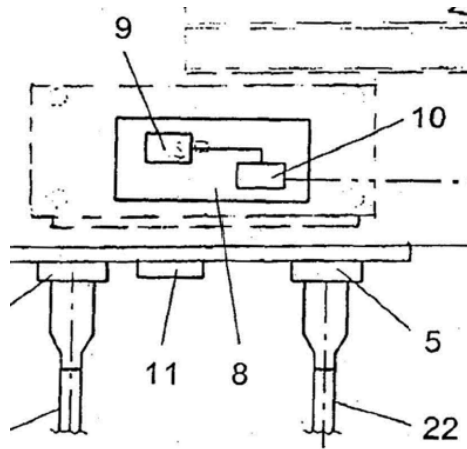
6. 1[e]: wherein the central controller has a power sharing control input for control of the preconditioned air unit power consumption

Lechmotoren discloses and renders obvious this limitation. Leeb Decl. ¶¶238-241. For example, Lechmotoren discloses power sharing with the aircraft. Specifically, Lechmotoren discloses an arrangement where “[t]he air conditioning unit (1) is... connected electrically in series between the power supply unit (7) and the aircraft (23).” Lechmotoren 6:37-7:2; *see also id.* Fig. 3 (reproduced below). “The air conditioning unit (1) only draws as much output from the power supply unit (7) as is not needed by the aircraft (23). The control system (8) is preferably designed to use as much of the remaining energy as possible to operate the air conditioning unit (1).” *Id.* 8:10-17.



Lechmotoren Fig. 3 (excerpted)

To implement this feature, Lechmotoren’s control system includes a measuring device (9) for measuring the aircraft’s power demands. Lechmotoren 8:23-27. The measuring device can be either integrated into the control system or arranged externally to the control system. *Id.* 8:25-27. In the latter example, when the measuring device is external to the control system, the measuring device provides an input to the control system. *See id.* 8:19-27 (describing “several [input/output] interfaces” of the control system). Leeb Decl. ¶240. For example, in Figure 2, reproduced in part below, the measuring device (9) provides an input to the regulating device (10) of the control system. The regulating device (10) “adjusts the output of the air-conditioning pack (4) to the available residual energy and controls it in a suitable manner”—i.e., based on the power sharing input from the measurement device (9). Lechmotoren 8:27-31.



Excerpt of Lechmotoren Fig. 2

Accordingly, the control system of Lechmotoren includes a power sharing input, provided by an external measuring device, which is used for controlling the PCA's power consumption based on how much power needs to be shared with the aircraft. Leeb Decl. ¶241.

D. Claim 2

1. Limitations 2[pre]-2[d]

Limitations 2[pre]-2[d] are identical to limitations 1[pre]-1[d]. As discussed above, the combination of Lechmotoren and Taras discloses and renders obvious these limitations. *See* Leeb Decl. ¶¶242-246; Section VII.C.1-5.

- 2. 2[e]: wherein the central controller automatically adjusts the cooling performed by the preconditioned air unit according to at least one of: the selected type of aircraft, the ambient temperature, the humidity, the cabin temperature, or the outgoing airflow from the preconditioned air unit.**

Lechmotoren discloses this limitation. Leeb Decl. ¶¶247-248. For example, Lechmotoren discloses that its “suitable control system (8)... allows the air

conditioning output to be adapted to different ambient conditions. These can be climatic or technical environmental conditions, e.g., temperature, humidity, aircraft size, etc.” Lechmotoren 8:4-10. To that end, Lechmotoren also discloses sensors connected to the control system that can measure a range of temperatures and humidity values. *Id.* 11:37-12:7. “One or more sensors or switches (21) can be placed in the aircraft (23) during air-conditioning and measure or switch by remote control on site.” *Id.* 12:34-13:8. Thus, the combination of Lechmotoren and Taras renders claim 2 obvious. Leeb Decl. ¶¶247-248.

E. Claim 13: A preconditioned air unit according to claim 2, wherein the central controller has a power sharing control input for control of the preconditioned air unit power consumption.

As discussed above, Lechmotoren and Taras disclose and render obvious claim 2. Also as discussed above, Lechmotoren further discloses and renders obvious this limitation, which is identical to limitation 1[e]. *See* Section VII.C.6; Leeb Decl. ¶250.

VIII. Ground 5: Lechmotoren in view of Taras and Takahashi (Claims 14-22)

A. Motivation to Combine

Takahashi is in the same field of endeavor of Lechmotoren and Taras, and the ’169 patent, which includes refrigeration systems that employ well-known thermodynamic principles. *See, e.g.*, Takahashi 4:9-28 (describing a cooling unit having a compressor, condenser, evaporator, and expansion device); *see* Leeb Decl.

¶251; *see also* Section VII.B. Accordingly, Takahashi, Kreymer, and Taras are analogous to each other.

A POSITA would have been motivated to combine Takahashi with Lechmotoren and Taras to obtain a fault-tolerant PCA system. Leeb Decl. ¶¶253-255. Takahashi discloses a multi-cooler refrigeration system that can detect operational abnormalities and self correct. *See* Takahashi 7:17-66. A POSITA would recognize this feature as an improvement to a PCA system having multiple cooling packs, such as Lechmotoren's. Leeb Decl. ¶253. To implement this feature, Takahashi discloses a control architecture with unit controllers 24 associated to each cooling unit 4, and a central controller 23 in communication with the unit controllers. *See* Takahashi 3:41-4:2. Takahashi also discloses sensors connected to the unit controllers 24 to monitor the cooling units 4. *Id.* 7:17-25. When the unit controller 24 detects abnormal operation, it notifies the central controller 23. *Id.* 7:41-45. The unit controller 24 then requests the remaining cooling units 4 to compensate for the abnormality, through their unit controllers 24. *Id.* 7:46-66.

A POSITA would recognize the fault-tolerant feature as an improvement to a PCA system having multiple refrigerant circuits, such as Lechmotoren's. Leeb Decl. ¶255. For example, the fault-tolerant architecture of Takahashi's allows a refrigeration system with multiple refrigerant circuits, such as Lechmotoren's, to preserve its cooling output upon failure of one of the refrigerant circuits, by

increasing the operation of the remaining coolers to compensate the loss resulting from the failure. *See* Takahashi 7:17-66.

Moreover, the POSITA would have been motivated to modify the of Lechmotoren to implement the architecture disclosed in Takahashi, to implement this fault-tolerant feature. Leeb Decl. ¶253. Specifically, the POSITA would modify the controller by introducing individual unit controllers to control a respective refrigerant circuit, and that are themselves controlled by a central controller. *See e.g.*, Takahashi Fig. 1 (reproduced above). For example, the unit controllers provide monitoring of the respective refrigerant circuits and can report abnormalities or disruption to the central controller. *Id.* 7:17-21. Moreover, when an abnormality is detected, the unit controller may stop operation of the refrigerant circuit and inform the central controller. *Id.* 7:40-45. Finally, the central controller may control working refrigerant circuits to increase its output capacity to compensate the loss from the failed circuit. *Id.* 7:46-66.

Finally, a POSITA would have had a reasonable expectation of success in implementing the modification of the PCA of Lechmotoren with the VFD systems of Takahashi. Leeb Decl. ¶¶256-257. The controller architecture of Takahashi employs well-known elements (i.e., controllers, sensors, and communication lines), to perform well-known functions (i.e., monitor, control, measure, exchange information). *Id.* ¶256.

Even though Takahashi's particular application of cooling a liquid is not the same as cooling air moving through a parked aircraft, this difference is immaterial to a POSITA. Leeb Decl. ¶257. Takahashi's cooling units are only different from a PCA's refrigeration unit in that Takahashi's evaporator, vaporizer 7, cools a liquid pipeline 5, instead of cooling an air flow. *See, e.g.*, Takahashi 3:64-4:2. As explained by Taras, a POSITA would have known that technological solutions for control of VFDs in refrigeration systems that refrigerate liquids would also work with refrigeration systems that refrigerate air flows. Taras ¶16 ("[T]he particular components of the system can be changed to accomplish the specific space conditioning objective. Such refrigerant system components are known by a [POSITA]. For instance, fans moving air across the condenser and evaporator could be replaced by pumps circulating liquid, [e.g.], water or brine, for heat transfer purposes."); *see also id.* ¶32 (stating "control methodology" applicable to air flow refrigeration can be applied to liquid pumps).

B. Claim 16

1. Limitations 16[pre]-16[d]

As discussed above for claim 2, the combination of Lechmotoren and Taras discloses and renders obvious these limitations. *See* Leeb Decl. ¶¶258-267; Sections VII.C-D.

2. 16[e] wherein each refrigeration system of the plurality of refrigeration systems is configured for failure detection so

that, in the event that one of the refrigeration systems fails, the failing refrigeration system transmits a failure signal to the central controller.

Takahashi discloses and renders obvious this limitation. Leeb Decl. ¶¶268-270; Sections VII.C-D. As discussed above, a POSITA would be motivated to apply Takahashi's controller architecture and transmission of failure signals to a PCA having multiple VFD-driven compressors which is obtained from combining Lechmotoren and Taras. Leeb Decl. ¶270.

C. Claims 17 and 22

As discussed above, Lechmotoren, Taras, and Takahashi discloses and renders obvious claim 16. Takahashi further discloses and renders obvious this limitation. Leeb Decl. ¶¶271-273. As discussed above, a POSITA would find obvious have been motivated to modify apply Takahashi's controller architecture, the transmission of failure signals in a PCA having multiple compressors, and the control strategy that employs compensation of failure of one compressor by increasing the output of the remaining compressors. Leeb Decl. ¶273.

D. Claim 18

As discussed above, Lechmotoren, Taras, and Takahashi discloses and renders obvious claim 16. Leeb Decl. ¶¶275-277. Taras further discloses and renders obvious this limitation. Taras discloses that the "plurality of variable frequency drives 275... are operated by the system controller." Taras ¶31. The VFDs that drive compressor motors "adjust[] the speed of the motor of [the]

compressor... by varying the frequency... of the power provided.” *Id.* ¶19; Leeb Decl. ¶¶274-75.

Additionally, Takahashi also discloses and renders obvious this limitation. *See* Section V.E; Leeb Decl. ¶276. As discussed above, a POSITA would find obvious to implement the VFD control architecture of Takahashi to the control the VFDs in the system resulting from the combination of Lechmotoren and Taras. Accordingly, a POSITA would find obvious to implement the unit controller for variation of the output frequency of the VFDs.

E. Claim 19

As discussed above, Lechmotoren, Taras, and Takahashi discloses and renders obvious claim 18. Takahashi renders obvious the additional limitation of claim 19. *See* Section V.F; Leeb Decl. ¶¶277-280. A POSITA would find obvious to incorporate the connected temperature sensor of Takahashi to adjust the speed of the refrigeration system compressors in response to the temperatures. Leeb Decl. ¶279; *see also* Taras ¶19 (discussing adjustment of temperatures to adequate cooling to a thermal load).

F. Claim 20

As discussed above, Lechmotoren, Taras, and Takahashi discloses and renders obvious claim 18. Takahashi further discloses and renders obvious this additional limitation of claim 20. *See* Section V.G; Leeb Decl. ¶281. As discussed

in connection with claims 18, a combination of Lechmotoren, Taras, and Takahashi provides a system with a central controller (e.g., Takahashi's controller 23) that is connected to a unit controller (e.g., Takahashi's unit controller 24) that controls a VFD. *See* Section VIII.D; *see also* Takahashi Fig. 1.

G. Claim 21

As discussed above, Lechmotoren, Taras, and Takahashi discloses and renders obvious claim 16. As discussed in Ground 2, a POSITA, using his knowledge, would find this additional limitation obvious. *See* Section V.H; Leeb Decl. ¶¶282-287.

H. Claim 14

As discussed above, Lechmotoren and Taras discloses and renders obvious claim 2. *See* Section VII.D; Leeb Decl. ¶¶288-290. Takahashi further discloses and renders obvious this limitation, which is identical to claim 16[e]. *See* Section VIII.B.

I. Claim 15

- 1. 15[a]: A preconditioned air unit according to claim 2, wherein: at least one variable frequency driver has a controller that is configured for variation of the output frequency of the at least one variable frequency driver;**

As discussed above, Lechmotoren and Taras disclose and render obvious claim 2. Taras and Takahashi further disclose and render obvious this limitation, which is identical to the limitation of claim 18. *See* Section VI.H; Leeb Decl. ¶291.

2. **15[b]: the controller is configured for variation of the output frequency of the at least one variable frequency driver above the frequency of the mains supply of the preconditioned air unit;**

Taras discloses and renders obvious this limitation, which is identical to the limitation in claim 7. *See* Section (IV.I); Leeb Decl. ¶292.

3. **15[c]: at least one variable frequency driver is configured to keep the ratio between the output voltage and the frequency substantially constant;**

The knowledge of POSITA in view of Lechmotoren, Taras, and Takahashi discloses and renders obvious this limitation, which is broader than the limitation of claim 21. *See* Section VIII.G; Leeb Decl. ¶¶293-94.

4. **15[d]: each refrigeration system of the plurality of refrigeration systems is configured for failure detection so that, in the event that one of the refrigeration systems fails, the failing refrigeration system transmits a failure signal to the central controller; and**

Takahashi discloses and renders obvious this limitation, which is identical to the limitation of claims 14 and 16[e]. *See* Sections VIII.B.2 and VIII.H ; Leeb Decl. ¶295.

5. **15[e]: the central controller is further configured to automatically adjust the required amount of cooling among the remaining properly operating refrigeration systems of the plurality of refrigeration systems in response to the failure signal.**

Takahashi discloses and renders obvious this limitation, which is identical to the limitation of claim 17. *See* Section VIII.H; Leeb Decl. ¶296.

IX. The Board Should Reach the Merits of This Petition

There are no factors supporting discretionary denial of this Petition. The '169 patent is not subject to any proceeding to support denial under *Fintiv*. See *Apple Inc. v. Fintiv*, IPR2020-00019, Paper 11 (Mar. 20, 2020) (precedential). The arguments and references presented herein were never previously presented to the Patent Office to support denial under *Advanced Bionics v. MED-EL Elektromedizinische Gerate GmbH*, IPR2019-01469, Paper 6 (Feb. 13, 2020) (precedential).

X. Mandatory Notices under 37 C.F.R. §42.8

A. Real Parties-in-Interest

The real parties in interest are Dabico Airport Solutions Inc. (“Dabico” or “Petitioner”), Dabico Corporation, Dabico Airport Solutions Pvt. Ltd., Mirabilis Group LLC, and Fernweh Group LLC.

B. Related Matters

There are no other related matters.

C. Grounds for Standing

Petitioner certifies that the '169 patent is available for *inter partes* review and that Dabico is not barred from requesting this proceeding.

D. Lead and Backup Counsel and Service Information

Pursuant to 37 C.F.R. §§42.8(b)(3), 42.8(b)(4), and 42.10(a), Dabico designates the following lead counsel:

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Pursuant to 37 C.F.R. § 42.10(b), a Power of Attorney from Dabico is being filed concurrently herewith. Dabico consents to electronic service.

E. Fee for *Inter Partes* Review

The Director is authorized to charge the fee specified by 37 C.F.R. § 42.15(a) to Deposit Account No. 506269.

XI. Conclusion

For the reasons set forth above, Petitioner Dabico respectfully requests *inter partes* review of the challenged claims of the '169 Patent.

Respectfully submitted,

Dated: January 9, 2025

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CERTIFICATE OF COMPLIANCE WITH 37 C.F.R. § 42.24

I hereby certify that this Petition complies with the word count limitation of 37 C.F.R. § 42.24(a)(1)(i) because the Petition contains a total of 13,655 words calculated by Microsoft Word's word-count feature. This total excludes the cover page, signature block, and the parts of the Petition exempted by 37 C.F.R. § 42.24(a)(1).

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CERTIFICATE OF SERVICE

The undersigned certifies that a complete copy of this Petition for *Inter Partes* Review of U.S. Patent No. 9,771,169 and all Exhibits and other documents filed together with this Petition were served on the official correspondence address for the patent shown in Patent Center:

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