

PARTIES AND BOARD ONLY

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

DYNAMIC AIR INC.,
Petitioner,

v.

M-I DRILLING FLUIDS UK LTD.,
Patent Owner.

Case IPR2016-00259
Patent 7,544,018 B2

Before PHILLIP J. KAUFFMAN, WILLIAM V. SAINDON, and
RICHARD E. RICE, *Administrative Patent Judges*.

RICE, *Administrative Patent Judge*.

FINAL WRITTEN DECISION

*Finding Claims 1, 2, and 4–9 Unpatentable
35 U.S.C. § 318(a) and 37 C.F.R. § 42.73*

I. INTRODUCTION

Dynamic Air Inc. (“Petitioner”) filed a Petition (Paper 1, “Pet.”) for *inter partes* review challenging claims 1–9 (“the challenged claims”) of U.S. Patent No. 7,544,018 B2 (Ex. 1005, “the ’018 Patent”). Petitioner supported the Petition with a declaration from John W. Carson, Ph.D. (Ex. 1034). M-I Drilling Fluids UK Ltd. (“Patent Owner”) did not file a Preliminary Response.

We instituted a trial as to all of the challenged claims on the following grounds. Paper 8 (“Institution Decision” or “Inst. Dec.”), 18.

Reference(s)	Basis	Claims Challenged
Dietzen I, ¹ Dietzen II, ² Ciaffone, ³ Laster, ⁴ Pneumatic Conveying, ⁵ and Toth ⁶	§ 103(a)	1–9
Pneumatic Conveying, Macawber, ⁷ Macawber Coal Ship, ⁸ Ciaffone, Dietzen I, Dietzen II, and Toth	§ 103(a)	1–9

¹ US 5,402,857, issued Apr. 4, 1995 (Ex. 1012).

² US 6,179,071 B1, issued Jan. 30, 2001 (Ex. 1013).

³ US 3,601,068, issued Aug. 24, 1971 (Ex. 1006).

⁴ US 4,332,530, issued June 1, 1982 (Ex. 1014).

⁵ R.D. MARCUS ET AL., PNEUMATIC CONVEYING OF SOLIDS: A THEORETICAL AND PRACTICAL APPROACH (1990) (Ex. 1009).

⁶ US 5,647,514, issued July 15, 1997 (Ex. 1017).

⁷ *The System that Gives Pneumatic Conveying a Good Name*, BULLETIN 912, Macawber Engineering Ltd. (1985) (Ex. 1007).

⁸ *Coal-Fired Ships Reappear*, 88:9 COMPRESSED AIR 5, 21–24 (1983) (Ex. 1008).

After institution of the trial, Patent Owner filed a Response to the Petition (Paper 32, “P.O. Resp.”), to which Petitioner filed a Reply (Paper 42, “Pet. Reply”). Patent Owner supported the Response with declarations from Mr. Colin Lauder (Ex. 2052) and Dr. Stuart Brown (Ex. 2057). Patent Owner did not move to amend any claim of the ’018 Patent.

We heard oral argument on February 22, 2017. A transcript of the argument has been entered in the record (Paper 52, “Tr.”).

We have jurisdiction under 35 U.S.C. § 6. The evidentiary standard is a preponderance of the evidence. *See* 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d). This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73.

For the reasons explained below, we conclude that Petitioner has demonstrated by a preponderance of evidence that claims 1, 2, and 4–9 are unpatentable.

A. Related Proceedings

We understand that Petitioner and Patent Owner are parties to a federal district court case⁹ involving the ’018 Patent. *See* Pet. 1; Paper 7, 2. We also understand that Petitioner has filed a total of six petitions, including the instant Petition, for *inter partes* review of patents involved in that litigation. *See* Pet. 1; Paper 7, 3.

⁹ Case 0:14-cv-04857, pending in the U.S. District Court for the District of Minnesota.

B. The '018 Patent

The '018 Patent, titled “Method and Apparatus for Pneumatic Conveying of Drill Cuttings,” is a continuation of U.S. Application No. 10/705,086 (now U.S. Patent No. 7,186,062 (“the '062 Patent”)), which is a continuation of U.S. Application No. 10/018,124 (now U.S. Patent No. 6,709,217 (“the '217 Patent”)), and claims priority to a U.K. application filed on June 16, 1999. Ex. 1005, (54), (63), (30), 1:7–19.

As stated in the '018 Patent Specification, “the present invention is based on the surprising discovery that it is possible to transport a material in the form of a thick heavy paste by means of pneumatic conveying from a relatively large vessel.” *Id.* at 2:1–4. The Specification further states that, conventionally, “it has been supposed that pneumatic conveying systems were only suitable for relatively free flowing material or conveying of small batches of wet sticky materials.” *Id.* at 2:4–7. “Thus, according to the present invention there is provided a method, apparatus and system for conveying a non-free flowing paste comprising loading the paste into a vessel and applying a compressed gas to the vessel to cause the material to flow out of the vessel.” *Id.* at 2:8–12. “The non-free flowing paste may be a thick and/or heavy paste or clay like material, e.g. oil rig drill cuttings.” *Id.* at 2:13–14.

Figure 1 of the '018 Patent is reproduced below.

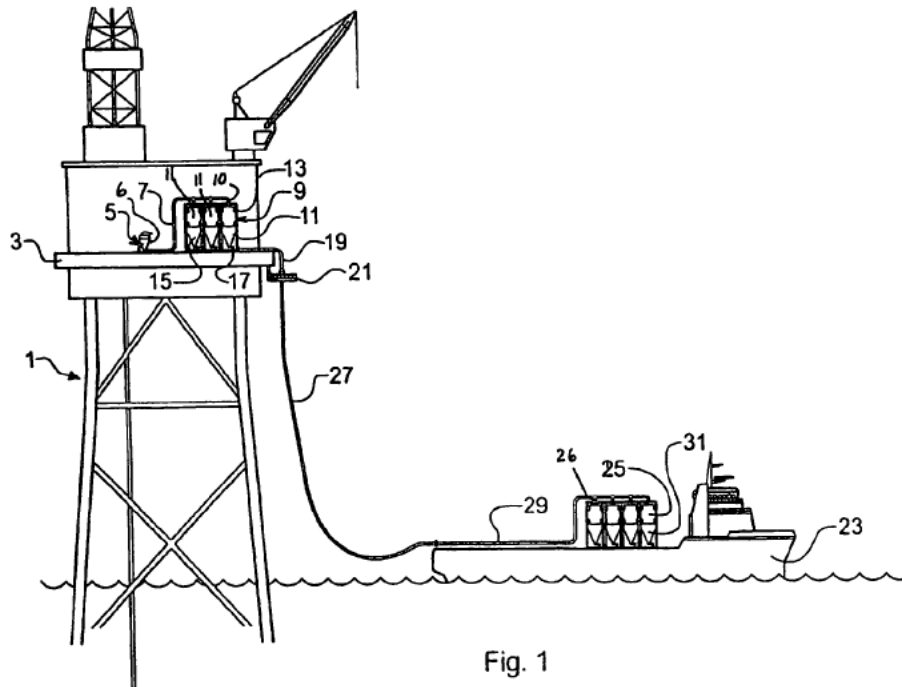


Fig. 1

Figure 1 is a diagrammatic elevation view illustrating offshore oil rig 1 with pressure vessel 5, into which screened drill cuttings from the drilling process are loaded. *Id.* at 3:26–28, 55–58. Pressure vessel 5 includes an upper material inlet, lower conical portion 6, and a lower material outlet. *Id.* at 3:58–60. The Specification discloses that “the entire vessel [referring to vessel 5] may be similar to that manufactured and sold by Clyde Materials Handling Limited.” *Id.* at 3:63–65. As illustrated in Figure 1, pipe 7 connects pressure vessel 5 to container assembly 9 comprising a number of vessels 11 (described as “ISO^[10] container sized vessels”), from which material may be discharged via hose 27 to container assembly 25 on supply boat 23. *Id.* at 4:11–31.

According to the Specification, altering the cone angle of the lower conical portion of a pressure vessel can facilitate movement of sticky

¹⁰ International Standards Organization.

materials that otherwise tend to collect around the sides of the vessel. *Id.* at 2:36–64. The Specification contrasts “core flow or funnel flow” and “mass flow”:

Because of the nature of the material being handled in the method of the present invention, there is a tendency for the flow of the material out of the vessel to be less than complete. This is because the type of flow which occurs during discharge is of a form known as *core flow or funnel flow*. When this type of flow occurs, the material directly above the outlet falls through the outlet, e.g. the outlet valve, so that a falling core of material is created directly above the outlet. However, with sticky materials, the material around this core does not move. As the core falls, a depression occurs in the top surface of the material and the material surrounding that depression falls into the core. In the case of a sticky material there is a tendency for material around the core to remain in the vessel.

It has been discovered that even for the sort of material with which this invention is concerned, it is possible to change the nature of the flow out of the vessel by altering the cone angle of the lower conical portion of the vessel. If the included cone angle is changed below a certain or critical value, then the flow changes from core flow to so-called *mass flow*. In the case of mass flow, the material descends as a mass in a uniform way towards the outlet with all the material moving. Accordingly the combination of the use of a vessel designed to achieve mass flow and the application of a compressed gas above the surface of the material is such that it is possible to push the contents of the vessel through the outlet so as fully to empty the vessel.

Id. at 2:35–60 (emphasis added). The Specification also distinguishes “[c]onventionally known pressure vessels [] expected to withstand a maximum pressure of 2 bar” from the apparatus of “a preferred embodiment [that] includes a vessel adapted to be pressurised by compressed gas to between 4 and 8 bar.” *Id.* at 3:18–21.

C. Prosecution History of '018 Patent

During the prosecution of the '018 Patent, the Examiner issued an Office Action rejecting claims 13, 14, and 16–19 as anticipated by, and claims 15, 20, and 21 as obvious over, U.S. Patent No. 6,345,672 to Dietzen (“Dietzen III”). Ex. 2020, 84–85. Notably, Dietzen III disclosed vacuum tank 28 having auger 44 to transfer drill cuttings that settle in the tank. Ex. 3001, 6:44–51, Figs. 3, 3A, 13. In response to the Office Action, the applicant amended independent claim 13 to recite “without employing a non-pneumatic means for forcing said at least a portion of said not-free flowing oil well drill cuttings out from said first pressure vessel.” *Id.* at 92. The Examiner then issued a Notice of Allowance. *Id.* at 102.

D. Illustrative Claim

Claim 1, reproduced below, is illustrative of the claimed subject matter:

1. A system to convey non-free flowing drill cuttings comprising:
 - an oil well drilling rig, said oil well drilling rig having a storage vessel, for holding non-free flowing drill cuttings;
 - a first conduit having a first end and a second end, said first end connected to said storage vessel; and
 - a boat having a first pressure vessel, said first pressure vessel connected to said second end of said first conduit, said first pressure vessel configured to receive said non-free flowing drill cuttings from said storage vessel via said first conduit, said first pressure vessel configured to allow a compressed conveyance gas to be introduced therein, to force at least a portion of said non-free flowing oil well drill cuttings in said first pressure vessel to move out to a container, without employing a non-pneumatic means for forcing said at least a portion of said

non-free flowing oil well drill cuttings out from said first pressure vessel.

Ex. 1005, 6:58–67.

II. ANALYSIS

A. Claim Construction

In an *inter partes* review, the Board gives claim terms in an unexpired patent their broadest reasonable interpretation in light of the specification of the patent in which they appear. 37 C.F.R. § 42.100(b); *Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2144–46 (2016). Under that standard, a claim term generally is given its ordinary and customary meaning, as would be understood by one of ordinary skill in the art in the context of the entire disclosure. See *In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007). While our claim interpretation cannot be divorced from the specification and the record evidence, see *Microsoft Corp. v. Proxyconn, Inc.*, 789 F.3d 1292, 1298 (Fed. Cir. 2015) (quoting *In re NTP, Inc.*, 654 F.3d 1279, 1288 (Fed. Cir. 2011)), we must be careful not to import limitations from the specification that are not part of the claim language, see *SuperGuide Corp. v. DirecTV Enterprises, Inc.*, 358 F.3d 870, 875 (Fed. Cir. 2004). Any special definition for a claim term must be set forth in the specification with reasonable clarity, deliberateness, and precision. See *In re Paulsen*, 30 F.3d 1475, 1480 (Fed. Cir. 1994).

1. “non-free flowing drill cuttings” and “non-free flowing oil well drill cuttings”

Claim 1 recites both the term “non-free flowing drill cuttings” (Ex. 1005, 6:48–49, 54–55) and the term “non-free flowing oil well drill cuttings” (*id.* at 58–59, 62 (emphasis added)). The terms appear to be used interchangeably in the claims, and the parties do not argue any distinction in

their papers. We determine that the terms are interchangeable as used in the claims.

Petitioner contends that the term “non-free flowing drill cuttings” is indefinite and, more particularly, that “[t]he line between what material is ‘free flowing’ versus ‘non-free flowing’ is indefinite. Pet. 10–11 (citing Ex. 1034 ¶ 45). Petitioner argues that “[t]o the extent a construction of this term is required . . . , the broadest reasonable construction in view of the specification for ‘non-free flowing drill cuttings’ is a screened mixture of liquid and earth extracted material that exhibits some resistance to flow.” *Id.* at 12 (citing Ex. 1034 ¶ 47).

In response, Patent Owner proposes that “non-free flowing drill cuttings” means “material generated by the drilling of an oil well including a mixture of earth and drilling fluid or oil that does not generally flow freely by gravitational force.” PO Resp. 17. *Id.* (citing Ex. 2057 ¶ 85). In support of its construction, Patent Owner asserts: “Because the material conveyed in the ’018 patent is contrasted with ‘relatively free flowing material,’ the ’018 patent’s use of the term ‘non-free flowing’ is appropriately interpreted as material that ‘does not generally flow freely by gravitational force.’” *Id.* at 13–14 (citing Ex. 2057 ¶ 79); *see* Ex. 1005, 2:4–6.

In the Reply, Petitioner argues that the term “non-free flowing drill cuttings” as used in the patent refers to the resultant mixture of cuttings and “drilling mud”¹¹ *after screening* in a shaker house to remove the majority of

¹¹ “When drilling for oil in the ocean, the drill bit creates debris, called ‘cuttings,’ comprised of the rock formations through which the well is drilled. *See* Ex. 1003, 1:33–34. The drill bit is lubricated using a material referred to in the industry as ‘drilling mud.’ *See id.*, 1:35–36; Ex. 1032 ‘Carson Decl.’ ¶ 32.” Pet. 6 (emphasis added); *see* Pet. Reply 10.

the drilling mud. Pet. Reply 10–11 (citing Ex. 1005, 1:37–47). Petitioner also argues that “[t]he patent has a blanket characterization of drill cuttings as non-free flowing and a paste,” and that “[t]he patent should be read consistent with the specification, which describes all drill cuttings after the shaker house as non-free flowing drill cuttings.” *Id.* (citing Ex. 1005, 1:46–48, 65–67; 2:13–14).

We agree with aspects of both parties’ proposed claim constructions. We agree with Petitioner that the term “non-free flowing drill cuttings” refers to the resultant mixture of cuttings and drilling mud after screening (which we understand to include similar processing to separate drill cuttings from drilling mud, such as centrifuging). *See* Ex. 1005, 1:44–48, 65–67, 2:13–14, 6:5–6; *cf.* Ex. 2052 ¶ 10; Ex. 2057 ¶ 82). We agree with Patent Owner that the source of the resultant mixture is the drilling of an oil well, and that the mixture includes earth (drill cuttings) and drilling fluid or oil.¹² *See* Ex. 1005, 1:34–48; Ex. 2057 ¶¶ 81–83.

We do not agree with Patent Owner’s proposal to construe “non-free flowing drill cuttings” as drill cuttings that do not generally flow freely by gravitational force. There is insufficient support in the Specification for that proposal. The Specification does not distinguish between different types of screened drill cuttings, for example, screened drill cuttings that generally flow freely by gravitational force and those that do not. While the Specification describes screened drill cuttings in various ways, it is always referring to the same material. For example, the Specification refers explicitly to “thick, heavy pastes which are normally difficult to move and

¹² *See* Ex 1005, 1:37–39 (calling drilling fluid a special type of oil used as a lubricant.)

handle” (Ex. 1005, 1:31–32), “[screened] cuttings . . . transported ashore in the form of a very thick heavy paste” (*id.* at 1:44–48), “thick heavy paste material (e.g., drill cuttings)” (*id.* at 1:66–67), “a thick heavy paste” (*id.* at 2:3), “a non-free flowing paste” (*id.* at 2:9–10), “[t]he non-free flowing paste may be a thick and/or heavy paste or clay like material, e.g. oil rig drill cuttings” (*id.* at 2:13–14), and “a thick heavy paste” (*id.* at 3:10–11). As such, the Specification characterizes screened drill cuttings as a thick heavy paste as well as a non-free flowing paste and, thus, considers a thick heavy paste to be a non-free flowing paste.

We determine that the broadest reasonable interpretation consistent with the Specification of “non-free flowing drill cuttings” is “screened drill cuttings, i.e., screened material, generated by the drilling of an oil well, including a mixture of earth and drilling fluid or oil.”

2. “*mass flow*”

Claims 5 and 8 recite “a cone angle selected to enable *mass flow*” (emphasis added). Patent Owner contends that “mass flow” should be construed to mean that “material descends as a mass in a uniform way towards the outlet with all the material moving.” PO Resp. 17 (citing Ex. 2058 ¶¶ 91–92). We agree. *See* Ex. 1005, 2:35–60 (contrasting mass flow with core flow or funnel flow, in which a core of material directly above the outlet falls through the outlet but the material around that core does not move). Petitioner does not dispute Patent Owner’s proposed construction. We determine that the broadest reasonable interpretation of “mass flow” means that material descends as a mass in a uniform way towards the outlet with all the material moving.

B. Level of Ordinary Skill in the Art

Petitioner defines the level of ordinary skill in the art as follows:

A person of ordinary skill in the art to which the '018 patent pertains would have had at least a bachelor's degree in a science or engineering discipline, such as mechanical, industrial, or chemical engineering, along with at least 5 years of experience in the design of systems for the handling of bulk solid and fluid materials, including through the use of pneumatic conveyance. If the person had a graduate degree (master or Ph.D.) in an engineering or related discipline, s/he would have at least 3 years of experience in the design of systems for the handling and transfer of bulk solid and fluid materials, including pneumatic conveyance.

Pet. 12–13; *see* Ex. 1034 ¶ 28.

Patent Owner responds that “Petitioner’s proposed level of skill is unreasonably high.” PO Resp. 3. Patent Owner defines the person of ordinary skill in the art (“POSITA”) as follows:

Unlike Petitioner’s proposed POSITA, Patent Owner proposes that the person of ordinary skill in the art would have at least a bachelor’s degree in mechanical engineering or a similar discipline, at least two years of experience with systems that convey materials, and the flow and behavior of granular solids, slurries, and pastes. Ex. 2057, ¶10. If the person had an advanced degree in mechanical engineering or a similar discipline, that person need only a year of study and/or experience with systems that convey materials, and the flow and behavior of granular solids, slurries, and pastes. *Id.*

Id. at 4.

We do not agree with Patent Owner that Petitioner’s definition of the person of ordinary skill in the art is unreasonably high, and we adopt Petitioner’s definition for purposes of our Final Written Decision. While Petitioner’s definition requires five years of design experience at the bachelor’s degree level of education, Patent Owner’s definition does not

require any design experience at all. We agree with Petitioner that a person of ordinary skill in the art *designs* devices, and, thus, actively monitors the relevant technical literature, rather than is merely familiar with devices (e.g., an operator or a manufacturer), as proposed by Patent Owner. *See* Ex. 1034 ¶ 28; Ex. 1005, 2:62–64 (indicating that those skilled in the art would understand “that the critical cone angle will vary depending upon the material being conveyed”). Accordingly, we adopt Petitioner’s proposed level of ordinary skill.

C. Asserted Obviousness

A claim is unpatentable for obviousness under 35 U.S.C. § 103(a) if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains. *See KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). A patent claim composed of several elements, however, is not proved obvious merely by demonstrating that each of its elements was known, independently, in the prior art. *Id.* at 418. In analyzing the obviousness of a combination of prior art elements, it can be important to identify a reason that would have prompted one of skill in the art to combine the elements in the way the claimed invention does. *Id.* A precise teaching directed to the specific subject matter of a challenged claim is not necessary to establish obviousness. *Id.* Rather, “any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.” *Id.* at 420. The question of obviousness is resolved on the basis of underlying factual determinations, including: (1) the scope and content of

the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) objective evidence of nonobviousness, i.e., secondary considerations, if in evidence. *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

1. Asserted Obviousness of Claims 1–9 over Dietzen I and II, Ciaffone, Laster, and Pneumatic Conveying, and Toth

Petitioner challenges claims 1–9 as obvious over Dietzen I and II, Ciaffone, Laster, Pneumatic Conveying, and Toth. For the reasons discussed below, we determine that Petitioner has established, by a preponderance of the evidence, that claims 1, 2, and 4–9, but not claim 3, would have been obvious over Dietzen I and II, Ciaffone, Laster, Pneumatic Conveying, and Toth.

a. Overview of Dietzen I and Dietzen II

Dietzen I is a United States patent that issued in 1995. Ex. 1012, [45]. Dietzen II, which is related to Dietzen I, issued from a continuation-in-part application filed on March 2, 1999. Ex. 1013, (22). Petitioner contends, and Patent Owner does not contest, that Dietzen I qualifies as prior art under 35 U.S.C. § 102(b) and that Dietzen II qualifies as prior art under 35 U.S.C. § 102(e). Pet. 21–22.

Dietzen I discloses a “method and apparatus for removing drill cuttings from an oil and gas well drilling platform.” Ex. 1012, 2:19–21. The method involves physically separating, on the drilling platform, waste drilling fluid from waste drill cuttings. *Id.* at 2:25–29. The separated waste drilling fluid is recycled for use in the well bore during drilling operations, and the separated waste drill cuttings are collected in a trough and suctioned from the trough to a holding tank on the drilling platform. *Id.* at 2:29–39.

Subsequently, the drill cuttings are emptied from the tank at a remote disposal site. *Id.* at 2:48–52.

Dietzen II discloses transferring the waste drill cuttings from holding tanks on the drilling platform to storage tanks on a work boat via a flow line. Ex. 1013, 2:58–59. Figure 1A of Dietzen II is reproduced below.

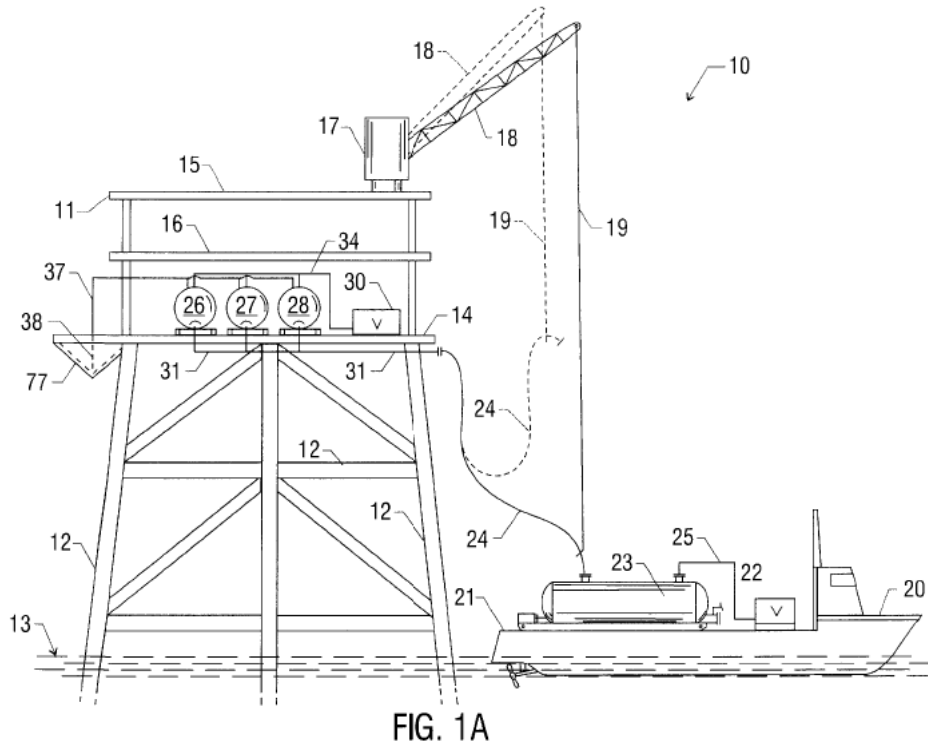


Figure 1A is an elevation view illustrating work boat 20 moored next to offshore oil and gas well drilling platform 11. Ex. 1013, 4:10–34. The deck of boat 20 supports vacuum unit 22, vacuum lines 25, and one or more storage tanks 23. *Id.* at 4:34–36. Drilling platform 11 supports one or more tanks for holding cuttings that have been removed from the well bore during drilling. *Id.* at 4:40–44. Suction line 24 can be used to form a removable connection between the tanks on the drilling platform and the boat storage tanks. *Id.* at 4:50–53.

b. Overview of Ciaffone

Ciaffone is a United States patent that issued in 1971. Ex. 1006, [45]. Petitioner contends, and Patent Owner does not contest, that Ciaffone is prior art under 35 U.S.C. § 102(b). Pet. 13.

Ciaffone discloses a system and process for pneumatically conveying waste materials over long distances, without the need for bins, hoppers, hydraulic rams, screw feeders, conveyor belts, and the like between the ejector and the incinerator. Ex. 1006, 1:7–9, 18–20, 30–32, 1:70–2:6. Waste materials that can be conveyed pneumatically, as disclosed in Ciaffone, include screenings, grit, sludge cake, skimming, hospital waste, refuse, garbage, bark, plastics, and the like. *Id.* at 1:70–73. According to Ciaffone, its system and process overcome problems in the art associated with conveyance of waste materials that are wet and bulky. *Id.* at 1:18–20, 30–32.

Figure 2 of Ciaffone, which is reproduced below, depicts a preferred embodiment. *Id.* at 2:51–54.

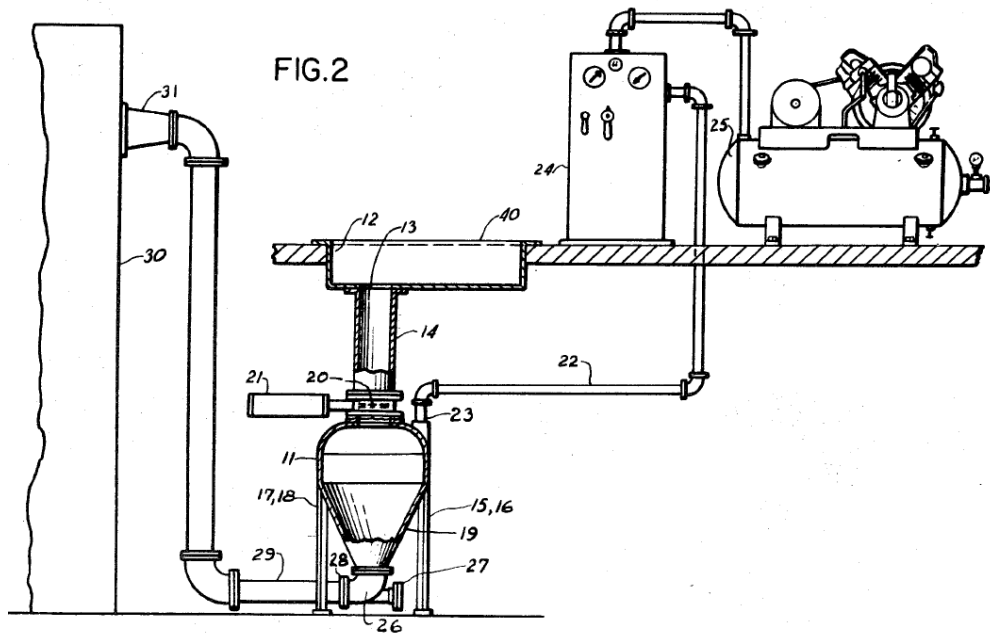


Figure 2 illustrates pneumatic ejector 11, conical section 19 of the ejector, inlet chute 14, pressure air line 22, and discharge pipe 29. *Id.* at 2:55–3:3. As shown in Figure 2, discharge pipe 29 extends horizontally from the bottom of the ejector, rises vertically to the level of the entrance to incinerator 30, and then proceeds horizontally to connect with the incinerator. *Id.* at 3:6–9. Ciaffone discloses that this piping configuration achieves “the most efficient conveyance of the waste material.” *Id.* at 3:9–11. Ciaffone explains this is due to compaction of the waste:

Thus, when the waste is compacted in the ejector and the first horizontal section as well as when it passes through the vertical section it is necessarily present in a compact, tightly knit unit which can be acted upon by the full force of the pressurized air and thereby lifted to the requisite height. I[n] contrast, when the waste is dispersed through greater areas of the discharge pipe, the air is diffused among the separated particles and a concurrent diminution in the applied air pressure conveying the total charge is experienced.

Id. at 3:11–19. Ciaffone further explains the process as follows:

When the waste is compacted in the conical section of the ejector, the inlet valve is closed and air under pressure is forced into the ejector through the air inlet. The pressure within the vessel is allowed to build up to an appropriate level so as to overcome the force represented by the mass of the waste material whereupon this compacted mass is blown out through the discharge pipe to be deposited into the incinerator. Based upon the pressure of air applied, the waste can be lifted and delivered over any reasonable distance to the incinerator; heights of up to about 100 feet and distances of up to 2,000 feet being practical for purposes of this invention.

Id. at 3:29–40. As disclosed in Ciaffone, ejectors can range in size from about 1 to 500 cubic feet. *Id.* at 3:65–66. Ciaffone discloses that the pressure utilized to eject the waste may range from about 5 to 100 psi, which we find equates to about 0.3 to 6.89 bar. See Ex. 1006, 3:66–68; Ex. 1032 ¶ 57. Ciaffone discloses a “four cubic foot experimental ejector,” in which an air pressure of approximately five psi (approximately 0.3 bar) was required to overcome the force represented by the mass of a three cubic foot barrel of waste solids. Ex. 1006, 3:69–4:5.

c. Overview of Laster

Laster is a United States patent that issued in 1982. Ex. 1014, [45]. Petitioner contends, and Patent Owner does not contest, that Laster qualifies as prior art under 35 U.S.C. § 102(b). Pet. 24.

Laster discloses a pneumatic pumping apparatus for pumping thick, difficult-to-pump slurry fluids, such as drilling mud. Ex. 1014, 1:11–13. Specifically, Laster addresses the problem of transferring waste drilling mud that becomes “very thick”:

In the oil field industry, and especially associated with drilling platforms, drilling rigs and the like, it is known to use a thick viscous fluid known as drilling mud during the proper

procedures for drilling wells. . . . The mud used in drilling is quite thick and difficult to pump or move when it is used up. . . . [U]nwanted mud which is often polluted or too filthy to reclaim must be pumped to a holding pond or pit which is known in the art as a “reserve pit.”

Pumps which are known in the art for the pumping of drilling mud . . . suffer in that they are inadequate or inefficient in pumping mud as the mud thickens. *This is particularly a problem when the weather is quite cold and the mud becomes very thick* and difficult if not impossible to transmit from the rig cellar to the reserve pit using conventional pumps. It is not unknown for an oilman or other drilling rig personnel to hand empty the rig cellar using a shovel and bucket when the drilling mud in the cellar becomes so thick that conventional pumps are ineffective in discharging the cellar of the mud and trash which collect there within. It is to this problem that the present invention is directed.

Id. at 1:20–48 (emphasis added). Laster teaches that “a desired buildup of pressure can be achieved using a sump tank of suitable pressure requirements and a source of compressed air sufficient to move any fluid even, *heavy viscous drilling mud*, slurries, oil, and the like.” *Id.* at 2:27–31 (emphasis added). Laster discloses a sump tank having wall thicknesses to withstand pressures of 0–200 psi. *Id.* at 3:31–34; Pet. 24 (citing Ex. 1032 ¶ 96).

c. Overview of Pneumatic Conveying

Petitioner asserts, and Patent Owner does not contest, that Pneumatic Conveying is a textbook published in 1990 that qualifies as prior art under 35 U.S.C. § 102(b). Pet. 18; Ex. 1009.

Pneumatic Conveying describes high pressure feeding devices. Ex. 1009, 273–308. “Common to all such high pressure feeding devices is the ‘blow vessel’ designed to meet both the requirements as a material

feeder and the relevant design codes for pressure vessels.” *Id.* at 273. As taught by Pneumatic Conveying, “[b]low vessels are essentially conical bottomed pressure vessels fitted with the necessary valves and fittings to suit the particular feeding requirements.” *Id.* “[T]here are three basic design parameters which can influence blow vessel performance: (a) cone angle; (b) vessel volume; and (c) vessel pressure.” *Id.* at 279. Pneumatic Conveying states that “[t]he increased use of blow vessels for feeding materials with ‘bad’ flow properties necessitates the selection of a suitable cone angle.” *Id.* According to Pneumatic Conveying, it is advisable to use small capacity blow vessels for materials that “have ‘bad’ flow characteristics or which have such free flowing characteristics that they tend to ‘flood’ the conveying line.” *Id.* at 281–282. Pneumatic Conveying teaches that “small capacity blow vessels are designed on the basis of conveying material as a series of discrete plugs rather than as a continuous stream.” *Id.* at 282.

Pneumatic Conveying identifies a small capacity blow vessel sold by Simon Macawber SA Ltd, South Africa, that is “designed for materials with ‘bad’ flow characteristics.” *Id.* at 281–282, Fig. 7.32. Dr. Carson testifies that this blow vessel is the “same Denseveyor system” described in Macawber and Macawber Coal Ship (Exs. 1007 and 1008, discussed below). Ex. 1034 ¶¶ 79, 144, 151.

Pneumatic Conveying also teaches that “it is sound practice to design a blow vessel for high operating pressures.” Ex. 1009, 282–83. Pneumatic Conveying states: “There is a relatively small cost differential between a vessel constructed to operate [at] 400 kPa (4 bar) and one constructed to operate at 700 kPa (7 bar).” *Id.* at 283. Pneumatic Conveying further

teaches that “[t]he added pressure capacity could provide the user with an opportunity of extending either the capacity or the length of the conveying line without the need to purchase a second blow vessel.” *Id.*

d. Overview of Toth

Toth is a United States patent that issued in 1997. Ex. 1017, [45]. Petitioner asserts, and Patent Owner does not contest, that Toth qualifies as prior art under 35 U.S.C. § 102(b). Pet. 25. According to Petitioner, “Toth teaches a pressure vessel storage container housed in a frame that complies with standards such as those issued by the [ISO]” and that, ‘in order to be commercially acceptable,’ a container must comply with ISO standards.” *Id.* (citing Ex. 1017, 1:28–35, 2:15–31). Dr. Carson testifies that “Toth explains, as was well known and obvious to those in the materials handling industry long before 1997, that a hopper can be ‘fitted inside a frame conforming to the external size requirements of ISO.’” Ex. 1034 ¶ 109 (citing Ex. 1017, 2:30–33).

e. Obviousness Analysis

Petitioner contends that the combination of Dietzen I and II, Ciaffone, Laster, Pneumatic Conveying, and Toth teaches the subject matter of claims 1–9. Pet. 27–43.

(1) Reasons for Combining the References

Petitioner asserts that Dietzen I and II teach pneumatically conveying screened drill cuttings, but rely on suction (i.e., negative pressure) as the means of conveyance. *Id.* at 30–33; see Ex. 1034 ¶¶ 116, 123. Petitioner reasons that a POSITA would have been motivated to substitute a positive-pressure conveyance system in place of the negative-pressure conveyance system described in Dietzen I and II because “a positive pressure system can

create a larger pressure differential than a negative pressure system” and, thus, “negative pressure . . . systems are generally limited to shorter distances and lower material volumes than positive pressure systems.” Pet. 30–31 (citing Ex. 1034 ¶ 1117; Ex. 1015 (DAVID MILLS, PNEUMATIC CONVEYING AND DESIGN (1990)), 27). For those reasons, Petitioner argues that a POSITA would have been motivated to substitute the negative-pressure conveyance system of Dietzen I and II with Ciaffone’s positive-pressure conveyance system as modified based on the teachings Laster, Pneumatic Conveying, Macawber, and Macawber Coal Ship. Pet. 30–37.¹³

Dr. Carson testifies that, given the use of negative-pressure to convey screened oil rig drill cuttings, as disclosed in Dietzen I and II, a POSITA would have had a reasonable expectation of success in using the positive-pressure equipment described in Ciaffone, Laster, and Pneumatic Conveying to convey non-free flowing drill cuttings. Ex. 1034 ¶¶ 117–25. For example, Dr. Carson testifies:

Dietzen I and II would have also given those of ordinary skill in the art a reasonable expectation of success in using the positive-pressure pneumatic conveying equipment described by Ciaffone and the other pneumatic conveying references I have discussed. Dietzen I and II both confirm that screened drill cuttings can be pneumatically conveyed using negative, or vacuum, pressure. As I already explained, those of ordinary skill in the art would have had a strong expectation that pneumatic conveyance with positive pressure would effectively convey drill cuttings as well. Thus, the success of Dietzen I and II would have

¹³ According to Petitioner, Macawber and Macawber Coal Ship “describe the efficacy of the same Denseveyor system discussed in Pneumatic Conveying, and the efficacy identified in those references—that the system can convey ‘sticky,’ ‘cohesive,’ and ‘high moisture content materials’—is inherent to the system.” Pet. 33 n.4 (citing Ex. 1007, 2).

given those of ordinary skill in the art further confidence that pneumatic conveyance using the positive pressure system of Ciaffone and similar systems would be an effective means for conveying non-free flowing drill cuttings, including in the form of a paste or sludge.

Id. ¶ 123; see Pet. 32 (“Dietzen I and II would have given a POSITA a strong expectation of success in using Ciaffone’s pneumatic conveying equipment to convey non-free flowing drill cuttings.”).

In response, Patent Owner argues that a POSITA would not have considered looking beyond the Dietzen I system “[g]iven that the vacuum system only worked for drill cuttings fresh off the shaker.” PO Resp. 21 (citing Ex. 2057 ¶¶ 111, 150–151). Patent Owner also argues that a “POSITA would not have considered that pressure differential alone would have overcome the problems in Dietzen II that required an auger.” *Id.* (citing Ex. 2057 ¶¶ 115–116, 150–151).

Patent Owner’s arguments do not respond adequately to Petitioner’s persuasive obviousness rationale that a POSITA would have substituted a positive-pressure conveyance system in place of the negative-pressure conveyance system of Dietzen I and II because negative pressure systems are generally limited to shorter distances and lower material volumes than positive systems. Further, Patent Owner’s arguments do not address sufficiently Ciaffone’s teaching that a positive-pressure vessel with a conical bottom section can be used to convey materials without the need for bins, hoppers, hydraulic rams, screw feeders, conveyor belts, and the like. See Ex. 1006, 1:70–2:6. As explained by Petitioner, Dietzen II uses an auger to augment use of negative pressure for moving settled materials horizontally from the bottom of a vessel. Pet. Reply 15; Ex. 2021 ¶¶ 154:6–155:5. In contrast with Dietzen II’s relatively low-pressure vacuum system, a positive-

pressure system such as taught by Ciaffone, with an operating pressure of up to 6.89 bar, blows materials out of the conical bottom section of the vessel. *See supra* Section II.C.1.b.

Patent Owner further argues that a “POSITA would have discounted positive pressure given th[at] non-free flowing drill cuttings cannot be fragmented.” PO Resp. 22 (citing Ex. 2057 ¶¶ 44, 150). We find this argument unpersuasive because Ciaffone’s blow vessel does not require fragmentation of the material to be conveyed. Rather, Ciaffone teaches compaction of the material in a tightly knit unit that can be acted upon by the full force of the pressurized air, in contrast with dispersion of the waste such that air is diffused among the separated particles resulting in diminution in the applied air pressure conveying the total charge. Ex. 1006, 3:11–19. Further, Pneumatic Conveying teaches that “small capacity blow vessels are designed on the basis of conveying material as a series of discrete plugs rather than as a continuous stream.” Ex. 1009, 282, Fig. 7.32. Pneumatic Conveying further explains: “As such, the capacity of the vessel is selected such that on discharge a plug is formed which is just long enough to prevent blocking [of the conveying line].” *Id.* Pneumatic Conveying discloses that “[i]f the material to be conveyed is unusually cohesive, a plug forming system will yield good results” and, “[a]s the plugs are relatively impermeable, they remain separated even over long conveying distances.” *Id.* at 346. Based on these teachings, a POSITA would not have understood that it was necessary to fragment non-free flowing drill cuttings, contrary to Patent Owner’s argument.

For the reasons given, Petitioner has provided a sufficient reason with rational underpinning for combining Dietzen I and II, Ciaffone, Laster, and

Pneumatic Conveying. See *KSR*, 550 U.S. at 418 (“[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.”) (quoting *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)).

Petitioner additionally relies on *Toth* to support its argument that “[i]t would have been obvious to a POSITA to use an ISO container sized vessel.” Pet. 39 (citing Ex. 1034 ¶ 139). Petitioner asserts that: “As stated in *Toth*, “in order to be commercially acceptable, . . . a freight container must be designed and built to internationally recognized standards such as those issued by the United Nations [and] the [ISO].” *Id.* at 39–40 (citing Ex. 1017, 1:28–32, 2:30–33; Ex. 1020). Petitioner further argues that “[u]sing ISO container sized structures is, and has been, standard practice for decades.” *Id.* at 40 (citing Ex. 1017, 1:28–32, 2:30–33; Ex. 1020); Ex. 1034 ¶ 139 (Dr. Carson testifying that “[i]t was known and obvious to transport drill cuttings on a ship, and it would have been obvious to one of ordinary skill in the art to design the vessel to fit within an ISO container frame.”).

In response, Patent Owner argues that “Petitioner has not provided the necessary analysis as to why the person of ordinary skill in the art would have combined *Toth* with any of the cited references.” PO Resp. 42. Patent Owner further argues that a POSITA would not have considered the vessel of *Toth* with any of the cited references.” *Id.* at 43.

As discussed further below, we agree with Patent Owner that Petitioner has not provided a sufficient reason for combining the teachings of *Toth* with the teachings of *Dietzen I and II*, *Ciaffone*, *Laster*, and *Pneumatic Conveying*. See *KSR*, 550 U.S. at 418.

(2) *Claim 1*

We determine that Dietzen I, Dietzen II, Ciaffone, Laster, and Pneumatic Conveying teach the limitations of independent claim 1, including a first pressure “configured to allow a compressed conveyance gas to be introduced therein, to force at least a portion of said non-free flowing oil well drill cuttings in said first pressure vessel to move out to a container, without employing a non-pneumatic means for forcing said at least a portion of said non-free flowing oil well drill cuttings out from said first pressure vessel.” See Pet. 36–38; Ex. 1034 ¶¶ 131–137. Ciaffone teaches a pressure vessel with a conical bottom section for pneumatically conveying wet and bulky waste materials over long distances, without the need for bins, hoppers, hydraulic rams, screw feeders, conveyor belts, and the like. Ex. 1006, 1:7–9, 18–20, 30–32, 1:70–2:6, 2:55–3:3. Ciaffone also teaches that the pressure vessel should be from about 1 to 500 cubic feet in volume and from about 0.3 to 6.89 bar in operating pressure. Ex. 1006, 1:70–2:6, 3:65–68.

Pertinent to designing Ciaffone’s vessel to convey non-free flowing drill cuttings, Pneumatic Conveying teaches that “there are three basic design parameters which can influence blow vessel performance: (a) cone angle; (b) vessel volume; and (c) vessel pressure.” Ex. 1009, 279. In accordance with the teachings of Pneumatic Conveying, a POSITA would have selected a cone angle for the conical bottom section of Ciaffone’s vessel suitable to convey non-free flowing drill cuttings. See *id.* (teaching that “[t]he increased use of blow vessels for feeding materials with ‘bad’ flow properties necessitates the selection of a suitable cone angle.”). Further, a POSITA would have selected a small-capacity vessel suitable for

high operating pressures. *See id.* at 281–283. Laster would have confirmed that positive pressure could be used to convey non-free flowing drill cuttings. *See* Ex. 1014, 2:27–31 (describing positive-pressure equipment for conveying “heavy viscous drilling mud”); Ex. 1032, 174 (Dr. Carson testifying that “Laster would have further provided those of ordinary skill in the art with a more than reasonable expectation that pneumatic conveyance could be used to convey non-free flowing drill cuttings, including in the form of a paste or sludge.”).

We are not persuaded by Patent Owner’s argument that Dietzen I and II do not disclose non-free flowing drill cuttings. PO Resp. 38–42. Patent Owner argues that “[t]he ‘drill cuttings’ disclosed in Dietzen I and II that are transferred from the trough to the tank are *not* non-free flowing” because the drill cuttings fall via gravity into the trough. *Id.* at 38–39 (citing Ex. 2057 ¶¶ 107, 112, 179). Patent Owner also argues that Dietzen II teaches that use of an auger (non-pneumatic means) is required to move non-free flowing drill cuttings that have “set up or congealed” when stored in a holding tank. *Id.* at 41 (citing Ex. 2057 ¶¶ 181–82).

We agree with Petitioner, however, that Dietzen I and II disclose separated waste drill cuttings that are generated by a recycling procedure on a drilling rig in essentially the same manner as described in the ’018 Patent. *See supra* Section II.C.1.a; Pet. Reply 12–13, 15–16. We see no credible basis for distinguishing the separated waste drill cuttings in Dietzen I and II from “non-free flowing drill cuttings” as we have construed that term. Under our claim interpretation, “non-free flowing drill cuttings” are “screened drill cuttings, i.e., screened material generated by the drilling of an oil well including a mixture of earth and drilling fluid or oil.” *See*

Section II.A.1. At oral argument, Patent Owner agreed that Dietzen I discloses non-free flowing drill cuttings. Tr. 97:20–22 (“We would agree that Dietzen I shows the conveyance of non-free flowing drill cuttings, but it uses negative pressure. It doesn’t use positive pressure.”).

Patent Owner’s remaining arguments also are unpersuasive. We do not agree that Dietzen II’s disclosure of a negative-pressure conveyance system that includes an auger teaches away from using “non-pneumatic means” for moving non-free flowing drill cuttings. See PO Resp. 27–28. Dietzen II does not mention, much less discourage, utilizing a positive-pressure system, such as taught in Ciaffone, in which material is blown out of the conical bottom section of the vessel rather than moved by an auger. See *In re Fulton*, 391 F.3d 1195, 1201 (Fed. Cir. 2004) (requiring, in order to “teach away,” that a reference “criticize, discredit, or otherwise discourage the solution claimed”).

Patent Owner argues that Laster does not disclose non-free flowing drill cuttings and would not have provided a POSITA with an expectation of success. PO Resp. 36 (citing Ex. 2057 ¶ 175). Patent Owner characterizes Laster as directed to “*fluids*.” *Id.* We disagree because, as explained by Dr. Carson:

Laster is directed to drilling mud that has been used to the point that it has become too “polluted or too filthy to reclaim.” [Ex. 1014, 1:30–33]. One of ordinary skill would understand this statement to be indicating that drilling mud has been so contaminated with drill cuttings that it can no longer be used for drilling operations and must be removed from the site for treatment and/or disposal. Laster says that this mud can get so thick that “[i]t is not unknown for an oilman or other drilling rig personnel to hand empty the cellar rig using a shovel and bucket[”] because the material is too thick “if not impossible to

transmit” using conventional impeller-driven pumps. *Id.* at 1:34–48.

Ex. 1034 ¶ 93.

We also disagree with Patent Owner’s argument that Pneumatic Conveying is “directed to pneumatic conveyance of dry solids, specifically solids in the form of powders.” PO Resp. 33 (citing Ex. 1009, 1, 2; Ex. 2057 ¶¶ 168–169). We credit Dr. Carson’s testimony that Pneumatic Conveying identifies hundreds of materials that had been pneumatically conveyed by 1990, including “cellulose acetate (wet),” “edible paste products,” and “papermill wood waste (wet).” Ex. 1034 ¶ 78 (citing Ex. 1009, 3–5). On cross-examination, Dr. Carson credibly testified that “paper mill wood waste (wet)” “could be a paste or a sludge” and that “edible paste products” are paste. Ex. 2021, 135:16–136:5. Dr. Carson also credibly testified that Pneumatic Conveying “does refer to a cohesive material, of which a sludge and a paste would be considered cohesive.” *Id.* at 134:23–25. As noted above, Pneumatic Conveying discloses that conveying “unusually cohesive” material in a plug forming system “will yield good results” and that the plugs “remain separated even over long conveying distances.” Ex. 1009, 346.

For these reasons, we determine that Dietzen I and II, Ciaffone, Laster, and Pneumatic Conveying teach the limitations of claim 1.

(3) Claim 3

Claim 3 recites “[t]he system of claim 1, wherein said storage vessel is an ISO container sized vessel.” Petitioner has not persuaded us that a POSITA would have combined the teachings of Toth and the other references to achieve the limitations of claim 3. In particular, Petitioner has not explained sufficiently how the prior art practice of using standard

ISO-size containers for commercial shipments would have provided a reason for a POSITA to use an ISO-size container as a storage vessel on an oil well drilling rig for holding non-free flowing drill cuttings, as required by claim 3. Although Petitioner argues that “[u]sing ISO container sized structures is, and has been, standard practice for decades” (Pet. 40), Petitioner has not shown that any “ISO container sized structures” in the prior art were capable of being used as a storage vessel on an oil well drilling rig for holding non-free flowing oil well drill cuttings.

Dr. Carson’s testimony does not fill the gap in Petitioner’s arguments. *See* Ex. 1034 ¶ 139. That “[i]t was known and obvious to transport drill cuttings on a ship,” as Dr. Carson testifies, does not explain sufficiently why a POSITA predictably would have designed the storage vessel on the oil well drilling rig “to fit within an ISO container frame.” *See id.*

For these reasons, we determine that Petitioner has not shown, by a preponderance of the evidence, that claim 3 would have been obvious over Dietzen I and II, Ciaffone, Laster, Pneumatic Conveying, and Toth.

(4) Claim 4

Claim 4 recites: “The system of claim 1, wherein said storage vessel is a pressure vessel adapted to allow a conveyance gas to be introduced therein, wherein the pressure of said conveyance gas forces at least a portion of said non-free flowing oil well drill cuttings out from said storage vessel to said first conduit.” Petitioner contends that claim 4 recites “how the pressure vessels of Ciaffone and Pneumatic Conveying function — compressed air is introduced into the vessel to force the materials out of the vessel and into the discharge conduit.” Pet. 40 (citations omitted). We agree with, and adopt, Petitioner’s arguments. In opposition, Patent Owner

repeats arguments that we have previously discussed and rejected. *See supra* Section II.C.1.e(2).

For these reasons, we determine that Ciaffone and Pneumatic Conveying teach the limitation added by claim 4.

(5) Claims 5 and 8

Dependent claims 5 and 8 add the limitation that the vessel “has a conical portion defining a cone angle selected to enable mass flow of said non-free flowing drill cuttings.” Petitioner contends that Pneumatic Conveying teaches the limitation added by these dependent claims. *See* Pet. 41. Petitioner argues:

POSITAs were well aware how to select a cone angle to enable mass flow. [E. 1034] ¶ 144. The ‘018 patent specification acknowledges, “[i]t is well known that the critical cone angle will vary depending upon the material being conveyed as such [sic] would be well understood by those skilled in the art.” Ex. 1005, 2:61–64. In addition, Pneumatic Conveying expressly teaches that when dealing with “materials with ‘bad’ flow properties,” the solution lies in the “selection of a suitable cone angle.” Ex. 1009, 279. Pneumatic Conveying then goes on to discuss the concept of mass flow and addresses the factors that influence the flow characteristics of a material out of a conical-shaped structure, including the selection of an appropriate cone angle. *Id.*, 410–420; 279–282.

Id.

Patent Owner does not agree that Pneumatic Conveying teaches “mass flow of said non-free flowing drill cuttings.” PO Resp. 46 (citing Ex. 2057 ¶¶ 185–186). Patent Owner argues that Pneumatic Conveying’s teachings are limited to stored solids, and “a POSITA would not have been motivated to use a vessel for solids from Pneumatic Conveying to design a vessel for

mass flow of pastes or non-free flowing [oil well drill/drill] cuttings.” *Id.* (citing Ex. 1009, 411; Ex. 2057 ¶¶ 185–186).

In support of Patent Owner’s argument, Dr. Brown testifies that Pneumatic Conveying does not provide information on “anything close to ‘non-free flowing [oil well drill/drill] cuttings’ or a ‘thick, heavy paste,’” and, thus, a POSITA “would not look to designs presented in Pneumatic Conveying.” Ex. 2057 ¶ 185. We give little weight to this testimony because, as discussed above, we credit Dr. Carson’s testimony that Pneumatic Conveying identifies hundreds of materials, including paste and cohesive material. *See supra* Section II.C.1.e(2). We also credit Dr. Carson’s testimony that Pneumatic Conveying explains that pressure vessels increasingly were being used to convey materials with “bad” flow properties, and that “Pneumatic Conveying would have also shown those of ordinary skill in the art that pneumatic conveying with a positive pressure system would be an effective way to transport non-free flowing drill cuttings, including in the form of a paste or sludge.” Ex. 1034 ¶ 124.

Dr. Brown also testifies that the information in Pneumatic Conveying with respect to mass flow concerns granular solids. Ex. 2057 ¶ 185 (citing Ex. 1009, 411). He further testifies that because “the flow behavior of non-free flowing [oil well drill/drill] cuttings is distinct from that of granular solids . . . a person of ordinary skill in the art would gain no insight in designing a vessel for paste to produce mass flow from a vessel designed to contain granular solids.” *Id.* We give little weight to this testimony because Dr. Brown does not address all of the information in Pneumatic Conveying that is relevant to mass flow, as discussed further below.

In contrast with Dr. Brown, Dr. Carson testifies: “As explained in Pneumatic Conveying, those of ordinary skill in the art knew that the cone angle is an important variable to adjust in order to achieve mass flow.” Ex. 1034 ¶ 144 (citing Ex. 1009, 280–282, 410–420; Ex. 1046, 68–74, 147–151). Consistent with Dr. Carson’s testimony, the ’018 Patent discloses that “[i]t is well known that the critical cone angle [to achieve mass flow] will vary depending upon the material being conveyed [and] as such would be well understood by those skilled in the art.” Ex. 1005, 2:61–63.

We credit the testimony of Dr. Carson over the conflicting testimony of Dr. Brown because Dr. Carson’s testimony addresses the full Pneumatic Conveying disclosure, and is consistent with that disclosure, while Dr. Brown’s testimony does not address the full Pneumatic Conveying disclosure, and is not completely consistent with that disclosure. For example, under the subheading “Factors influencing blow vessel performance,” Pneumatic Conveying teaches that “[t]he increased use of blow vessels for feeding materials with ‘bad’ flow properties necessitates the selection of a suitable cone angle.” Ex. 1009, 279. Pneumatic Conveying further explains that “[v]essels with incorrectly designed cone angles will result in either ‘ratholing’ or ‘bridging’ problems.” *Id.* at 279, Fig. 7.30. These teachings of Pneumatic Conveying are not limited to granular solids, contrary to Dr. Brown’s testimony.

Figure 7.30 of Pneumatic Conveying (*id.* at 280) is reproduced below:

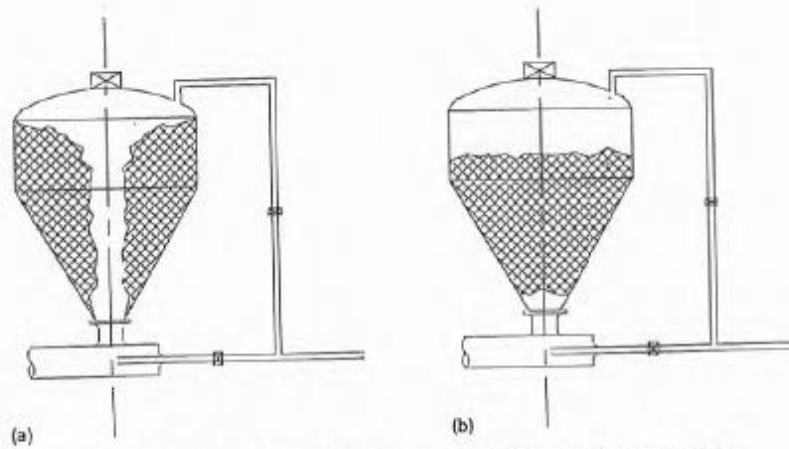


Figure 7.30 Discharge problems from a blow vessel, (a) ratholing; (b) bridging.

Figure 7.30 comprises two figures, (a) and (b), illustrating the blow vessel discharge problems known as “ratholing” and “bridging,” respectively. As described in Pneumatic Conveying, “[r]atholing [illustrated in figure (a) on the left above] results in the formation of a blow hole through the material mass and, once formed, it is not possible to transport any more material.” *Id.* at 279. “Bridging problems [illustrated in figure (b) on the right above] result in the product forming a barrier across the outlet of the vessel which prevents any further material flow.” *Id.* The “ratholing” problem described in Pneumatic Conveying is the same problem that the ’018 Patent describes as “core flow” or “funnel flow.” *See supra* Section I.B; Ex. 1005, 2:35–60.

Pneumatic Conveying teaches that “[t]he selection of a suitable cone angle could be aided by the use of the classical silo or hopper design criteria,” but cautions that “these design criteria do not take into consideration that the product is under pressure and in certain situations, gas also percolates through the material.” Ex. 1009, 279. Pneumatic Conveying then states: “At present, much of the cone angle selection criteria are based

on empirical data obtained from experience.” *Id.* Again, Pneumatic Conveying provides information relating to cone angle selection that is not limited to granular solids, contrary to Dr. Brown’s testimony.

In a separate chapter, Pneumatic Conveying presents information relating to classical silo or bin design. *Id.* at 409–455. Under the subheading “Common flow problems from a silo bin,” Pneumatic Conveying again discusses the problems of “ratholing” and “bridging.” *Id.* at 410. On the next page, under the subheading “Characteristic flow of granular and powdered products from a storage bin,” Pneumatic Conveying discusses and contrasts two flow situations, “mass flow” and “funnel flow.” *Id.* at 411. As explained under that subheading, “mass flow from a bin implies that the total volume of the stored solids is in motion.” *Id.* “A mass flow bin is devoid of any channeling, surging, flooding, hang-ups or bridging.” *Id.* The information provided in Pneumatic Conveying relating to classical silo or bin design complements the separate information in Pneumatic Conveying relating to design of blow vessels generally.

For these reasons, we determine that Pneumatic Conveying teaches the limitation recited in claims 5 and 8 that the vessel “has a conical portion defining a cone angle selected to enable mass flow of said non-free flowing drill cuttings.”

(6) *Claims 2, 6, 7, and 9*

We are persuaded by, and adopt, Petitioner’s argument and evidence that the combination of Dietzen I and II, Ciaffone, Laster, Pneumatic Conveying, and Toth teaches the additional limitations recited in claims 2, 6,

7, and 9. See Pet. 20, 39, 42–43, 53; Ex. 1034 ¶¶ 138, 145–47.¹⁴ Patent Owner relies on its arguments with respect to independent claim 1 and does not argue the separate patentability of claims 2, 6, 7, and 9.

(7) Secondary Considerations

Patent Owner asserts objective evidence of nonobviousness in the form of commercial success, praise by others, and skepticism by experts. PO Resp. 62–68. Patent Owner argues that its CleanCut system “practices each claim of the ’018 Patent.” *Id.* at 63. Citing the declaration of Mr. Lauder, Patent Owner asserts: “In all of the jobs that use the CleanCut system, at least some of the material conveyed was non-free flowing drill cuttings and the CleanCut system is usually deployed on an oil well drilling rig.” *Id.* (citing Ex. 2052 ¶¶ 25–26). Patent Owner asserts that the CleanCut system has experienced substantial increases in sales since its introduction in 2002 and that, in 2014, the system “had nearly an 80% market share in the market for pneumatic conveyance of pastes/drill cuttings in the oil industry, a market that did not exist before Patent Owner launched its CleanCut system.” *Id.* at 64–65 (citing Ex. 2053 ¶¶ 42–43, 47). Patent Owner also asserts that customers and trade publications have praised the safety and efficiency of the CleanCut system. *Id.* at 66–67 (citing Ex. 2052 ¶¶ 52–59). Patent Owner provides evidence of praise from ChevronTexaco (Ex. 2041, 3–4, 12–13, 31–32) and Britannia (Ex. 2042, 5, 17, 19), as well as the

¹⁴ We note with respect to dependent claim 9, which requires the first pressure vessel to be adapted to withstand pressures of between 4 and 8 bars, that Petitioner asserts that Pneumatic Conveying discloses vessels constructed to operate at 7 bar. Pet. 20 (citing Ex. 1009, 282–83). Petitioner also argues that “Pneumatic Conveying expressly teaches the limitations of claims 4–5 and 8–9.” *Id.* at 53.

National Ocean Industries Association, which awarded the “Safety in Seas Award” to the CleanCut system (Ex. 2052 ¶ 52). Patent Owner also presents evidence of skepticism by experts in the pneumatic conveyance industry “suggesting that pastes such as drill cuttings could not be conveyed by pneumatic means.” *Id.* at 67–68 (citing Ex. 2052 ¶¶ 50–51; Ex. 2036, 242; Ex. 2038, 1).

The CleanCut system, according to Patent Owner, “consists of two different pressure vessels, one smaller vessel called the CCB that receives the cuttings from the shaker house and then pneumatically conveys the cuttings through conduits or pipes to the other larger type of pressure vessel called an ISO-Pump.” *Id.* at 63. As described by Patent Owner, “ISO-Pumps can also be installed on ships called PSVs that service the oil rig.” *Id.* Patent Owner asserts that, “[a]s established in the Declaration of Colin Lauder submitted herewith, Patent Owner’s CleanCut system to pneumatically convey drill cuttings practices each claim of the ’018 patent.” *Id.* Mr. Lauder testifies:

26. The CleanCut system is usually deployed on an oil well drilling rig, and when an ISO Pump is included as part of the system, the oil well drilling rig will have a storage vessel for holding non-free flowing drill cuttings, namely the ISO-Pump (Ex. 2025 at 12). The ISO-Pump has attached to it a conduit that has both a first end and a second end, with the first end attached to the ISO Pump (Ex. 2025 at 14–16; 21). *The CleanCut system can also have ISO-Pumps installed on PSVs and when they do, this ISO-Pump equates to the first pressure vessel on the boat required by Claim 1 (See Ex. 2025 at 21).* The ISO-Pump on the PSV is then connected to the second end of the conduit that is attached to the ISO-Pump on the rig so as to allow the transfer of the drill cuttings from the ISO-Pump on the rig to the ISO-Pump on the PSV (See Ex. 2025 at 21). Compressed conveyance gas is then applied to the ISO-Pump on the rig (the first pressure

vessel) and this conveyance gas, without using any non-pneumatic means, forces at least a portion of the non-free flowing oil well drill cuttings in the ISO-Pump on the rig to discharge out of the ISO-Pump (Ex. 2025 at 14–16; 21). The CleanCut system therefore, practices claim 1 of the '018 patent. Ex. 2052 ¶ 26 (emphasis added). We agree with Mr. Lauder that Patent Owner's CleanCut system practices claim 1 when an ISO-Pump is installed on a PSV.

Non-Pneumatic Means

Petitioner disputes Patent Owner's evidence that the CleanCut system practices the claimed invention. Pet. Reply 22–23. Petitioner argues that “[t]he *prosecution history* excludes the use of other means, such as ‘heat addition, aerating action . . . or the addition of a fluidizing agent’ to assist the top conveying gas in conveying material.” *Id.* at 22 (emphasis added) (citing PO Resp. 31); Tr. 132:2–22. As discussed below, we are not persuaded by Petitioner's argument relying on the prosecution history.

During prosecution of the related '217 Patent, the Examiner initially rejected the claims over a reference (U.S. Patent No. 6,152,656 to Curtis et al.) that disclosed pulsed-jet bin aerators. Ex. 2017 (File History of '217 Patent), 223. The Examiner allowed the claims over that reference after adding a “sole means” claim limitation that required the compressed conveyance gas provided to the vessel to be the sole means for inducing movement of the material in the vessel. *Id.* at 318–322, 332–333. Petitioner has not persuaded us that the Examiner's Amendment, or the Examiner's remarks explaining that amendment, still have bearing on the present case.

The initially-filed claims in the '018 Patent application did not recite “sole means,” “without employing a non-pneumatic means,” or similar language. *See, e.g.*, Ex. 2020, 40–43. During prosecution of the '018

Patent, the applicant amended the claims to overcome the Examiner's rejection based on Dietzen III, which discloses a non-pneumatic device, i.e., an auger, for transferring drill cuttings that settle in a vacuum tank. *See supra* Section I.C. The applicant's amendment *added* a "without employing a non-pneumatic means" claim limitation that requires at least a portion of the non-free flowing drill cuttings in a first pressure vessel on a boat to move out to a container, without employing a non-pneumatic means for forcing the non-free flowing drill cuttings out from the vessel. Ex. 2020, 92, 97–98. Claim 1 of the '018 Patent issued with that claim limitation. *See* Ex. 1005, 6:60–63. Accordingly, the Examiner's remarks about a negative limitation in the '217 Patent prosecution do not appear to bear on the '018 Patent because the negative limitation in the '018 Patent's claims was first introduced during prosecution of the '018 Patent to overcome a prior art rejection based on Dietzen III, which was not applied by the Examiner during prosecution of the '217 Patent. Thus, there is no direct tie between the "sole means" negative limitation in the '217 Patent and the "without employing" negative limitation in the '018 Patent.¹⁵

Petitioner also has not persuaded us that Patent Owner's CleanCut system includes a non-pneumatic means for forcing non-free flowing drill cuttings out from the ISO-Pump. Petitioner argues that "[t]he CleanCut system uses aeration jets, line air, and even oil injection to aid conveyance." *Id.*

¹⁵ We note that the "without employing" negative limitation in the '018 Patent includes different language and has a different prosecution history that the "without employing" negative limitation in the '062 patent in IPR2016-00262 and IPR2016-00263—thus, the different outcomes.

Petitioner points to evidence that the ISO-Pump has pulse air nozzles in the cone of the vessel to induce movement of non-free flowing drill cuttings:

The ISO-pump Operating & Maintenance Instructions describes pulse air nozzles, called “aeration nozzles,” in the cone of the vessel. PO-2025, 45, 47. The manual states the pulse air will mitigate the effects of materials which have a tendency to bridge and help with problematic drill cuttings such as “Tertiary Reactive Clays.” *Id.* at 60. These nozzles “break up/fluidize” the material. *Id.*

Id. at 23. Petitioner has not persuaded us that the pulse air nozzles constitute “non-pneumatic” means. Rather, the evidence cited by Petitioner shows that the nozzles emit pulse air to break up or fluidize material in the ISO-Pump and, thus, are pneumatic devices. *See* 2025, 60.

Additionally, Petitioner points to evidence of an “Oil Injection Facility” that aids movement of the material. Pet. Reply 23 (citing Ex. 2025, 17). The Oil Injection Facility provides a mechanism for cleaning the conveying pipe, or coating the interior of the vessel prior to first use. Ex. 2025, 17. Petitioner has not persuaded us that the Oil Injection Facility functions to force materials out from the ISO-Pump, and, thus, has not persuaded us that the Oil Injection Facility is a non-pneumatic means *for forcing* non-free flowing drill cuttings out from the ISO-Pump, as required by claim 1.

Finally, Petitioner contends that “air is introduced into the conveyance line/conduit to help move discrete slugs of drill cuttings along the pipes.” Pet. Reply 23 (citing Ex. 1110, 148–149, 209–211; Ex. 1108, 119–120). Petitioner has not persuaded us that introduction of air into the conveyance

line/conduit is a *non-pneumatic means* for forcing non-free flowing drill cuttings out from the ISO-Pump, as required by claim 1.

Nexus

Petitioner asserts that Patent Owner's evidence of secondary considerations, particularly as to commercial success, lacks a nexus with the claimed invention. *Id.* at 22. Petitioner asserts that "[t]he revenues identified by [Patent Owner] include every type of installation, and they do not show revenue for systems that also include a boat per the '018 patent." *Id.* (citing Ex. 2052 ¶¶ 40–44; Ex. 1110, 56–58).

"[T]here is a presumption of nexus for objective considerations when the patentee shows that the asserted objective evidence is tied to a specific product and that product 'is the invention disclosed and claimed in the patent.'" *WBIP, LLC v. Kohler Co.*, 829 F.3d 1317, 1329 (Fed. Cir. 2016) (quoting *J.T. Eaton & Co. v. Atl. Paste & Glue Co.*, 106 F.3d 1563, 1571 (Fed. Cir. 1997)). Patent Owner, however, carries the burden of demonstrating that the "thing . . . that is commercially successful is the invention disclosed and claimed in the patent." *Demaco Corp. v. F. Von Langsdorff Licensing Ltd.*, 851 F.2d 1387, 1392 (Fed. Cir. 1988).

To determine the commercial success of the CleanCut system, Mr. Lauder compared the sales and profit margins of jobs that involved at least one CCB to the sales and profit margins of jobs that did not utilize any of the CleanCut system. Ex. 2052 ¶ 41. Mr. Lauder did not make any attempt to identify the sales and profit margins of jobs that involved an ISO-Pump installed on a PSV. As such, Patent Owner's evidence of commercial success is not limited to jobs that involve a PSV, or even an ISO-Pump, much less an ISO-Pump installed on a PSV. Accordingly, Patent Owner has

failed to show a sufficient nexus between the evidence of commercial success and the claimed invention.

With respect to praise, Petitioner asserts that the evidence shows praise for features of the prior art, for example, Dietzen II, and does not show praise for any potentially inventive features of the CleanCut system. *Id.* at 24–25. We do not agree with the broad sweep of Petitioner’s argument. In reporting on the Safety at Seas Award, for example, an industry publication praises the dense phase pneumatic conveying technology of the CleanCut system as a totally enclosed pneumatic system for collecting and transporting drill cuttings from offshore rigs to onshore treatment and disposal facilities:

The CLEAN CUT dense phase pneumatic conveying technology was named the recipient of this year’s award in recognition of its contributions to safety at sea. The totally enclosed pneumatic system is used to collect and transport drill cuttings from offshore rigs and platforms to onshore treatment and disposal facilities. Compared with the typical “skip and ship” approach, the system offers a safer and more environmentally acceptable method of collecting, storing and transporting drill wastes. A key benefit of the technology is a significant reduction in crane lifts.

Ex. 2044, 1; *see also* Ex. 2052 ¶ 52. We note, however, that the “key benefit” that was recognized in connection with the Safety at Seas Award is “a significant reduction in crane lifts” (Ex. 2044, 1), which is also a benefit of Dietzen II’s prior art vacuum conveyance system. *E.g.*, Ex. 1013 (Dietzen II), 2:58–59 (describing the transfer of waste drill cuttings from holding tanks on the drilling platform to storage tanks on a work boat via a flow line).

Patent Owner’s additional evidence of praise by others is similar in nature. ChevronTexaco, for example, identifies the benefits of both

reducing crane lifts and having an enclosed system that eliminates spillage. Ex. 2041, 31–32; Ex. 2052 ¶ 55; *see also* Ex. 2052 ¶ 59 (describing industry publication comparing CleanCut system with “skip and ship” approach). We note, however, that some of Patent Owner’s evidence does not appear to involve an ISO-Pump installed on a PSV. *See, e.g.*, Ex. 2052 ¶ 54 (describing BP installation that allowed for the storage of drill cuttings in ISO-Pumps located on the drilling rig when the skips could not be filled due to weather or other uncertainties); Ex. 2052 ¶ 56 (describing Britannia installation that reduced down time by storing cuttings in ISO-Pumps located on the drilling rig when skips could not be offloaded due to weather or other uncertainties).

Petitioner also argues that the underlying evidence does not support Mr. Lauder’s testimony that experts were skeptical of the invention. Pet. Reply 24 (citing Ex. 2052 ¶¶ 50–51; Ex. 2036; Ex. 2037; Ex. 2038). We agree that Patent Owner’s evidence is insufficient to show skepticism. The referenced statement in Exhibit 2036 regarding the addition of water to the material to be conveyed relates only to dilute-phase pneumatic conveying. *See* Ex. 2036, 2. No such statement is made with respect to dense-phase pneumatic conveying. The referenced statement in Exhibit 2037 regarding sticky materials relates to a vacuum pneumatic ash-handling system, and does not express skepticism that other types of pneumatic conveying systems were capable of conveying non-free flowing oil well drill cuttings. Ex. 2037, 3. Further, as discussed above, Dietzen II explicitly discloses use of a vacuum system to convey non-free flowing drill cuttings. Exhibit 2038 is an article from a website in 2015, and irrelevant.

For the reasons discussed above, we accord weight to Patent Owner's evidence of praise by others, but no weight to Patent Owner's evidence of commercial success and skepticism.

(8) Conclusion

Upon weighing the competing arguments and evidence presented by the parties, including Patent Owner's asserted evidence of secondary considerations of nonobviousness, we determine that Petitioner has shown, by a preponderance of the evidence, that claims 1, 2, and 4–9, but not claim 3, are unpatentable as obvious over Dietzen I and II, Ciaffone, Laster, Pneumatic Conveying, and Toth. Patent Owner's evidence of praise by others is insufficient to overcome the strong evidence of obviousness with respect to claims 1, 2, and 4–9.

2. Asserted Obviousness of Claims 1–9 over Pneumatic Conveying, Macawber, Macawber Coal Ship, Ciaffone, and Toth

In view of our determination that claims 1, 2, and 4–9 are unpatentable over Dietzen I and II, Ciaffone, Laster, Pneumatic Conveying, and Toth, we do not address Petitioner's additional assertion that claims 1, 2, and 4–9 would have been unpatentable for obviousness over Pneumatic Conveying, Macawber, Macawber Coal Ship, Ciaffone, and Toth. We address below only Petitioner's additional assertion that claim 3 would have been obvious over those references.

a. Overview of Macawber

Macawber is a company brochure, published by Macawber Engineering Limited, England (the "Macawber company"), that describes a dense phase pneumatic conveying system called the "Denseveyor."

Ex. 1007, 2. The brochure describes the Macawber company's extensive materials handling capability:

Macawber's general materials handling capability is extensive. We have evaluated and installed systems to handle soda ash and limestone, for use in the glass industry; vermiculite for making fire resistant plasterboards, sugar, and even waste steel chippings from industrial production lines. Materials such as ultra fine cohesive powders from sub-micron to granular material; from hot knockout zircon foundry sand at 480°C, to high moisture content materials; from chemicals and foodstuffs to fertilisers. The list is endless, in fact at Macawber we call it our A-Z of Materials Handling.

Id. at 2. As described in Macawber, the Denseveyor includes a conically-shaped pressure vessel. *Id.* at 5.

b. Overview of Macawber Coal Ship

Macawber Coal Ship describes use of the Denseveyor (*see supra* Section II.D.1.d) for handling coal and ash on a modern steamship.

Ex. 1008, 21. The physical characteristics of the coal and ash include lumps of coal as large as 3 inches, high levels of fines below 1/8 inch, and high ash content, including "clays, which when coupled with high-moisture contents, form a sticky, difficult-to-handle material that blocks the pneumatic pipeline." *Id.* Macawber Coal Ship discloses that the Denseveyor "could handle, without damage, coal with lumps as large as 3 inches, as well as untreated fines, regardless of moisture content." *Id.* at 22.

c. Obviousness Analysis

Claim 3 adds the limitation that the storage vessel on the oil well drilling rig for holding non-free flowing drill cuttings "is an ISO container sized vessel." Petitioner has not persuaded us that a POSITA would have combined the teachings of Toth and the other references to achieve the

limitations of claim 3. In particular, Petitioner has not explained sufficiently why the prior art practice of using standard ISO-size containers for commercial shipments would have motivated a POSITA to use an ISO-size container as a storage vessel on an oil well drilling rig for holding non-free flowing drill cuttings, as required by claim 3. Although Petitioner argues that “[u]sing ISO container sized structures is, and has been for over 30 years, standard for the shipping industry” (Pet. 54 (citing Ex. 1034 ¶ 162)), Petitioner has not shown that any “ISO container sized structures” in the prior art were capable of being used as a storage vessel on an oil well drilling rig for holding non-free flowing oil well drill cuttings.

Dr. Carson’s testimony does not fill the gap in Petitioner’s arguments. *See* Ex. 1034 ¶ 162. That “[i]t was known and obvious to transport drill cuttings on a ship,” as Dr. Carson testifies, does not explain sufficiently why a POSITA predictably would have designed the storage vessel on the oil well drilling rig “to fit within an ISO container frame.” *See id.*

For these reasons, we determine that Petitioner has not shown, by a preponderance of the evidence, that claim 3 would have been obvious over Pneumatic Conveying, Macawber, Macawber Coal Ship, Ciaffone, and Toth.

III. CONCLUSION

For the foregoing reasons, we determine that Petitioner has shown, by a preponderance of the evidence, that claims 1, 2, and 4–9 of the ’018 Patent are unpatentable.

This Final Written Decision discusses or cites information that the parties have indicated is confidential, including portions of the transcript of the oral argument filed under seal at the request of the parties. Accordingly, we have entered this decision in the Board’s E2E system as “Board and

Parties Only.” If either Party believes that any portion of this decision or the transcript of the oral argument should be maintained under seal, the Party must file, within five (5) business days from the entry of the decision, a motion to seal portions of the decision or transcript. The motion must include a proposed redacted version of the decision or transcript, accompanied by an explanation as to why good cause exists to maintain under seal each redacted portion. In the absence of a motion to seal by the specified deadline, the full version of this decision and the transcript will become public. Any opposition to a motion must be filed within three (3) business days from the date of entry of the motion; no reply to an opposition is authorized.

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that claims 1, 2, and 4–9 of U.S. Patent No. 7,544,018 B2 are unpatentable;

FURTHER ORDERED that each of the parties is authorized to file, within five (5) business days from the date of entry of this Final Written Decision, a motion to seal portions of the decision and/or transcript of the oral argument that includes a proposed redacted version of the decision and/or transcript and an explanation as to why good cause exists to maintain under seal each redacted portion;

FURTHER ORDERED that any opposition to a motion to seal portions of the decision or transcript must be filed within three (3) business days from the date of entry of the motion; and

FURTHER ORDERED that no reply to an opposition is authorized.

IPR2016-00259
Patent 7,544,018 B2

This is a Final Written Decision. Parties to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

IPR2016-00259
Patent 7,544,018 B2

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