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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte MICHAEL ANTHONY SCHULTZ[1]

Appeal 2017-011522
Application 13/882,688
Technology Center 1600

Before RICHARD M. LEBOVITZ, RYAN H. FLAX, and TIMOTHY G. MAJORS, *Administrative Patent Judges*.

FLAX, *Administrative Patent Judge*.

DECISION ON APPEAL

This is a decision on appeal under 35 U.S.C. § 134(a) involving claims directed to a method for producing one or more products from a gas stream comprising methane. Claims 22–26, 28–31, and 37–41 are on appeal as rejected under 35 U.S.C. § 103(a). We have jurisdiction under 35 U.S.C. § 6(b).

We affirm.

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[1] Appellant identifies the Real Party in Interest as "LanzaTech New Zealand Limited." Appeal Br. 2.

STATEMENT OF THE CASE

Claim 22 is representative and is reproduced below:

> 22. A method for producing one or more products from a gas stream comprising methane, the method comprising;
>
> a) converting at least a portion of the methane in the gas stream to a substrate comprising CO and H_2 by catalytic oxidation;
>
> b) passing a portion of the substrate to a methanol synthesis vessel operated at conditions to convert at least a portion of the CO and H_2 to methanol; and
>
> c) passing a second portion of the substrate of step (a) to a first bioreactor containing a culture of at least one carboxydotrophic microorganism and anaerobically fermenting at least a portion of the substrate comprising CO and H_2 to produce at least one product selected from the group consisting of alcohols and acids.

Appeal Br. 11.

The following rejections are appealed:

Claims 22–26, 28–31, and 37–39 stand rejected under 35 U.S.C. § 103(a) over Schinski[2] and Simpson.[3] Answer 3.

Claims 22, 25–26, and 39–41 stand rejected under 35 U.S.C. § 103(a) over Schinski, Simpson, and Burk.[4] *Id.* at 7.

DISCUSSION

"[T]he examiner bears the initial burden, on review of the prior art or on any other ground, of presenting a *prima facie* case of unpatentability. If that burden is met, the burden of coming forward with evidence or argument

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[2] US 6,596,781 B1 (issued July 22, 2003) ("Schinski").
[3] US 2009/0203100 A1 (published Aug. 13, 2009) ("Simpson").
[4] US 2009/0191593 A1 (published July 30, 2009) ("Burk").

shifts to the applicant." *In re Oetiker*, 977 F.2d 1443, 1445 (Fed. Cir. 1992). Arguments made by Appellant in the Appeal Brief and properly presented in the Reply Brief have been considered; arguments not so-presented in the Briefs are waived. *See* 37 C.F.R. § 41.37(c)(1)(iv) (2015); *see also Ex parte Borden*, 93 USPQ2d 1473, 1474 (BPAI 2010) (informative) ("Any bases for asserting error, whether factual or legal, that are not raised in the principal brief are waived.").

"The combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results." *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 416 (2007). "[W]hen a patent claims a structure [or method] already known in the prior art that is altered by the mere substitution of one element [or step] for another known in the field, the combination must do more than yield a predictable result." *Id.* (citing *United States v. Adams*, 383 U.S. 39, 50–51 (1966)). "In determining whether the subject matter of a patent claim is obvious, neither the particular motivation nor the avowed purpose of the patentee controls. What matters is the objective reach of the claim. If the claim extends to what is obvious, it is invalid under § 103." *Id.* at 419.

"[T]he question is whether there is something in the prior art as a whole to suggest the *desirability*, and thus the obviousness, of making the combination, not whether there is something in the prior art as a whole to suggest that the combination is the *most desirable* combination available." *In re Fulton*, 391 F.3d 1195, 1200 (Fed. Cir. 2004) (citation omitted). "[I]f a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill." *KSR*, 550 U.S. at 417. "[F]amiliar items may have obvious uses beyond their primary purposes, and in many cases a person of ordinary skill will be able to fit the teachings of multiple patents together like pieces of a puzzle." *Id.* at 420.

Findings of Fact (FF)

We adopt the Examiner's findings of fact and rationale on obviousness as set forth in the Final Action and Answer. Final Action 2–8; Answer 3–12. The following findings of fact highlight certain evidence:

FF1. Schinski discloses a process for producing Fischer-Tropsch products (e.g., various liquid and solid hydrocarbons, which are generally upgraded to lubricating oils and transportation fuels) and acetic acid. Schinski Abstract, 2:42–44.

FF2. Schinski discloses converting methane (CH_4) to CO and H_2, which Schinski calls "synthesis gas" or "syngas," using the following chemical processes:

$$2CH_4 + O_2 \rightarrow 2CO + 4H_2 \qquad (1)$$

$$CH_4 + H_2O \rightarrow CO + 3H_2 \qquad (2)$$

$$CH_4 + CO_2 \rightarrow 2CO + 2H_2 \qquad (3)$$

Schinski 1:48–63. Schinski discloses converting methane to CO/H_2-containing syngas in a syngas reactor. Schinski 4:65–5:2.

FF3. Further to the preceding finding of fact, Schinski discloses converting CO, CO_2, and H_2-containing syngas, as derived from methane, into methanol, using the following chemical processes:

$$CO + 2H_2 \leftrightarrow CH_3OH \qquad (4)$$

$CO_2 + 3H_2 \rightarrow CH_3OH + H_2O$ (5)

Schinski 2:1–14. Schinski discloses converting the syngas into methanol in a methanol reactor using a catalyst, e.g., copper. Schinski 5:4–7.

FF4. Further to the preceding finding of fact, Schinski discloses converting methanol to acetic acid (in presence of a catalyst), using the following chemical process:

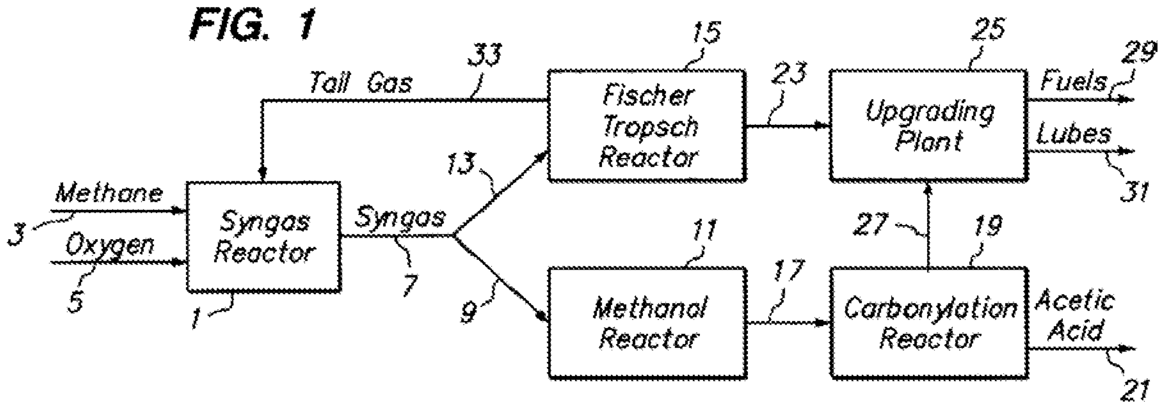
$CO + CH_3OH \rightarrow CH_3COOH$ (6)

Schinski 2:15–24. Schinski discloses converting methanol into acetic acid in a carbonylation reactor using a rhodium catalyst and methyl iodide promoter. Schinski 5:9–14.

FF5. Schinski discloses routing some of the syngas (CO/H_2) to a Fischer-Tropsch reactor, contacting it with a catalyst (e.g., Fe, Ni, Co, Ru, and Re), and forming Fischer-Tropsch crude products, which could then be upgraded to commercial products, such as jet fuel or gasoline. Schinski 5:21–30, 11:40–12:30.

FF6. Schinski also discloses that tail gases remain after the Fischer-Tropsch reaction, i.e., CO, CO_2, and H_2, and that such tail gasses can be recycled as syngas and converted to methanol by the reactions discussed in previous findings of fact. Schinski 5:47–6:10.

FF7. Further to the preceding findings of fact, Schinski discloses a system of reactors/vessels for performing reactions and associated plumbing for transporting gasses at its Figure 1, which is reproduced below:



Schinski Figure 1 is a flowchart showing that syngas (CO and H_2 derived from methane, *see supra* FF2) is produced in a syngas reactor 1, then partially diverted 9 to a methanol reactor 11 and partially diverted 13 to a Fischer-Tropsch reactor 15, where the respective methanol and Fischer-Tropsch products are produced from the syngas. Schinski Figure 1 further shows the methanol is passed 17 to a carbonylation reactor 19 to produce acetic acid 21. Schinski Figure 1 further shows that tail gas (CO, CO_2, and H_2, *see supra* FF6) from the Fischer-Tropsch reactor is recycled 33 as syngas 1. Schinski Figure 1 further shows that "overhead gasses," including H_2, CH_4, CO_2, and CO, are passed 27 from the carbonylation reactor 19 to support refining of the Fischer-Tropsch products in some way. *See* Schinski 5:18–21.

FF8. Simpson discloses a process to increase the efficiency of anaerobic fermentation, which uses CO to produce acetate (free acetic acid), and converts the acetate to H_2 and CO_2 to use in the fermentation with anaerobic bacteria (e.g., *Clostridium*) to produce ethanol. Simpson Abstract, ¶¶ 45–56, 79, 82, 94.

FF9. Simpson discloses, *inter alia*, "[e]thanol is rapidly becoming a major hydrogen-rich liquid transport fuel around the world," for example in the United States, Brazil, and Europe, thus evidencing the industrial desirability of producing ethanol. Simpson ¶¶ 2–4.

FF10. Simpson states:

> It has long been recognised that catalytic processes [e.g., Fischer-Tropsch catalyst reactions] may be used to convert gases consisting primarily of CO and/or CO and hydrogen (H_2) into a variety of fuels and chemicals. However, micro-organisms may also be used to convert these gases into fuels and chemicals. These biological processes, although generally slower than chemical reactions, have several advantages over catalytic processes, including higher specificity, higher yields, lower energy costs and greater resistance to poisoning.

Simpson ¶ 6.

FF11. Simpson discloses, "[a]naerobic bacteria have been demonstrated to produce ethanol and acetic acid from CO, CO_2 and H_2 via the acetyl CoA biochemical pathway," and

> Theoretically, in a fermentation substrate gas containing CO, H_2 and CO_2 at a concentration ratio of 1:1:0.33, two thirds of the CO can be converted to ethanol according to equations 3 and 4 below:
>
> $$6CO + 2H_2O \Rightarrow CH_3CH_2OH + 4CO_2 \quad 3.$$
>
> $$6H_2 + 2CO_2 \Rightarrow CH_3CH_2OH + 3H_2O \quad 4.$$
>
> In combination these equations give the equation below:
>
> $$6H_2 + 6CO \Rightarrow CH_3CH_2 + 2CO_2 \quad 5.$$

Simpson ¶¶ 87–92.

FF12. Moreover, Simpson discloses "a fermentation process according to the present invention described above will result in a fermentation broth comprising one or more alcohols, preferably ethanol, and acetate [acetic acid], as well as bacterial cells, in the liquid nutrient medium." Simpson ¶ 107–113.

FF13. Simpson also discloses "the process of the present invention involves recycling of the acetate by-product of the CO-to-ethanol fermentation, by converting it to H_2 and CO_2 gases and using the H_2," and further that a preferred way of doing so is by microbial oxidation, e.g., using a *Clostridium* bacteria, in the same fermentation reactor in which the ethanol fermentation product is produced or in a second, separate bioreactor. Simpson ¶¶ 116–121.

FF14. Simpson discloses that its substrate gases can be produced from a variety of sources, including petroleum refining processes and methanol production, among others. Simpson ¶ 84.

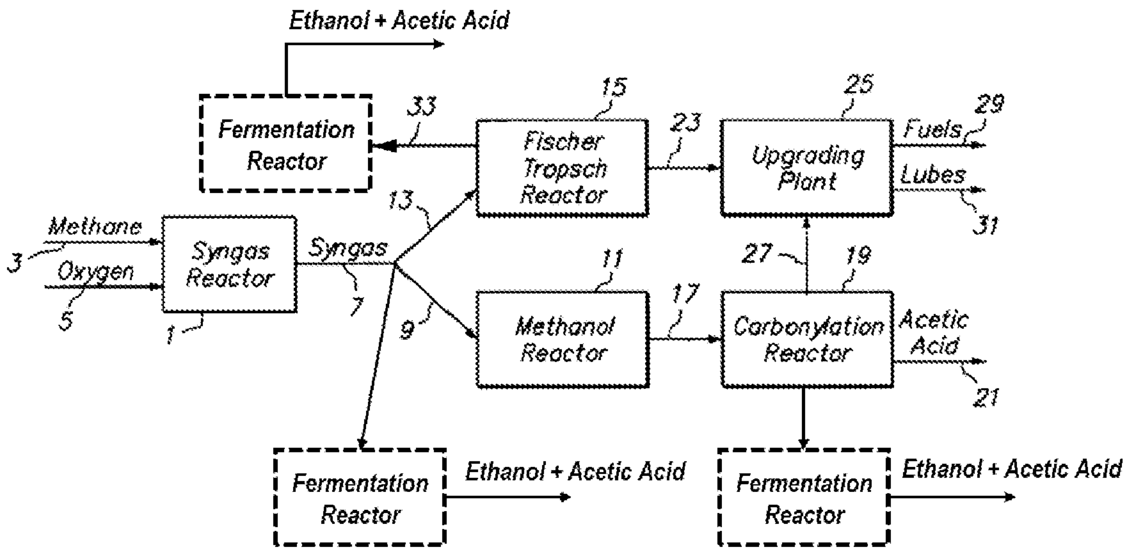
Analysis

The Examiner determined that it would have been obvious to combine the teachings of Schinski and Simpson to add the fermentation process of Simpson, which utilizes a gas substrate like the syngas components of Schinski, to the natural gas/methane processing system of Schinski. Final Action 4–8; Answer 3–12. The Examiner determined that Schinski taught claim 22's steps "a)" and "b)" requiring converting methane to CO and H_2 (syngas) and converting a portion of the CO/H_2 gas substrate to methanol, respectively. *See* Final Action 4–5; Answer 3–5; *see also* FF1–FF7. Concerning claim 22's step "c)," the Examiner noted that "Schinski does not specifically teach that [the] syngas [used in] the methanol production process is [also] used as a source of syngas for the fermentation bioreactors." Final Action 5, 7. Thus, the Examiner looked to Simpson's teachings that such syngas (a CO, H_2, CO_2 containing gas stream) is used as a substrate for fermentation using an anaerobic bacteria (e.g., *Clostridium*) to produce ethanol and acetic acid. Final Action 5–7; Answer 4–6; *see also* FF8–FF14. The Examiner determined that Schinski and Simpson would have been obvious to combine because "[b]oth the Fischer-Tropsch process [of Schinski] and the fermentation process [of Simpson] are similar because they are both methods of producing fuel and it would have been obvious to have substituted one method of fuel production for another especially since both processes can successfully use syngas as a substrate." Answer 10. We discern no error in the Examiner's determinations.

The ultimate issue presented here is whether it would have been obvious to add Simpson's fermentation step to Schinski's methods so that some of Schinski's syngas (CO/H_2) would have been used to produce ethanol (i.e., CO converts to acetate, which converts to H_2 and CO_2, which converts to ethanol). And, if adding Simpson's fermentation to Schinski's method was obvious, a second question is whether doing so would prevent Schinski's method from producing Fischer-Tropsch products?

We conclude, in agreement with the Examiner's determinations, that it would have been obvious to add Simpson's fermentation process to Schinski's method and that doing so would not render the new system unsatisfactory for Schinski's purposes—Fischer-Tropsch products could still be produced. Such a combined system can be illustrated based on Schinski's

Figure 1, annotated to show where/how Simpson's fermentation steps could and would have been added, as shown below:



The illustration above is based on Schinski's Figure 1, but adds a (or several) fermentation reactor(s) (dashed-line boxes), as disclosed by Simpson, fed either by syngas directly from the Schinski syngas reactor, as are Schinski's methanol reactor and Fischer-Tropsch reactor, or by gas remaining after Schinski's Fischer-Tropsch reaction is completed, or by gas remaining after Schinski's carbonylation reaction is completed, as is otherwise disclosed in Schinski as recycled syngas to be reused in other reactions (or in a combination of these). FF5–FF7. In any such location, the fermentation reactor would produce ethanol and acetic acid from CO and H_2 gas. FF8, FF11–FF13. Schinski explains that ethanol is a valuable product and Schinski discloses acetic acid is also a valued product. FF1, FF7–F11. It is apparent from Simpson's disclosure that ethanol is a desirable industrial product and that it can be produced from the same resources and substrates as the products produced by Schinski's system. FF8–F11, FF14. Adding

Simpson's fermentation processing to Schinski's system would add a valuable product without needing additional resources. The process based on Schinski and Simpson would use the CO, CO_2, and H_2, already used for, or even already in, the Schinski system, even using recycled gas from the Fischer-Tropsch tail gas, which was already a fraction of the original syngas split-off from the gas used to produce the Schinski methanol and acetic acid. Furthermore, the skilled artisan would still produce the Schinski Fischer-Tropsch products because Schinski discloses splitting and gas diversion, or recycling, systems.

"[T]he test of obviousness is not express suggestion of the claimed invention in any or all of the references but rather what the references taken collectively would suggest to those of ordinary skill in the art *presumed* to be familiar with them." *In re Rosselet*, 347 F.2d 847, 851 (CCPA 1965) (emphasis in original). "The combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results." *KSR*, 550 U.S. at 416. "[W]hen the question is whether a patent claiming the combination of elements of prior art is obvious," the answer depends on "whether the improvement is more than the predictable use of prior art elements according to their established functions," and, further, "if a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill." *Id.* at 417. "[I]n many cases a person of ordinary skill will be able to fit the teachings of multiple patents together like pieces of a puzzle." *Id.* at 420.

> Because the desire to enhance commercial opportunities by improving a product or process is universal—and even common-sensical— . . . there exists in these situations a motivation to combine prior art references even absent any hint of suggestion in the references themselves. In such situations, the proper question is whether the ordinary artisan possesses knowledge and skills rendering him *capable* of combining the prior art references.

Dystar Textilfarben GmbH & Co. Deutschland KG v. C.H. Patrick Co., 464 F.3d 1356, 1368 (Fed. Cir. 2006).

Here, there would have been a universal desire to enhance the commercial opportunities presented by the Schinski systems and methods by producing more/additional commercially desirable products. Further, adding Simpson's fermentation to such a system to produce ethanol would have been merely combining familiar elements (and using existing and present gas substrates) using known methods, and would have been a predictable use of prior art elements according to their established functions. As shown in Schinski, the artisan routinely diverted and recycled gases to achieve efficiency and to make more than one product at the same time. *See* Schinski, Fig. 1 splitting syngas into two streams to make products in the Fischer-Tropsch reactor and the Methanol reactor.

Appellant argues repeatedly that, according to Simpson, acetate is "an unwanted by-product which must be disposed of or converted to some other product." Appeal Br. 6, 8 ("Simpson is teaching away" for this reason), 9; *see also* Reply Br. 3. This is not persuasive. Even if acetate can ultimately be used to produce more ethanol, this does not mean acetate (acetic acid) is not a desired product or desired by-product of Simpson's methods. *See, e.g.*, FF12. Rather, the acetate is further employed by Simpson in a fermentation process. FF13. The record on appeal does not support Appellant's contention.

Appellant also argues that the claim limitation, "anaerobically fermenting at least a portion of the substrate comprising CO and H_2 to produce at least one product selected from the group consisting of alcohols and acids," is a Markush group and, therefore, requires that only the recited alcohols and acids be products produced by this step. Appeal Br. 6–8; *see also* Reply Br. 2. This argument is not persuasive. As discussed by the Examiner, this limitation recites "produce *at least* one product." This language leaves open the possibility that more things could be produced. This interpretation is supported by Appellant's Specification, which describes that, when either ethanol (C_2H_5OH) or acetic acid (CH_3COOH) is produced in the claimed fermentation process, water (H_2O) is also necessarily produced (e.g., 5% water when producing ethanol), as are microbial cells. Spec. 15, 19–20, 26. Furthermore, even were this limitation interpreted, as Appellant argues, to require only alcohol and/or acid to be produced (as products), such a restriction is limited to the claimed fermentation step (methanol is also a product of the claimed method) and Simpson discloses such a fermentation step. FF8. Whether Schinski's Fischer-Tropsch process produces other products, as argued by Appellant, is not determinative.

Regarding claim 23, Appellant argues the claims require using an exit stream from the also-claimed methanol synthesis vessel, rather than syngas. Appeal Br. 9; *see also* Reply Br. 3. Whether given the name "syngas" or called exit gas or tail gas, the gas mixture claimed and disclosed by Simpson to be used for a fermentation substrate includes CO and H_2. Simpson discloses that such a gas substrate can come from a variety of sources, including petroleum refining processes and methanol production, like that disclosed by Schinski. FF14. Schinski discloses that gasses (CO, CO_2, and H_2) not consumed in its methanol production can be used in subsequent production processes. Schinski 6:7–16; FF7. The very gasses that exit Schinski's methanol reactor are those disclosed by Simpson to be a fermentation substrate, thus, it would have been obvious to use them for such a purpose for the reasons discussed above.

Appellant states, "[r]egarding claims 29-31, the exit stream from the carbonylation reactor is passed to the fermentation reactor which produces alcohols and acids and not hydrocarbons and waxes." Appeal Br. 9. This statement is not persuasive for the same reasons Appellant's argument over claim 23 was not persuasive.

Regarding claims 25 and 26, Appellant argues that his

> process takes the hydrogen rich stream from the fermentation reactor to a second bioreactor where the hydrogen and CO2 is converted to acetate. In contrast to this, Schinski takes the tail gas from the Fischer-Tropsch zone to the catalytic oxidation reactor. Merely saying that Schinski teaches recycling various exit stream is not sufficient to render obvious Applicants' specific recycling steps. There must be some suggestion in the art to do the specific recycling step.

Appeal Br. 9; *see also* Reply Br. 3. This argument is not persuasive. Schinski does not merely teach recycling gas, generally; it discloses recycling the same or substantially similar gas mixture Simpson discloses using as a substrate for fermentation. Schinski discloses producing acetate/acetic acid from its methanol production and subsequent carbonylation, and then recycling the by-product CO and H_2, which Simpson discloses to be an intermediate product in its fermentation process. FF7, FF8. As discussed above, Simpson suggests using gases from other industrial production processes for its own fermentation substrate. FF14. Therefore, using the exit stream from Schinski's methanol production vessel in a carbonylation vessel would have been obvious, as in Appellant's claim 29, as would Appellant's claim 30's use of an exit gas of such a carbonylation vessel for a fermentation substrate in a bioreactor, as suggested by Simpson.

Regarding the obviousness rejection over Schinski, Simpson, and Burke, Appellant merely incorporates the same arguments addressed above. Appeal Br. 10. We are, therefore, unpersuaded for the same reasons.

SUMMARY

The obviousness rejections are each affirmed.

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

AFFIRMED