UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte FRANKLIN DELANO LOMAX, JR., JOHN P. REARDON
and JASON P. BARBOUR

Appeal 2008-1991
Application 10/642,159
Technology Center 1700

Decided: September 29, 2008

Before EDWARD C. KIMLIN, THOMAS A. WALTZ and
CATHERINE Q. TIMM, *Administrative Patent Judges*.

WALTZ, *Administrative Patent Judge*.

DECISION ON APPEAL

Appellants seek review under 35 U.S.C. § 134 from the Examiner's rejections in the Final Office Action. This Board has jurisdiction under 35 U.S.C. § 6(b). For reasons stated below, the decision of the Examiner is AFFIRMED.

Claims 1, 44-53, 55- 62, 64-75, 86-95, and 97-120 are pending and stand finally rejected in the Final Office Action dated April 5, 2006. App. Br. 2.

The invention is directed to an integrated chemical reactor for the production of hydrogen from hydrocarbon fuels. Spec. 1. Claim 1 is illustrative and reproduced below.

> 1. A reactor, comprising:
>
> a unitary shell assembly having at least a first inlet, a first outlet, a second inlet and a second outlet;
>
> a first flow path extending within said shell assembly from said first inlet to said first outlet, said first flow path having a steam reformer section comprising a steam reforming catalyst, and a water gas shift reactor section comprising a water-gas shift catalyst, said steam reformer section being located upstream of said water gas shift reactor section, said steam reformer section and said water gas shift reactor section are formed of an array of tubes;
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> a second flow path extending within said shell assembly from said second inlet to said second outlet, said second flow path having a cooling section configured to cool said water gas shift reactor section and a heating section configured to heat said steam reformer section, wherein said cooling section and said heating section are fluidly connected; and
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> baffles provided within said shell assembly and provided exterior of said tubes, said baffles being configured to force a heat transfer medium flowing outside said tubes across the array of tubes in a direction substantially normal to a longitudinal axis of said tubes,
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> wherein said heating section is downstream of said cooling section along said second flow path, and
>
> wherein said first and second flowpaths are not fluidly connected.

The Examiner has relied on the following prior art as evidence of unpatentability of the pending claims:

Robin	4,021,366	May 3, 1977
Hackemesser	4,127,389	Nov. 28, 1978
Furuta	JP 58-045740 A	Mar. 17, 1983
Leftin	4,539,310	Sep. 3, 1985
Parenti	4,847,051	Jul. 11, 1989
Yoshioka	JP 02-111601 A	Apr. 24, 1990
Grotz	4,959,079	Sep. 25, 1990
Ng	5,382,271	Jun. 17, 1995
Collins	5,458,857	Oct. 17, 1995
Koga	EP 0 529 329 B1	Mar. 26, 1997
Boneberg	EP 0 974 393 A2	Jan. 26, 2000
Boneberg	6,277,339	Aug. 21, 2001

The pending claims stand rejected as follows:

1. Claims 1, 48, 49, 55-59, 62, 64-75, 91, 92, 97, 100-104, and 107-119 stand rejected pursuant to 35 U.S.C. § 103(a) as obvious over Boneberg (EP '393 or US '339)[1] in view of Yoshioka and Hackemesser. Ans. 4-9.

2. Claims 44, 45, 87-89, and 120 stand rejected pursuant to 35 U.S.C. § 103(a) as obvious over Boneberg in view of Yoshioka and Hackemesser, as applied to claims 1 and 75, *supra*, and further in view of Ng. Ans. 9-10.

3. Claims 46 and 90 stand rejected pursuant to 35 U.S.C. § 103(a) as obvious over Boneberg in view of Yoshioka, Hackemesser and Ng, as

[1] EP 0 974 393 A2 and US 6,277,339, both having Boneberg as principal inventor, claim priority to the same German application. All references to Boneberg herein are to the US patent which is, according to the Examiner, the English language equivalent of EP '393 (Ans. 4).

applied to claims 44, 45, 88, and 89, *supra*, and further in view of Collins. Ans. 11.

4. Claim 47 stands rejected pursuant to 35 U.S.C. § 103(a) as obvious over Boneberg in view of Yoshioka and Hackemesser, as applied to claim 1, *supra*, and further in view of Robin. Ans. 11-12.

5. Claims 50, 51, 98, and 99 stand rejected under 35 U.S.C. § 103(a) as obvious over Boneberg in view of Yoshioka and Hackemesser, as applied to claims 1 and 75, *supra*, and further in view of Nagai. Ans. 12-13.

6. Claims 52, 53, 86, and 93-95 stand rejected pursuant to 35 U.S.C. § 103(a) as obvious over Boneberg in view of Yoshioka and Hackemesser, as applied to claims 1, 48, 75, and 91 above, and further in view of Parenti or Grotz. Ans. 13-14.

7. Claims 60 and 105 stand rejected pursuant to 35 U.S.C. § 103(a) as obvious over Boneberg in view of Yoshioka and Hackemesser, as applied to claim 1, *supra*, and further in view of Leftin. Ans. 14.

8. Claims 61 and 106 stand rejected pursuant to 35 U.S.C. § 103(a) as obvious over Boneberg in view of Yoshioka and Hackemesser, as applied to claim 1, *supra*, and further in view of Furuta. Ans. 14-15.

FINDINGS OF FACT (FF)

1. Boneberg (Fig. 1) discloses a unitary shell assembly (common reaction chamber 1) having at least a first inlet (for stream 2), a first outlet (for stream 6), a second inlet (for stream 5) and a second outlet (for stream 7); a first flow path extending within said shell assembly 1 from said first inlet 2 to said first outlet 6, said first flow path having a steam reformer section comprising a steam reforming catalyst (reformer stage 12 containing

a suitable catalytic material, not shown), and a water gas shift reactor section comprising a water-gas shift catalyst (CO shift stage 10, containing a suitable catalytic material, not shown), said steam reformer section 12 being located upstream of said water gas shift reactor section; a second flow path extending within said shell assembly 1 from said second inlet 5 to said second outlet 7, said second flow path having a cooling section (upstream part 9) configured to cool said water gas shift reactor section and a heating section (downstream part 11) configured to heat said steam reformer section 12, wherein said cooling section and said heating section are fluidly connected. *See* col. 3, ll. 31-55.

2. Yoshioka (Abstract and Figures) discloses a conventional tube bundle design comprising a unitary shell assembly (outer box 7) having a first inlet (inlet 10 for steam and natural gas), a first outlet (outlet 11 for hydrogen), a second inlet (inlet 8 for off gas and air), and a second outlet (outlet 9 for combustion exhaust); said shell assembly 7 comprising a first flow path defined by a tube bundle or array of tubes (pipes 6 containing steam reforming catalyst 5) and extending from the first inlet 10 to the first outlet 11; and said shell assembly 7 comprising a second flow path exterior of tubes 6 extending from the second inlet 8 to the second outlet 9; said first and second flowpaths not being fluidly connected, and said first and second flowpaths being arranged for countercurrent flow *(see* Figures).

3. Hackemesser (Figure 1) discloses an exchange reactor having a shell assembly 1 with a first inlet (by tube inlet chamber 14a), a first outlet (by tube outlet chamber 14c), a second inlet (by shell inlet chamber 12a), and a second outlet (by shell outlet chamber 12c), a plurality of tubes or tube bundle 14b within the shell assembly 10 (col. 2, ll. 24-49*; see* Fig. 1), the

tubes alternately passing through the central opening of annular flow directors 42, 45 and circular flow directors 44. Col. 5, ll. 5-8 and col. 5, ll. 29-34. The circular and annular flow directors create an alternating inward and outward radial flow path of a heat transfer medium across the tubes. Col. 5, ll. 29-45.

4. Hackemesser further discloses that cross-current flow in a shell and tube heat exchanger provides uniform heat distribution and temperature gradient along the tube bundle, col. 5, ll. 40-45.

5. Boneberg discloses that counter-current flow design provides advantageous cold-starting performance, col. 4, ll. 40-45.

6. Boneberg does not teach a shell-and-tube exchange reactor, in contrast to the present invention. Rather, Boneberg discloses a single partition 4 which longitudinally divides the shell assembly into a reaction chamber 1 and a combustion chamber 3. Col. 3, ll. 31-33.

PRINCIPLES OF LAW

Section 103 forbids issuance of a patent when 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 said subject matter pertains. *KSR Int'l Co. v. Teleflex Inc.,* 127 S. Ct. 1727, 1734 (2007).

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 ordinary skill in the art, and (4) where in evidence, so-called

secondary considerations. *Graham v. John Deere Co.,* 383 U.S. 1, 17-18 (1966).

When a work is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or a different one. If a person of ordinary skill can implement a predictable variation, § 103 likely bars its patentability. For the same reason, 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. *KSR*, 127 S. Ct. at 1740.

The combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. *Id* at 1739.

DISCUSSION

1. Obviousness over Boneberg in view of Yoshioka and Hackemesser

Claims 1, 48, 49, 55-59, 62, 64-75, 91, 92, 97, 100-104, and 107-119 stand rejected pursuant to 35 U.S.C. § 103(a) as obvious over Boneberg in view of Yoshioka and Hackemesser. Appellants traverse the rejection as applied to claim 1, App. Br. 6-12, but do not separately argue the patentability of the remaining claims, other than by their dependency on, and the patentability of, claim 1. App. Br. 12. We therefore review the claims of this rejection as a group, to stand or fall together, with claim 1 as representative. 37 C.F.R § 41.37(c)(1)(vii).

In the Final Office Action, the Examiner found that Boneberg and Yoshioka disclosed all the limitations of the claimed subject matter except

for the limitation of baffles within said shell assembly. Ans. 4-6. We agree. *See* FF 1, FF 2. The Examiner also found that Hackemesser disclosed a reactor with a shell, having a tube array within the shell, and having baffles exterior of the tube array, configured to force a heat transfer medium outside of the tubes in a direction substantially normal to the longitudinal axis of the tubes (hereinafter referred to as "cross-current flow"). Ans. 6. The Examiner concluded that combining the disclosures of Boneberg, Yoshioka, and Hackemesser to arrive at the present claimed invention would have been obvious to a person of ordinary skill in the art, because Hackemesser teaches that cross-current flow results in efficient heat transfer. Ans. 6, *see* FF 3.

Appellants contend that the combination was not obvious under § 103, because Boneberg teaches a counter-current flow design, that such a flow design is a necessary fact for the invention described to achieve its objectives, and that the countercurrent flow "must be preserved." Reply Br. 11. Thus, Appellants argue, combining a cross-current flow design, as found in Hackemesser, with Boneberg would be directly contrary to the teachings of Boneberg. App. Br. 10.

While Boneberg discloses a counter-current flow design within the shell of the reactor, we find nothing that teaches away from using any other flow design. Boneberg does not utilize a shell and tube design configuration. FF 6. Rather, the Examiner cites Yoshioka and Hackemesser to provide the elements of a tube bundle within a shell assembly. Ans. 5. The construction of the reactor utilized in Boneberg, with only its longitudinal partition plate to separate flow paths, does not teach away from using a shell-and-tube design, much less a cross-current flow design. Boneberg only provides an alternate design, without criticizing, discrediting

or otherwise discouraging the shell-and-tube, cross-current design known in the prior art. *In re Fulton*, 381 F.3d 1195, 1201 (Fed. Cir. 2004). The other prior art relied upon by the Examiner, especially Hackemesser, provides the disclosure of a shell-and-tube reactor utilizing cross-current flow design.

Using the Boneberg design with the cross-current, shell-and-tube design would have been obvious to one of ordinary skill in the art because Hackemesser notes that "[d]ue to high temperatures of the heating fluid, the utilization of alternating radial flow is very important to uniform heat distribution and temperature gradient along the tube bundle." FF 4. Both forms of flow design appear in the analogous art and within the technical grasp of one skilled in the art. *See KSR*, 127 S.Ct. at 1739.

Accordingly, we determine that the Appellants have not shown the Examiner reversibly erred in making the rejection, and the rejection is sustained.

2. Obviousness over Boneberg and Yoshioka in view of Hackemesser and Ng.

Claims 44, 45, 87-89, and 120 stand rejected pursuant to 35 U.S.C. § 103(a) as obvious over Boneberg in view of Yoshioka and Hackemesser, as applied to claim 1, *supra*, and further in view of Ng.

Appellants traverse this rejection solely by arguing for the patentability of independent claim 1, on which claims 44, 45, and 87 depend, and on independent claim 75, on which claims 88, 89, and 120 depend. Appellants argue that the addition of Ng does not correct the deficiencies of the combination of the other three cited prior art references. App. Br. 19-20. Appellants do not argue that Ng does not teach the additional limitations of

the rejected claims, or that combining the additional elements of Ng with those of the prior combination would not have been obvious to a person of ordinary skill in the art. *Id.*

Since we have sustained the prior rejection of claim 1 and, by representation, claim 75 over Boneberg in view of Yoshioka and Hackemesser, we accordingly determine that Appellants have failed to show the Examiner reversibly erred in rejecting the listed claims. The rejection is thus sustained.

3. Obviousness over Boneberg in view of Yoshioka, Hackemesser and Ng and further in view of Collins

Claims 46 and 90 were rejected pursuant to 35 U.S.C. § 103(a) as obvious over Boneberg in view of Yoshioka, Hackemesser, and Ng, as applied to claims 45 and 89, on which the two claims respectively depend, and further in view of Collins.

Appellants traverse this rejection solely by arguing for the patentability of claims 45 and 89, on which claims 46 and 90 respectively depend. App. Br. 20-21. Appellants argue that the addition of Collins does not correct the deficiencies of the combination of the other four cited prior art references. Appellants do not argue that Collins does not teach the additional limitations of the instant rejected claims, or that combining the additional elements of Collins with those of the prior combination would not have been obvious to a person of ordinary skill in the art. *Id.*

Since we have sustained the prior rejection of claims 46 and 89 over Boneberg in view of Yoshioka, Hackemesser, and Ng, *supra*, we accordingly determine that Appellants have failed to show the Examiner

reversibly erred in rejecting the listed claims. Therefore, the rejection is sustained.

4. Obviousness over Boneberg in view of Yoshioka and Hackemesser and further in view of Robin

Claim 47 was rejected pursuant to 35 U.S.C. § 103(a) as obvious over Boneberg in view of Yoshioka and Hackemesser, and further in view of Robin.

Appellants traverse this rejection solely by arguing for the patentability of claim 1, on which claim 47 depends, App. Br. 21-22. Appellants argue that the addition of Robin does not correct the deficiencies of the combination of the other three cited prior art references. Appellants do not argue that Robin does not teach of the additional limitations of the rejected claims, or that combining the additional elements of Robin with those of the prior combination would not have been obvious to a person skilled in the art. *Id.*

Since we have sustained the prior rejection of claim 1, over Boneberg in view of Yoshioka and Hackemesser, we accordingly determine that Appellants have failed to show the Examiner reversibly erred in rejecting the listed claims. The rejection is sustained.

5. Obviousness over Boneberg in view of Yoshioka and Hackemesser, and further in view of Nagai

Claims 50, 51, 98, and 99 stand rejected under 35 U.S.C. § 103(a) as obvious over Boneberg in view of Yoshioka and Hackemesser, as applied to claim 1 (with respect to claims 50 and 51) and claim 75 (with respect to claims 98 and 99), upon which these claims depend, and further in view of Nagai.

Appellants traverse this rejection solely by arguing for the patentability of claim 1, on which claims 50 and 51 depend (App. Br. 22), and of claim 75, on which claims 98 and 99 depend, App. Br. 22-23. Appellants argue that the addition of Nagai does not correct the deficiencies of the combination of the other three cited prior art references. Appellants do not argue that Nagai does not teach the additional limitations of the rejected claims, or that combining the additional elements of Robin with those of the prior combination would not have been obvious to a person of ordinary skill in the art. *Id.*

Since we have sustained the prior rejection of claim 1, over Boneberg in view of Yoshioka and Hackemesser, we accordingly determine that Appellants have failed to show the Examiner reversibly erred in rejecting the listed claims. The rejection is sustained.

6. Obviousness over Boneberg in view of Yoshioka and Hackemesser and further in view of Parenti or Grotz

Claims 52, 53, and 86, dependent on claim 1, and claims 93-95, dependent on claim 75, stand rejected pursuant to 35 U.S.C. § 103(a) as obvious over Boneberg in view of Yoshioka and Hackemesser, as applied to claims 1 and 75, *supra*, and further in view of Parenti or Grotz.

Appellants traverse this rejection solely by arguing for the patentability of claim 1 and claim 75, upon which these rejected claims depend, App. Br. 23-24. Appellants argue that the addition of either Parenti or Grotz does not correct the deficiencies of the combination of the other three cited prior art references. Appellants do not argue that either Parenti or Grotz does not teach the additional limitations of the rejected claims, or that combining the additional elements of Parenti or Grotz with those of the prior

combination would not have been obvious to a person of ordinary skill in the art. *Id.*

Since we have sustained the prior rejections of claims 1 and 75 over Boneberg in view of Yoshioka and Hackemesser, we accordingly determine that Appellants have failed to show the Examiner reversibly erred in rejecting the listed claims. The rejection is sustained.

7. Obviousness over Boneberg in view of Yoshioka and Hackemesser and further in view of Leftin.

Claim 60, dependent on claim 1, and claim 105, dependent on claim 75, stand rejected pursuant to 35 U.S.C. § 103(a) as obvious over Boneberg in view of Yoshioka and Hackemesser, as applied to claims 1 and 75, *supra*, and further in view of Leftin.

Appellants traverse this rejection solely by arguing for the patentability of claims 1 and 75. App. Br. 24-25. Appellants argue that the addition of Leftin does not correct the deficiencies of the combination of the other three cited prior art references. Appellants do not argue that Leftin does not teach the additional limitations of the rejected claims, or that combining the additional elements of Leftin with those of the prior combination would not have been obvious to a person of ordinary skill in the art. *Id.*

Since we have sustained the prior rejection of claim 1, over Boneberg in view of Yoshioka and Hackemesser, we accordingly determine that Appellants have failed to show the Examiner reversibly erred in rejecting the listed claims. The rejection is sustained.

8. Obviousness over Boneberg in view of Yoshioka and Hackemesser and further in view of Furuta.

Claim 61, dependent on claim 1, and claim 106, dependent on claim 75, stand rejected pursuant to 35 U.S.C. § 103(a) as obvious over Boneberg in view of Yoshioka and Hackemesser, as applied to claims 1 and 75, *supra*, and further in view of Furuta.

Appellants traverse this rejection solely by arguing for the patentability of claims 1 and 75. App. Br. 25-26. Appellants argue that the addition of Furuta does not correct the deficiencies of the combination of the other three cited prior art references. Appellants do not argue that Furuta does not teach the additional limitations of the rejected claims, or that combining the additional elements of Furuta with those of the prior combination would not have been obvious to a person of ordinary skill in the art. *Id.*

Since we have sustained the prior rejection of claim 1, over Boneberg in view of Yoshioka and Hackemesser, we accordingly determine that Appellants have failed to show the Examiner reversibly erred in rejecting the listed claims. The rejection is sustained.

CONCLUSION

In summary, we sustain the eight rejections on appeal of all the pending claims in the application, for the reasons set forth in the Answer and above. The decision of the Examiner is affirmed.

TIME PERIOD FOR RESPONSE

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

AFFIRMED

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