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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte JOHN ERIC ROLLINGER,
MICHAEL IGOR KLUZNER, and ROBERT ROY JENTZ

Appeal 2017-004885
Application 13/353,240
Technology Center 3700

Before BRADLEY B. BAYAT, FREDERICK C. LANEY, and PAUL J. KORNICZKY, *Administrative Patent Judges*.

KORNICZKY, *Administrative Patent Judge*.

DECISION ON APPEAL

STATEMENT OF THE CASE

Pursuant to 35 U.S.C. § 134(a), Appellants John Eric Rollinger, Michael Igor Kluzner, and Robert Roy Jentz[1] appeal from the Examiner's decision, as set forth in the Final Office Action dated April 5, 2016 ("Final Act."), rejecting claims 1, 3, 4, 6–12, 14–19, and 21–27.[2] We have jurisdiction under 35 U.S.C. § 6(b). A hearing was held on April 18, 2019.

We REVERSE.

THE CLAIMED SUBJECT MATTER

The patent application is directed to an air/fuel imbalance monitor. Claims 1, 10, and 18 are the independent claims on appeal. Claim 1, reproduced below with disputed limitations italicized for emphasis, is illustrative of the claimed subject matter:

> 1. A method for an engine comprising:
>
> injecting fuel to generate a series of rich, lean, and stoichiometric conditions in an engine cylinder;
>
> *identifying, via an electronic controller, an air/fuel imbalance in the cylinder based on crankshaft accelerations generated by the series of rich, lean, and stoichiometric conditions and sensed by the controller*;
>
> while injecting fuel to generate the series of rich, lean, and stoichiometric conditions, keeping the engine at stoichiometry by injecting fuel to generate another series of lean, rich, and stoichiometric conditions in another cylinder, *the identifying based on a slope or shape of the sensed crankshaft accelerations mapped by the controller versus air/fuel ratios corresponding to the series of rich, lean, and stoichiometric conditions*; and

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[1] Appellants identify Ford Global Technologies, LLC as the real party in interest. Appeal Brief, dated September 6, 2016 ("Appeal Br."), at 3.

[2] Claims 2, 5, 13, and 20 are cancelled. Appeal Br. 32–36 (Claims App'x.).

adjusting, via the controller, an amount of fuel supplied to the cylinder identified as imbalanced.

REFERENCES

In rejecting the claims on appeal, the Examiner relied upon the following prior art:

Minamitani	US 4,703,735	Nov. 3, 1987
Moser	US 4,984,551	Jan. 15, 1991
Nankee	US 5,255,661	Oct. 26, 1993
Watabe	JP 11-030132	Feb. 2, 1999
Javaherian	US 6,668,812 B2	Dec. 30, 2003
Hohner	DE 10 2007 043 734 A1	Mar. 19, 2009
Nakagawa	US 2011/0100327 A1	May 5, 2011
Nishida	US 2011/0191006 A1	Aug. 4, 2011

REJECTIONS

The Examiner made the following rejections:

1. Claims 1, 6, and 7 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Minamitani, Watabe, and Moser.

2. Claim 3 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Minamitani, Watabe, and Nankee.

3. Claims 26 and 27 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Minamitani, Watabe, and Nishida.

4. Claims 4, 8, and 9 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Minamitani, Watabe, and Javaherian.

5. Claims 10–12, 14, 15, 17–19, 21, and 22 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Nakagawa, Minamitani, and Moser.

6. Claim 16 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Nakagawa, Minamitani, and Javaherian.

7. Claims 23–25 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Nakagawa, Minamitani, and Hohner.

Appellants seek our review of these rejections.

DISCUSSION

Rejection 1: Claims 1, 6, and 7 as Unpatentable Over Minamitani, Watabe, and Moser

The Examiner finds that Minamitani and Moser disclose all of the limitation of independent claim 1 except for the limitation reciting that "identifying . . . an air/fuel imbalance in the cylinder based on crankshaft accelerations generated by the series of rich, lean, and stoichiometric conditions and sensed by the controller" is "based on a slope or shape of the sensed crankshaft accelerations mapped by the controller versus air/fuel ratios corresponding to the series of rich, lean, and stoichiometric conditions." Final Act. 4–5. The Examiner finds that this missing limitation is disclosed by Watabe. *Id.* at 5–6. The Examiner explains that Watabe states that, "When there is a cylinder with a large difference of a combustion state especially at the time of idle operation, there is a problem which becomes, so that the vibration and sound by the aforementioned rotational variation are transmitted also to a driver, and impairs the amenity." *Id.* at 6 (citing Watabe ¶ 2). The Examiner also finds that Watabe is directed to "[i]dentifying an air/fuel imbalance would allow normalization of the air-fuel ratio between engine cylinders, thereby for example, reducing vibrations while the engine idles" (*id.* at 6), and that "Watabe uses the functional

relationship between the slope/shape of the sensed crankshaft accelerations versus a variation in air-fuel ratios to adjust an amount of fuel to an imbalanced cylinder" (Ans. 13 (citing Watabe ¶¶ 29–32)). The Examiner asserts that Watabe identifies an air/fuel imbalance because "Watabe is directed toward reducing variations in the rotational speed of the engine crankshaft [0004], due to incorrect quantities of air and fuel supplied to an identified engine cylinder [0002]," and the "routine of Figure 4 shows that both the throttle opening, and therefore the intake air amount, and the fuel injection amount are corrected in steps S103 and S104 to achieve a target air-fuel ratio [0032]." Ans. 13.

The Examiner reasons that it would have been obvious to a person having ordinary skill in the art at "to combine Watabe's steps of identifying an air/fuel imbalance in a cylinder based on a shape of crankshaft accelerations mapped versus air/fuel ratios, and adjusting an amount of fuel supplied to the imbalanced cylinder with the method for an engine disclosed by Minamitani." Final Act. 6.

Appellants contend that the Examiner's findings as to Watabe are erroneous. Reply Br. 2–5. We agree. First, Appellants correctly explain that "paragraph [0002] of Watabe does not describe incorrect quantities of air and fuel being supplied to an identified engine cylinder as alleged," and "[i]Instead, this passage describes various other phenomena that affect the combustion states, such as the compression ratio, tip bore diameter, etc." *Id.* at 2. We agree with Appellants that the "Answer fails to rebut this point, and instead continues to rely on paragraph [0002] without an explanation of where it allegedly describes incorrect quantities of air and fuel supplied to an identified engine cylinder." *Id.*

Second, Appellants further assert that, contrary to the Examiner's findings about the routine of Figure 4 of Watabe, "the routine of Fig. 4 of Watabe has nothing to do with identifying an air/fuel ratio imbalance," and "is described at paragraphs [0029] – [0032] of Watabe." *Id.* We agree with Appellants that Watabe's

> routine includes determining which engine cylinder has the lowest revolution speed relative to an average revolution speed of all engine cylinders (at S101 and S102), increasing the quantity of air supplied to that cylinder to improve combustion stability (at S103), and increasing the quantity of fuel injected to that cylinder to maintain a target air/fuel ratio (at S104).

Id. Appellants correctly explain, "the air/fuel ratio is not modified via the routine of Fig. 4," and "the quantity of fuel injected to the cylinder is increased in accordance with the increased amount of air supplied to the cylinder, to ensure that the air/fuel ratio will remain at the target air/fuel ratio." *Id.*; *see* Watabe ¶ 31 ("[S]tabilization becomes possible by improving operational status by making suction air quantity increase, and also making fuel oil consumption increase to the cylinder in which the combustion state got worse, so that a target air fuel ratio may not be changed."). We agree with Appellants that Watabe "is not concerned with identifying an air/fuel ratio imbalance, and instead focuses on other factors leading to combustion instability (e.g., variations in cylinder dimensions due to imprecise manufacturing methods, etc.)." *Id.* (citing Watabe ¶¶ 2–3). The Examiner does not explain how the fact that Watabe adjusts fuel injection quantity to preempt a possible air/fuel ratio imbalance discloses identifying an air/fuel ratio imbalance as recited in claim 1.

For these reasons, we do not sustain the Examiner's rejection of independent claim 1, and claims 6 and 7 which depend from claim 1, based on Minamitani, Watabe, and Moser.

Rejections 2–4: Claims 3, 4, 8, 9, 26, and 27

Claims 3, 4, 8, 9, 26, and 27 depend from independent claim 1. The Examiner rejected claim 3 based on Minamitani, Watabe, and Nankee, claims 4, 8, and 9 based on Minamitani, Watabe, and Javaherian, and claims 26 and 27 based on Minamitani, Watabe, and Nishida. Final Act. 6–8. The Examiner's reliance on Nankee, Javaherian, and Nishida does not cure the deficiencies in the combination of Minamitani and Watabe as described above in connection with the rejection of claim 1. Thus, we do not sustain the Examiner's rejections of claims 3, 4, 8, 9, 26, and 27.

Rejection 5: Claims 10–12, 14, 15, 17–19, 21, and 22 as Unpatentable Over Nakagawa, Minamitani, and Moser

Independent claim 10 recites, in part, "mapping the crankshaft accelerations versus air/fuel ratios corresponding to the modulated air/fuel ratio conditions in the selected cylinder via the electronic engine controller." Appeal Br. 33 (Claims App'x.). Independent claim 18 recites, in part, a controller configured to

> identify a cylinder with a potential air/fuel imbalance based on crankshaft accelerations generated by a series of rich, lean, and stoichiometric conditions in the cylinder, while keeping the engine at stoichiometry, wherein the identifying is based on a slope or shape of a mapping of sensed crankshaft accelerations versus air/fuel ratios corresponding to the series of rich, lean, and stoichiometric conditions as compared with an ideal torque

> curve versus air/fuel ratios corresponding to the series of rich, lean, and stoichiometric conditions.

Id. at 35–36. The Examiner finds that Nakagawa "discloses mapping the crankshaft accelerations versus air/fuel ratios corresponding to the modulated air/fuel ratio conditions in the selected cylinder via the electronic engine controller." Ans. 15; *see* Final Act. 10–11. The Examiner explains:

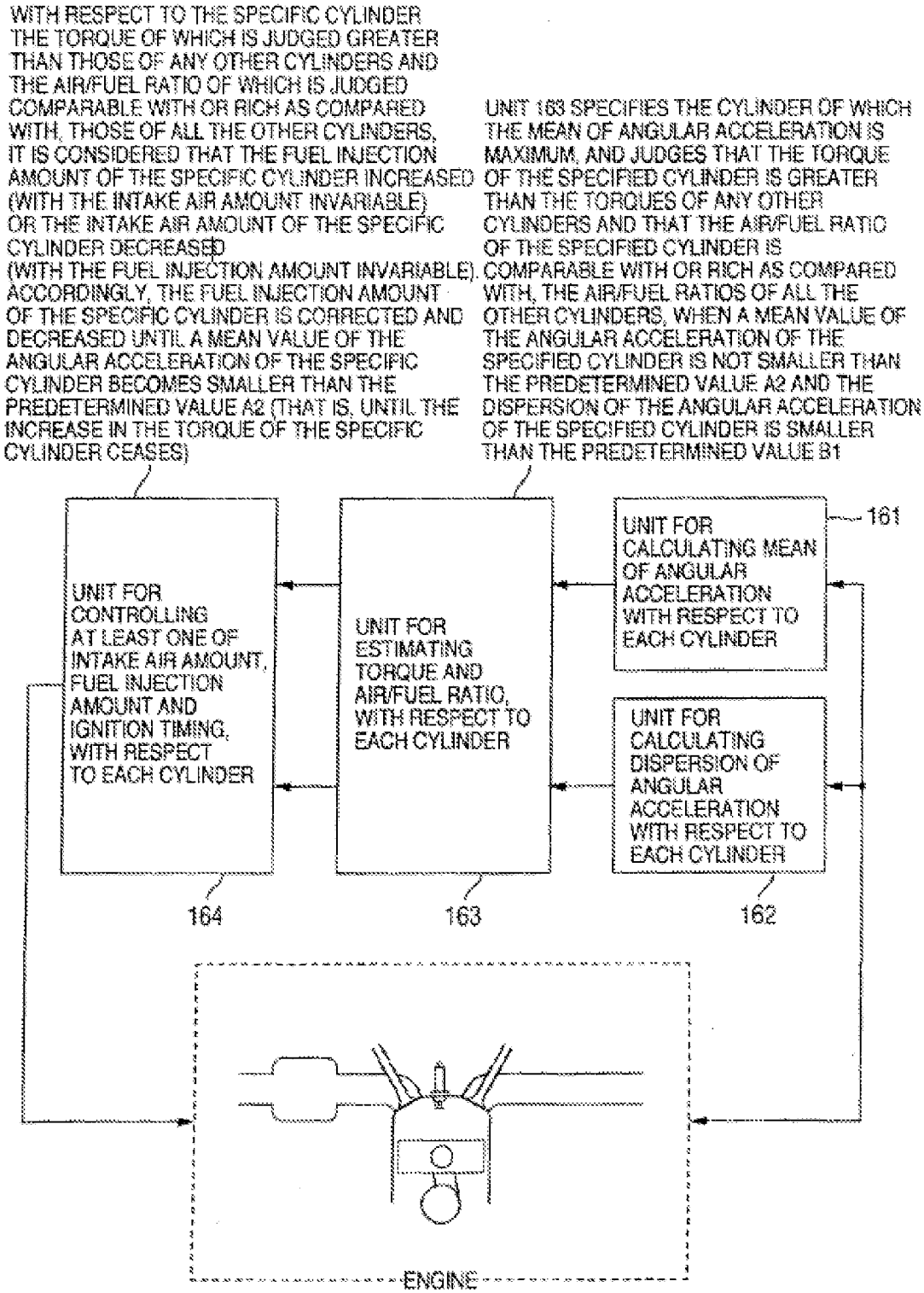
> As shown in Figure 15, unit 163 estimates the air/fuel ratio based on the dispersion of angular acceleration with respect to each cylinder calculated in unit 162. Nakagawa further discloses identifying via the electronic engine controller a potential air/fuel imbalance in the selected cylinder based on a slope or shape of the mapping of the crankshaft accelerations versus the modulated air/fuel ratios compared with an ideal curve, wherein the mapping of the crankshaft accelerations versus air/fuel ratios further includes calculating a curve fit to the corresponding modulated air/fuel ratio conditions in the selected cylinder, wherein normalized torque accelerations are used to populate the mapping of the crankshaft accelerations versus air/fuel ratios. As shown in Figure 15, with identification of the air/fuel imbalance, unit 164 corrects the air/fuel imbalance using a calculated curve fit that decreases the fuel injection amount until a mean value of the angular acceleration of the specific cylinder becomes smaller than the predetermined value A2. Normalized torque accelerations are used to populate the mapping of crankshaft accelerations as shown by units 163 and 164. The predetermined value A2 is determined as a value for which an increase in torque for the identified cylinder ceases.

Ans. 15–16.

Appellants argue that the Examiner's findings are erroneous because "Fig. 15 of Nakagawa, along with the remainder of the reference," does not disclose "that various claim features are shown in Fig. 15 of Nakagawa." Reply Br. 7; *see* Appeal Br. 24–25. We agree.

Figure 15 of Nakagawa is reproduced below:

FIG.15


WITH RESPECT TO THE SPECIFIC CYLINDER THE TORQUE OF WHICH IS JUDGED GREATER THAN THOSE OF ANY OTHER CYLINDERS AND THE AIR/FUEL RATIO OF WHICH IS JUDGED COMPARABLE WITH OR RICH AS COMPARED WITH, THOSE OF ALL THE OTHER CYLINDERS, IT IS CONSIDERED THAT THE FUEL INJECTION AMOUNT OF THE SPECIFIC CYLINDER INCREASED (WITH THE INTAKE AIR AMOUNT INVARIABLE) OR THE INTAKE AIR AMOUNT OF THE SPECIFIC CYLINDER DECREASED (WITH THE FUEL INJECTION AMOUNT INVARIABLE). ACCORDINGLY, THE FUEL INJECTION AMOUNT OF THE SPECIFIC CYLINDER IS CORRECTED AND DECREASED UNTIL A MEAN VALUE OF THE ANGULAR ACCELERATION OF THE SPECIFIC CYLINDER BECOMES SMALLER THAN THE PREDETERMINED VALUE A2 (THAT IS, UNTIL THE INCREASE IN THE TORQUE OF THE SPECIFIC CYLINDER CEASES)
UNIT 163 SPECIFIES THE CYLINDER OF WHICH THE MEAN OF ANGULAR ACCELERATION IS MAXIMUM, AND JUDGES THAT THE TORQUE OF THE SPECIFIED CYLINDER IS GREATER THAN THE TORQUES OF ANY OTHER CYLINDERS AND THAT THE AIR/FUEL RATIO OF THE SPECIFIED CYLINDER IS COMPARABLE WITH OR RICH AS COMPARED WITH, THE AIR/FUEL RATIOS OF ALL THE OTHER CYLINDERS, WHEN A MEAN VALUE OF THE ANGULAR ACCELERATION OF THE SPECIFIED CYLINDER IS NOT SMALLER THAN THE PREDETERMINED VALUE A2 AND THE DISPERSION OF THE ANGULAR ACCELERATION OF THE SPECIFIED CYLINDER IS SMALLER THAN THE PREDETERMINED VALUE B1
UNIT FOR CONTROLLING AT LEAST ONE OF INTAKE AIR AMOUNT, FUEL INJECTION AMOUNT AND IGNITION TIMING, WITH RESPECT TO EACH CYLINDER
UNIT FOR ESTIMATING TORQUE AND AIR/FUEL RATIO, WITH RESPECT TO EACH CYLINDER
UNIT FOR CALCULATING MEAN OF ANGULAR ACCELERATION WITH RESPECT TO EACH CYLINDER
UNIT FOR CALCULATING DISPERSION OF ANGULAR ACCELERATION WITH RESPECT TO EACH CYLINDER
161
162
163
164
ENGINE

Nakagawa explains that Figure 15 schematically shows an engine control apparatus wherein

> the intake air amount of the specific cylinder the torque of which is judged comparable with those of all the other cylinders and the air/fuel ratio of which is judged leaner than those of any other cylinders, is corrected and decreased until the dispersion of the angular acceleration of the specific cylinder becomes smaller than the predetermined value B1.

Nakagawa ¶ 37. The Examiner findings do not explain where Nakagawa discloses "mapping the crankshaft accelerations versus air/fuel ratios corresponding to the modulated air/fuel ratio conditions in the selected cylinder via the electronic engine controller" as recited in claim 10, or where Nakagawa discloses using a slope or shape of mapping as compared with an ideal curve or inclusion of calculating a curve fit as recited in claim 18.

Thus, we do not sustain the rejection of independent claims 10 and 18, and their dependent claims 11, 12, 14, 15, 17, 19, 21, and 22.

Rejections 6 and 7: Claims 16 and 23–25

The Examiner rejected claim 16 based on Nakagawa, Minamitani, and Javaherian, and claims 23–25 based on Nakagawa, Minamitani, and Hohner. Final Act. 13–14. The Examiner's reliance on Javaherian and Hohner does not cure the deficiencies in the combination of Nakagawa and Minamitani as described above in connection with the rejection of independent claims 10 and 18. Thus, we do not sustain the Examiner's rejections of claims 16 and 23–25.

DECISION

For the above reasons, the Examiner's rejections of claims 1, 3, 4, 6–12, 14–19, and 21–27 under 35 U.S.C. § 103 are REVERSED.

REVERSED