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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte STEPHEN WILLIAM MAGNER and
MRDJAN J. JANKOVIC

Appeal 2017-005478
Application 13/410,159
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 Stephen William Magner and Mrdjan J. Jankovic[1] appeal from the Examiner's decision, as set forth in the Final Office Action dated April 6, 2016 ("Final Act."), rejecting claims 2–12, 15–17, 19, and 20.[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 claims are directed to a post catalyst dynamic scheduling and control. Claims 2, 15, and 19 are the independent claims on appeal. Claim 2 is reproduced below with disputed limitations italicized for emphasis:

> 2. A method for controlling an engine exhaust with an upstream sensor and a downstream sensor, comprising:
> adjusting a set-point for the downstream sensor based on a rate of change of air mass flow upstream of an engine;
> comparing a measured exhaust reading from the downstream sensor to the set-point to generate an error, and determining a feedback correction from the error with a feedback controller; and
> adjusting fuel injection to control exhaust fuel-air ratio (FAR) at the downstream sensor to the adjusted set-point based on the feedback correction, and to control exhaust FAR at the upstream sensor to an upstream sensor set-point,

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[1] Appellants identify Ford Global Technologies, LLC as the real party in interest. Appeal Brief, dated November 7, 2016 ("Appeal Br."), at 4.

[2] Claims 1 and 14 are cancelled. Appeal Br. 41–46, Claims App. The Examiner withdrew the rejection of claims 13 and 18 under 35 U.S.C. § 103(a). *See* Answer, dated December 15, 2016 ("Ans."), at 18; *see also* Advisory Action, dated August 17, 2016 ("Adv. Act."), at 2.

> wherein the upstream sensor is a wide-band oxygen sensor and the downstream sensor is a narrow-band oxygen sensor, wherein *the adjusted set-point is further adjusted by a frequency shaping filter that suppresses higher frequencies and passes lower frequencies, and wherein the comparison to generate the error is determined after applying the frequency shaping filter to the adjusted set-point.*

Claim 15 is reproduced below with disputed limitations italicized for emphasis:

> 15. A method of controlling fuel injection in an engine comprising:
>
> determining a fuel-to-air ratio (FAR) of an exhaust stream at a first oxygen sensor loop positioned upstream of a catalytic converter and at a second oxygen sensor loop positioned downstream of the catalytic converter;
>
> determining a downstream set-point based on operating conditions;
>
> adjusting the downstream set-point based on a rate of change of mass flow upstream of the engine;
>
> converting the adjusted downstream set-point to FAR; determining an error between the adjusted downstream set-point FAR and a measured downstream FAR;
>
> determining an upstream set-point based on the determined error; and
>
> adjusting fuel injection based on the upstream set-point and measured upstream FAR;
>
> wherein an upstream sensor is a Universal Exhaust Gas Oxygen (UEGO) sensor, and a downstream sensor is a Heated Exhaust Gas Oxygen (HEGO) sensor, the *adjusting of the downstream set-point including mapping, with a map, a calculated rate of change of a filtered air mass flow into a delta HEGO set-point adjustment, the mapping including where smaller air flow rates of change, near zero, provide smaller HEGO set-point changes,*

> *intermediate to large air flow rates of change create larger dynamic HEGO setpoint changes, and even larger air flow rates of change provide smaller HEGO set-point changes.*

Claim 19 is reproduced below with disputed limitations italicized for emphasis:

> 19. A method of diagnosing catalyst degradation in an engine comprising:
>
> determining a fuel-to-air ratio (FAR) of an exhaust stream at a universal exhaust gas oxygen (UEGO) sensor positioned upstream of a catalytic converter and at a heated exhaust gas oxygen (HEGO) sensor positioned downstream of the catalytic converter;
>
> *adjusting a set-point for a HEGO sensor loop based on a rate of change of mass flow upstream of the engine*;
>
> adjusting fuel injection to control the FAR to match desired set-points; and
>
> during selected conditions, *adjusting a downstream sensor set-point transiently and independently of operating conditions* over a range within a maximum voltage and a minimum voltage, identifying catalyst degradation based on a response to adjusting the set-point.

REFERENCES

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

Abthoff	US 4,733,358	Mar. 22, 1988
Shimizu	US 5,359,853	Nov. 1, 1994
Mayer	US 5,432,701	July 11, 1995
Bush	US 5,842,340	Dec. 1, 1998
Yasui	US 6,904,355 B2	June 7, 2005
Sealy	US 6,945,033 B2	Sept. 20, 2005
Nakahara	US 6,990,953 B2	Jan. 31, 2006
Schnaibel	US 2003/0150209 A1	Aug. 14, 2003
Shirakawa	US 2005/0022512 A1	Feb. 3, 2005
Piwonka	US 2005/0096835 A1	May 5, 2005
Jones	US 2007/0234708 A1	Oct. 11, 2007
Kato	US 2008/0066727 A1	Mar. 20, 2008
Rajagopalan	US 2009/0266052 A1	Oct. 29, 2009

REJECTIONS

The Examiner made the following rejections:

1. Claim 2 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Kato, Abthoff, Bush, Yasui, and Jones.

2. Claims 3, 5, 6, and 15 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kato, Abthoff, Bush, Yasui, Shirakawa, Nakahara, and Jones.

3. Claim 4 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Kato, Abthoff, Bush, Yasui, Shirakawa, Nakahara, Schnaibel, and Jones.

4. Claims 7, 8, and 16 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kato, Abthoff, Bush, Yasui, Shirakawa, Nakahara, Sealy, and Jones.

5. Claim 9 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Kato, Abthoff, Bush, Yasui, Shirakawa, Nakahara, Sealy, Mayer, and Jones.

6. Claims 10 and 11 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kato, Abthoff, Bush, Yasui, Shirakawa, Nakahara, Sealy, Mayer, Shimizu, and Jones.

7. Claim 12 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Kato, Abthoff, Bush, Yasui, Shirakawa, Nakahara, Sealy, Mayer, Piwonka, and Jones.

8. Claim 17 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Kato, Abthoff, Bush, Yasui, Shirakawa, Nakahara, Sealy, Mayer, and Jones.

9. Claims 19 and 20 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Shimizu and Bush.

Appellants seek our review of these rejections.

DISCUSSION

Rejection 1: Claim 2
as Unpatentable Over Kato, Abthoff, Bush, Yasui, and Jones

Claim 2 recites, in part, a method for controlling an engine exhaust with an upstream and a downstream sensor wherein an "adjusted set-point is further adjusted by a frequency shaping filter that suppresses higher frequencies and passes lower frequencies, and wherein the comparison to generate the error is determined after applying the frequency shaping filter to the adjusted set-point." The Examiner finds that this limitation is disclosed by Yasui. Final Act. 13, ¶¶ 38–39. The Examiner states that Yasui teaches that

> when a response of the first exhaust gas sensor is enhanced, chemical noise may appear in the output of the first exhaust gas sensor. The first decimation filter can remove such chemical noise. The air-fuel ratio control based on the output from the first decimation filter prevents the purification rate of the catalyst from deteriorating.

Id. ¶ 39 (citing Yasui, 2:42–48). According to the Examiner, Yasui discloses "a vehicle controller for controlling an air-fuel ratio (Title) comprising frequency shaping filter (first decimation filter 36) that suppresses higher frequencies and passes lower frequencies, wherein the comparison to generate the error is determined after applying the frequency shaping filter to the adjusted set-point." *Id.* ¶ 38 (citing Yasui, 7:43–52).

Appellants contend that the Examiner's findings regarding Yasui are erroneous because Yasui does not teach or suggest that the "comparison to generate the error is determined after applying the frequency shaping filter to the adjusted set-point" as recited in claim 2. *See, e.g.*, Reply Brief, dated February 15, 2017 ("Reply Br."), at 2–5. We agree. Claim 2 addresses in part, a method of adjusting a set-point for a downstream exhaust sensor. As explained in the Specification, the method includes generating a reference set-point (e.g., at determiner 204), and passing this set-point through a frequency-shaping filter (e.g., lag-lead filter 206). *See* Spec. 9–10 and Fig. 2. After the set-point is filtered, it may be compared to the output of a downstream exhaust gas sensor (e.g., HEGO 127) to generate an error signal, which is then used to determine a feedback correction for controlling the air-fuel ratio. *Id.*

We agree with Appellants that Yasui teaches a different method of controlling air-fuel ratio in a vehicle. Reply Br. 3. Figure 4 of Yasui is reproduced below:

Figure 4

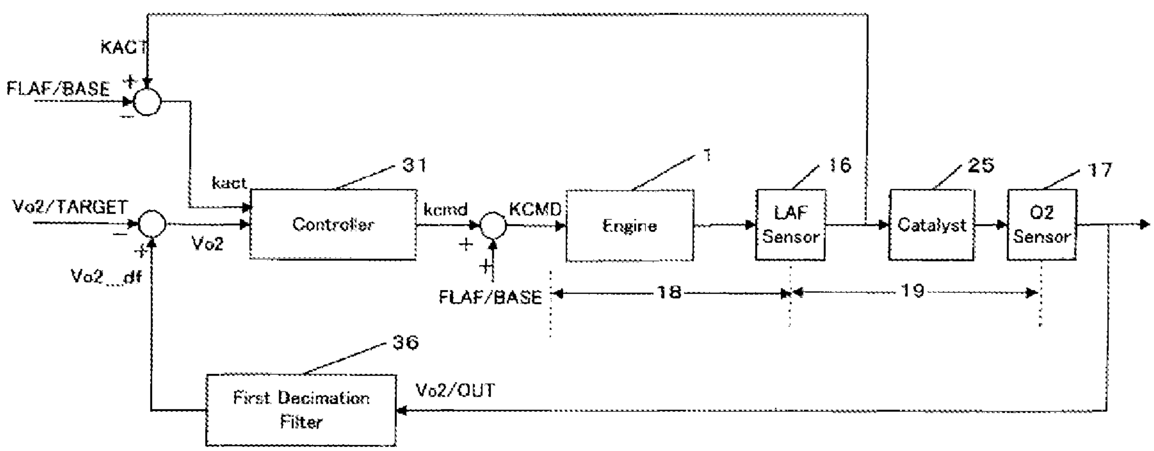

Figure 4 is a block diagram of air-fuel ratio control according a first embodiment of the Yasui. Yasui, 4:36–40. Referring to Figure 4 and column 7, lines 36–63 of Yasui, Yasui generates output Vo2/OUT from a downstream exhaust sensor (02 sensor 17), and then filters that output with first decimation filter 36 to generate filtered exhaust sensor output Vo2_df. Filtered exhaust sensor output Vo2_df is then compared to reference set-point Vo2/TARGET to generate error Vo2. Yasui, 7:36–63. Error Vo2 is then used to correct air-fuel ratio set-point (KCMD). *Id.* We agree with Appellants that "Yasui teaches applying a frequency shaping filter to the downstream exhaust sensor output, whereas claim 2 calls for adjusting the set-point, not the output, of the downstream sensor by the frequency shaping filter." Reply Br. 3–4.

For these reasons, we do not sustain the rejection of claim 2.

Rejections 2–7: Dependent Claims 3–12

Claims 3–12 depend from independent claim 2. As mentioned above, to reject claims 3–12 under 35 U.S.C. § 103, the Examiner relies on different combinations of Kato, Abthoff, Bush, Yasui, Shirakawa, Nakahara, Schnaibel, Sealy, Mayer, Shimizu, Piwonka, and Jones. *See* Final Act. 13–21. The Examiner's findings and reasoning regarding Shirakawa, Nakahara, Schnaibel, Sealy, Mayer, Shimizu, Piwonka, and Jones, however, do not remedy the deficiencies in Yasui as discussed above in connection with claim 2. Thus, we do not sustain the rejections of claims 3–12.

Rejection 2: Claim 15 as Unpatentable Over
Kato, Abthoff, Bush, Yasui, Shirakawa, Nakahara, and Jones

Independent claim 15 recites, in part, a method for controlling fuel injection in an engine wherein "the adjusting of the downstream set-point including mapping, with a map, a calculated *rate of change of a filtered air mass flow* into a delta [Heated Exhaust Gas Oxygen] HEGO set-point adjustment, the mapping including where smaller air flow rates of change, near zero, provide smaller HEGO set-point changes, intermediate to large air flow rates of change create larger dynamic HEGO set-point changes, and even larger air flow rates of change provide smaller HEGO set-point changes." Appeal Br. 44–45, Claims App. (emphasis added). The Examiner relies on Shirakawa and Nakahara to teach or suggest this limitation. Final Act. 14–15, ¶¶ 44–49.

As to Shirakawa, the Examiner finds that Shirakawa discloses a map relating a rotational speed of an engine to a target air fuel ratio. *Id.* ¶ 44 (citing Shirakawa, Figure 10). The Examiner finds that Figure 10 of

Shirakawa discloses a relationship between an exhaust air-fuel ratio set-point on the ordinate and engine rotational speed NE on the abscissa. Ans. 19. Figure 10 of Shirakawa, as annotated by the Examiner, is reproduced below:

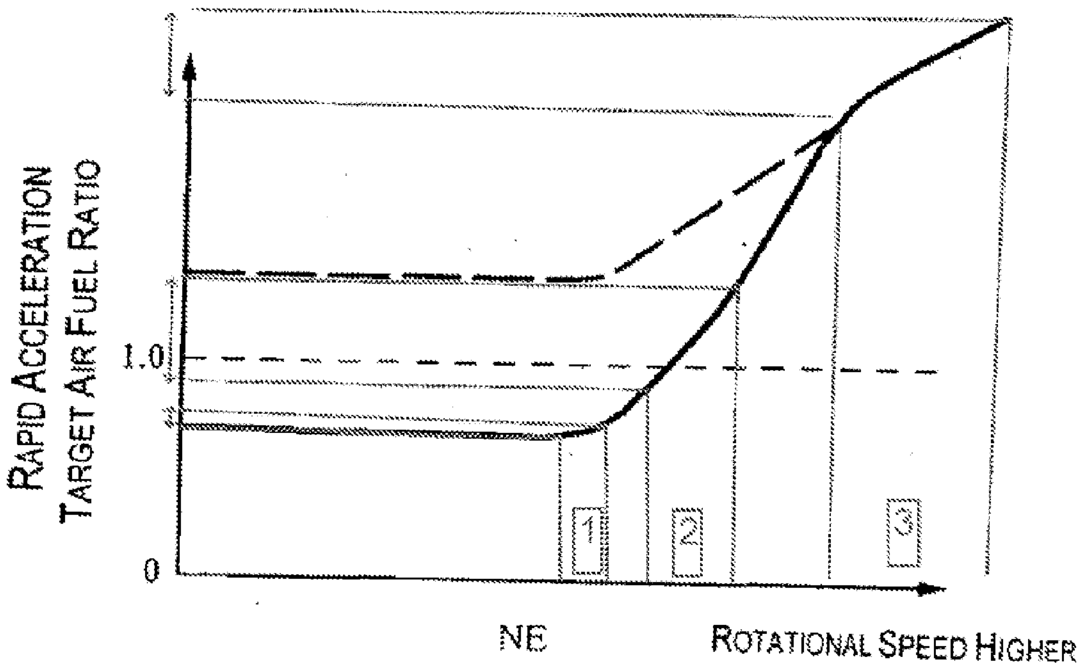

Fig. 10

Ans. 21. Figure 10 illustrates one embodiment of "a characteristic curve of a rapid acceleration target air fuel ratio. Shirakawa ¶ 20. According to the Examiner, the annotated Figure 10 "show[s] first, second and third slopes corresponding to first, second and third changes in engine rotational speed for given changes in air-fuel ratio setpoint." Ans. 20. The Examiner finds that Figure 10 shows a map which maps engine rotational speed to an air-fuel ratio set-point, including smaller speed changes near the origin providing smaller set-point adjustments, intermediate to large derivatives providing larger set point adjustments, and even larger derivatives providing smaller set point changes. Final Act. 14, ¶ 44. Because Shirakawa does not relate a HEGO set-point adjustment to a rate of change of filtered air mass flow the Examiner relies on Nakahara. *Id.* 14, ¶ 46.

As to Nakahara, the Examiner finds that "Nakahara discloses an acceleration control for an internal combustion engine wherein the rate of change of a filtered intake air flow (see electronic throttle 14) increases as the rotational speed of the engine increases, above a threshold rotational speed." Final Act. 14, ¶ 47 (citing Nakahara, 4:35–43). According to the Examiner, this is graphically represented by Figure 2 of Nakahara, which is reproduced below:

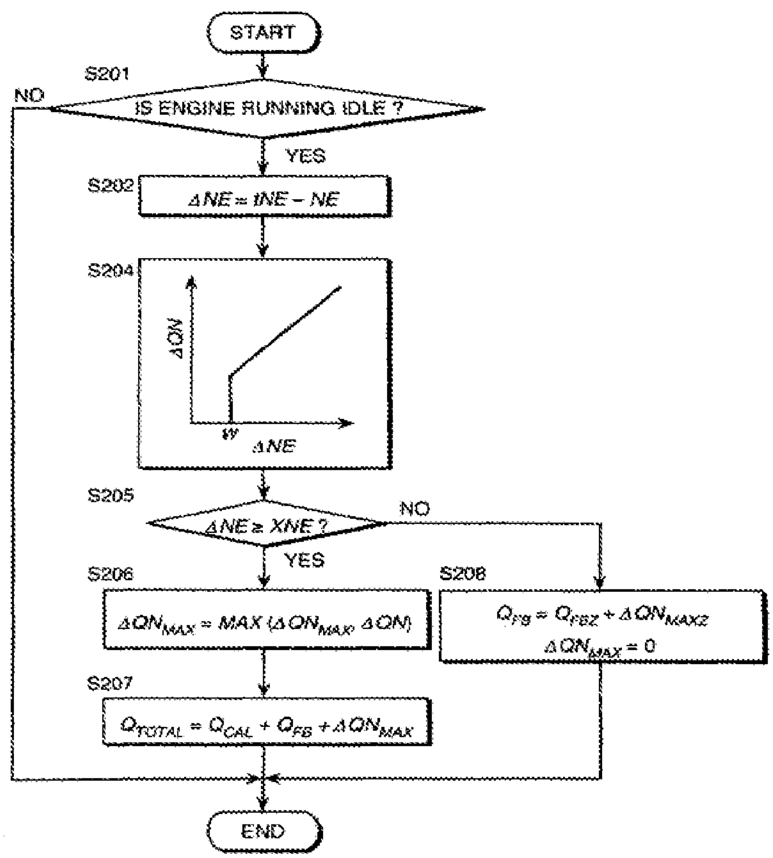

FIG. 2

Figure 2 illustrates a flowchart describing an intake air flow rate correction routine performed by Nakahara's controller. Nakahara, 2:32–33. Referring to step S204, the Examiner explains that quantity ΔQN is an intake air flow rate increase amount, quantity ΔNE represents the difference in engine speed, and ΔQN measured over a time interval such as the routine execution interval represents a rate of change in the air flow rate upstream of the engine. Ans. 19 (citing Nakahara, 4:35–43, 3:53–62, 8:18–22).

According to the Examiner,

> Both Nakahara (see Col. 1, lines 22-32) and Shirakawa [see paragraphs 0006-0008] are concerned with improving control during an acceleration condition. Thus, combining the maps to generate a mapping, as claimed, that relates the target air-fuel ratio setpoint to the rate of change in air flow rate simply involves creating a function of three variables (air-fuel ratio setpoint, engine speed, rate of change of intake air flow rate) from two equations with a common variable (engine speed). The mapping resulting from the combination would suggest to a person of ordinary skill that it would describe at least the relationship between the target air-fuel ratio setpoint and the rate of change in air flow rate during an acceleration condition.

Id. at 19–20.

The Examiner reasons that it would have been obvious to a person having ordinary skill in the art "to perform the proportional engine speed to rate of change of mass airflow control disclosed by Nakahara with the exhaust system disclosed by at least Kato and Abthoff, to allow stable engine speed response characteristics such as quick convergence and minimization of overshoot," and "to adjust the setpoint of the downstream HEGO sensor disclosed by Kato and Bush, using the adjustment according to engine speed (an[d] therefore rate of change of mass airflow) disclosed by Shirakawa, to also improve acceleration and torque performance when the engine is under full load at a low rotational speed, such as during idling." Final Act. 15, ¶ 49.

Appellants contend that the Examiner's findings and reasoning regarding Nakahara and Shirakawa are erroneous because they do not teach or suggest that the "comparison to generate the error is determined after applying the frequency shaping filter to the adjusted set-point" as recited in claim 2. *See, e.g.*, Ans. 19–25. We agree.

First, we agree with Appellants that the Examiner has not provided sufficient evidence and reasoning to combine the maps from Nakahara and Shirakawa. Reply Br. 21. The Examiner admits that the quantities described in Nakagawa and Shirakawa are different, and neither reference discloses the claimed variable — rate of change of a filtered air mass flow amount. Ans. 19–20. Moreover, neither reference discloses using the *rate of change of a filtered air mass flow* to make "a delta HEGO set-point adjustment, the mapping including where smaller air flow rates of change, near zero, provide smaller HEGO set-point changes, intermediate to large air flow rates of change create larger dynamic HEGO set-point changes, and even larger air flow rates of change provide smaller HEGO set-point changes" as recited in claim 15. The evidence in Nakahara and Shirakawa cited by the Examiner does not support the Examiner's finding that "mapping [a] target air-fuel ratio setpoint to the rate of change in air flow rate simply involves creating a function of three variables (air-fuel ratio setpoint, engine speed, rate of change of intake air flow rate) from two equations with a common variable (engine speed)," or that the "mapping resulting from the combination would suggest to a person of ordinary skill that it would describe at least the relationship between the target air-fuel ratio setpoint and the rate of change in air flow rate during an acceleration condition." Ans. 19–20.

Second, we agree with Appellants that, even if such a relationship were possible, the resulting map would relate a target air-fuel ratio to an engine to an air flow amount increase. Appeal Br. 23 (citing Nakahara, 4:30–35). Therefore, the Examiner's purported map is not the same as that required by claim 15, which relates a rate of change of an airflow amount to a HEGO set-point adjustment. Thus, even ignoring the problems with combining these two maps, such a combination still does not achieve the appropriate relationship between quantities to reproduce the features of claim 15.

For the reasons above, we do not sustain the Examiner's rejection of claim 15.

Rejections 4, 8: Dependent Claims 16 and 17

Claims 16 and 17 depend from independent claim 15. As mentioned above, to reject claims 16 and 17 under 35 U.S.C. § 103, the Examiner relies on different combinations of Kato, Abthoff, Bush, Yasui, Shirakawa, Nakahara, Sealy, Mayer, and Jones. *See* Final Act. 13–21. The Examiner's findings and reasoning regarding Sealy, Mayer, and Jones, however, do not remedy the deficiencies in Shirakawa and Nakahara as discussed above in connection with claim 15. Thus, we do not sustain the rejections of claims 16 and 17.

Rejection 9: Claims 19 and 20
as Unpatentable Over Shimizu and Bush

Independent claim 19 recites, in part, a method of diagnosing catalyst degradation in an engine wherein "adjusting a set-point for a HEGO sensor loop [is] based on a rate of change of mass flow upstream of the engine" and "adjusting a downstream sensor set-point transiently and independently of operating conditions over a range within a maximum voltage and a minimum voltage." The Examiner finds that this limitation is taught by Shimizu at column 14, lines 35–42, "wherein Shimizu teaches that during transient operating conditions the period in feedback control becomes larger;" column 20, lines 25–38, "wherein Shimizu teaches that the degree of transition of operating condition include conditions can be represented by the rate of change of air mass flow;" and column 13, lines 25–61, "wherein Shimizu discloses adjusting a set-point for the downstream sensor." Final Act. 5, ¶ 7.

The Examiner argues that

> [Appellants] narrowly interpret[] output of a downstream oxygen sensor as an operating condition. However, because claim 19 does not specify what the selected conditions are, or what the operating conditions are, or any limitation defining the minimum or maximum voltage, *the output of the downstream oxygen sensor is only one possible operation condition or selected condition* and any adjustment of the setpoint meets the claim.

Ans. 22–23 (emphasis added).

However, in light of the Examiner's assessment that an output of the downstream oxygen sensor is an "operating condition," Shimuzu does not adjust the downstream sensor set-point "independently of operating conditions" as required by claim 19. Thus, we do not sustain the rejection of claim 19, and claim 20 which depends from claim 19.

DECISION

For the above reasons, the Examiner's rejections of claims 2–12, 15–17, 19, and 20 under 35 U.S.C. § 103 are REVERSED.

REVERSED