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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/002,724	01/21/2016	Shayan Ahmadian	91650US01;67097-3315PUS1	8103

54549 7590 06/18/2020

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EXAMINER
CHAU, ALAIN

ART UNIT	PAPER NUMBER
3741	

NOTIFICATION DATE	DELIVERY MODE
06/18/2020	ELECTRONIC

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte SHAYAN AHMADIAN, CHARLES W. HALDEMAN, MARK F. ZELESKY, CHRISTOPHER T. BERGMAN, and SEBASTIAN MARTINEZ

Appeal 2020-000317
Application 15/002,724
Technology Center 3700

Before: PHILLIP J. KAUFFMAN, TARA L. HUTCHINGS, and ALYSSA A. FINAMORE, *Administrative Patent Judges*.

KAUFFMAN, *Administrative Patent Judge*.

DECISION ON APPEAL

STATEMENT OF THE CASE

Pursuant to 35 U.S.C. § 134(a), Appellant[1] appeals from the Examiner's decision to reject claims 1, 3–11, 13–16, and 21–25. Final Act. 2–20. We have jurisdiction under 35 U.S.C. § 6(b).

We affirm in part.

CLAIMED SUBJECT MATTER

The claims relate to the measurement of heat flux within a thermal barrier coating ("TBC") of a component of the turbine section of a gas turbine engine. Spec. ¶¶ 3–4, 38. The intensity of radiation emanating from a localized region of the component is measured at two different wavelengths. Spec ¶ 50. Because the radiation emission and transmission characteristics of the TBC and the underlying substrate differ (Spec. ¶ 48), the two measurements provide an indication of a temperature difference *dT* between the barrier coating and substrate (Spec. ¶ 52). The controller calculates instantaneous heat flux at a localized region using Fourier's law, as a function of: the thermal conductivity of the coating, the thickness of the coating, and the temperature difference. Spec. ¶ 52 (Equation 1).

Claims 1 and 11 are independent. Claims 1 and 3 are reproduced below:

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[1] We use the word "Appellant" to refer to "applicant" as defined in 37 C.F.R. § 1.42. Appellant identifies the real party in interest as United Technologies Corporation. Appeal Br. 1.

1. A turbine section comprising:

a component including a coating on a substrate;

at least one sensor positioned a distance from the component, the at least one sensor configured to detect radiation emitted from at least one localized region of the coating at a first wavelength and configured to detect radiation emitted from the substrate corresponding to the at least one localized region at a second, different wavelength;

wherein the first wavelength and the second wavelength are utilized to determine a heat flux relating to the at least one localized region; and

a controller electrically coupled to the at least one sensor, the controller configured to determine an instantaneous value of the heat flux based upon a comparison of the first wavelength and the second wavelength.

3. The turbine section as recited in claim 1, wherein the at least one localized region includes a first localized region and a second, different localized region, and the controller is configured to determine a spatial gradient based upon the instantaneous value of the heat flux at the first localized region and an instantaneous value of heat flux at the second localized region.

REJECTIONS

I. Claims 1, 3–10, and 21 are rejected under 35 U.S.C. § 103 as unpatentable over Markham and Sabol.[2] Final Act. 2–9.

II. Claims 11, 15, 16, and 22–24 are rejected under 35 U.S.C. § 103 as unpatentable over Markham, Sabol, and Wang. Final Act. 10–18.[3]

III. Claims 13, 14, and 25 are rejected under 35 U.S.C. § 103 as unpatentable over Markham, Wang, Sabol, Nirmalan, in combination with one or more of McCarty, Cunha, and Reichert. Final Act. 18–20.[4]

ANALYSIS

I. Claims 1, 4–10, and 21[5]

Appellant makes three arguments that claim 1 is patentable.

First, regarding the recitation in independent claim 1 that "the controller [is] configured to determine an instantaneous value of the heat flux based upon a comparison of the first wavelength and the second wavelength," Appellant argues both that the Examiner admitted that

[2] Markham (US 2004/0179575 A1, published Sept. 16, 2004); Sabol et al. (US 2006/0056960 A1, published Mar. 16, 2006).
[3] Wang et al. (US 2014/0376588 A1, published Dec. 25, 2014).
[4] Nirmalan et al. (US 6,422,743 B1, issued July 23, 2002); McCarty et al. (US 2,906,494, issued Sept. 29, 1959); Cunha (US 5,253,976, issued Oct. 19, 1993); Reichert (US 6,427,448 B1, issued Aug. 6, 2002).
[5] Appellant argues these claims as a group. *See* Appeal Br. 3–6; Reply Br. 2–3; 37 C.F.R. § 41.37(c)(1)(iv).

Markham fails to disclose this limitation, and that the Examiner did not assert that Sabol discloses this limitation. Appeal Br. 4.

We agree with Appellant that the Examiner found that Markham does not disclose the limitation at issue. *See* Final Act. 3. Appellant's assertion that the Examiner did not assert that Sabol discloses the limitation misses the point because, as detailed below, the Examiner contends that the limitation at issue is met based on a combination of the references.

Markham describes a pyrometer system for monitoring the temperature and condition of TBC turbine blades. Markham ¶¶ 3, 33; Fig. 2. The Examiner correctly finds that Markham's pyrometer system includes detectors for generating signals in response to radiation in two different wavelength ranges, a long wavelength infrared radiance ("LWIR") and a short wavelength infrared radiance ("SWIR"). Final Act. 3 (citing Markham ¶¶ 21, 33).[6] More specifically, Markham's pyrometer system generates signals related to two wavelengths of radiation for a particular spot on a blade, one at the outer surface of the coating, and the other at the surface of the substrate underlying the coating. *Id*. (citing Markham ¶¶ 20, 47).

The Examiner correctly finds that Sabol describes heat flux sensor 61 for measuring heat flux across a TBC deposited on gas turbine blade 18. Final Act. 3–4 (citing Sabol ¶ 61; Figs. 6C, 7). Heat flux sensor 61 includes thermocouples 66 deposited in TBC 60. Sabol ¶¶ 62–63; Fig. 7. "As heat

[6] Although the underlying terms are found in the Final Action and in Markham, the abbreviations "LWIR" and "SMIR" are found only in the Final Action.

flows vertically into or out of thermal barrier coating 60, each thermocouple 66 will record a different temperature measurement. By measuring the temperature differences and knowing the thickness and thermal conductivity of thermal barrier coating 60, the heat flux can be obtained." Sabol ¶ 64.

In light of this, the Examiner proposes to incorporate Sabol's technique for calculating heat flux based on a comparison of values representing temperature difference into Markham's system. Appellant's argument that Sabol does not disclose the limitation at issue is unpersuasive because it is an individual attack on the reference that fails to address the rejection as articulated by the Examiner.

Appellant's second argument is that the Examiner's reason for combining the references is conclusory. Appeal Br. 5; *see also* Reply Br. 3 (asserting that the "Examiner essentially relies on simple substitution to support the rejection").

The Examiner provides the following rationale:

> to incorporate the controller configured to determine the heat flux based on a comparison of values representing temperature differences within the component and coating, as taught by Sabol, to the system of Markham, in order to provide a controller that can calculate a heat flux across the component to obtain information indicative of the health of the component and the coating, permitting an analysis of the component to determine a need for replacement or other corrective action.

Final Act. 4 (citing Sabol ¶¶ 61, 64, 73–74). Appellant's unsupported assertion that the Examiner's finding is conclusory (Appeal Br. 5; Reply Br. 3) does not directly or effectively address the Examiner's reasoning. The

portions of Sabol cited by the Examiner disclose that by knowing the thickness and thermal conductivity of a thermal barrier coating, the heat flux across that thermal barrier can be calculated, and this data may be used for analysis of the health of the component such as through repair, replacement, or maintenance decisions. Therefore, the Examiner's finding that one of ordinary skill in the art would have had reason to modify Markham's system provides a sufficient factual underpinning to support the rejection and is not conclusory.

Third, Appellant contends that the proposed modification of incorporating Sabol's thermocouples 66 into Markham's blade would have impermissibly changed the principle of operation of Markham by eliminating Markham's detectors 24, 25, and 28. Appeal Br. 4–5. Appellant mischaracterizes the rejection. The Examiner proposes to modify Markham's controller to calculate heat flux using Sabol's technique from the temperature difference generated by Markham's system. Ans. 22–23, 25. The proposed modification would not have required bodily incorporation of Sabol's thermocouples or controller into Markham's system, as Appellant suggests. *See* Appeal Br. 5; Reply Br. 3.

We are persuaded by the Examiner's findings and reasoning to sustain the rejection of claims 1, 4–10, and 21 under 35 U.S.C. § 103 as unpatentable over Markham and Sabol.

II. Claims 11, 15, 16, 23, and 24

Appellant contends that claim 11, and its dependent claims 15, 16, 23, and 24, are patentable based on the same contentions Appellant presents in connection with the patentability of claim 1. Appeal Br. 4–6; Reply Br. 2–3. We sustain the rejection of claims 11, 15, 16, 23, and 24 under 35 U.S.C. § 103 as unpatentable over Markham, Wang, and Sabol for the reasons discussed earlier.

III. Claims 13, 14, and 25

Claims 13, 14, and 25 depend from independent claim 11. Appellant presents no arguments for the patentability of these dependent claims separate from those addressing the patentability of claim 1 over the teachings of Markham and Sabol. We sustain the rejection of claims 13, 14, and 25 under 35 U.S.C. § 103 as unpatentable over Markham, Wang, Sabol, Nirmalan, in combination with one or more of McCarty, Cunha, and Reichert, for the reasons discussed earlier.

IV. Claims 3 and 22

Claim 3 depends from independent claim 1, and claim 22 depends from independent claim 11. Each of claims 3 and 22 recites:

> wherein the at least one localized region includes a first localized region and a second, different localized region, and the controller is configured to determine a spatial gradient based upon the instantaneous value of the heat flux at the first localized region

> and an instantaneous value of heat flux at the second localized region.

The Examiner interprets the term "first localized region" and the "second, different localized region," as recited in claims 3 and 22, as being sufficiently broad to encompass "different, distinct surfaces of the component (i.e. on top of the coating) and the surface of the substrate of the component (i.e. the surface the coating is applied on top of)." Ans. 27. According to the Examiner, "Markham further teaches a spatial gradient measured between the two surfaces in the form of a temperature gradient, which would naturally be 'based upon' the heat flux in the regions since heat flux is determined by temperatures measured in the two regions . . . ." Ans. 27.

Appellant contends that the Examiner has interpreted claims 3 and 22 too broadly. Appeal Br. 6; Reply Br. 3–4. Per Appellant:

> Based on the Examiner's own reasoning, there would be no heat flux calculated at either of the alleged first and second localized regions since the Examiner relies on a single surface ("i.e., on top of the coating") at a single depth to be the alleged first localized region and relies on another single surface ("i.e., the surface the coating is applied on top of") at a single depth to be the alleged second localized region.

Reply Br. 4 (citation omitted). Appellant's argument is persuasive.

As recited in each of independent claims 1 and 11, heat flux is determined based on radiation emitted from at least one localized region of the coating at a first wavelength and radiation emitted from the

corresponding region of the substrate at a second wavelength. Put simply, heat flux is based on measurements at corresponding surfaces. Moreover, the Examiner acknowledges heat flux is determined from measurements at corresponding surfaces, i.e., different depths. Ans. 27

The Examiner interprets claims 3 and 22 to require a measurement at each of two different regions of the component, thereby requiring only one heat flux. To the contrary, these claims require a spatial gradient between two heat fluxes, namely "the heat flux at the first localized region" and the "heat flux at the second localized region." Therefore, we agree with Appellant that the Examiner's finding that Markham teaches the subject matter of claims 3 and 22 is based on an overly broad interpretation of the claims. We do not sustain the rejection of claim 3 under 35 U.S.C. § 103 as unpatentable over Markham and Sabol; or the rejection of claim 22 under 35 U.S.C. § 103 as unpatentable over Markham, Wang, and Sabol.

DECISION SUMMARY

In summary:

Claims Rejected	35 U.S.C. §	Reference(s)/Basis	Affirmed	Reversed
1, 3–10, 21	103	Markham, Sabol	1, 4–10, 21	3
11, 15, 16, 22–24	103	Markham, Wang, Sabol	11, 15, 16, 23, 24	22

13, 14, 25	103	Markham, Wang, Sabol, Nirmalan, McCarty, Cunha, Reichert	13, 14, 25	
Overall Outcome			**1, 4–11, 13–16, 21, 23–25**	**3, 22**

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). *See* 37 C.F.R. § 1.136(a)(1)(iv).

AFFIRMED IN PART