UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte RAMGOPAL DAROLIA,
MARK DANIEL GORMAN, and JOSEPH DAVID RIGNEY

Appellants

Appeal 2008-3818
Application 10/922,527[1]
Technology Center 1700

Decided: October 15, 2008

Before ADRIENE LEPIANE HANLON, THOMAS A. WALTZ, and MARK NAGUMO, *Administrative Patent Judges*.

NAGUMO, *Administrative Patent Judge*.

DECISION ON APPEAL

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[1] Application 10/922,527, *Article Protected by a Strong Local Coating*, filed 20 August 2004. The specification is referred to as the "527 Specification," and is cited as "Spec." The real party in interest is listed as General Electric Co. (Appeal Brief filed 25 June 2007 ("Br."), 1.)

A. Introduction

Ramgopal Darolia, Mark Daniel Gorman, and Joseph David Rigney ("Darolia") timely appeal under 35 U.S.C. § 134(a) from the final rejection of claims 1-20. We AFFIRM.

The subject matter on appeal relates to an article of manufacture, such as a turbine blade, that is protected in two different areas by two different coatings. The article comprises a substrate containing aluminum (Al). The first protective layer contains at least 3 atomic percent more aluminum than the substrate. The second protective layer contains at least about 60 weight percent of platinum ("Pt"), rhodium ("Rh"), palladium ("Pd"), or combinations of these metals. The first protective layer overlies a first region of the surface of the substrate. The second protective layer overlies a second region of the surface of the substrate different from the first region. The coatings are said to protect the substrate against extreme temperatures, e.g., around 2000° F (1270° C). The second protective layer is said to be mechanically stronger, but heavier and more expensive. Accordingly, in embodiments, the second protective layer is applied to areas that experience the greatest thermal and mechanical stress, such as the leading and trailing edges and tips of turbine blades.

Representative Claim 1 reads:

Claim 1
A protective article comprising:
a substrate having a surface and a substrate aluminum content;
a first protective layer overlying a first region of the surface of the substrate, wherein

> the first protective layer has a composition having a first-protective-layer aluminum content at least 3 atomic percent greater than the substrate aluminum content; and
>
> a second protective layer overlying a second region of the surface of the substrate different from the first region, wherein
>
> the second protective layer has a composition having at least about 60 percent by weight of an element selected from the group consisting of platinum, rhodium, palladium, and combinations thereof.

(Claims App., Br. 24; indentation and paragraphing added.)

The Examiner has maintained the following ground of rejection:[2]

A. Claims 1-20 stand rejected under 35 U.S.C. § 103(a) in view of the combined teachings of Zhao 157,[3] Zhao 782,[4] Zhao 088,[5] Ross, [6] and Wustman. [7]

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[2] Examiner's Answer mailed 3 October 2007 ("Ans.").

[3] Ji-Cheng Zhao and Melvin Robert Jackson, *Article for High Temperature Service and Method for Manufacture*, U.S. Patent 6,861,157 B2 (1 March 2005), based on application 10/063,089, filed 18 March 2002.

[4] Ji-Cheng Zhao and Melvin Robert Jackson, *Diffusion Barrier Coatings, and Related Articles and Processes*, U.S. Patent 6,746,782 B2 (8 June 2004), based on application 09/681,821, filed 11 June 2001.

[5] Ji-Cheng Zhao et al., *Materials for Protection of Substrates at High Temperature, Articles Made Therefrom, and Method for Protecting Substrates*, U.S. Patent 6,720,088 B2 (13 April 2004), based on application 09/683,700, filed 5 February 2002. (Ramgopal Darolia, the first-named inventor in this Appeal, is listed as an inventor of the 088 patent.)

[6] Earl W. Ross et al., *Nickel-based Superalloys for Producing Single Crystal Articles having Improved Tolerance to Low Angle Grain Boundaries*, U.S. Patent 5,399,313 (1995).

[7] Roger D. Wustman et al., *Method for Preparing a Gas Turbine Airfoil Protected by Aluminide and Platinum Aluminide Coatings*, U.S. Patent 6,413,584 B1 (2002).

Briefly, the Examiner relies on Ross for teachings of typical compositions, particularly the aluminum content, of superalloys that are said to be used as substrates for turbine blades. The Examiner relies on Zhao 782 and on Zhao 088 for teachings of a first protective layer on superalloys such as those taught by Ross. The Examiner relies on Zhao 157 for teachings of a second protective layer on superalloys. Finally, the Examiner finds that Wustman teaches that two separate coatings—an aluminide and a platinum aluminide—may be used to protect separate regions of a gas turbine component in such a way that the protection is optimized according to the properties of the coatings. (Ans. 9.) The Examiner concludes that it would have been obvious to use the platinum coating taught by Zhao 157 and the aluminide coating taught by Zhao 088 to coat different areas of a superalloy turbine blade to take selective advantage of the different properties of the protective coatings. (*Id.* at 10.)

B. Findings of Fact

Findings of fact ("FF") throughout this Decision are supported by a preponderance of the evidence of record.

The 527 Specification

1. According to the 527 Specification, turbine vanes and blades for jet engines are typically made of nickel-based superalloys. (Spec. 1:[0003].)

2. In one conventional approach, aluminum-rich layers are said to be provided as protective coatings, the surfaces of which oxidize to produce an aluminum oxide scale that inhibits further oxidation. (Spec. 2:[0005].)

3. The claimed invention provides an object with first and second protective coatings. (Spec. 2:[0008].)

4. The first protective surface coating has three percent more aluminum content than the substrate, "and is typically a diffusion aluminide or aluminum containing overlay." (Spec. 2:[0008].)

5. Diffusion aluminides are said to be prepared by depositing a layer of aluminum on the surface of the substrate followed by "interdiffusing" atoms from the aluminum layer with atoms of the substrate, presumably by heating the object. (Spec. 8-9[0028].)

6. The second protective overlayer is said to overlie a second region of the substrate different from the first region. (Spec. 2:[0008].)

7. The second protective overlayer is said to comprise at least about 60 weight percent of Pt, Rh, Pd, or combinations of these metals. (Spec. 2:[0008].)

8. The mechanical strength of the second protective layer is said to be significantly greater than that of the first protective layer. (Spec. 3:[0012].)

9. Accordingly, the second protective layer is used on turbine blade **20** airfoils **22** in areas **42** such as the trailing edge **30**, leading edge **32**, or tip **34**. (Spec. 6:[0023]), as shown in Figures 1 and 2, which are shown below:

FIG. 1

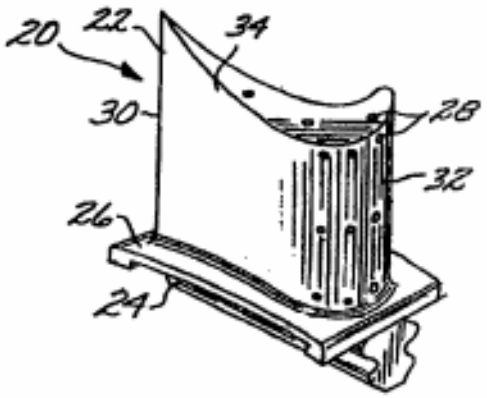
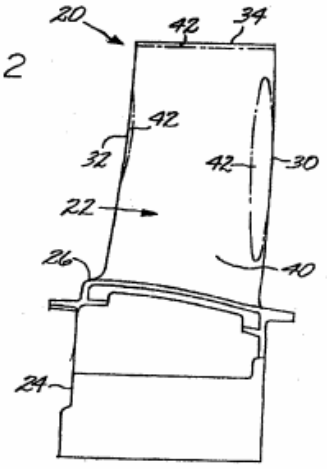


FIG. 2



{527 Specification figures 1 and 2 are said to show two views of a turbine blade airfoil.}[8]

10. Areas covered by the first protective layer are labeled **40** in Figure 2. (Spec. 5:[0023]-6:[0024].)

11. The 527 Specification reports compositions (by weight percent only), of numerous superalloys, wherein the aluminum content ranges from 5 w% to 6.6 w%. (Spec. 6:[0025]-8:[0026].)

[8] The text in curly braces following the Figures is provided to ensure compliance with section 508 of the U.S. Rehabilitation Act for publication of this Decision on the USPTO website pursuant to the Freedom of Information Act. It is not part of the Decision.

Ross (superalloy)

12. Ross describes nickel-based superalloys as having, *inter alia*, an aluminum content of 3 w% to 5 w%. (Ross 4:52-57.)

13. Ross provides more detailed descriptions, in Table I, in which, most preferably, the Al content is 4.1–4.3 w%. (Ross 6:45–67.)

14. Based on the median values of the most-preferred compositions shown in Table I, the median atomic weight percent of aluminum in the most preferred alloys is given by the expression

$$\text{atomic \% Al} = (m_{Al}/Mw_{Al})/\Sigma_i(m_i/Mw_i) \approx 9.2 \text{ a\%},$$

where m_i is the mass of element i, based on 100 g of total material, Mw_i is the molar mass of element i, and Σ_i denotes the sum over all elements i in the alloy.

Zhao 782 (first protective layer)

15. Zhao 782 describes barrier coatings for metal components such as turbine blades. (Zhao 782 3:53–55.)

16. Zhao defines the term "barrier coating" or "barrier layer" as "a layer of material which prevents the substantial migration of aluminum from an overlying coating to an underlying substrate." (Zhao 782 3:55–58.)

17. The barrier coating includes about 15 atom% ("a%") to about 95 a% chromium (Cr) (Zhao 782 4:5); about 5 a% to about 60 a% of rhenium (Re), tungsten (W), ruthenium (Ru), or combinations thereof (*id.* at 4:21–24); often 1 a% to about 35 a% nickel (Ni), cobalt (Co), or iron (Fe); and may include aluminum, especially when high levels of aluminum are present in the substrate or in the overlying coating (*id.* at 4:4–57).

18. According to Zhao 782, "In this context, 'relatively high aluminum levels' refers to amounts greater than about 10 atom % for the substrate, and amounts greater than about 40 atom % for the coating over the barrier coating." (Zhao 782 4:57–61.)

19. Zhao 782 describes various types of protective coatings that can be applied over the barrier layer, such as oxidation-resistant coatings that are aluminide coatings or overlay coatings. (Zhao 782 6:40-46.)

20. According to Zhao 782, one technique to apply such a layer is to electroplate a noble metal such as platinum onto the barrier layer, followed by a diffusion step, deposition of a layer of Ni, Co, Fe, and an aluminiding step. (Zhao 782 6:49-56.)

21. Zhao 782 states that these kinds of coatings are often referred to as "diffusion coatings," and usually have relatively high aluminum content compared to superalloy substrates. (Zhao 782 6:65-67.)

22. Moreover, according to Zhao 782, these coatings often function as the primary protective layer, or the "environmental coating."
(Zhao 782 6:67-7:2.)

Zhao 088 (first protective layer)

23. Zhao 088 describes compositions useful as diffusion barriers that have high oxidation resistance as well as high resistance to solid state diffusion of aluminum and other elements found in superalloys. (Zhao 088 2:44-52.)

24. Embodiments of the diffusion layer are said to be comprised of about 20 a% to about 80 a% Ru, various amounts (2-40 a%) of Al, Cr, Co, and the balance Ni. (Zhao 088 2:53-3:24.)

25. Zhao 088 further describes an article for use in a high-temperature, oxidative environment that comprises a substrate with a diffusion barrier made from the above composition. (Zhao 088 3:25-35.)

26. Zhao describes Specimen A and comparative Specimen B, prepared by depositing an aluminum-rich material having a composition of about 54 a% Ni, about 40 a% Al, and about 6 a% Cr, onto the surface of a diffusion barrier layer on a nickel superalloy, and directly onto the surface of a nickel-based superalloy without an intervening diffusion barrier layer, respectively. (Zhao 088 8:62-9:1.)

27. Specimens A and B were heated to 1100° C for 400 hours and examined for the formation of diffusion zones. (Zhao 088 9:1-10.)

Zhao 157 (second protective layer)

28. Zhao 157 describes articles said to be useful as turbine blades comprising, e.g., a Ni-based superalloy (Zhao 157 1:26-30) and "a protective layer disposed over the substrate, the protective layer comprising at least about 60 atomic percent of a metal selected from the group consisting of platinum (Pt), palladium (Pd), rhodium (Rh), osmium (Os), iridium (Ir), and mixtures thereof." (Zhao 2:42-49; 3:40-51.)

29. In other embodiments, a diffusion layer may be placed between the superalloy and the protective layer ((Zhao 4:15-30), and a thermal barrier layer may be placed on top of the protective layer (Zhao 4:59-5:2.)

Wustman (protecting two different areas with two different coats)

30. Wustman describes a "highly selective approach to the protection of the turbine components, optimizing the performance of the protective system

at various portions of the component. Expensive platinum is conserved, . . . " (Wustman 2:7-10.)

31. In Wustman's words, the method comprises two steps, first:

> masking a portion of the airfoil section, leaving an unmasked portion of the airfoil section, and depositing a noble metal such as platinum onto the airfoil section as a substrate. The result is that the unmasked portion has the noble metal layer thereon and the masked portion has no noble metal layer thereon.

(Wustman 2:18-23.)

32. In the second step, "[t]he mask is removed, and an aluminum-containing layer is deposited onto the airfoil section of the article. Typically the noble metal, the aluminum-containing layer, and the substrate material are interdifffused." (Wustman 2:23-27.)

33. Wustman teaches that areas that are most susceptible to mechanical property degradation low-cycle fatigue are masked, leaving an unmasked portion on which a noble metal such as platinum is deposited. The result is that the unmasked portion has the noble metal layer thereon and the masked portion has no noble metal layer thereon (Wustman 2:17-22.) The area with platinum will coat thicker and have a higher total aluminum content than an area without platinum. (Wustman 2:33-36.)

34. The more thickly coated areas are said to be more prone to mechanical property degradation such a low-cycle fatigue cracking.
(Wustman 2:37-39.)

C. Discussion

Darolia bears the burden, as the Appellant, of proving reversible error in the Examiner's rejection. *See, e.g., In re Kahn*, 441 F.3d 977, 985-86

(Fed. Cir. 2006) ("On appeal to the Board, an applicant can overcome a rejection [under § 103] by showing insufficient evidence of prima facie obviousness or by rebutting the prima facie case with evidence of secondary indicia of nonobviousness.") (quoting *In re Rouffet*, 149 F.3d 1350, 1355 (Fed. Cir. 1998)).

Darolia's Rebuttal

Darolia presents a series of arguments directed at perceived shortcomings of the references (Br. 3-7), followed by arguments based on three principles of establishing a prima facie case of obviousness set out in the MPEP (Br. 7-13.) Finally, Darolia runs through each of claims 2-4, and 7-20 with what amounts to a general denial that the limitations recited in those claims are found in any of the references. We shall address these arguments *seriatim*, more or less following Darolia's Brief.

Darolia argues first that Zhao 157 is not properly applied as evidence of obviousness because it requires that its metal coating have no more than 3 a% of strong oxide-formers such as Al, Cr, and Zr, whereas claims 1 and 12 require that the first protective layer have at least 3 atomic percent more aluminum than the substrate. (Br. 3-4.) Thus, Darolia argues, Zhao 157 teaches away from the claim limitation. (Br. 6.)

These arguments are without merit, as Zhao 157 has not been used as evidence regarding the obviousness of the first protective layer. Rather, Zhao 157 has been used as evidence of the second protective layer. Darolia does not address the teachings of Zhao 157 identified by the Examiner as being relevant to the second protective layer.

Darolia argues further that Zhao 157 teaches a protective layer that covers the entire surface, whereas the claims require two separate coatings on two separate regions. (Br. 4.)

This argument is without merit because it is the combination of the teachings of Zhao 157 with Wustman and the other Zhao references that is the basis of the obviousness rejection. *In re Merck*, 800 F.2d 1091, 1097 (Fed. Cir. 1986) ("Non-obviousness cannot be established by attacking references individually where the rejection is based upon the teachings of a combination of references. *In re Keller*, 642 F.2d 413, 425[, 208 USPQ 871, 881] (CCPA 1981).")

Darolia argues that Zhao 782 teaches away from the appealed subject matter because it does not teach the presence of at least about 60 weight percent of Pt, Rh, Pd, or combinations thereof, as is required by the second protective layer. (Br. 6.)

This argument is without merit because Zhao 782 has not been used as evidence of the obviousness of the second protective layer. Rather, the Examiner has relied on Zhao 782 as evidence of the obviousness of the first protective layer. Darolia does not, however, address the teachings of Zhao 782 that are relevant to the first protective layer.

Darolia argues that Zhao 088 also teaches away from the appealed subject matter because it teaches aluminum contents as low as 2 atomic percent. (Br. 7.)

This argument is without merit because it does not address the teachings of Zhao 088 of much higher aluminum content layers pointed out by the Examiner (Ans. 5), including samples A and B, which includes an

aluminum-rich layer comprising about 40 a% Al overlying a nickel-based superalloy (Zhao 088 8:62-9:1; FF 26).

Finally, Darolia argues that Wustman also teaches away from the present invention because it teaches specific layers to be applied to different regions, and the specific layers taught are not the types of layers recited in the claims on appeal. (Br. 7.)

This argument is without merit because it is based on a misapprehension of the Examiner's position. The Examiner found that Wustman teaches coating different areas of a turbine assembly with different types of coatings to take advantage of the superior properties of the different types of coatings for areas of the turbine subjected to different conditions. The Examiner found further that these teachings would have suggested to the person having ordinary skill in the art that the platinum-rich layers taught by Zhao 157 would be advantageously used in certain regions, while the diffusion aluminide layers taught by Zhao 088 would be advantageously used in other areas. Darolia has not pointed to any error in the Examiner's position.

Darolia treads over the same ground with three further arguments. First, Darolia asserts that there is no objective basis to combine the references because Zhao 157 limits the amount of strong oxide forming elements, such as aluminum, to no more than 3 a%, while Zhao 088 inconsistently teaches aluminum contents up to 40 % percent. (Br. 9.) Wustman, according to Darolia, teaches two layers, neither of which is a layer taught by the Zhao references. (Br. 10.) None of these references, argues Darolia, can be combined rationally. (*Id.*)

As discussed *supra*, these arguments are based on mischaracterizations of the Examiner's arguments, in that they criticize Zhao 157 as not teaching the first protective layer, and Zhao 088 as not teaching the second protective layer. In so doing, they fail to address the Examiner's arguments that Zhao 157 teaches the second protective layer, while Zhao 088 teaches the first protective layer. Similarly, the criticism of the use of the teachings of Wustman are misplaced, as discussed *supra*.

Second, Darolia asserts that the Examiner has not adequately addressed the requirement that there be a reasonable expectation of success for the combination proposed by the Examiner. (Br. 10.) Darolia does not explain, however, what indication is in the record—including the 527 specification—that the person having ordinary skill in the art would have doubted, prior to the filing date of the 527 specification, that different parts of a turbine airfoil, for example, could be coated with different compositions. Nor has Darolia directed our attention to any alleged incompatibility of the first and second coatings that might have led to such a doubt. Accordingly, we find no basis for reversible error in this argument.

Third, Darolia argues that not all of the claim limitations are taught or suggested by the references. (Br. 10-11.) This argument is a rehash of the argument that Wustman fails to teach using the protective layers taught by the Zhao references. We do not find this argument persuasive of reversible error. As explained *supra*, we are confident that the level of skill in the art is sufficient that the ordinary worker would adapt a suggestion that two different coatings may be applied to a turbine airfoil to match different material properties to different environmental conditions to any compositions known to be useful for turbine protective coatings.

Darolia's final set of arguments amount to a recitation of the critical limitations of each claim followed by the assertion that "Applicant finds no such teaching in any of the references in the context of the parent claim nor does Applicant find anything in the explanation of the rejection that points out where a teaching might be found." (Br. 13-22.) Darolia does not, however, address any of the specific findings made by the Examiner, e.g., in the Final Rejection[9] at 2-3 or at 4-5, repeated in the Answer (Ans. 6-7 and 9). Such a general denial, at most, amounts to an invitation to scour the record for evidence to counter the evidence advanced by the Examiner. As that is Darolia's burden, we decline the invitation.

D. Summary

In view of the record and the foregoing considerations, it is:

ORDERED that the rejection of claims 1-20 under 35 U.S.C. § 103(a) in view of the combined teachings of Zhao 157, Zhao 782, Zhao 088, Ross, and Wustman is AFFIRMED; and

FURTHER ORDERED that no time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a).

AFFIRMED

[9] Office action mailed 25 January 2007, "Final Rejection."

MAT

McNees Wallace Nurick LLC
100 Pine Street
P.O. Box 1166
Harrisburg PA 17108-1166