The opinion in support of the decision being entered today
is *not* binding precedent of the Board

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte ANDREW JAY SKOOG,
JANE ANN MURPHY, and THOMAS JOHN TOMLINSON

Appeal 2007-0950
Application 11/099,264
Technology Center 1700

Decided: September 13, 2007

Before EDWARD C. KIMLIN, BRADLEY R. GARRIS, and
CHARLES F. WARREN, *Administrative Patent Judges*.

WARREN, *Administrative Patent Judge*.

DECISION ON APPEAL

Applicants appeal to the Board from the decision of the Primary Examiner finally rejecting claims 1 through 20 in the Office Action mailed April 12, 2006. 35 U.S.C. §§ 6 and 134(a) (2002); 37 C.F.R. § 41.31(a) (2006).

We affirm the decision of the Primary Examiner.

Claims 1 and 14 illustrate Appellants' invention of a method for applying a plasma sprayed coating to a material, and are representative of the claims on appeal:

1. A method for applying a plasma sprayed coating to a material comprising:

providing a substrate, the substrate having a surface;

providing a suspension comprising a carrier liquid and sold particles suspended therein, the solid particles including thermal barrier coating constituents;

injecting the suspension into a plasma jet of a plasma spray device; and

directing the resulting plasma jet toward the substrate surface to deposit a gradient film formed from the constituents onto the substrate surface.

14. A method for applying a plasma sprayed coating to a material comprising:

providing a substrate, the substrate having a surface;

providing a liquid/solid mixture comprising a carrier liquid and sold particles intermixed therewith, the solid particles including thermal barrier coating constituents;

providing particulate thermal barrier coating constituents other than in a liquid/solid mixture;

separately injecting the liquid/solid mixture and the particulate thermal barrier coating constituents into a plasma jet of a plasma spray device; and

directing the resulting plasma jet toward the substrate surface to deposit a gradient film formed from the constituents onto the substrate surface.

The Examiner relies on the evidence in these references:

Peterson	US 3,573,090	Mar. 30, 1971
Strutt	US 6,025,034	Feb. 15, 2000
Gambino	US 2002/0086152 A1	Jul. 4, 2002

Appellants request review of the following grounds of rejection under 35 U.S.C. § 103(a) advanced on appeal (Br. 3):[1]

Claims 1 through 7, 10, and 11 as unpatentable over Strutt in view of Peterson (Answer 3-6); and

Claims 8, 9, and 12 through 20 as unpatentable over Strutt in view of Peterson as applied and further in view of Gambino (*id.* 6-8

Appellants argue the claims in the first ground of rejection as a group, argue the claims in the second ground of rejection as a group, and further argue only claims 12 and 13, claim 17, and claim 20 with specificity (Br. 5 and 8-11). Thus, we decide this appeal based on independent claims 1 and 14 as representative of the respective grounds of rejection and further on claim 12, dependent on claim 1, claim 17, dependent on claim 14, and independent claim 20 to the extent argued. 37 C.F.R. § 41.37(c)(1)(vii) (2006).

With respect to the first ground of rejection, the Examiner finds Strutt teaches, among other things, a suspension of solid thermal barrier coating constituent particles and a carrier liquid which can be injected into a plasma of a plasma spray gun to deposit a coating in the form of a gradient film (Answer 4, citing Strutt, e.g., col. 3, l. 65, to col. 4, l. 5). The Examiner finds "Strutt teaches all the features of these claims except that the suspension is specifically injected into the plasma jet of the plasma spray device" (*id.* 5). The Examiner contends the disclosure at column 7, ll. 48-55, of Strutt is merely exemplary and does not limit the teachings at columns 3-4 (*id.* 13 and 14-15). The Examiner finds Peterson teaches,

[1] The Examiner did not advance the ground of rejection under 35 U.S.C. § 112, second paragraph, and states the rejection is withdrawn (Answer 3).

among other things, an injector "to inject a fluidized material of solid particles suspended in a fluid into the plasma jet" of a plasma spray gun, wherein the "fluid stream can be a carrier gas of the plasma forming gas," and the particles are injected into the plasma jet right before or after exit from the gun (*id.* 5). The Examiner concludes it would have been obvious to one of ordinary skill in the art to modify Strutt to inject the liquid/particle suspension into the plasma of the plasma spray device as suggested by Peterson because Peterson teaches introducing the suspension into the plasma jet of the plasma spray gun (*id.* 6; *see also* 13-14 and 16-17).

With respect to the second ground of rejection, the Examiner finds the combination of Strutt and Peterson does not teach, among other things, "separately injecting particulate thermal barrier coating constituents not in liquid through a separate injector to the plasma jet," and the size of the constituent particles (Answer 6). The Examiner finds Gambino teaches, among other things, a first spray stream of "composite particulate materials not suspended in liquid," which particles can have a particle size of 20 to 200 microns, and a second stream of smaller particles suspended in liquid separately injected from a separate injector system (*id.* 7, citing Gambino, e.g., ¶¶ 0028, 0030, and 0043-0045, and Fig. 5; see also Answer 22-23 and 25-26). The Examiner finds Gambino to be analogous art because the problem of plasma thermal spraying using particles suspended in liquid is reasonably pertinent to the particular problem faced by Appellants and further addressed by Strutt (Answer 21-22). The Examiner concludes it would have been obvious to one of ordinary skill in the art to modify the combined teachings of Strutt and Peterson to provide separate injection of

particles in liquid suspension and not in liquid suspension into the plasma spray jet as suggested by Gambino and to use an appropriate particle (*id.* 8).

With respect to the first ground of rejection, Appellants contend the claim limitation "injecting the suspension into a plasma jet of a plasma spray device" is not taught by Strutt and Peterson (Br. 5). Appellants contend Strutt, at column 7, lines 50-55, as relied on by the Examiner, teaches introducing a suspension as an aerosol into the gas feed of a plasma gun and thus prior to forming the plasma jet exiting the gun (*id.*). Appellants contend Peterson teaches conventional introduction of powder particles fluidized with feed gas into a plasma jet, but not a suspension of particles in a liquid carrier (*id.*, citing Peterson col. 4, ll. 3-5). Appellants contend Peterson does not disclose that the term "fluidize" connotes "particles entrained in a liquid" but rather uses the term in its common meaning of particles suspended in a gas (Reply Br. 2). Appellants contend Strutt as relied on teaches away from the combination with Peterson because of the introduction of the suspension into the gas feed, as contrasted with Strutt's "other embodiments which describe introduction points for materials that are not discussed with respect to the second embodiment" relied on (Br. 5-6). Appellants contend Peterson teaches conventional introduction of particles fluidized in feed gas, and not in a liquid, into the flame of a plasma spray gun, and one of ordinary skill in the art would understand the injection locations are limited to those disclosed (*id.* 6-7). Appellants thus contend impermissible hindsight was used to arrive at the claimed invention by combining these references (*id.* 7).

With respect to the second ground of rejection, Appellants contend Gambino is non-analogous art as it is directed to producing flexible magnets

by thermal spraying, and one of ordinary skill in the art would not look to such reference with respect to such reference to apply thermal barrier coating constituents to obtain a high temperature coating (Br. 8). With respect to claim 12, Appellants specify "further comprising the step of separately injecting particulate thermal barrier coating constituents into the plasma jet of the plasma spray device," and contend "Gambino illustrates that the composite particles are already in the plasma flame when it emerges from the gun" and does not teach this limitation (*id.* 9, citing Gambino Figs. 1 and 5). Appellants contend that the disclosure of Gambino's Fig. 5 relied on to support a second injector does not do so because "[a]s understood," such disclosure shows "only a single injector positioned to inject a suspension of gas fluidized magnetic particles into the plasma flame to supplement the composite particles already exiting the plasma torch 10" (*id.* 9). Appellants further contend, in this respect, that Gambino's "Figure 1 fails to show any injector configured to inject a material into the plasma jet, while Figure 5 shows only a single injector," in arguing that the reference does not show a plasma gun and both a liquid injector and a powder injector as specified for the apparatus encompassed by claim 20 (*id.* 11). With respect to claim 17, Appellants contend one of ordinary skill in the art would not be motivated to combine Gambino's teachings of magnetic particles having a particle size of 20-200 microns with Strutt's teachings of a particle size range of 10 to 50 microns (*id.*).

The issues in this appeal are whether the Examiner has carried the burden of establishing a prima facie case of obviousness in each of the grounds of rejection advanced on appeal.

The plain language of independent claim 1 specifies a method for applying a plasma sprayed coating comprising at least the step, among other things, of injecting a suspension of carrier liquid and any solid particles containing any thermal barrier coating constituents, into any plasma jet of any plasma spray device, capable of forming a gradient film at any point at which the plasma jet is being formed or has been formed. Indeed, we find the Specification discloses the liquid suspension is introduced into the plasma jet "typically at or near the plasma flame" (Specification ¶ 6). Independent claim 14 contains the same language and further specifies separately injecting the liquid suspension and solid thermal barrier coating constituent particles other than in a liquid/solid mixture into the plasma jet. Independent claim 20 specifies a device capable for applying a thermal barrier coating system comprising at least, among other things, a liquid injector and a powder injector for injecting suspension and a powder, respectively, into a plasma jet exiting any plasma gun capable of applying a thermal barrier coating system. Claim 12, dependent on claim 1, requires the same separate liquid and powder injections as claim 14. Claim 17, dependent on claim 14, specifies the barrier coating constituents in the liquid suspension have a particle size of about 10 microns and the particulate thermal barrier coating constituents have a particle size larger than about 74 microns.

We agree with the Examiner's findings of fact from Strutt, Peterson, and Gambino, to which we add the following. We find Strutt would have disclosed to one of ordinary skill in this art a method for reprocessing

as-synthesized nanoparticles powder in an aggregated form suitable for conventional spray deposition of nanostructured coatings, the resulting spray-dried powders having an optimal range of 10-50 microns (Strutt, e.g., col. 3, ll. 48-64, and col. 4, l. 47 to col. 5, l. 51, and col. 7, ll. 20-33). Strutt further discloses "a method for direct nanoparticle injection of as-synthesized powders into the combustion flame or plasma of a conventional thermal spray deposition device, wherein the . . . powders are first dispersed in a liquid medium by means of ultrasound," which "[d]irect injection . . . method allows reproducible deposition of . . . coatings without an intermediate [spray drying] step" (*id.*, e.g., col. 3, l. 65, to col. 4, 1. 6; *see also* col. 3, ll. 48-54, and col. 9, ll. 28-40). In this method, the nanostructured powder feeds having a particle size of 3 to 30 nanometers are directly introduced to a thermal spray after ultrasound dispersion to form a colloidal suspension or slurry (*id.*, col. 7, ll. 34-47).

In the latter method, a suspension or slurry of nanoparticles can be directly introduced into the fuel feed of the plasma gun, which method permits, among other things, two nanoparticle feed systems operating continuously (Strutt, col. 7, l. 34, to col. 8, l. 5). The direct injection of colloidal suspension of nanostructured powders into the combustion zone of a thermal spray gun produced coating similar to those generated using powder agglomerates as feed materials (*id.*, col. 7, l. 34, to col. 8, l. 5). The direct injection method can also be used to incorporate ceramic nanostructured particles into the nanocomposite coating, and a method in which "a slurry mixture of ceramic nanoparticles and hollow microspheres is introduced into a combustion flame or plasma . . . to selectively melt the

nanoparticles while leaving the microspheres unmelted" is exemplified (*id.* col. 8, l. 66, to col. 9, l. 9, and Example 8). Strutt discloses "conventional powders used in thermal spray coating" can include powder agglomerates with particle sizes 5 to 25 microns with minimum size of the constituent particles in the range of 1 to 0.5 microns, and in contrast, nanostructured constituent particles range from 1 to 100 nanometers (*id*. col. 3, ll. 17-27).

Strutt also discloses a method in which nanostructured coatings are formed from nanoparticles prepared in situ using metalorganic aerosol feedstocks generated ultrasonically (Strutt col. 4, ll. 12-16). Strutt illustrates in Fig. 5, aerosol 84 of liquid metalorganic precursor 80 is formed by ultrasonic nozzle 82 and thus sprayed into plasma flame 86 at the exit nozzle of a plasma gun, yielding nanoparticles 90 (*id*. col. 9, ll. 11-27).

We find Peterson would have disclosed to one of ordinary skill in this art that in conventional plasma spray deposit processes, a gas-fluidized particle stream is injected into the plasma effluent (Peterson col. 1, ll. 23-46). Peterson discloses a method of applying a plasma spray coating in which a spray deposit coating can be formed in a conventional system by injecting a gas-fluidized stream of fine particles 22 through conduit 16 into plasma effluent 14 in which conduit 16 can be configured with respect to plasma generator 10 in at least the two ways illustrated in Fig. 1. First, conduit 16 is positioned through anode 11 into the channel leading to exit orifice 19 at a point after plasma formation via arch 15 in chamber 20. And, second, conduit 16 is mounted on the outer surface of anode 11 below exit orifice 19. *See id.*, col. 3, ll. 3-11, and col. 3, l. 65, to col. 4, l. 21.

We find Gambino would have disclosed to one of ordinary skill in this art a thermal spray arrangement illustrated in Fig. 1 in which thermal spray gun 10 includes heating means having a flame torch, wherein the flame torch is positioned adjacent the outlet of spraying means, the latter including a nozzle through which a composite mixture of magnetic particles and a fluidizing gas is pumped (Gambino, e.g., ¶¶ 0006, 0009, 0025 and 0028). Gambino further discloses a thermal spray arrangement illustrated in Fig. 5 in which thermal spray gun 10 includes suspension atomizing system that provides second spray stream 150 by pumping a liquid mixture of fluid and magnetic particles via atomizing probe 140 which combines the liquid mixture with atomizing gas 130, and the outlet of atomizing probe 140 is situated outside of and near the outlet of thermal spray gun 10 (*id.*, e.g., ¶¶ 0006, 0013, 0014, and 0043-0045). The composite particles of magnetic particles and matrix particles can have an average particle size of about 20 to about 200 microns, and the magnetic particles can have a particle size of about 1 to about 10 microns (*id.*, e.g., ¶¶ 0030 and 0032).

Appellants acknowledge conventional processes use "[s]tandard plasma spray technology primarily uses powder feeders to deliver powdered coating material into a plasma jet of a plasma spray gun" (Specification, e.g., 0003 and 0019).

We determine the combined teachings of Strutt and Peterson and further with Gambino, the scope of which we determined above, provide convincing evidence supporting the Examiner's case that the claimed invention encompassed by claims 1, 12, 14, 17, and 20, as we interpreted these claims above, would have been prima facie obviousness of to one of

ordinary skill in the coating arts familiar with applying coating compositions to surfaces using plasma thermal spray devices.

We determine one of ordinary skill in the art would have found in Strutt the teaching that colloidal suspensions or slurries of as-synthesized thermal barrier coating nanoparticles and mixtures thereof with other nanostructured particles can be directly injected either into the flame or into the plasma of a conventional thermal spray gun. Injection at either point, of course, satisfies the claim requirement for injection of the suspension of nanoparticles into the plasma jet of a plasma spray device. Indeed, while Strutt does not specifically illustrate injection into the plasma, the reference teaches direct injection into the combustion zone as well as the in situ formation of nanoparticles by direct injection of an atomized precursor into the plasma flame. Peterson establishes it was conventional to inject a gas fluidized powder into the plasma of a conventional spray gun, internal to or external of the plasma generator, as Appellants acknowledge.

Accordingly, we agree with the Examiner that one of ordinary skill in this art routinely following the combined teachings of Strutt and Peterson would have reasonably arrived at the claimed processes encompassed by claim 1, including all of the limitations thereof arranged as required therein, without recourse to Appellants' Specification. Indeed, Strutt teaches injection of the suspension or slurry of nanoparticles into plasma and this person would have readily followed other disclosures in Strutt and knowledge in the art in doing so. *See, e.g., In re Kahn*, 441 F.3d 977,

985-88, 78 USPQ2d 1329, 1334-37 (Fed. Cir. 2006); *In re Dow Chem. Co.*, 837 F.2d 469, 473, 5 USPQ2d 1529, 1531-32 (Fed. Cir. 1988);[2] *In re Keller*, 642 F.2d 413, 425, 208 USPQ 871, 881 (CCPA 1981);[3] *see also In re O'Farrell*, 853 F.2d 894, 903-04, 7 USPQ2d 1673, 1680-81 (Fed. Cir. 1988) ("For obviousness under § 103, all that is required is a reasonable expectation of success." (citations omitted)).

We cannot agree with Appellants that Strutt's specific disclosure of introducing a suspension or slurry of nanoparticles in the fuel feed for the plasma gun in contrast to other teachings in the reference, teaches away from the combination thereof with Peterson. Indeed, Strutt specifically teaches introduction into plasma even though not specifically exemplified, and one of ordinary skill in the art would have followed knowledge in the art, including Peterson, in practicing that teaching. *See, e.g., In re Lamberti*, 545 F.2d 747, 750, 192 USPQ 278, 280 (CCPA 1976) ("The fact that neither of

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[2] The consistent criterion for determination of obviousness is whether the prior art would have suggested to one of ordinary skill in the art that [the claimed process] should be carried out and would have a reasonable likelihood of success, viewed in light of the prior art. [Citations omitted] Both the suggestion and the expectation of success must be founded in the prior art, not in the applicant's disclosure.

Dow Chem., 837 F.2d at 473, 5 USPQ2d at 1531.

[3] The test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference; nor is it that the claimed invention must be expressly suggested in any one or all of the references. Rather, the test is what the combined teachings of the references would have suggested to those of ordinary skill in the art.

Keller, 642 F.2d at 425, 208 USPQ at 881.

the references expressly discloses asymmetric dialkyl moieties is not controlling; the question under 35 U.S.C. § 103 is not merely what the references expressly teach, but what they would have suggested to one of ordinary skill in the art at the time the claimed invention was made.”).

With respect to the second ground of rejection, Strutt would have suggested injecting two streams of suspensions or slurries of nanoparticles, and teaches the reprocessed powder mixtures can be conventionally spray deposited and the suspension or slurry of as-synthesized powders can be injected into plasma. Gambino establishes that a gas fluidized powder can be injected by spraying means adjacent the flame torch in the thermal spray gun, and thus, into the torch flame, and that a suspension of particles can be injected via an atomizing system situated outside of the thermal spray gun. Thus, Gambino’s thermal spray gun accommodating these two streams provides for the separate injection of liquid/solid particle mixtures and of solid particles as specified in the methods encompassed by claims 12 and 14, and reasonably appears capable of applying a thermal barrier layer as specified for the devices encompassed by claim 20. With respect to claim 17, Strutt teaches that conventionally applied powder mixtures have a much larger particles size than the nanoparticles injected via a suspension or slurry as does Gambino. Indeed, both Strutt and Gambino disclose the same particle size range for nanoparticles as claimed, and Gambino’s particle size range for conventional powder mixture overlaps Strutt’s range and the claimed range.

Accordingly, we agree with the Examiner that one of ordinary skill in this art routinely following the combined teachings of Strutt, Peterson, and

Gambino would have used Gambino's spray gun with atomizing system to separately inject Strutt's conventional thermal barrier powder mixture and suspension or slurry of nanoparticles in the reasonable expectation of forming a thermal barrier coating as taught by Strutt. Thus, this person would have reasonably arrived at the claimed processes encompassed by claims 12, 14, and 17 and the claimed device encompassed by claim 20, including all of the limitations thereof arranged as required therein, without recourse to Appellants' specification. *See, e.g., Kahn*, 441 F.3d at 985-88, 78 USPQ2d at 1334-37; *Dow Chem.*, 837 F.2d at 473, 5 USPQ2d at 1531-32; *Keller*, 642 F.2d at 425, 208 USPQ at 881; *see also O'Farrell*, 853 F.2d at 903-04, 7 USPQ2d at 1680-81.

We are not persuaded otherwise by Appellants' contentions. We determine that one of ordinary skill in this art would have considered Gambino because, as the Examiner points out, the reference is reasonably pertinent to the problem of plasma thermal spraying particles suspended in liquid which is addressed by Strutt, and thus, would have commended itself to this person's attention in applying Strutt's materials, even though it is in a different field of endeavor. Indeed, Appellants do not contend Gambino's device is incapable of applying Strutt's conventional powder mixture and liquid suspension of nanoparticles to a substrate to obtain a thermal barrier coating. *See, e.g.*, *In re Clay*, 966 F.2d 656, 659, 23 USPQ2d 1058, 1060-61 (Fed. Cir. 1992). ("A reference is reasonably pertinent if, even though it may be in a different field from that of the inventor's endeavor, it is one which, because of the matter with which it deals, logically would have commended itself to an inventor's attention in considering his problem."). With respect

to claim 17, each of Strutt and Gambino would have reasonably suggested to one of ordinary skill in this art that the particle size of powders and of nanoparticles in suspension for application via thermal spray gun is a result effective variable which can be adjusted within the range taught. *See, e.g., In re Aller*, 220 F.2d 454, 456, 105 USPQ 233, 235 (CCPA 1955) ("[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.").

Accordingly, based on our consideration of the totality of the record before us, we have weighed the evidence of obviousness found in the combined teachings of Strutt and Peterson and further with Gambino with Appellants' countervailing evidence of and argument for nonobviousness and conclude that the claimed invention encompassed by appealed claims 1 through 20 would have been obvious as a matter of law under 35 U.S.C. § 103(a).

The Primary Examiner's decision is affirmed.

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) (2007).

AFFIRMED

tc/ls

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