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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte LAKSHMAN CHANDRASEKARAN
and ANDREW DAVID FOREMAN

Appeal 2019-006280
Application 11/663,938
Technology Center 1700

Before KAREN M. HASTINGS, GEORGE C. BEST, and
JANE E. INGLESE, *Administrative Patent Judges*.

BEST, *Administrative Patent Judge*.

DECISION ON APPEAL

Pursuant to 35 U.S.C. § 134(a), Appellant¹ appeals from the Examiner's decision to reject claims 1–4, 8–12, 14, 15, 19–23, and 25–32 of Application 11/663,938. Final Act. (May 30, 2018). We have jurisdiction under 35 U.S.C. § 6.

For the reasons set forth below, we *reverse*.

¹ We use the word “Appellant” to refer to “applicant” as defined in 37 C.F.R. § 1.42. Appellant identifies QINETIQ LIMITED as the real party in interest. Appeal Br. 1.

I. BACKGROUND

The '938 Application describes fiber reinforced polymer (FRP) composites. Spec. 1. According to Appellant's Specification, prior art FRP composites comprise a thermoset or thermoplastic polymer matrix phase which has a fibrous phase embedded therein. *Id.* Such FRP composites have relatively poor resistance to impact damage due to the lack of plastic deformation mechanisms for absorbing impact energy. *Id.* Prior to filing of the '938 Application, others proposed incorporating shape memory alloy (SMA) wires in the FRP composite material to improve impact resistance. *Id.*

According to Appellant, SMA-reinforced FRP composite materials have not been produced on a commercial scale as of filing of the '938 Application. *Id.* at 1–2. The '938 Application's Specification describes a composite structure comprising a polymer matrix with reinforcing fibers and SMA wires arranged in a manner that is said to be amenable to integration with existing FRP composite manufacturing processes. *Id.* at 2–3.

Claims 1 and 14 are representative of the '938 Application's claims and are reproduced below from the Claims Appendix of the Appeal Brief.

1. A load bearing composite structure comprising
at least one ply of a polymer matrix with reinforcing fibres and
shape memory alloy (SMA) wires embedded therein,

the SMA wires being of a composition and in a
proportion to substantially enhance the impact resistance
of the structure at a predetermined operating temperature
or range thereof,

wherein said alloy is of a type which exhibits
predominantly a stress-induced martensitic
twinning response at said operating temperature or
range,

the composite structure comprising one or more integral woven preforms,

wherein the one or more integral woven preforms comprise reinforcing tows extending in the warp direction and reinforcing tows extending in the weft direction,

wherein

each of the reinforcing tows extending in the warp direction include[s] at least one SMA wire *at a lateral edge of the tow* and

each of the reinforcing tows extending in the weft direction include[s] at least one SMA wire *at a lateral edge of the tow*.

Appeal Br. 12 (paragraphing, indentation, and emphasis added).

14. A fabric comprising

shape memory alloy (SMA) wires woven together with fibres of a different composition,

the SMA wires being of a composition and in a proportion to substantially enhance the impact resistance of the fabric at a predetermined operating temperature or range thereof

wherein said alloy is of a type which exhibits predominantly a stress-induced martensitic twinning response at said operating temperature or range[,]

the fabric comprising reinforcing tows extending in the warp direction and reinforcing tows extending in the weft direction,

wherein

each of the reinforcing tows extending in the warp direction include[s] at least one SMA wire *at a lateral edge of the tow* and

each of the reinforcing tows extending in the weft direction include[s] at least one SMA wire *at a lateral edge of the tow*.

Id. at 13 (paragraphing, indentation, and emphasis added).

II. REJECTIONS

On appeal, the Examiner maintains the following rejections:

1. Claims 1–4, 9–12, 14, 15, 20–23, 25, 27, and 29–32 are rejected under 35 U.S.C. § 103(a) as unpatentable over the combination of Paine² and Prakash.³ Final Act. 2.
2. Claims 8 and 19 are rejected under 35 U.S.C. § 103(a) as unpatentable over the combination of Paine, Prakash, and Benjamin.⁴ Final Act. 6.
3. Claims 26 and 28 are rejected under 35 U.S.C. § 103(a) as unpatentable over the combination of Paine, Prakash, Homma,⁵ and Cho.⁶

² US 5,614,305, issued March 25, 1997.

³ US 2004/0242096 A1, published December 2, 2004.

⁴ US 6,852,261 B2, issued February 8, 2005.

⁵ US 5,396,932, issued March 14, 1995.

⁶ JP-2003-335876 A, published November 28, 2003. We rely upon the English language abstract entered into the record on May 30, 2018.

III. DISCUSSION

Appellant argues for reversal of the rejections of all pending claims based upon the limitations found in independent claims 1, 14, and 26. Appeal Br. 7–10. Appellant does not present separate arguments for the patentability of any dependent claim. *Id.* Accordingly, we shall limit our discussion to independent claims 1, 14, and 26. 37 C.F.R. § 41.37(c)(1)(iv). Each dependent claim will stand or fall with its parent independent claim.

A. Rejection of claims 1–4, 9–12, 14, 15, 20–23, 25, 27, and 29–32 over the combination of Paine and Prakash

The Examiner rejected independent claims 1 and 14 as unpatentable over the combination of Paine and Prakash. Final Act. 2–5.

Appellant argues that the Examiner has failed to show where each element of independent claims 1 and 14 is found in the prior art. Appeal Br. 7.

In particular, independent claim 1 encompasses FRP composites comprising one or more integral woven preforms. The preforms comprise reinforcing tows extending in the warp direction and reinforcing tows extending in the weft direction. Each reinforcing tow extending in either the warp or weft direction includes at least one SMA wire at a lateral edge of the tow.

Similarly, independent claim 14 encompasses a woven fabric comprising reinforcing tows extending in the warp and weft directions. Each reinforcing tow extending in either the warp or weft direction includes at least one SMA wire at a lateral edge of the tow.

According to Appellant, the Examiner has not met the burden of demonstrating that the prior art describes or suggests reinforcing tows

including an SMA wire located *at a reinforcing tow's lateral edge*. Appeal Br. 8–10. In particular, Appellant argues that

Prakash discloses[,] in Figure 1, a net (20) made of wires (30, 32) oriented in two directions where wires (30, 32) can be single strands or filaments or made of multiple strands or filaments. (See Prakash at para[.] [0030]). Prakash further discloses that the wires can be made of metal. Notably, Prakash does not disclose (i) the use of SMA wires for any purpose; (ii) any two component tow material; and (iii) a tow material with a lateral edge component. In addition, the remaining cited prior art references are silent about these independent claim features as well. The Board should, therefore, reverse the examiner's obviousness rejection of all claims because the cited prior art fails to disclose or suggest all features of each independent claim 1, 14 and 26.

Id. at 10.

We begin by considering the proper interpretation of the claim term “reinforcing tow.”

During prosecution, the PTO gives the language of the proposed claims the broadest reasonable meaning of the words in their ordinary usage as they would be understood by one of ordinary skill in the art, taking into account any definitions or other enlightenment provided by the written description contained in the applicant's specification. *In re Morris*, 127 F.3d 1048, 1054–55 (Fed. Cir. 1997).

In this context, the ordinary meaning of the term “tow” is “a loose[,] essentially untwisted strand of synthetic fibers.” *Tow* | *Definition of Tow by Merriam-Webster*, Merriam-Webster.com (August 26, 2020) <https://www.merriam-webster.com/dictionary/tow>; *see also define: tow—Google Search*, Google.com (August 26, 2020) <https://bit.ly/31fWxwd> (“a bundle of untwisted natural or man-made fibers”). Moreover, it is apparent

that a person of ordinary skill in the art at the time of the invention would have understood that the term “fiber” is broad enough to include SMA wires. *See, e.g.*, Spec. 1. (“[T]o enhance the impact resistance of FRP composite structures[,] it is been proposed to incorporate a proportion of shape memory alloy (SMA) fibres (or wires—which term will be used for preference herein) distributed within the material.”); Prakash ¶ 3 (“Common reinforcing fibers include but are not limited to polyester, rayon, fiberglass, carbon, nylon, silicon carbide, and wire by way of example.”).

Next, we turn to the effect of the adjective “reinforcing” on the breadth of the definition of “tow.” In the context of the ’938 Application, there are two possibilities: (1) “reinforcing” states the purpose of the tow, i.e., it is a functional limitation, or (2) “reinforcing” limits the normal composition of the tow to non-SMA wire reinforcing fibers such as the carbon, glass, high modulus polyethylene, boron, or polyaramid fibers described in the ’938 Application’s Specification. *See* Spec. 1, 4.

The Specification indicates that the term “reinforcing” is used in the latter sense. The Specification repeatedly describes the non-SMA fiber portion of the FRP composite as “reinforcing fiber” or “fibrous reinforcement.” For example, the Specification states that

the invention accordingly resides in a composite structure comprising a polymer matrix with reinforcing fibres and shape memory alloy (SMA) wires embedded therein, the SMA wires being of a composition and in a proportion to substantially enhance the impact resistance of the structure at a predetermined operating temperature or range thereof, and wherein the SMA wires woven together with at least some of the reinforcing fibres in one or more integral preforms.

By incorporating the SMA wires in an integrated woven preform together with the usual fibrous reinforcement in the

structure according to the invention[,] several advantages may accrue.

Spec. 2. *See also id.* (“SMA wires can be incorporated with the fibrous tows”; “SMA is already integrated with the fibrous reinforcement.”); *id.* at 3 (discussing incorporation of SMA wires into weave structure of fibrous reinforcement); *id.* at 4 (“The fibrous reinforcement in the structure according to the invention may be of any of the usual (non-SMA) types employed in FRP composites but is preferably one of the group of advanced fibres . . . including carbon (including graphite), glass, aramid (e.g.[,] Kevlar ®), high modulus polyethylene or boron fibres.”).

The Specification does not contemplate use of SMA wires as the material in the fibrous reinforcing tow. Indeed, the Specification explains that such a structure would be undesirable: “The use of the woven SMA/fibrous preform is also of advantage in terms of handleability. Separate SMA wire meshes are difficult to handle because the wires tend to slip over one another and this distorts the mesh shape.” Spec. 2.

For the reasons set forth above, we conclude that, at the time of the invention, a person having ordinary skill in the art would understand the term “reinforcing tow” to be an essentially untwisted bundle of non-SMA fibers of the type normally used to reinforce FRP composites.

In view of this claim construction, we must reverse the rejection of claims 1 and 14. The Examiner found that the combination of Paine and Prakash suggests the claimed reinforcing tows within SMA wire located at a lateral edge of the tow. Answer 10–11. In particular, the Examiner found that Paine teaches the use of SMA wires and Prakash describes the use of reinforcing material comprised of woven tows of wires. *Id.* Based on these descriptions, the Examiner reasoned that “in each multi-filament tow of only

SMA wires, the one wire at the lateral edge of the tow must be an SMA wire.” *Id.* at 11.

This reasoning is insufficient to describe or suggest the claimed reinforcing tows recited in claims 1 and 14. The Examiner has explained how the prior art describes or suggests an FRP composite comprised of a woven reinforcing material made of tows of SMA wires, which necessarily have an SMA wire at the lateral edges of each of the tows. The Examiner, however, has not explained how or why a person having ordinary skill in the art at the time of the invention would have used an SMA wire at the lateral edge of a tow of non-SMA reinforcing fibers. In other words, the Examiner has not explained how the combination of Paine and Prakash describes or suggests each element of independent claims 1 and 14.

We, therefore, reverse the rejection of claims 1 and 14.

B. Rejection of claims 8 and 19 over the combination of Paine, Prakash, and Benjamin

Claims 8 and 19 depend from independent claims 1 and 14 respectively. Appellant does not present separate arguments for reversal of the rejection of claims 8 and 19. Thus, these claims stand or fall with their parent independent claim.

As discussed above, we have reversed the rejection of independent claims 1 and 14. We, therefore, also reverse the rejection of claims 8 and 19.

C. Rejection of claims 26 and 28 over the combination of Paine, Prakash, Homma, and Cho

Independent claim 26 is directed to an FRP composite having reinforcing tows comprising flat carbon reinforcing fibers with SMA wires located at an edge of the flat carbon reinforcing fiber.

We conclude that the Examiner erred in rejecting claim 26 for the reasons we have already discussed in our reversal of the rejection of claims 1 and 14. Thus, we reverse the rejection of claims 26 and 28.

IV. CONCLUSION

In summary:

| Claims Rejected | 35 U.S.C. § | Reference(s)/Basis | Affirmed | Reversed |
|---|--------------------|----------------------------|-----------------|---|
| 1-4, 9-12, 14, 15, 20-23, 25, 27, 29-32 | 103(a) | Paine, Prakash | | 1-4, 9-12, 14, 15, 20-23, 25, 27, 29-32 |
| 8, 19 | 103(a) | Paine, Prakash, Benjamin | | 8, 19 |
| 26, 28 | 103(a) | Paine, Prakash, Homma, Cho | | 26, 28 |
| Overall Outcome | | | | 1-4, 8-12, 14, 15, 19-23, 25-32 |

REVERSED