UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte RICHARD D. BREAULT

Appeal 2008-5002
Application 10/649,244
Technology Center 1700

Decided: August 29, 2008

Before CHARLES F. WARREN, TERRY J. OWENS, and
MICHAEL P. COLAIANNI, *Administrative Patent Judges*.

COLAIANNI, *Administrative Patent Judge*.

DECISION ON APPEAL

Appellant appeals under 35 U.S.C. § 134 the final rejection of claims 12-21. We have jurisdiction over the appeal pursuant to 35 U.S.C. § 6(b).

We AFFIRM-IN-PART.

INTRODUCTION

Appellant claims a process of cooling fuel cells by evaporative cooling during fuel cell operation comprising, in relevant part, providing a barrier layer between a water channel and a steam channel, causing the liquid water to boil by reducing the pressure in the steam channel and condensing the steam outside the fuel cell and recirculating a portion of the condensed steam back to the flowing liquid water, wherein the steam originated as the flowing liquid water converted into steam and passed the barrier layer into the steam channel (claim 12). Appellant further claims a method of evaporatively cooling a plurality of adjacent fuel cells including, in relevant part, the step of drawing a vacuum in second channels (i.e., the steam channels) to reduce the pressure in the second channels to below the vapor pressure of water in the first channels to cause the liquid water to boil and produce steam that passes through the barrier layer into the second channel (claim 16).

Claims 12 and 16 are illustrative:

> 12. In a stack of fuel cells, wherein adjacent cells are separated by a porous, hydrophobic barrier layer having a water intrusion pressure that prevents liquid water from crossing between cells through the barrier layer under normal operating conditions, the cell on one side of the barrier layer defining a flow channel for liquid water adjacent that one side of the barrier layer, the cell on the other side of the barrier layer defining a flow channel for steam adjacent that other side of the barrier layer, said water and steam flow channels being in vapor communication with each other through the barrier layer, the process of cooling the fuel cells by evaporative cooling during fuel cell operation comprising the steps of:

flowing liquid water into and through the water flow channel and out of the fuel cell, the water being heated within the water channel by heat produced by the fuel cell;

causing the liquid water to boil as it flows through the water channel by reducing the pressure in the steam channel below the vapor pressure of the flowing liquid water to convert at least some of the water to steam that passes through the barrier layer into the steam channel, wherein the pressure in the steam channel is increased or decreased during cell operation in response to the operating temperature of the cell to increase or decrease the operating temperature of the cell to achieve a desired cell operating temperature; and

condensing the steam outside the fuel cell and recirculating a portion of the condensed steam back to the flowing liquid water, wherein the steam originated as the flowing liquid water converted into steam and passed through the barrier layer into the steam channel.

16. A method for evaporatively cooling a plurality of adjacent fuel cells, wherein each cell comprises an electrolyte layer sandwiched between a porous anode water transport plate and a porous cathode water transport plate, the anode plate of one cell extending from the electrolyte layer of the cell to one side of a porous hydrophobic, electrically conductive barrier layer separating the two adjacent cells, and the cathode plate of the adjacent cell extending from the electrolyte layer of said adjacent cell to the other side of said barrier layer, the steps of:

a) flowing liquid water adjacent one side of the barrier layer through first channels formed between one of the cell water transport plates and the barrier layer;

b) drawing a vacuum in second channels formed between the transport plate of the adjacent cell and the other side of the barrier layer to reduce the pressure in the second channels to below the vapor pressure of the water in the first channels to cause the liquid water to boil and produce steam that passes through the barrier layer into the second channels;

c) removing the steam from the second channels; and

d) controlling the amount of evaporative cooling by controlling the steam pressure in the second channels.

The Examiner relies on the following prior art reference as evidence of unpatentability:

Stedman	3,704,172	Nov. 28, 1972

The rejection as presented by the Examiner is as follows:

1. Claims 12-21 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Stedman.

Appellant separately argues claims 12 and 16. Pursuant to 37 C.F.R. § 41.37(c)(1)(vii), we address Appellant's arguments and evidence with respect to the above rejection with regard to claims 12 and 16.

OPINION

With regard to claim 12, Appellant argues that Stedman discloses using a closed-cycle cooling mode and an open-cycle (i.e., evaporative) cooling mode that vents the coolant to the atmosphere such that combining a radiator/condenser with open-cycle cooling mode would render Stedman's device inoperable for its intended purpose (Br. 11, 16). With regard to claim 16, Appellant argues that Stedman is silent with respect to drawing a vacuum so as to cause the coolant water to boil, form steam, and evaporatively cool the fuel cell stack as required by the claim (Br. 14, 15). Appellant provides a copy of the Declaration of Gregory Reynolds (hereinafter the Reynolds Declaration) filed January 8, 2007, which was considered by the Examiner, refuting the Examiner's findings regarding the Stedman reference.

Stedman discloses a dual mode fuel cell system having a closed-cycle cooling mode and an open-cycle cooling mode (Stedman, col. 1, ll. 23-27). The closed-cycle cooling mode uses a circulating coolant to remove heat from the fuel cell stack, while the recovered electrolyte diluent is stored for use during the open-cycle cooling mode (Stedman, col., 1, ll. 56-60). In the open-cycle cooling mode electrolyte diluent carried by a stream of recirculating reactant gas is vented overboard; venting starts whenever diluent must be removed at a rate higher than the rate the closed-cycle electrolyte diluent removal subsystem can handle (Stedman, col. 1, ll. 61-67). During the open-cycle cooling mode, heat is removed by evaporation and venting of the stored liquid electrolyte diluent (Stedman, col. 1, ll. 67-68). Stedman discloses that the dual mode has flexibility from the capability of the system to reject waste heat either by vapor venting or radiator means (Stedman, col. 2, ll. 1-3). Stedman discloses that the dual mode system is advantageous for space shuttle vehicles where the heat removal by a radiator is not possible on reentry or satellites where space for radiator heat removal areas are limited (Stedman, col. 2, ll. 4-6).

Stedman further discloses that the open-cycle mode evaporatively cools the fuel cell by feeding the condensed and accumulated diluent in liquid storage means 62 through an inlet 32, which crosses an evaporative cooling means 30, and exits from the fuel cell via outlet 34 (Stedman, col. 2, ll. 70-72). The closed-cycle mode feeds cooling water to the fuel cell stack through an inlet 26 and the cooling water exits the stack at outlet 28 (Stedman, col. 2, ll. 68-70). Stedman discloses that the closed-cycle coolant loop 42 has a heat exchange means 46 (e.g., a radiator), fan 48 and an accumulator 39, such that the coolant is cooled by the fan to lower the temperature thereof (Stedman, col. 3, ll. 8-19). Stedman further discloses that the diluent is vented in open-cycle mode by sensing the humidity of the diluent stream with sensor 82 and venting via valve 84 as a function of the humidity sensed (Stedman, col. 3, ll. 65-75; col. 4, ll. 1-5). Stedman discloses using a condenser 56 to condense the diluent and store it in liquid storage means 62 for use in the open-cycle mode (Stedman, col. 3, ll. 23-35).

A claimed invention that merely rearranges old elements with each performing the same function it has been known to perform and yields no more than what one would expect from such an arrangement would have been obvious. *KSR Int'l Co. v. Teleflex Inc.*, 127 S. Ct. 1727, 1740 (2007). In determining whether a claimed invention would have been obvious a court may ask whether the combination is nothing more than the predictable use of prior art elements according to their established function. *Id*. The obviousness analysis need not seek out precise teachings directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ. *KSR*, 127 S. Ct. at 1741.

The Examiner finds that though Stedman does not disclose condensing and recirculating the steam that passes through the barrier 30 during open-cycle mode, Stedman does teach condensing and recirculating the steam exiting the coolant channel 28 of the closed-cycle mode to recover the coolant (Ans. 3). Based on this disclosure, the Examiner finds that the teachings of the reference, as a whole, would have suggested condensing and recycling the steam produced during the open-cycle mode to recover the diluent coolant (Ans. 3-4). We agree.

With regard to claim 12, Appellant's primary argument is that condensing and recycling coolant from the exhaust line following the pressure relief means 36 would render Stedman's dual mode fuel system inoperable for its intended purpose. Specifically, Appellant contends that Stedman's open-cycle mode vents the diluent coolant such that adding a radiator or condenser to the exhaust from the evaporative cooling line would radically change the open cycle cooling mode of Stedman to a closed-cycle cooling mode (Br. 16). We do not agree.

Rather, we find Stedman to disclose that it is known to use a radiator and condenser to recover coolant from a cooling loop and that the open-cycle venting is used where the heat removal by a radiator is not possible , such as where space for radiator cooling is limited. In our view such disclosures indicate that it would have been obvious to combine a radiator/condenser with the evaporative cooling open-mode cycle to collect and reuse the coolant where the space or conditions permit. That Stedman vents the coolant does not diminish the fact that Stedman evaporatively cools regardless of the venting; venting is simply a way to dispose of the coolant. In other words, combining a radiator/condenser with the evaporative coolant exhaust line following valve 36 would not eliminate the evaporative cooling. Rather, using a radiator/condenser would simply permit the beneficial recovery of coolant as taught by Stedman.

We add that combining a radiator/condenser with Stedman's open-cycle mode would not completely form a closed-cycle as Appellant's contend. Stedman discloses that in the open-cycle mode electrolyte diluent, carried by a stream of recirculating reactant gas in which electrolyte diluent is formed (i.e., loop 54), is vented overboard (i.e., the diluent is vented via valve 84) (Stedman, col. 1, ll. 61-64; col. 3, ll. 65-75; col. 4, ll. 1-5). Stedman further discloses that venting automatically occurs whenever diluent must be removed at a rate higher than the rate the closed-cycle electrolyte removal subsystem can handle (Stedman col. 1, ll. 64-67). Stedman discloses using evaporative cooling and venting the stored diluent (i.e., the diluent stored in liquid storage means 62) (Stedman, col. 1, ll. 67-68).

These disclosures clearly indicate that the diluent is vented from two locations in the open-cycle mode. First, the diluent is vented via valve 84. Second, the recovered diluent stored in liquid storage means 62 is vented after evaporation. Accordingly, placing a radiator/condenser in the evaporative cooling exhaust line would not completely form a closed system because the diluent may still be vented via valve 84. Accordingly, Appellant's argument that combining a radiator/condenser with the open-cycle mode would render it inoperable for its intended purpose is not persuasive.

Moreover, in light Stedman's disclosures, we conclude that it would have been obvious to combine a radiator/condenser with Stedman's open-cycle mode exhaust line following valve 36 because such is merely the predictable use of a prior art element (i.e., a radiator/condenser) according to its established function (i.e., condensing, cooling, and recovering coolant). *KSR*, 127 S. Ct. at 1740. That Stedman does not explicitly state to add a radiator/condenser to the open-cycle mode exhaust line is not dispositive because Stedman discloses using a condenser/radiator for coolant recovery and we may take into account the inference and creative steps that one of ordinary skill in the art would employ. *KSR*, 127 S. Ct. at 1741.

For the above reasons, we sustain the Examiner's § 103 rejection of claim 12 over Stedman.

With regard to claim 16, we agree with Appellant's argument that Stedman does not disclose drawing a vacuum in the second channels. The Examiner's only finding that Stedman discloses drawing a vacuum is based upon the disclosure of a pressure relief means 36, which the Examiner interprets as creating a vacuum in the steam channel (Ans. 3). However, the Examiner has not provided any evidence to substantiate that a pressure relief valve would create a vacuum (i.e., a sub-atmospheric pressure in the line as exemplified by Appellant on page 9 of the Specification).

Rather, we agree with the statements provided in the Reynolds Declaration that pressure relief valves do not create or draw a vacuum for fluids upstream of the pressure relief valves (Reynolds Declaration ¶ 17). The pressure upstream of the pressure relief valve is higher than the pressure downstream of the pressure relief valve (Reynolds Declaration ¶ 17), and the pressure relief valve opens when the pressure upstream reaches a value greater than a preset pressure. Such evidence, in our view, refutes the Examiner's unsubstantiated finding that Stedman's pressure relief means 36 draws a vacuum.

Accordingly, because the Examiner has not established that all the claim features are taught or suggested by Stedman, we cannot sustain the Examiner's § 103 rejection of claims 16-21 over Stedman. *In re Royka*, 490 F.2d 981, 985 (CCPA 1974). For the same reasons, we cannot sustain the

Examiner's § 103 rejection of claims 13-15 over Stedman, which also recite the vacuum feature.

DECISION

We do not sustain the Examiner's § 103(a) rejection of claims 13-21 over Stedman.

We sustain the Examiner's § 103 rejection of claim 12 over Stedman.

The Examiner's decision is affirmed-in-part.

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).

AFFIRMED-IN-PART

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