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BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte BOON OOI, ALOYSIUS WONG, and TIEN KHEE NG

Appeal 2019-004869
Application 14/868,422
Technology Center 3600

Before JENNIFER D. BAHR, JAMES P. CALVE, and
LEE L. STEPINA, *Administrative Patent Judges*.

CALVE, *Administrative Patent Judge*.

DECISION ON APPEAL

STATEMENT OF THE CASE

Pursuant to 35 U.S.C. § 134(a), Appellant[1] appeals from the decision of the Examiner to reject claims 1, 2, 5, 8, 9, 13–16, 22, 23, 26, 27, 31, 35, 68, 85, and 91. Final Act. 1 (Office Action Summary). We have jurisdiction under 35 U.S.C. § 6(b).

We AFFIRM.

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[1] "Appellant" refers to "applicant" as defined in 37 C.F.R. § 1.42. Appellant identifies King Abdullah University of Science and Technology as the real party in interest. Appeal Br. 2.

CLAIMED SUBJECT MATTER

The claims are directed to "a system for growing plants using light amplification by stimulated emission of radiation (i.e., laser)." Spec. ¶ 2. The pulsing frequency of the laser light may be based on the photoreceptor qualities of the plant varieties in growth chamber 202 to optimize the growth of particular plants, save energy, and reduce heat. *Id.* ¶ 55.

Claims 1, 35, and 68 are independent with claim 1 reproduced below.

> 1. An agriculture system comprising:
>
> a growth chamber having one or more walls defining an interior portion of the growth chamber;
>
> a tray disposed within the interior portion of the growth chamber, the tray configured to support growth media and one or more agriculture products; and
>
> a light source configured to produce pulsed laser light at a pulsing frequency selected based on photoreceptor qualities of the one or more agriculture products and to illuminate at least a part of the interior portion of the growth chamber with pulsed laser light produced by the light source.

REJECTIONS

Claims 1, 27, and 91 are rejected under 35 U.S.C. § 103 as unpatentable over Allen (US 3,673,733, iss. July 4, 1972) and Licamele (US 2013/0102076 A1, pub. Apr. 25, 2013).

Claims 2, 8, 9, 15, 16, 35, and 68 are rejected under 35 U.S.C. § 103 as unpatentable over Allen, Licamele, and Yajima (WO2015040785A1, pub. Mar. 26, 2015).

Claim 5 is rejected under 35 U.S.C. § 103 as unpatentable over Allen, Licamele, and Farkas (US 2016/0327228 A1, pub. Nov. 10, 2016).

Claims 13 and 14 are rejected under 35 U.S.C. § 103 as unpatentable over Allen, Licamele, and Fisher (US 5,998,597, iss. Dec. 7, 1999).

Claim 22 is rejected under 35 U.S.C. § 103 as unpatentable over Allen, Licamele, and Ara (US 2015/0313091 A1, pub. Nov. 5, 2015).

Claim 23 is rejected under 35 U.S.C. § 103 as unpatentable over Allen, Licamele, and Ikeda (US 4,817,332, iss. Apr. 4, 1989).

Claim 26 is rejected under 35 U.S.C. § 103 as unpatentable over Allen, Licamele, and Gebhardt (US 4,331,128, iss. May 25, 1982).

Claim 31 is rejected under 35 U.S.C. § 103 as unpatentable over Allen, Licamele, and Stults (US 3,326,540, iss. June 20, 1967).

Claim 85 is rejected under 35 U.S.C. § 103 as unpatentable over Allen, Licamele, Yajima, and Chui (US 2015/0048260 A1, pub. Feb. 19, 2015).

ANALYSIS

Claims 1, 27, and 91 Rejected over Allen and Licamele

Regarding claim 1, the Examiner cites Allen to teach an agriculture system with growth chamber 3 and walls 4–7 defining an interior, a tray in the interior to support growth media and agricultural products, and a light source (fluorescent lights 31). Final Act. 2. The Examiner cites Licamele for using a laser light to optimize photosynthesis of agricultural products in a growing chamber by pulsing the laser light at a frequency selected based on photoreceptor qualities of the agricultural products as claimed. *Id.* at 2–3.

The Examiner reasons it would have been obvious to a skilled artisan to modify Allen's system to include a pulsed laser light source at a pulsing frequency based on the photoreceptor qualities of one or more agricultural products, as Licamele teaches, to provide an optimal wavelength absorbance of photosynthetic pigment (photoreceptor) and thereby optimally enhance photosynthesis as Licamele teaches to do. *Id.* at 3.

Light Source Pulses at Frequency Based on Photoreceptor Qualities

Appellant argues that Licamele's teaching to activate light source 215 to emit light at a pre-selected *wavelength* determined according to optimal wavelength absorbance of a photosynthetic pigment (photoreceptor) is not emitting light source *pulses* at frequencies based on photoreceptor qualities as claimed. Appeal Br. 6–7; Reply Br. 3. Appellant argues that Licamele pre-selects wavelengths based on the optical wavelength absorbance of a photosynthetic pigment, which "is not the same as the claimed pulsing frequency of a pulsed laser light." Appeal Br. 7–8. Appellant argues that Licamele selects the wavelength of the emitted light based on the optimal *wavelength* absorbance and not the claimed *pulsing frequency*, which is different from the wavelength of the emitted light. *Id.* at 9; *id.* at 10 ("The pulsing frequency is related to how often the laser device is turned on and off while the frequency of the light beam has to do with how often the electric field that describes the light beam oscillates."). Appellant asserts that Licamele's relating of a wavelength of the light to the absorbance of a photosynthetic pigment of a photosynthetic organism differs from pulsing frequency of the light source, and thus Allen and Licamele fail to teach or suggest this feature. *Id.* at 9–11. Appellant contends that the photoreceptor qualities are wavelengths, ratios, and intensities. Reply Br. 3–4.

In response, the Examiner explains that Licamele provides a flashing light such as a laser that may flash at a frequency that is selected based on pigment qualities of an agriculture product(s), and the rate may be adjusted for different pigments to provide optimal light energy and minimal energy. Ans. 4 (citing Licamele ¶¶ 42, 43). The Examiner reasons that Licamele thus configures a light source to produce *pulsed* laser light as claimed. *Id.*

The Examiner has the better position. Like the claimed agriculture system, Licamele promotes the growth of photosynthetic organisms by illuminating the organisms in a photobioreactor. Licamele ¶¶ 2–4; Spec. ¶¶ 2, 26, 55. Like Appellant (*see* Spec. ¶ 42), Licamele provides a laser light continuously *or intermittently* based on the photobioreactor design, types of photosynthetic organisms, and products produced, and uses *laser light* as a flashing (intermittent) light source as claimed. Licamele ¶¶ 41–43, 101–03.

Like Appellant, Licamele provides a *flashin*g light source at different wavelengths and adjusts the wavelengths *and* the rate of *flashing (pulsing)* to "provide optimal light energy with minimal energy usage" to photosynthetic organisms with different pigments that saturate and desaturate at different rates. *Id.* Thus, "certain types of luminescent material [lights] can provide flashing light in the millisecond rate to optimally enhance photosynthesis without wasting energy" and "flashing may be caused by a device *external* to the photobioreactor, such as by a flash lamp or *laser*." *Id.* ¶ 42 (emphasis added). These teachings support the Examiner's findings that Licamele pulses laser light frequencies based on photoreceptor qualities, as claimed, in addition to adjusting the wavelength of a laser light. Appellant does not apprise us of Examiner error in these findings. *See* Appeal Br. 6–11.

In this regard, Licamele uses a programmable control system 900 that regulates the photoperiod of light emitted by light source 215 in a *duty-cycle* that sets the amount of time that light source 215 is activated to emit light as a fraction of the total time period. *Id.* ¶ 102. Light source 215 is activated and adjusted to a duty-cycle that increases photosynthetic efficiency of the photosynthetic organism. *Id.* In addition, a wavelength is set to optimize absorbance of a photosynthetic pigment (photoreceptor). *Id.* ¶ 103. Thus, Licamele pulses laser light at frequencies and wavelengths to grow plants.

The Specification describes a similar process of regulating pulsing frequency to improve photosynthesis efficiency and optimize growth. Spec. ¶¶ 45, 55. A light source is pulsed to match a photoreceptor's "response time," which is the time for light to pass through a plant cell wall into the cytosol and chloroplast where photoreceptors respond to the light. *Id.*

Licamele also pulses laser light at different rates, wavelengths, and intensities to optimize energy absorption by photoreceptors of organisms and increase photosynthesis efficiency. Licamele ¶¶ 39–43, 101–03. The pulsed laser light is tailored to photoreceptor qualities such as rates of saturation, intensity, and wavelength. Licamele ¶¶ 39–43. The saturation rates measure how quickly photoreceptors respond to (absorb) light to start photosynthesis and "reset" by desaturating so more light can be absorbed. *Id.* ¶ 41. Thus, Licamele teaches the advantages of pulsing laser light at rates that stimulate photoreceptor response but avoids oversaturation of photoreceptors, which must be desaturated for a time (reset) before more light can be absorbed for photosynthesis. *Id.* (such overexposure stresses a photosynthetic organism).

Appellant argues that paragraph 45 of the Specification defines the claimed photoreceptors as being related to the photoreceptor response time. Reply Br. 7. We reproduce the pertinent portion of the Specification below.

> The laser light source 412 may further be configured so that the pulses occur at intervals equal to or longer than the time taken for plant photoreceptors to be excited (i.e., the time taken for the light to pass through plant cell wall and membrane and into the cytosol and chloroplast where light detecting molecules called photoreceptors response to the light).

Spec. ¶ 45. Licamele also pulses a laser to "excite" a photoreceptor to saturation, i.e., a time equal to or longer than the time taken to excite the photoreceptors to produce photosynthesis. Licamele ¶¶ 41–43.

Licamele recognizes that photosynthetic organisms contain different pigments that absorb light for photosynthesis at different rates so pulsing lasers can provide optimal light energy with minimal energy usage. *Id.* ¶ 43. Tuning pulsing frequencies to the rate at which a photoreceptor(s) responds to the light, e.g., by absorbing it to generate a photosynthetic effect, thereby increases the photosynthetic efficiency of the organism. *Id.* ¶¶ 102, 103.

Claim 1 recites a pulsing frequency "based on photoreceptor qualities of one or more agricultural products." Appeal Br. 16 (Claims App.). We agree with the Examiner that Licamele teaches photoreceptors that *respond* to pulsing light by absorbing it at different absorption rates of photoreceptor pigments. The absorption rates are photoreceptor *qualities* (response times) for which a light pulsing frequency is adjusted in Licamele even if we treat Appellant's Specification as providing a definition of photoreceptor qualities to be a response time. Reply Br. 6–7. Indeed, Licamele teaches absorption rates as intervals that are longer than the time taken for a photoreceptor to be excited leading to saturation or oversaturation. Licamele ¶¶ 41–43, 101–03. These teachings satisfy the Specification's description of intervals equal to or *longer than* the time taken for plant photoreceptors to be excited.

Claim 1 does not recite features of the response time or photoreceptor *qualities*. Nor has Appellant explained why Licamele's absorption of pulsed light to generate photosynthesis differs from *exciting* a photoreceptor in the chloroplast of a plant, which creates photosynthetic effect and boosts energy efficiency of the system. Spec. ¶ 45. Licamele boosts energy efficiency by using pulsed light frequencies to boost energy absorption and photosynthesis without oversaturating photoreceptors. Licamele ¶ 41. Even if "qualities" include wavelengths, ratios, and intensities (Reply Br. 3), Licamele adjusts wavelengths, intensities, and ratios as well. *See* Licamele ¶¶ 39–43, 101–03.

Accordingly, we sustain the rejection of claim 1 and claim 27, which is not argued separately from claim 1. *See* 37 C.F.R. § 41.37(c)(1)(iv).

Claim 91

Claim 91 depends from claim 1 and recites "wherein the light source configured to select a pulsing frequency of the pulsed laser light such that pulses occur at intervals equal to or longer than a time taken for plant photoreceptors to be excited." Appeal Br. 21. The Examiner cites Licamele for this feature as for the rejection of claim 1 above. *See* Final Act. 5–6.

Appellant argues that Licamele's teachings about laser frequencies are not pulses that occur at intervals equal to or longer than a time taken for plant receptors to be excited as claimed. Appeal Br. 13–14. This argument is not persuasive for the reasons discussed above, namely, Licamele teaches pulsed laser light at intervals equal to or longer than a time taken for plant photoreceptors to be excited. Licamele ¶¶ 41–43, 101, 102. A skilled artisan would understand these teachings to mean that the pulsing of the flashing laser light is set to intervals at least long enough for the plant's photoreceptors to absorb the light energy and become excited to produce photosynthesis. The Specification describes this *excited response time* as

> Plant receptors require time to convert light energy into the energy used for photosynthesis. As a result, using pulses of visible laser light instead of a continuous wave, the agriculture system can save energy by avoiding the illumination of plant photoreceptors during periods where the plants would not utilize the illuminating light. Moreover, utilizing pulsed laser light can reduce the amount of heat generated by the laser light source.

Spec. ¶ 55. Licamele describes this same process in the discussion of tuning laser pulses to avoid oversaturation, which does not enhance photosynthesis and also stresses the organism. Licamele ¶¶ 41–43.

Appellant also argues that "excited" is defined in paragraph 45 of the Specification to mean "has to do with the time necessary for the light to get to the photoreceptor." Reply Br. 7. This argument is not persuasive because paragraph 45 describes the intervals of the laser light pulses passing through plant cell walls and membranes into the cytosol and chloroplast "where light detecting molecules called photoreceptors *response* [*sic*] *to the light*." Spec. ¶ 45 (emphasis added). Thus, laser pulse intervals are configured to cause photoreceptors to *respond to the laser light* and thereby to become *excited*. Paragraph 45 describes photoreceptor excitement as photoreceptor response to the light, which the Specification further describes as the time needed to convert light energy into the energy used for photosynthesis. *See id.* ¶ 55.

Licamele pulses lasers at frequencies equal to or longer than the time it takes photoreceptors to absorb light energy and start photosynthesis. The pulse rates cause photoreceptors to respond by absorbing light energy, and producing photosynthesis more efficiently. Licamele ¶¶ 41–43, 101, 102.

Thus, we sustain the rejection of claim 91.

Claims 2, 8, 9, 15, 16, 35, and 68
Rejected over Allen, Licamele, and Yajima

Independent claims 35 and 68 recite agriculture systems and methods with similar features as claim 1 above, and also including an aperture(s) in a chamber wall through which light from an artificial light source disposed outside the chamber is guided into the chamber interior. Appeal Br. 19–20 (Claims App.). The Examiner again relies on Allen and Licamele to teach a growth chamber with a pulsed light source disposed external to the chamber and Yajima to teach an aperture in the growth chamber wall through which the outside light is guided and provided to the interior of a growth chamber, as claimed, relying similar findings as for claim 1 above. Final Act. 7–9.

Appellant argues that Yajima appears to teach light from source 22a enclosed in housing 11 and exiting from housing 11 to illumination region 33, which is not described as being a growth chamber. Appeal Br. 12–13.

The Examiner has the better position. The combined teachings of Allen and Licamele render obvious a growth chamber with a pulsed laser light external to the growth chamber as the Examiner correctly finds. Final Act. 7–9; Licamele ¶ 42 (flashing light/laser *external* to photobioreactor); Allen, 4:7–45, Fig. 3. Allen and Licamele avoid providing unwanted heat to photosynthetic organisms in the chamber. Licamele ¶ 44; Allen 4:7–45.

Yajima transmits light from an external light source to the inside of a growth area/chamber (outer box 11) through an aperture 11a, 11b in box 11. Yajima[2], 4, Fig. 2; Ans. 5. Licamele uses fiber optics to convey flashing light from a device external to the growth chamber. Licamele ¶ 42. Yajima teaches a known technique to pass a fiber/light into a growth chamber/area.

Appellant's Specification describes a similar configuration using an optical fiber to transmit light from an external laser inside a growth chamber. Spec. ¶ 49. The Examiner's proposal to use Yajima's aperture technique for conveying light from an external light source into a growth chamber/area to stimulate photosynthesis provides a rational underpinning for the proposed combination. *See KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007).

Thus, we sustain the rejection of claims 35 and 68. We also sustain the rejection of dependent claims 2, 8, 9, 15, 16, which are not argued separately. *See* 37 C.F.R. § 41.37(c)(1)(iv).

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[2] Refers to English language translation, dated Dec. 27, 2017, from https://patents.google.com/patent/WO2015040785A1/en

Rejections of Claims 5, 13, 14, 22, 23, 26, 31, and 85

Appellant argues generally that "[a]s the reference teachings fail to suggest all the limitations of the rejected claims, reversal of all outstanding rejections is respectfully requested." Appeal Br. 15. To the extent that this argument is intended to assert the patentability of these claims based on their dependency from an independent claim[3] for the reasons asserted above as to those independent claims, this argument is not persuasive for the reasons discussed above for those claims. Because this argument does not assert any additional allegations of error by the Examiner based on the specific findings made by the Examiner as to the limitations recited in these dependent claims (*see* 37 C.F.R. § 41.37(c)(1)(iv) (each ground of rejection contested by an appellant must be argued under a separate heading identifying the ground of rejection, claim number, statutory basis, and applied reference(s) explaining why the examiner erred as to each ground of rejection so contested)), we therefore sustain the rejections of these dependent claims as well.

CONCLUSION

Claims Rejected	**35 U.S.C. §**	**Reference/Basis**	**Affirmed**	**Reversed**
1, 27, 91	103	Allen, Licamele	1, 27, 91	
2, 8, 9, 15, 16, 35, 68	103	Allen, Licamele, Yajima	2, 8, 9, 15, 16, 35, 68	
5	103	Allen, Licamele, Farkas	5	
13, 14	103	Allen, Licamele, Fisher	13, 14	

[3] Claims 5, 13, 14, 22, 23, 26, and 31 depend directly from independent claim 1. Appeal Br. 17–19 (Claims App.). Claim 85 depends directly from independent claim 68. *Id.* at 21.

Claims Rejected	35 U.S.C. §	Reference/Basis	Affirmed	Reversed
22	103	Allen, Licamele, Ara	22	
23	103	Allen, Licamele, Ikeda	23	
26	103	Allen, Licamele, Gebhardt	26	
31	103	Allen, Licamele, Stults	31	
85	103	Allen, Licamele, Yajima, Chui	85	
Overall Outcome			1, 2, 5, 8, 9, 13–16, 22, 23, 26, 27, 31, 35, 68, 85, 91	

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