Filed on behalf of Petitioner
By: Patrick C. Keane, Esq. (patrick.keane@bipc.com)
Matthew L. Fedowitz, Esq. (matthew.fedowitz@bipc.com)
Ralph G. Fischer, Esq. (ralph.fischer@bipc.com)
BUCHANAN INGERSOLL & ROONEY PC
1737 King Street, Suite 500
Alexandria, Virginia 22314
Main Telephone (703) 836-6620
Main Facsimile (703) 836-2021

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HAMILTON TECHNOLOGIES LLC
Petitioner

v.

FLEUR TEHRANI
Patent Owner

Case No. IPR2020-01199
Patent 7,802,571

PETITION FOR INTER PARTES REVIEW OF U.S. PATENT NO. 7,802,571 UNDER 35 U.S.C. §§ 311-319 and 37 C.F.R. § 42.100 *et seq*.

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I. INTRODUCTION

Hamilton Technologies LLC ("Hamilton" or "Petitioner") requests *inter partes* review for claims 1-6, 9-12, 29-33, and 41 of U.S. Patent No. 7,802,571 ("the '571 Patent") (Ex.1001) pursuant 35 U.S.C. §§311-319 and 37 C.F.R. §42.100 *et seq*.

II. MANDATORY NOTICES PURSUANT TO 37 C.F.R. §42.8(A)(1)

A. Real Party-In-Interest

Petitioner certifies Hamilton Technologies LLC and its affiliated subsidiaries including Hamilton Holding Medical Corporation, Hamilton Company, Hamilton Medical AG, Hamilton Medical Inc., and Hamilton Bonaduz AG, are the real parties-in-interest pursuant 37 C.F.R. § 42.8(b)(1).

B. Identification of Related Matters Under 37 C.F.R. §42.8(b)(2)

The '571 Patent claims priority to U.S. Provisional Application No. 60/481,693 filed 11/21/2003. PCT Application No. PCT/US04/35393, published as WO 2005/051280, is a continuation of U.S. Patent Application No. 10/935,446.

The '571 Patent serves as a priority filing to GB 2423721B, which is the subject of an ongoing UK civil action: *Fleur Tehrani v (1) Hamilton Bonaduz AG, (2) Hamilton Medical AG, (3) Hamilton Medical UK Limited*, High Court of Justice, Business and Property Courts of England and Wales, Intellectual Property List (ChD), Intellectual Property Enterprise Court, Claim IP-2019-000196, Issue date 29 November 2019.

C. Lead and Backup Counsel

Pursuant to 37 C.F.R. §§42.8(b)(3) and 42.10(a), Petitioner identifies its lead and backup counsel as follows:

Lead Counsel for Patent Owner: Patrick C. Keane, Esq. Registration No. 32,858 BUCHANAN INGERSOLL & ROONEY PC 1737 King Street, Suite 500 Alexandria, Virginia 22314 Telephone (703) 838-6522 Facsimile (703) 836-2021 patrick.keane@bipc.com	**Backup Counsel for Patent Owner:** Ralph G. Fischer, Esq. Registration No. 55,179 BUCHANAN INGERSOLL & ROONEY PC Union Trust Building 501 Grant Street, Suite 200 Pittsburgh, Pennsylvania 15219 Telephone (412) 392-2121 Facsimile (412) 562-1041 ralph.fischer@bipc.com
Backup Counsel for Patent Owner: Matthew L. Fedowitz, Esq. Registration No. 61,386 BUCHANAN INGERSOLL & ROONEY PC 1700 K Street, NW, Suite 300 Washington, DC 20006 Telephone (202) 452-7306 Facsimile (202) 452-7989 matthew.fedowitz@bipc.com	

A Power of Attorney is filed herewith pursuant 37 C.F.R. §42.10(b).

D. Service Information Under 37 C.F.R. §42.8(b)(4)

Petitioner consents to e-mail service at the addresses listed above.

III. PAYMENT OF FEES

The undersigned authorizes the Office to charge Deposit Account No. 02-4800 for fees pursuant 37 C.F.R. §42.15(a).

IV. REQUIREMENTS UNDER 37 C.F.R. §42.104

A. Grounds for Standing

Pursuant 37 C.F.R. §42.104(a), Petitioner certifies that the '571 Patent is available for *inter partes* review pursuant 37 C.F.R. §42.102(a)(2), and Petitioner is not barred or estopped from requesting *inter partes* review challenging claims of the '571 Patent on Grounds of this Petition.

Neither Petitioner nor its privies have received a final written decision under 35 U.S.C. §318(a) with respect to any claim of the '571 Patent on any Ground that was raised or could have been raised by Petitioners or its privies in any *inter partes* review, post grant review, or covered business method patent review.

B. Identification of Challenges and Precise Relief Requested

Pursuant 37 C.F.R. §42.104(b), Petitioner challenges claims 1-6, 9-12, 29-33, and 41 of the '571 Patent, and requests that these claims be found unpatentable. Petitioner's Grounds for challenging patentability of claims 1-6, 9-12, 29-33, and 41 are:

Ground	References	Basis	Claims Challenged
1	Carmichael(Ex.1004), as evidenced by: ARDSNET (Ex.1007); and Waisel et al. (Waisel'95, Ex.1011)	102/103	1-2, 5-6, 11, 29, 31-33, 41
2	Carmichael in view of: Anderson (Ex.1013); U.S. Patent No. 4,986,268 (Tehrani, Ex.1006); and Rossi (Ex.1015)	103	1-6, 9-12 29-33, 41
3	Taube (Ex.1005) in view of: Carmichael (Ex.1004)/ARDSNET (Ex.1007); U.S. Pat. No. 6,148,814 (Clemmer, Ex.1008); and Rossi (Ex.1015)	103	1-6, 9-12 29-33, 41

Petitioners rely upon evidence in the Exhibit List, including the Declaration/*Curriculum Vitae* of Dr. Richard Imbruce (Exs. 1002, 1003, *see, e.g.,* Ex.1002, ¶¶19-491 and Appendices 1-3).

C. Prior Art Qualification of Asserted References

All prior art cited herein consists of U.S. patents and publications of established publishers, made publicly available before the critical date of November 21, 2002 pursuant pre-AIA 35 U.S.C. §102(b). *Hulu, LLC v. Sound View Innovations, LLC,* IPR2018-01039, Paper 29, pp.19-20 (PTAB Dec. 20, 2019) (precedential). Petitioner submits a confirmatory Declaration/*Curriculum Vitae* of Dr. Sylvia D. Hall-Ellis (Ex.1017), an expert in the field of library cataloging and classification.

Diagnosis and Therapy of Acute Respiratory Distress Syndrome in Adults: An International Survey, Journal of Critical Care, Vol. 11, No. 1 (March 1996), pp. 9-18 by Laurence Carmichael et al., published 3/31/96 ("Carmichael", Ex.1004), is prior art under 35 U.S.C. §102(b). *See* Ex.1017, ¶¶51-59,120.

Ventilation with Lower Tidal Volumes as Compared with Traditional Tidal Volumes for Acute Lung Injury and the Acute Respiratory Distress Syndrome, Journal of Medicine, Vol. 342, No. 18, May 4, 2000, pp.1301-1308 By The Acute Respiratory Distress Syndrome Network, published 5/4/2000 ("ARDSNET", Ex.1007), is prior art under 35 U.S.C. §102(b). *See* Ex.1017, ¶¶60-68,120.

PEFIOS: An Expert Closed Loop Oxygenation Algorithm by Waisel et al. published in the MEDINFO 1995 proceedings, published 1995 ("Waisel'95", Ex.1011), is prior art under 35 U.S.C. §102(b). *See* Ex.1017, ¶¶77-84,120.

A closed-loop controller for mechanical ventilation of patients with ARDS, Jeffrey R. Anderson et al., Biomed Sci Instrum. 2002; 38:289-94, published via PubMed database by November 6, 2002 ("Anderson", Ex.1013), is prior art under 35 U.S.C. §102(b). *See* Ex.1017, ¶¶94-101,120.

U.S. Pat. No. 4,986,268 to Tehrani, published 1/22/1991 ("Tehrani'268", Ex.1006) is prior art under 35 U.S.C. §102(b).

U.S. Pat. No. 5,388,575 to Taube, published 2/14/1995 ("Taube", Ex.1005) is prior art under 35 U.S.C. §102(b).

U.S. Pat. No. 6,148,814 to Clemmer, published 11/21/2000 ("Clemmer", Ex.1008) is prior art under 35 U.S.C. §102(b).

Intrinsic positive end-expiratory pressure ($PEEP_i$), Rossi, A. et al., Intensive Care Medicine, vol.21, pp.522-536, 1995, published 6/1995 and cited in the '571 Patent ("Rossi", Ex.1015), is prior art under 35 U.S.C. §102(b). *See* Ex.1017, ¶¶102-110,120.

V. BACKGROUND

A. The '571 Patent and Technical Background

1. The '571 Patent

The '571 Patent describes controlling a mechanical ventilator via alleged "novel features" which "reliably and robustly control PEEP (or CPAP), and F_{IO2}." Ex.1001, 2:25-30. "PEEP" is a known ventilator control parameter for Positive End Expiratory Pressure. "F_{IO2}" (aka FIO2 or FIO_2) is a known ventilator control parameter for the Fraction of Inspired Oxygen (O_2) in a patient's inspiratory gas (i.e., patient breathing-in). The '571 Patent claims are allowed as: first adjusting the FIO_2; and then adjusting PEEP to keep "a ratio of PEEP/F_{IO2} within a prescribed range". Ex.1001, Claim 1. This feature was publicly known more than one year before the earliest filing date of the '571 Patent. Ex.1002, ¶¶26-27, 37, 61-70.

The '571 Patent discloses that after determining FIO_2, the PEEP is adjusted and the "ratio of PEEP/F_{IO2} is calculated" in Fig. 3g, step 282 (*see* Ex.1001, 7:34-

36; 10:43-47). The '691 Patent ventilator is controlled using "two control programs" (Ex.1001, 2:53-54):

> One control program … is designed to automatically adjust F_{IO2} and PEEP (or CPAP), based on at least the measured oxygen levels of the patient. …
>
> …The other control program, most of which is described in U.S. Patent No. 4,986,268, is designed to control the frequency and ventilation for a next breath of the patient on the ventilator….

Id., at col.2:54-66 (underlining added).

Figure 1 of Owner's earlier USPN 4,986,268 ("Tehrani'268") (Ex.1006) illustrates the structure of a conventional automated ventilator ("respirator 60") with a processor 12 and related control components:

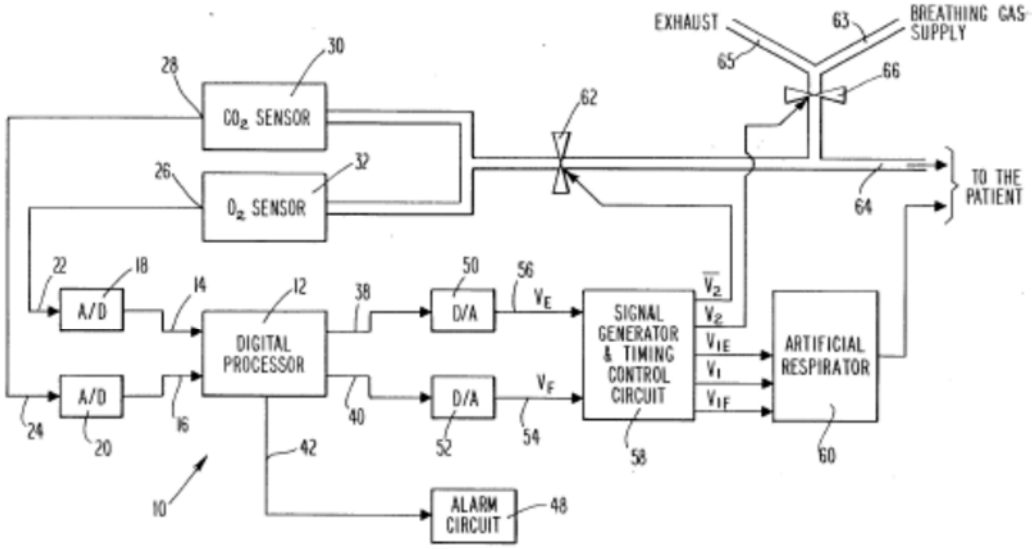
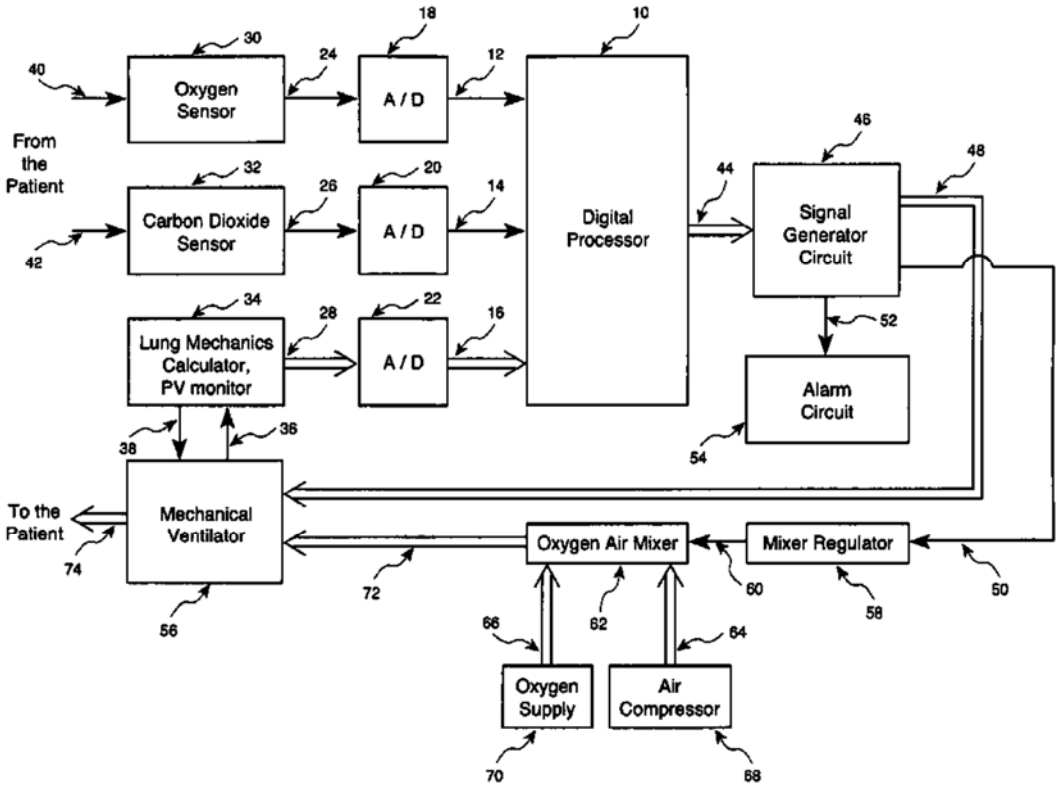


Fig. 1

The conventional structure of Tehrani'268 largely aligns with Figure 1 of the '571 Patent as modified to calculate PEEP/FIO_2:



The alleged "novel feature" of selecting F_{IO2} to keep a measured oxygen level above a defined value, and then incrementally adjusting PEEP to keep a "PEEP/ F_{IO2} ratio" within a predefined range was already known by 1996, well before the '691 Patent. Ventilator treatment protocols for Acute Respiratory Distress Syndrome ("ARDS") reported by Carmichael in 1996 adjust PEEP "in incremental fashion as FiO_2 requirements" of a patient increase. Ex.1004, Abstract. Carmichael's Figure 7 specifically illustrates adjusting PEEP (y-axis) over a prescribed range having

maximum PEEP values prescribed for each selected FIO_2 (x-axis) which thereby keep the PEEP/FIO_2 ratio within a prescribed range:

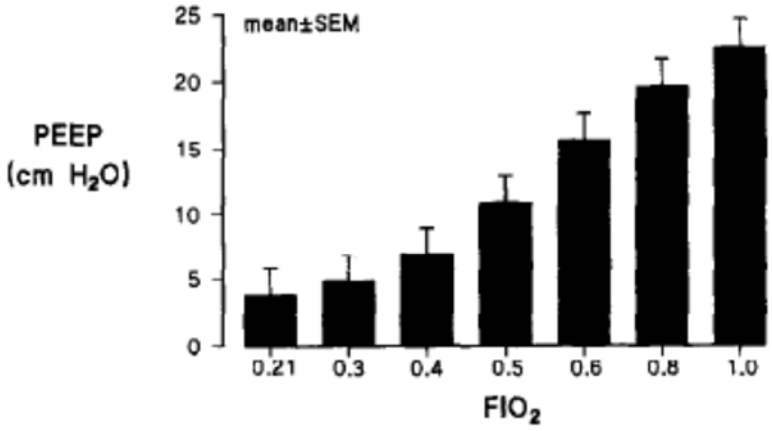


Fig 7. The maximum PEEP used at various FIO_2s.

As a patient's FiO_2 warrants a higher concentration of oxygen to achieve a desired value of oxygen, PEEP is incrementally increased. A prescribed "maximum PEEP" is set for a given FIO2 "before increasing to the next higher FIO2." Ex.1004, p.12, col.2:4-9.

Thus, Carmichael reports a treatment protocol whereby PEEP is determined to keep a ratio of PEEP/F_{IO2} within a prescribed range, and this treatment protocol is simply reprinted in the '571 Patent.

2. Prosecution File History Summary ("FH") (Ex.1009)

a. Feb. 6, 2009 Office Action And March 16, 2009 Request for Reconsideration

The USPTO rejects initial claims of the '571 Patent over Taube (Ex.1005), and U.S. Patents 5,705,735 ("Acorn", Ex.1018) and 5,365,922 ("Raemer", Ex.1019). Ex.1009, pp.248-253.

Owner asserts Taube fails to disclose the claimed determination of FIO2 "to reduce the difference between the measured oxygen level of the patient and a desired value'..." (Ex.1009, pp.233-234), and fails to disclose that:

> According to the invention, the control apparatus maintains PEEP/F_{IO2} within a clinically acceptable range to improve patient oxygenation.

Ex.1009, p.235 (underlining added).

b. Sept. 28, 2009 Appeal Brief

A subsequent Appeal Brief highlights claims 1 and 29 as distinguishing because:

> F_{IO2} is determined to reduce the difference between the measured oxygen level of the patient and a desired value, wherein PEEP is determined to keep a ratio of PEEP/F_{IO2} within a prescribed range and, while keeping the ratio within the prescribed range, to keep the measured oxygen level of the patient above a predefined value.

Ex.1009, pp.136-137.

Owner improperly attacks the Examiner's reliance upon Taube, and asserts:

> [T]he only objective stated in col. 4 of *Taube* regarding F_{IO2} is "to produce the highest obtainable patient arterial blood oxygen level…. There simply is no mechanism in place in *Taube's* algorithm for F_{IO2} to be determined toward reducing the difference between the measured oxygen level of the patient and a selectable desired value.

Ex.1009, pp.149-150, quoting Taube col.4:47-50.

c. January 22, 2010 Office Action And Appeal Brief Filed Feb. 12, 2010

A new rejection asserting anticipation by U.S. Pub. 2005/0051168 ("DeVries", Ex.1020) is similarly refuted by Owner (Ex.1009, pp.108-116):

> In *DeVries*, PEEP and F_{IO2} are set manually in a conventional manner. Unlike applicant's invention, in *DeVries* the values for F_{IO2} and PEEP remain fixed during therapy.

Ex.1009, pp.69-70 (underlining added); *see also Id.* at pp.73-83.

d. Allowance

A subsequent Office Action citing U.S. Pub. No. 2004/0003813 ("Banner", Ex.1021) is withdrawn, the Examiner noting (Ex.1009, pp.38-47):

> Banner does not teach … while keeping the ratio [PEEP/FIO2] within the prescribed range, to keep the measured oxygen level of the patient above a predefined value.

Ex.1009, p.23 (underlining added).

B. Overview of the Prior Art

1. Carmichael (Ex.1004)

Carmichael, mentioned *supra,* discloses physician-conducted survey results from 1994-1995 for setting prescribed minimum and maximum values of "best PEEP" for FiO_2 ventilator treatment protocols that keep the PEEP/FiO_2 ratio within a prescribed range for ARDS therapy. Ex.1004, pp.9, 14. The surveys are conducted pursuant "National Institutes of Health Grant Nos. HL 43167 and HL 07123 and the American Thoracic Society." *Id.*

Carmichael's "best PEEP" keeps the PEEP/FiO_2 ratio within a prescribed range while desired oxygen is "achieved through the use of increased FiO_2 and incremental application of PEEP." Ex.1004, pp.13-14. Measured oxygen is compared against a desired oxygen value in a closed-loop with reference to arterial partial pressure of oxygen "PaO_2 >60 mmHg" and "oxygen saturations of 86% to 90%." Ex.1004, p.13, col.2:48-52; p.14, col.1:30-34. PaO2 is derivable from pulse oximeter oxygen saturation readings. *See e.g.*, Ex.1001, 4:52-64. Ex.1002, ¶¶20-25.

Carmichael discloses FIO2 is set, and then PEEP is incrementally adjusted from a minimum up to a maximum (*i.e.*, "a specific PEEP they would not exceed"), thereby maintaining PEEP/FIO2 within a prescribed range. For example, at FIO2=0.6:

…the mean maximum PEEP applied was **…** 16 +/- 6 cm H_2O at 0.6.

Ex.1004, p.12 (underlining added).

Thus, PEEP is expressly adjusted to keep the PEEP/FIO2 ratio within a prescribed range. Ex.1002, ¶¶26-27,57-59.

2. ARDSNET (Ex.1007)

ARDSNET cites to Carmichael in footnote 36, and corroborates Carmichael's treatment protocols for ARDS as "Allowable" (*i.e.*, prescribed) ranges of PEEP/FIO2. ARDSNET "Table 1" clearly corroborates Carmichael's selecting FIO2, and then adjusting PEEP to keep a PEEP/FIO2 ratio within an "Allowable" range. Ex.1007, p.1303;Ex.1002, ¶¶40-42,60.

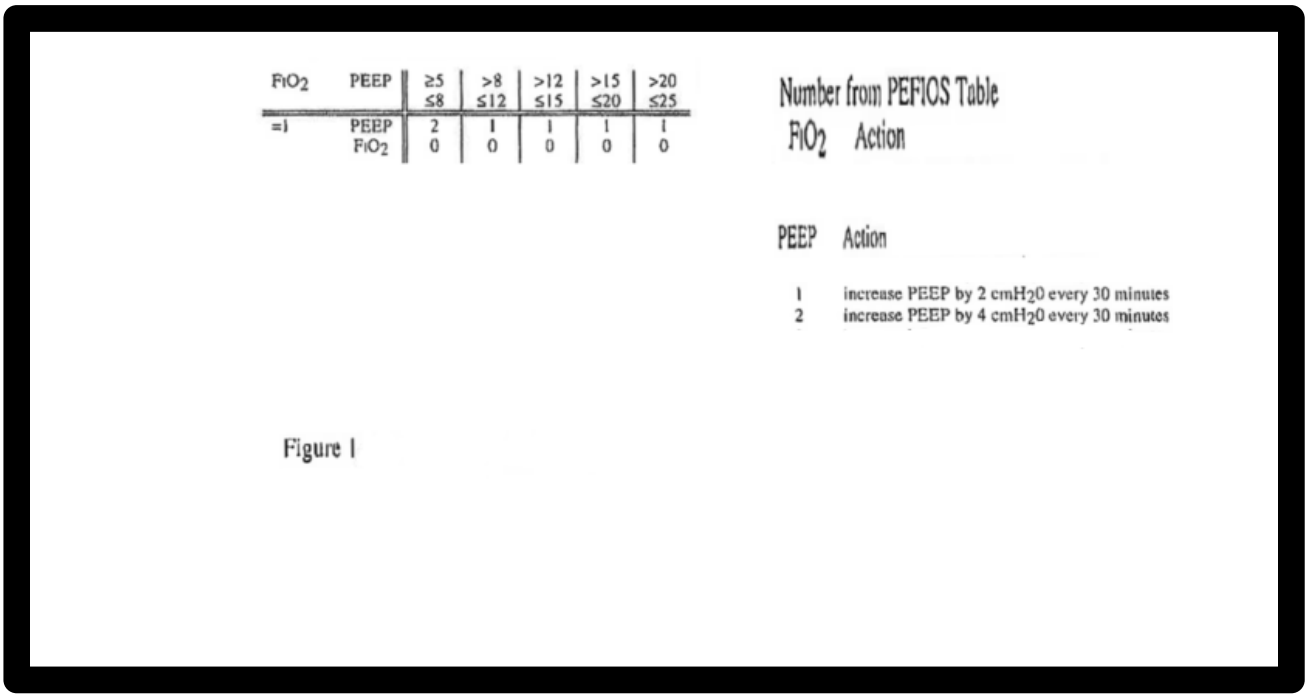
3. Waisel'95 (Ex.1011)

Waisel'95 discloses contemporaneous automated, closed-loop ventilator structures available for use in Carmichael's survey provide "closed-loop control of arterial oxygen saturation by changing PEEP and FIO2" (*i.e.*, a "PEFIOS" controller for PEEP/FIO2/O_2Sat).

The ventilators measure patient oxygen saturation "SaO_2" by "dual pulse oximetry (Nellcor-N100)" and "a Macintosh computer interfaced with a volume control ventilator (Hamilton Amadeus)." *Id.*; Ex.1011, §2.

A Figure 1 excerpt (see below) illustrates a therapy with a fixed value of F_IO_2 (*i.e.*, the "0" is an action of no increase or decrease in F_IO_2). In contrast, PEEP is

indicated as being incrementally varied (*i.e.*, "2" designates increase by 4 cmH_20 every 30 minutes; and "1" designates increase by 2 cmH_20 every 30 minutes):



FiO_2	PEEP	≥5 ≤8	>8 ≤12	>12 ≤15	>15 ≤20	>20 ≤25
=1	PEEP	2	1	1	1	1
	FiO_2	0	0	0	0	0

Number from PEFIOS Table

FiO_2 Action

PEEP Action

1 increase PEEP by 2 cmH_20 every 30 minutes
2 increase PEEP by 4 cmH_20 every 30 minutes

Figure 1

Ex.1002, ¶¶36-39.

A Figure 2 excerpt (see below) shows an uppermost horizontal line with fixed FIO2=1.0, while PEEP is incrementally varied over a range:

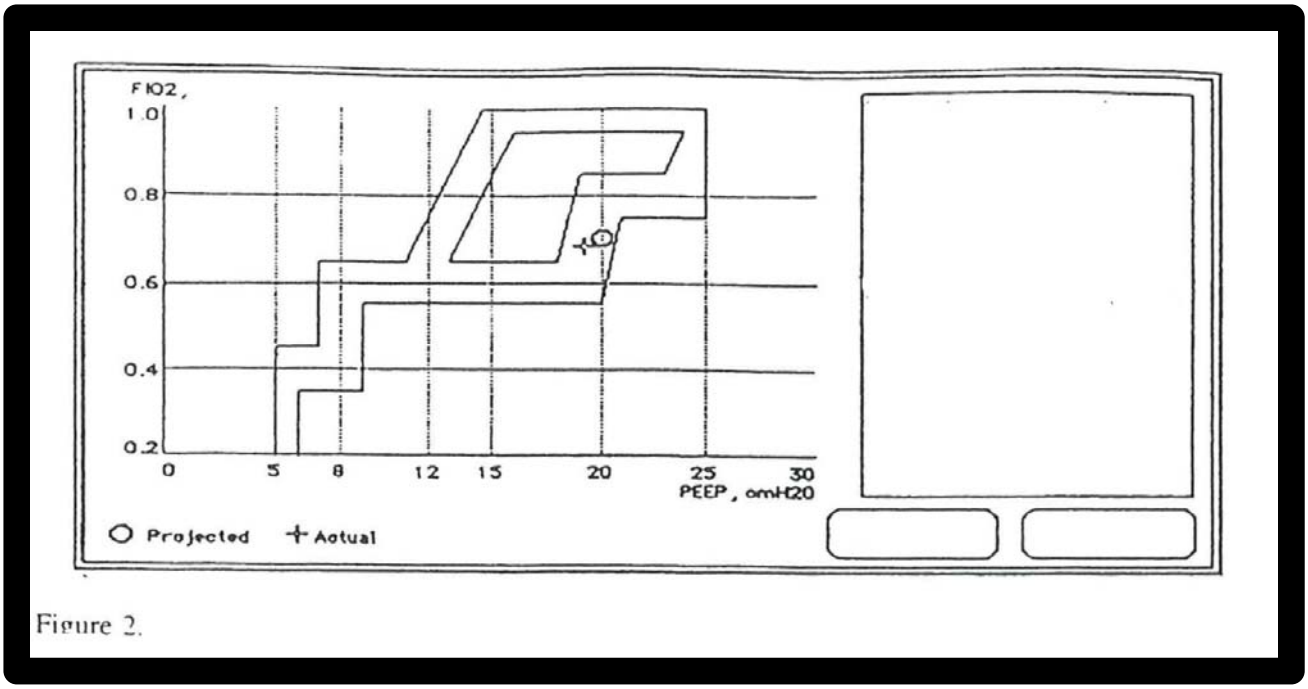


Figure 2.

4. Anderson (Ex.1013)

Anderson's automated, closed-loop ventilator structure maintains appropriate levels of PEEP and FiO2 in ARDS patients. Ex.1002, ¶¶43-50; Ex.1013, p.289 (Abstract):

> The closed-loop control system consists of an in-dwelling arterial oxygenation (PaO2) sensor …coupled to a Macintosh computer that continuously controls FiO2 and PEEP settings on a Hamilton Amadeus ventilator….The controller is based on a traditional proportional-integral-derivative (PID) approach …to control, or maintain, the patient's PaO2 level at a target value. *Id.*

Anderson's Figure 1 shows a closed loop controller:

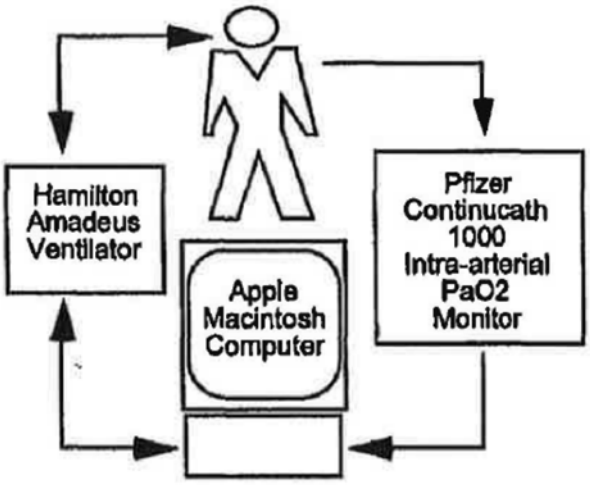
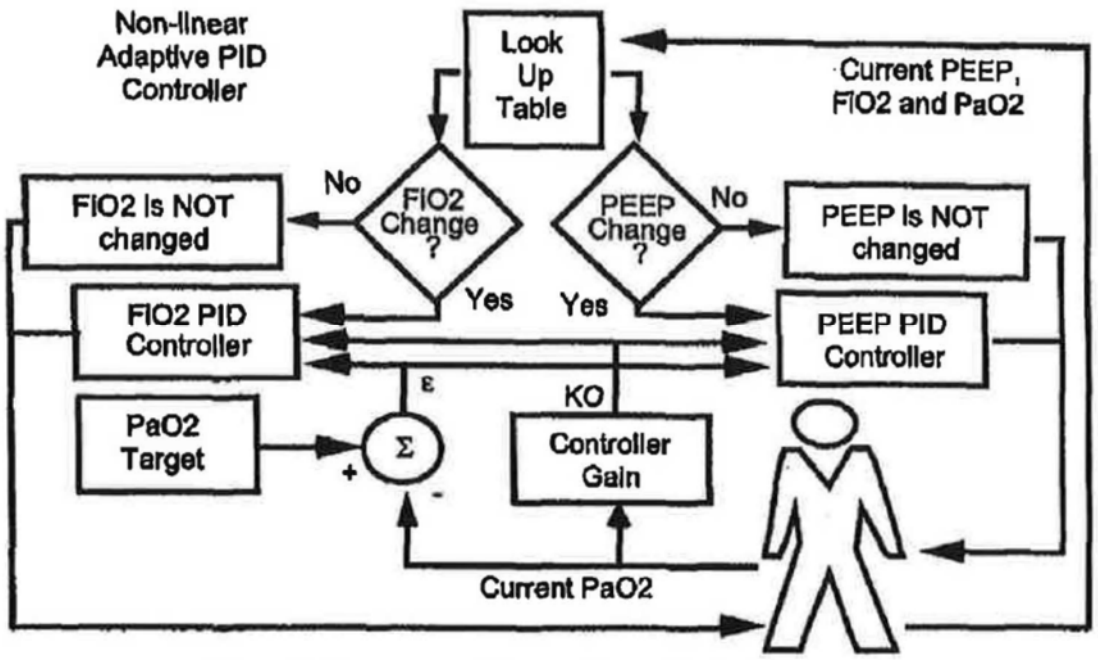


Figure 1. Hardware components of closed-loop control system.

The computer constantly reads important information from both the PaO2 monitor and Ventilator via RS232 serial ports. This information is used to calculate new values of PEEP and FiO2 that are subsequently transmitted to the ventilator for proper adjustments in patient therapy.

Ex.1013, p.290.

Figure 2 shows continuous control of FiO2 and PEEP:



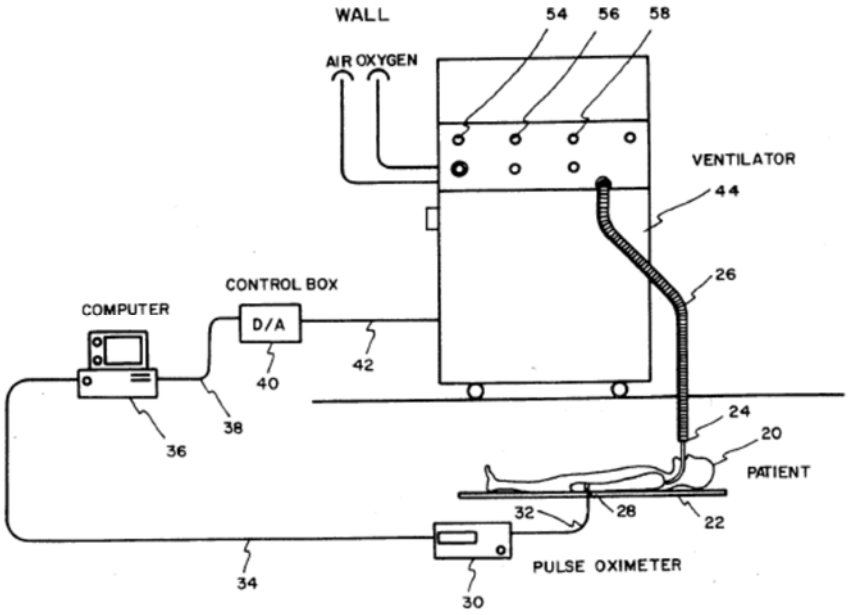
5. Tehrani'268 (Ex.1006)

Tehrani'268, discussed *supra*, is Owner's earlier patent which discloses an automated, closed-loop ventilator structure. Ex.1006, col.1:14-16. Figure 1 (reproduced *supra*) includes hardware components as referenced in the '571 Patent, such as controller 12, alarm circuit 48 and D/A converters 50/52. Ex.1006, col.3:55-60; Ex.1002, ¶¶51-56.

6. Taube (Ex.1005)

Taube's automated, closed-loop ventilator structure for "adaptive control" of the inspiratory ventilation time (Tinsp), PEEP and FiO_2, "is intended to make more automatic the control of the above patient parameters." Ex.1005, col.1:25-30. A "pulse oximeter senses a patient's hemoglobin saturation and pulse rate … to

determine the patient's corresponding partial pressure of arterial blood." Ex.1005, Abstract. The calculated "partial pressure of arterial blood" is then used to determine inspired oxygen (FiO_2) and PEEP." *Id.* Figure 1 shows Taube's ventilator:



Owner materially mischaracterizes Taube during prosecution of the '571 Patent as failing to disclose controlling a ventilator to a desired oxygen level":

> There simply is no mechanism in place in *Taube's* algorithm for F_{IO2} to be determined toward reducing the difference between the measured oxygen level of the patient and a selectable desired value.

Ex.1009, p.150.

Taube, to the contrary, expressly instructs control of a ventilator to a desired oxygen level (Ex.1002, ¶¶28-35):

> The level of inspired oxygen, peak expiratory end pressure, and inspiratory ventilation time provided from the ventilator to the patient is varied to maintain a desired predetermined partial pressure of arterial oxygen.

Ex.1005, Abstract (underlining added).

> The control mechanism is derived from the known relationship between the preset level of Tinsp, PEEP, minimum required FiO_2 delivered to the patient, and predetermined lung function dynamics in order to maintain a desirable PaO_2.

Id., col.1:37-41 (underlining added).

7. Clemmer (Ex.1008)

Clemmer's automated, closed-loop ventilator structure is programmable to implement a variety of treatment protocols. Ex.1008, col.1:45-48; 5:1-4. Fig. 1A shows an exemplary ventilator:

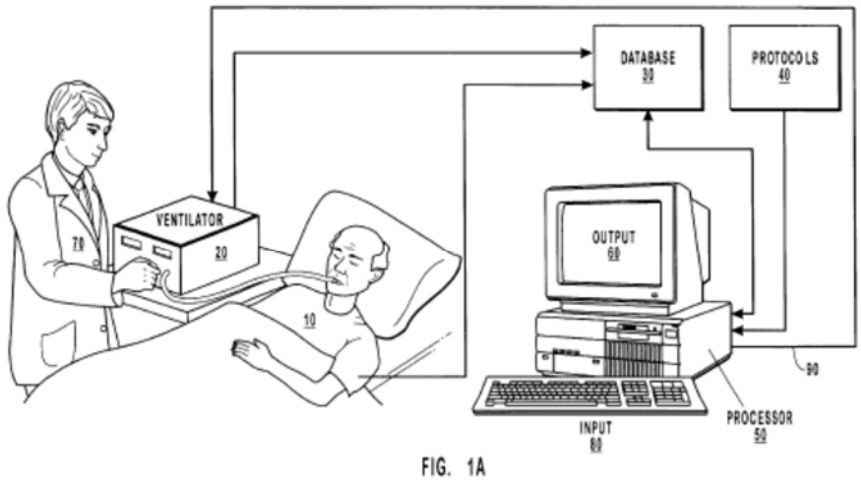


FIG. 1A

8. Rossi (Ex.1015)

Rossi discloses that a "PEEP" value for ventilator control includes an intrinsic "PEEPi." Ex.1015, pp.532-533; Ex.1002, ¶¶20,35,324.

> PEEPi is an inspiratory threshold load which has to be counterbalanced by the patient's inspiratory muscles either beginning inspiration or triggering the mechanical breath.

Ex.1015, p.532.

The "minimum and maximum level of PEEP are represented by $PEEP_{i,dyn}$ and $PEEP_i$, respectively." Ex.1015, p.533

C. Person of Ordinary Skill in the Art ("POSITA")

A POSITA, aware of all pertinent art, thinks along conventional wisdom in the art as a person of ordinary creativity. *Custom Accessories, Inc. v. Jeffrey-Allan Indus*., 807 F.2d 955, 963 (Fed. Cir. 1986). This includes specialized knowledge applicable to aspects of claimed subject matter. *See, e.g., AVX Corp. v. Greatbatch, Ltd*., IPR2014-00697, Paper 60 at 3 (PTAB Jan. 11, 2016).

For the '571 Patent, a POSITA would be: (i) a medically trained physician or clinician specializing in treating respiratory failure issues with at least five years of practical clinical ventilator experience treating such conditions; or (ii) a Master's degree in Electrical Engineering or a related field and about 5 years of practical experience with developing ventilators for clinical patient treatment; or (iii) a Bachelor's degree in Electrical Engineering or a related field and about 10 years of

practical experience with developing ventilators for clinical patient treatment. A higher level of education or specific skill might compensate less experience, and vice-versa. Ex.1002, ¶¶71-72.

VI. HOW THE CHALLENGED CLAIMS ARE TO BE CONSTRUED

Claim terms are construed "using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. §282(b), including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent." 37 C.F.R. §42.100(b). Claim terms are interpreted according to *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc), and its progeny.

Construction of means plus function terms "must identify the specific portions of the specification that describe the structure, material, or acts corresponding to each claimed function." 37 C.F.R. §42.104(b)(3). Construing a means-plus-function claim term is a two-step process that includes (1) identifying the claimed function and (2) "then determine what structure, if any, disclosed in the specification corresponds to the claimed function." *Williamson v. Citrix Online, LLC*, 792 F.3d 1339, 1351 (Fed. Cir. 2015). The structure disclosed in the specification is corresponding structure if the specification or prosecution history clearly links or

associates that structure to the function recited in the claim. *Golight, Inc. v. Wal-Mart Stores, Inc*., 355 F.3d 1327, 1334 (Fed. Cir. 2004).

Solely for purposes of this proceeding, constructions of claim terms of the '571 Patent that may require construction are proposed. Ex.1002, ¶¶77-111. Other claim terms are afforded their "ordinary and customary meaning" (*i.e.*, plain meaning). 37 C.F.R. §42.100(b). Ex.1002, ¶112.

Assertions under 35 U.S.C. §112 are not available challenges in an IPR proceeding. Claim constructions provided herein do not waive any such available challenges, including challenges of indefiniteness, which may be available in any District Court litigation proceedings that may arise.

A. "first means" (claim 1)

The term "first means" is a means-plus-function term construed to be an automated ventilator's processor "controlled by a software algorithm to operate on the input data, and to provide digital output data to control the ventilator and the gas mixer of the ventilator." Ex.1009, p.136; Ex.1001, 2:49-53; Ex.1002, ¶¶77-78; *see also* Ex.1001, 3:65-4:30; 12:23-41. Structure of the "first means" corresponds to automated ventilator processor components for performing functions of:

"processor 10" configured to execute the algorithms "shown in Figs. 2a-2c and 3a-3i." Ex.1009, pp.63, 136 (emphasis added); and

"processor 12" and a "programmable microcomputer" controlled by a "software algorithm to operate upon the input data and provide digital output data." Ex.1006, col.2:2-8 (emphasis added); *see also* Ex.1001, 1:10-12; 12:23-41.

B. "second means" (claim 1)

The term "second means" is a means-plus-function term construed to be a ventilator processor's signal generator. Ex.1009, p.136; Ex.1002, ¶¶79-80. Structure of the "second means" corresponds to automated ventilator system components for performing functions of:

signal generator 46 of FIG. 1, and to circuit diagrams of FIG. 4.

Ex.1009, pp.63, 136 (emphasis added).

C. "PEEP" (claims 1, 29)

The term "PEEP" refers to positive end expiratory pressure, and is mischaracterized in the '571 patent as being interchangeable with the term "CPAP" (Continuous Positive Airway Pressure). Ex.1001, 3:52-56; Ex.1002, ¶81.

D. "to reduce the difference between the measured oxygen level of the patient and a desired value" (claims 1 and 29)

This phrase is construed to mean that FIO2 is determined:

to reduce the difference between any measurement representative of arterial blood oxygen level of a patient and a desired value thereof

See, *e.g.*, Ex.1001, 8:26-44; Ex.1002, ¶¶82-85.

During examination, Owner explains this claim phrase requires FIO2 to be determined so that a "patient's arterial blood oxygen level converge" on a desired value. Ex.1009, p.155; *see also Id*., pp.146-150**.**

E. "PEEP is determined to keep a ratio of PEEP/F_{IO2} within a prescribed range" (claim 1)

This claim 1 phrase is construed to mean:

> **PEEP is determined, <u>after F_{IO2} is determined</u>, to keep a <u>calculated</u> ratio of PEEP/F_{IO2} within a prescribed range.**

Claim 1 requires determining PEEP to keep the "PEEP/F_{IO2} ratio" within a prescribed range, such that F_{IO2} must be determined in advance of PEEP for calculating a PEEP/F_{IO2} ratio. Ex.1002, ¶¶86-90.

The specification is consistent: "**After the determination of the required F_{IO2}**, the procedure of adjusting the PEEP value is started at F in step 282. In this step, the ratio of PEEP/F_{IO2} is **calculated**." Ex.1001, 10:43-47 (emphasis added); *see also* Fig. 3g, step 282.

The file history is consistent:

> PEEP output is therefore a function of F_{IO2}, which can vary according to patient conditions. This means PEEP will vary as F_{IO2} varies, within the limits of the prescribed ratio.

Ex.1009, p.76; *see also Id.*, pp.150-151 (citing Figures 3g-3i).

F. "determining … (ii) required positive end-expiratory pressure, PEEP, wherein a ratio of PEEP/F_{IO2} is maintained within a prescribed range" (claim 29)

This claim 29 phrase is similar to that of claim 1 and is similarly construed to mean:

> **determining … (ii) required PEEP, after F_{IO2} is determined, wherein a calculated ratio of PEEP/F_{IO2} is maintained within a prescribed range.**

This construction is consistent with the plain meaning of claim 29, wherein the determination of PEEP in "(ii)" occurs after the determination of F_{IO2} in "(i)". Ex.1002, ¶¶91-94.

The specification is consistent: "**After** the determination of the required F_{IO2}, the procedure of adjusting the PEEP value is started at F in step 282." Ex.1001, 10:43-44 (emphasis added).

The file history is consistent, wherein Owner explains: "Claim 29 is a method claim similar to claim 1", and PEEP is "determined so that '*a ratio of PEEP/F_{IO2} is maintained within a prescribed range,*' as recited in claim 29." Ex.1009, p.156 (italics in original).

G. "program means" (claims 11-12, 21)

The term "program means" is a means-plus-function term construed to correspond to processor structure for performing functions of:

a ventilator processor's stored computer software algorithm to operate on input data, and to provide digital output data to control the ventilator.

See Ex.1001, 2:49-53; Ex.1002, ¶¶95-104.

Figures 2a-2c illustrate that a ventilator "program, most of which is described in U.S. Pat. No. 4,986,268, is designed to control the frequency and ventilation for a next breath of the patient…." Ex.1001, 2:64-3:10; 4:44-7:33. Figures 2a-2c of the '571 Patent correspond to prior art Figures 3A-3C of Tehrani. Ex.1006, 7:45-11:5; Ex.1001, 7:25-33. The only difference is that in the '571 Patent, "the necessary adjustments in the [Inspiratory/Expiratory time] I:E ratio are controlled automatically as already described, and the levels of F_{IO2} and PEEP are automatically controlled by another algorithm." Ex.1001, 7:28-33 (brackets and underlining added).

Claim 11: The ventilator "program means" includes software for determining PaO_2, FIO2 and PEEP (*e.g.*, Figures 3a-3i, Ex.1001, 7:34-12:3).

Claim 12: The ventilator "program means" includes software for determining an artifact in data indicative of the measured oxygen level of the patient, for replacing or correcting the data based on the artifact, and for generating a warning signal in the event the artifact is determined (*e.g.*, Figures 2a-2c in Ex.1001, 4:44-7:33; Figures 3A-3C in Ex.1006, 7:45-11:5).

H. "alarm unit" and "alarm control signal" (claims 3-4)

The term "alarm unit" is construed to mean:

ventilator circuitry for generation of a signal in response to an alarm control signal.

See Figure 1 ("alarm circuitry 54), Figure 4 and the '571 Patent's specification at 2:60-65, 3:38-40, 5:5-55, 8:42-65, 10:5-55, 12:3-22; Ex.1002, ¶¶105-106.

The term "alarm control signal" is construed to mean:

an internal ventilator signal generated when a patient parameter is below a minimum value or above a maximum value.

See Figure 4 and the '571 Patent specification at 2:60-65, 3:38-40, 5:5-55, 8:42-65, 10:5-55, 12:3-22; Ex.1002, ¶¶107-108.

I. "data indicative of PEEPi is supplied by a monitor operatively coupled to the first means" (claim 10)

This phrase of claim 10 is construed to mean:

data indicative of PEEPi is supplied by a PEEP monitor (i.e., PEEP input port) operatively coupled to a ventilator processor (i.e., "first means").

PEEPi is a component of PEEP. The specification states PEEPi data is "provided automatically to the digital processor via an input port, or the calculated value of the pressure can be provided manually by the clinician either through one of the input ports or via software." Ex.1001, 7:63-67, Ex.1002, ¶¶109-111.

VII. PETITIONERS HAVE A REASONABLE LIKELIHOOD OF PREVAILING

A claim is anticipated if each element is found, either expressly or inherently, in a prior art reference. *See Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631 (Fed. Cir. 1987). The elements must be arranged as required by the claim, but this is not an *ipsissimis verbis* test, *i.e.*, identity of terminology is not required. *See In re Bond*, 910 F.2d 831 (Fed. Cir. 1990).

In *Kennametal, Inc. v. Ingersoll Cutting Tool Co*., 780 F.3d 1376 (Fed. Cir. 2015), the Federal Circuit "explained that 'a reference can anticipate a claim even if it d[oes] not expressly spell out' all the limitations arranged or combined as in the claim, if a person of skill in the art, reading the reference, would 'at once envisage' the claimed arrangement or combination." *The Chamberlain Grp., Inc. v. Techtronic Indus. Co*., 935 F.3d 1341**,** 2019 U.S.P.Q.2d 311576, *7 (Fed. Cir. 2019) (citing *Kennametal*, 780 F.3d at 1381). When a reference discloses elements in different locations in the disclosure, the relevant question is whether the reference is sufficiently clear in disclosing the combinability of those elements such that a skilled artisan would "at once envisage" the claimed combination. *Purdue Pharma L.P. v. Epic Pharma, LLC*, 811 F.3d 1345, 1358–59 (Fed. Cir. 2016).

Obviousness under 35 U.S.C. §103 is determined by evaluating the prior art scope and content, ascertaining differences between the claimed invention and the prior art, and resolving the level of ordinary skill in the relevant art, considering any

objective evidence of "secondary considerations" relevant to obviousness. *Graham v. John Deere Co.*, 383 U.S. 1 (1966).

A. Claims 1-2, 5-6, 11, 29, 31-33 and 41 Are Anticipated Or Rendered Obvious By Carmichael (Ground 1)

Carmichael anticipates every element of these claims. Ex.1002, ¶¶113-263, Appendix 1.

Carmichael alternately renders these claims obvious. The U.S. Patent Office has recognized that an alternate 35 U.S.C. 102/103 combination is permitted if it is unclear whether a reference teaches a particular limitation with sufficient specificity. *See, e.g., Pfizer, Inc. v. Genentech, Inc.*, IPR2017-02020, Paper 16 at 30-31 (PTAB Feb. 12, 2018).

1. Claim 1 Preamble: An apparatus for automatically controlling a ventilator

Carmichael reports a treatment protocol whereby PEEP is determined to keep a ratio of PEEP/F_{IO2} within a prescribed range in an automated ventilator mode of operation known in the art as the "assist control mode." Carmichael discloses "volume controlled ventilation" by mechanical ventilators and monitoring devices to achieve "best PEEP." Ex.1004, p.9, col.2:1-2; p.10, col.1:28-38.

Carmichael's disclosed "assist control mode" appears in Fig. 2 among "favored modes of mechanical ventilation in ARDS":

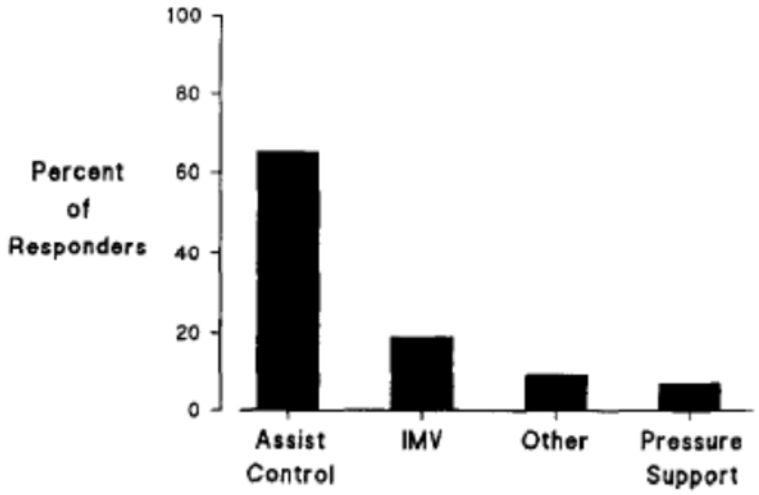


Fig 2. The favored modes of mechanical ventilation in ARDS.

Carmichael explains that "ventilation in ARDS patients" was "supported by a volume cycled ventilator using assist-control or intermittent-mandatory mode." Ex.1004, p.13. Carmichael's "assist-control mode" is the automatic control of a ventilator. Ex.1002, ¶¶119-123.

a. Element [1.1.]: first means for processing data indicative of at least a measured oxygen level of a patient, and for providing output data indicative of: required concentration of oxygen in inspiratory gas of the patient (F_{IO2}) and positive end-expiratory pressure (PEEP) for a next breath of the patient;

i. measured oxygen level of a patient

Carmichael's "assist control mode" of a processor-based ventilator (*i.e.,* "first means") processes data indicative of a patient's measured oxygen level by

monitoring acceptable "oxygen saturations of 86% to 90%." Ex.1004, p.14, col.1: 30-34.

Oxygen saturation level is measured via pulse "oximetry" (Ex.1004, p.14, col. 2:45-54). Measured oxygen saturation is used to derive PaO_2 (*i.e.*, arterial partial pressure of oxygen), which is indicative of a patient's oxygen level. Ex.1001, 4:52-64. Carmichael's ventilator control keeps PaO_2 greater than 60 mmHg (*i.e.*, corresponding to the aforementioned oxygen saturation of "86% to 90%), stating that "many references indicated that a PaO_2 >60 mmHg was desireable." Ex.1004, p.13, col.2:48-52. Ex.1002, ¶¶124-127.

Thus, Carmichael discloses an automated ventilator operating in an "assist control mode" to measure a patient's oxygen level.

ii. output data indicative of: (F_{IO2}) and (PEEP)

Carmichael's disclosed assist control mode uses the measured arterial oxygen level to provide output data indicative of FIO2 and PEEP for a patient's next breath. Ex.1004, pp.11-12, Fig. 7.

Carmichael teaches "a PaO_2 >60 mmHg was desirable and should be achieved through the use of increased FiO_2s and incremental application of PEEP." Ex.1004, pp.13-14. Carmichael's surveyed ventilator treatment protocols set an FIO2 level, and then set a "level of PEEP that would not be exceeded before increasing to the next higher FIO_2." Ex.1004, p.12.

Carmichael thus discloses an automated ventilator that constitutes first means for performing functions of processing data indicative of measured oxygen level and providing output data indicative of FIO2 and PEEP for a patient's next breath. Ex.1004, pp.11-14; Ex.1002, ¶¶128-135.

b. Element [1.2.]: wherein F_{IO2} is determined to reduce the difference between the measured oxygen level of the patient and a desired value;

Carmichael discloses determining FIO2 to reduce the difference between a patient's oxygen level and a desired value of oxygen saturation of "PaO_2 >60 mmHg" to be achieved. Ex.1004, pp.13-14; Ex.1002, ¶136.

c. Element [1.3.]: wherein PEEP is determined to keep a ratio of PEEP/F_{IO2} within a prescribed range and, while keeping the ratio within the prescribed range, to keep the measured oxygen level of the patient above a predefined value;

Carmichael discloses surveyed ventilator treatment protocols for "best PEEP" which first set an FIO2 level, and keep a ratio of FIO2/PEEP within a prescribed range by setting a maximum "level of PEEP that would not be exceeded before increasing to the next higher FIO_2." Ex.1004, p.12. For example, at an FIO_2 of 0.6, the PEEP is reported to have been varied from a minimum of 0 to a mean maximum PEEP of "16 +/- 6 cmH_2O". *Id.* The calculated ratio ofPEEP/FIO2 for FIO2 = 0.6 is therefore kept within a prescribed range from a minimum of 0 to a maximum selected among10/0.6 to 22/0.6 cmH_2O.

A Fig. 7 graph illustrates a minimum PEEP of 0 and "maximum PEEP" for each FIO2 setting to achieve desired PaO_2:

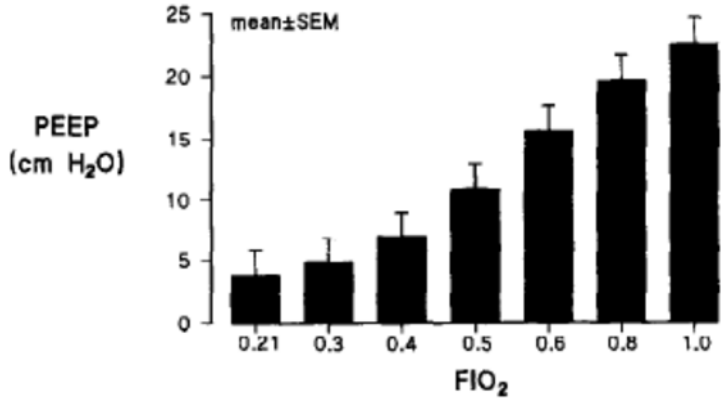


Fig 7. The maximum PEEP used at various FIO_2s.

Carmichael discloses keeping a PEEP/FIO2 ratio within a prescribed range while keeping measured oxygen above a predefined value. In Carmichael, a "best PEEP" is applied by ventilator systems so that PEEP will be "the least PEEP at which hemoglobin-oxygen saturation is considered adequate on nontoxic concentrations of inspired oxygen." Ex.1004, p.14. Regardless "of the method used to determine PEEP, levels between 10 and 15 cmH_2O typically turn out to be the 'best PEEP.'" Ex.1004, p.14. In an exemplary treatment, a minimum PEEP value is set to 0 and a maximum PEEP applied is reported to be 25 cmH_2O . Ex.1004, p.14, Ex.1002, ¶¶137-140.

Carmichael discloses an automated ventilator ARDS treatment protocol which keeps a PEEP/FIO2 ratio within a prescribed range, while keeping the patient's oxygen level above a predefined value (*e.g.,* "PaO_2 >60 mmHg"). Ex.1004, pp.13-14; Ex.1002, ¶141.

d. Element [1.4.]: second means, operatively coupled to the first means, for providing control signals, based on the output data provided by the first means, to the ventilator;

Carmichael discloses ventilators operating in an assist control mode of automated operation having signal generation ("second means") to perform a disclosed function of providing control signals to the ventilator based on Carmichael's disclosed FIO2 and PEEP output data. Ex.1004, pp.11-14; Fig. 7. Ex.1002, ¶¶142-144.

e. Element [1.5.]: wherein the control signals provided to the ventilator automatically control PEEP, and F_{IO2}, for a next breath of the patient.

Carmichael discloses PEEP and FIO2 determinations are automatically controlled during ventilator operation so a patient's arterial oxygen level will converge at a desired level (*e.g.*, "oxygen saturations of 86% to 90%"). Ex.1004, p.14, col.1:30-34. This "should be achieved through the use of increased FiO_2s and incremental application of PEEP." Ex.1004, pp.13-14. This occurs while keeping PEEP to a value within a range of zero (i.e. no application of PEEP) to 25 cm H_2O for a given FIO2 value. Ex.1004, pp.13-14.

A POSITA would "'at once envisage'" from Carmichael that conventional ventilator machines as disclosed therein control the PEEP and FIO2 of the ventilator in a manner which anticipates Claim 1. *See The Chamberlain Grp.,* 935 F.3d 1341**,** 2019 U.S.P.Q.2d 311576, *7 (Fed. Cir. 2019); Ex.1002, ¶¶145-148.

f. Claim 1 Alternately Is Obvious Over Carmichael

To the extent Carmichael's ARDS "assist control mode" is challenged as not specifically illustrating structural components for providing disclosed FIO2 and PEEP control signals, contemporaneous documents confirm that Carmichael's disclosed therapy of a mechanical ventilator "assist control mode" is a recognized processor-based ventilator control mode. ARDSNET (Ex.1007) confirms the FIO2 and PEEP therapy to be a prescribed treatment or one a POSITA would have understood to prescribe. Waisel'95 (Ex.1011) confirms that an "assist control mode" operating with "FIO2" and "PEEP" control signals is understood as a processor-based ventilator having an FIO2, PEEP signal generator.

B. Carmichael's Prescribed "PEEP/FIO2 Ratio" Is Evidenced By ARDSNET

ARDSNET footnote 36 cites Carmichael and corroborates Carmichael's "traditional" ARDS treatment therapy using a set FIO2 and adjustable minimum/maximum PEEP values for ventilator control. Ex.1007, pp.1302-1306. ARDSNET Table 1 and related text demonstrate Carmichael's prescribed control range of PEEP/FIO2. ARDSNET explicitly links a prescribed range of

minimum/maximum PEEP values to each FIO2 setting to keep a calculated PEEP/FIO2 ratio within a prescribed range. Ex.1007, pp.1302-1303.

Excerpts below from ARDSNET Table 1 (Ex.1007) illustrate that after selecting an "Oxygenation goal" and FIO2 of 0.4, PEEP is adjustable within a prescribed range of 5-8 cm of water; i.e., a calculated PEEP/FIO2 ratio is maintained within a prescribed range of 5/0.4 and 8/0.4. *Id.;* Ex.1002, ¶¶149-153.

TABLE 1. SUMMARY OF VENTILATOR PROCEDURES.*

VARIABLE	GROUP RECEIVING TRADITIONAL TIDAL VOLUMES	GROUP RECEIVING LOWER TIDAL VOLUMES
Ventilator mode	Volume assist–control	Volume assist–control
Oxygenation goal	PaO_2, 55–80 mm Hg, or SpO_2, 88–95%	PaO_2, 55–80 mm Hg, or SpO_2, 88–95%
Allowable combinations of FiO_2 and PEEP (cm of water)‡	0.3 and 5 0.4 and 5 0.4 and 8	0.3 and 5 0.4 and 5 0.4 and 8

C. Carmichael's "Assist Control Mode" Is A Recognized Automated Ventilator Control Mode As Evidenced by Waisel'95

A POSITA would have recognized Carmichael's ventilator "assist control mode" to include a processor/signal generator providing FIO2 and PEEP control signals as further evinced by contemporaneously available ventilators of Waisel'95. Ex.1011, §2. Waisel'95 demonstrates that a ventilator "assist control mode" at the time of Carmichael included first/second means for processor-based control of FIO2 and PEEP with closed-loop control of oxygen. Carmichael's reported "assist control mode" included data from an oximeter to achieve desired oxygen saturation (i.e., SaO_2), and according to Waisel, when a "measured SaO_2 greater than the goal saturation" occurs, the assist control mode "decreases therapy"; for measured SaO_2 less than the goal saturation, the assist control mode automatically "increases therapy." Ex.1011, §2.

Waisel'95 discloses an available for PEEP/FIO2/O_2Sat (PEFIOS) controller for closed-loop control of SaO_2 by changing PEEP and FIO2. The PEFIOS microcomputer interfaces with a volume control ventilator and various patient sensors. The PEFIOS controller was in a ventilator workstation ("VW#1"); *i.e.*, a "fully programmable mechanical ventilator based on the Amadeus, a microprocessor controlled ventilator." Ex.1011, §2.3. The VW#1 included: "a remote controllable Amadeus, a preprocessor [first means] to analyze analog data received from the VW#1 and various patient sensors, and the arbiter host [computer, or second means]."

Ex.1011, §2.3. In the automated mode of the VW#1, "a host computer has control over the Amadeus." *Id.*

Oxygen saturation levels are measured in Waisel'95 by a dual pulse oximetry (Nellcor-N100). *Id.* The "goal", or target saturation for the PEFIOS controller is adjustable to limits consistent with Carmichael. (Ex.1011, §2.2: "if an appropriate saturation is 90%, the clinician can choose that number, as well as the SaO2 ranges for each of the tiers of support").

Waisel'95 demonstrates that Carmichael's reported ventilators implementing an "assist control mode" include processors/signal generators performing routine, predictable closed-loop control to provide the functions disclosed therein. Ex.1002, ¶¶154-165.

1. Claim 2: The apparatus of claim 1, wherein the first means comprises a programmable microcomputer.

Carmichael discloses each element of Claim 2. Ex.1002, ¶166.

Carmichael discloses automated ventilators set "to control a ventilator so that a patient's oxygen saturation was at least at "86% to 90%" Ex.1004, p.14, col.1:30-34, and that this "should be achieved through the use of increased FiO_2s and incremental application of PEEP." Ex.1004, pp.13-14; Ex.1002, ¶¶166-168.

a. Claim 2 Alternately Is Obvious

A POSITA would have recognized Carmichael's ventilator "assist control mode" was implemented by a PEFIOS closed-loop controller for providing FIO2

and PEEP control signals to a processor-based ventilator like that of Waisel'95. Ex.1011, §2. *See* claim 1 *supra*; Ex.1002, ¶¶167-168.

2. Claim 5: The apparatus of claim 2, further comprising an analog to digital (A/D) converter connected to an input of the first means for converting analog signals from an oxygen sensor, indicative of the oxygen level of the patient, to digital data

Carmichael discloses oxygen sensors with reference to "Bedside oximetry". Ex.1004, p.13, col.2:46-48. A POSITA would have understood that the processor-based ventilator of Carmichael's survey would have included an A/D converter for converting analog patient oxygen data obtained via the disclosed oxygen sensor to digital inputs suitable for input to an automated ventilator. Ex.1002, ¶¶169-171.

a. Claim 5 Alternately Is Obvious

A POSITA would have recognized that Carmichael's ventilator "assist control mode" was implemented by a PEFIOS closed loop controller like that of Waisel'95 for providing FIO2 and PEEP control signals from analog oxygen input values. Ex.1011, §2. *See* claim 1 *supra*.

Waisel'95 explains that the PEFIOS ventilator system utilized "a preprocessor to analyze analog data." Ex.1011, §2.3. A POSITA would have understood A/D converters would have converted analog signals from a patient and an oxygen sensor to digital data inputs of the ventilator processor. Ex.1002, ¶¶172-175.

3. Claim 6: The apparatus of claim 5, wherein the oxygen sensor is a pulse oximeter measuring arterial hemoglobin oxygen saturation in the patient's blood.

Carmichael's "Bedside oximetry" is a well-known pulse oximeter that non-invasively indicates a measured arterial hemoglobin oxygen saturation in the patient's blood. Ex.1004, p.13; Ex.1002, ¶176.

a. Claim 6 Alternately Is Obvious

A POSITA would have understood the term "Bedside oximetry" of Carmichael to reference a pulse oximeter such as that of Waisel'95 for measuring arterial hemoglobin oxygen saturation of a patient. Ex.1011, §2; Ex.1002, ¶¶177-181.

4. Claim 11: The apparatus of claim 2, wherein the programmable microcomputer further comprises a program means for determining from the input data: the patient's arterial partial pressure of oxygen; the required FIO2; the required PEEP; for a next breath of the patient.

Carmichael's disclosed automated ventilator operating in an "assist control mode" includes ventilator means for performing disclosed functions of determining the patient arterial partial pressure oxygen ("PaO_2"), the required FIO2, and required PEEP for a next breath. Ex.1004, pp.12-14; Ex.1002, ¶¶182-183.

a. Claim 11 Alternately Is Obvious

A POSITA would have understood that Carmichael's ventilator "assist control mode" was implemented by a PEFIOS closed loop controller for determining PaO_2,

required FIO2 and required PEEP as disclosed by Waisel'95. Ex.1011, §2. *See* claim 1 *supra;* Ex.1002, ¶¶184-189.

Waisel'95 discloses PEFIOS controller software for determining from oximeter hemoglobin saturation input data the patient's PaO_2, required FIO2, and required PEEP for a next breath of the patient. Ex.1011, §2 and Figs. 1-2.

PaO_2 is derived from the desired oxygen saturation measurement using a well-known calculation methodology to account for patient blood parameters (*e.g.*, Ex.1008, 19:17-20:30). To the extent PEFIOS system did not derive PaO_2, a POSITA would have been motiviated to do so rather than rely on only a pulse oximeter reading, so as to provide a non-invasive and convenient way to monitor the PaO_2 of a patient for utilization of well-known oxygenation classifications for patients that undergo ventilator treatment. Ex.1002, ¶¶187-189 citing to Ex.1008, 19:24-20:56; Fig. 6.

5. Claim 29 (preamble): A method for automatically controlling a ventilator:

Carmichael's ventilator assist-control mode is automatic control of a ventilator. *See* claim 1 *supra*; Ex.1002, ¶190.

a. Element [29.1.]: (a) measuring an oxygen level of a patient and providing a data signal indicative of the measured oxygen level;

Carmichael discloses measuring patient oxygen level and providing a data signal indicative of oxygen level. Ex.1004, pp.13-14 and claim element 1.1, *supra*; Ex.1002, ¶¶191-195.

b. Element [29.2.]: (b) determining: (i) required concentration of oxygen in an inspiratory gas of the patient, FIO2, based on the data signal indicative of the measured oxygen level of the patient and to reduce the difference between the measured oxygen level of the patient and a desired value;

Carmichael discloses determining required FIO2 based on measured oxygen level of a patient to converge on a desired value. Ex.1004, pp.12-14 and claim element 1.1, 1.2 *supra*; Ex.1002, ¶¶196-205.

c. Element [29.3.]: (b) determining: (ii) required positive end-expiratory pressure, PEEP, wherein a ratio of PEEP/FIO2 is maintained within a prescribed range, and to keep the measured oxygen level of the patient above a predefined value;

Carmichael discloses determining required PEEP to keep a PEEP/FIO2 ratio within a prescribed range so the patient oxygen level will converge to a desired value above a predefined minimum threshold value. Ex.1004, pp.12-14 and claim element 1.3, *supra*; Ex.1002, ¶¶206-210.

d. Element [29.4.]: (c) providing data signals indicative of the required FIO2 and the required PEEP based upon the determining of step (b), for automatically controlling FIO2 and PEEP for a next breath of the patient

Carmichael discloses an automated ventilator control providing data signals indicative of required FIO2 and PEEP for automatically controlling a patient's next breath, such that patient oxygen will converge to a desired value. Ex.1004, pp.12-14 and claim element 1.3-1.5, *supra*; Ex.1002, ¶¶211-213.

e. Claim 29 Alternately Is Obvious

Alternately, claim 29 would have been obvious to a POSITA based on Carmichael's disclosure when interpreted with contemporaneous knowledge in the art regarding automated ventilators operating in an assist control mode as disclosed by Waisel'95, and regarding corroborated use of PEEP/FIO2 as a ventilator control parameter as disclosed by ARDSNET. *See* claim 1, *supra*; Ex.1002, ¶¶214-230.

6. Claim 31: The method of claim 29, wherein the data signal indicative of measured oxygen level of the patient is in analog form and is converted to digital form before the determining of step (b), and wherein the providing of step (c) further comprises converting the data signals from digital to analog form.

Carmichael discloses or would have rendered obvious each element of Claim 31. See discussion of claim 5, *supra*. Ex.1002, ¶¶231- 238.

Carmichael's automated ventilator operating in an assist control mode converts analog measurement data (*e.g.*, patient oxygen and/or bedside oxygen

measurements) to digital form for input to the automated ventilator, as recognized by Waisel'95.

Carmichael's automated ventilator would have similarly converted digital control signals produced thereby to analog signals for controlling patient FIO2 and PEEP using the disclosed mechanical ventilator. D/A conversion of signals from a ventilator processor would be required, either in application to ventilator valves that adjust prescribed treatment to a patient, or in the patient's own analog physiology (e.g., lungs) reported upon by Carmichael. Use of automated ventilators with D/A conversion is further evidenced by Waisel'95. Ex.1002, ¶¶233, 239-241; *see e.g.*, Ex. 1011; *see also* Owner's acknowledged availability of D/A conversion in Ex.1006, Fig.1 *supra*.

7. Claim 32: The method of claim 31, wherein the measuring of the oxygen level of the patient comprises measuring an arterial hemoglobin oxygen saturation of the patient via pulse oximetry.

Carmichael discloses or would have rendered obvious Claim 32. *See* discussion regarding claim 6, *supra*. Ex.1002, ¶¶242-249.

8. Claim 33: The method of claim 32, wherein an arterial partial pressure of oxygen of the patient is derived from the arterial hemoglobin oxygen saturation of the patient measured by the pulse oximeter.

Carmichael discloses or would have rendered obvious claim 33 for reasons discussed with claim 6, *supra*. Ex.1002, ¶¶250-260.

The derivation of arterial partial pressure from arterial hemoglobin oxygen saturation is a known practice of Carmichael's disclosed "bedside oximetry", and/or would have been obvious to incorporate therein per Waisel'95. Ex.1002, ¶¶256-260, citing to Ex.1008, 19:8-20:56.

9. Claim 41: The method of claim 29, wherein the required concentration of oxygen in the inspiratory gas of the patient (FIO2) is calculated by using a stepwise control scheme and/or by using a proportional-integral-derivative (PID) technique.

Carmichael discloses at least one of the optional alternate calculations of FIO2 recited in claim 41. Ex.1002, ¶¶261-263. Carmichael's Fig. 7 discloses FIO2 is calculated in a step-wise, incremental scheme, whereby a maximum PEEP is set by a clinician "before increasing to the next higher FIO2." Ex.1004, p.12. At each FIO2, PEEP is adjusted before selecting a next FIO2. For example, Carmichael reports that for FIO2=0.6, the mean maximum PEEP applied was "16 +/- 6 cm H_2O" before incrementing to a next FIO2. Ex.1004, pp.12-14.

The PID technique of claim 41 is not a required claim limitation and is not specifically disclosed by Carmichael, but was a known technique for use in oxygen calculation that would have been obvious to substitute into automated ventilators reported upon by Carmichael. *See, e.g.*, Ex.1013, Figure 2 *supra,* and discussion thereof in Ground 2 *infra.*

D. Claims 1-6, 9-12, 29-33 And 41 Would Have Been Obvious Over Carmichael In View Of Anderson, Tehrani'268, and Rossi (Ground 2)

Claims 1-6, 9-12, 29-33, and 41 are obvious in view of Carmichael, Anderson, Tehrani '268, and Rossi. Ex.1002, ¶¶264-407, Appendix 2.

1. Claim 1

Claim 1 is reproduced in Ground 1 *supra.*

a. The Scope Of Carmichael And Anderson

Carmichael, discussed as anticipatory in Ground 1 *supra*, discloses automated ventilators operating in assist control mode to provide prescribed ARDS treatment protocols. Although the disclosed automated ventilators reported upon have the claimed functions recited in the '571 Patent, the disclosed ventilator architectures are not described in detail.

Anderson discloses an automated ventilator architecture for providing the functions reported upon by Carmichael to maintain prescribed minimum/maximum levels of PEEP (*e.g.*, "best PEEP") and FiO2 in ARDS patients. Ex.1002, ¶¶264-275 Ex.1013, p.289 (Abstract):

> The closed-loop control system consists of an in-dwelling arterial oxygenation (PaO2) sensor …coupled to a Macintosh computer that continuously controls FiO2 and PEEP settings on a Hamilton Amadeus ventilator….The controller is based on a traditional proportional-integral-derivative (PID) approach …to control, or maintain, the patient's PaO2 level at a target value.

Id.

Anderson's automated ventilator and control is shown in annotated Figure 1:

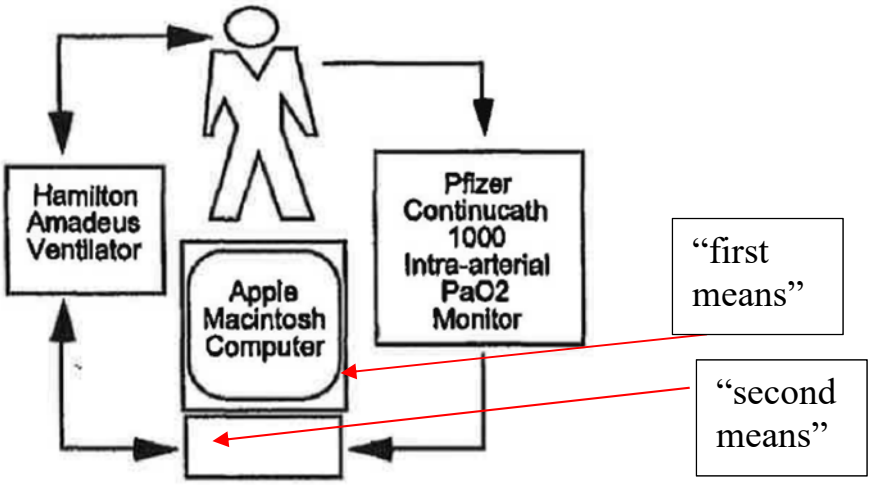


Figure 1. Hardware components of closed-loop control system.

The computer constantly reads important information from both the PaO2 monitor and Ventilator via RS232 serial ports. Ex.1002, ¶¶271-272. This information is used to calculate new values of PEEP and FiO2 that are subsequently transmitted to the ventilator for proper adjustments in patient therapy. Ex.1013, p.290.

b. A POSITA Would Have Been Motivated To Implement Carmichael's Ventilator Treatment On Anderson's Ventilator

A POSITA would have been expected to implement Carmichael's disclosed PEEP/FIO2 treatment protocol discussed *supra* on an automated ventilator as disclosed by Anderson. Anderson's ventilator is intended to "systematically maintain appropriate levels of positive end-expiratory pressure (PEEP) and inspired oxygen (FiO2)" in ARDS patients. Ex.1013, p.289 (Abstract). Operation of

Anderson's ventilator according to Carmichael's ARDS treatment protocol of determining PEEP, after determining FIO2, to keep a calculated ratio of PEEP/FIO2 within a prescribed range would have been predictable and routine ventilator operation. Ex.1002, ¶¶273-275.

2. Claim 2

Carmichael, discussed as anticipatory in Ground 1 *supra,* discloses an "assist control mode" of operation, and Anderson discloses an automated ventilator with program means (*e.g.*, program modules). Ex.1013, p.290 (Macintosh computer running a controller defined by LABVIEW software); Ex.1002, ¶276.

3. Claim 3: The apparatus of claim 2, further comprising: an alarm unit; the first means further determines whether there has been an artifact in the measured oxygen levels and replaces and/or corrects the data determined to be based on the artifact; the second means further provides an alarm control signal to the alarm unit to warn of the artifact in the measured oxygen levels.

Carmichael, discussed *supra*, discloses ARDS treatment protocols to avoid oxygen toxicity and dangerously low levels of oxygen to avoid patient death. Ex.1004, p.11. A POSITA would have understood the Carmichael ventilators having an automated assist control mode to include an alarm unit, whereby the processor/signal generation (first/second means) internally determine/correct data artifacts in a patient's measured oxygen level. Ex.1002, ¶¶277-295.

Anderson makes this clear, teaching PaO2 "data is constantly checked for errors or disruption by comparing current readings of PaO2 with past values. If erroneous readings are detected, a warning is displayed and the erroncous values are not used in the controller." Ex.1013, p.292, *see also* pp.290, 293. Where an error or artifact is detected, "prior values" are utilized. Ex.1013, p.293.

a. The Scope Of Tehrani'268 (Ex. 1006)

Detecting an artifact, and correction or replacement to account for that artifact, would alternately have been an obvious modification in view of Tehrani'268's express disclosure of this feature. Tehrani'268 discloses specific alarm and warning units for an automated ventilator interface, and is incorporated by reference into the '571 Patent. Ex.1001, 1:10-13, 1:40-65; Ex.1002, ¶¶284-289. The '571 Patent admits that integration of an alarm unit, oxygen level artifact detection, and a warning into a ventilator was well-known.

Tehrani'268 includes the same degree of disclosure for alarm and warning features as is disclosed and claimed in the '571 Patent. *Compare* Ex.1006, 8:5-35 and Fig. 1 *with* Ex.1001, 4:63-5:23 and Fig. 1.

Tehrani'268, like the '571 Patent, detects artifacts in the measurement of S_{pO2}. The '571 Patent states that an "artifact" is detected when "the calculated partial pressure of oxygen, P_{aO2}, is compared with a minimum acceptable value. If the calculated P_{aO2} is less than a minimum acceptable value, then control passes to step

220 in which an artifact is assumed and an alarm is generated." Ex.1001, 8:42-47. This is the same alarm unit, computer configuration and function as disclosed in 8:26-33 of Tehrani'268. Ex.1001, col.7:28-33 and Fig. 1; Ex.1002, ¶288.

Tehrani'268 expressly discloses that an alarm unit for oxygen level artifact detection as recited in claim 3), and a warning related to a detected oxygen artifact level are well-known prior art ventilator interface design features.

b. A POSITA Would Have Been Motivated To Use Tehrani'268's Alarm Functionality In Anderson's Ventilator System As A Safety Measure

A POSITA would have recognized Carmichael's disclosed avoidance of oxygen toxicity in a patient or the patient experiencing a dangerously low oxygenation level and been motivated to include the Tehrani'268 alarm unit and alarm configuration into an automated ventilator of Carmichael having the system automation components disclosed by Anderson (*e.g.*, the Macintosh computer running the LABVIEW control program). Ex.1013, p.290.

Utilizing a well-known control scheme for a ventilator computer to detect an artifact and generate an alarm output to a clinician as taught by Tehrani'268 would have been an obvious modification to a ventilator to assist clinicians in detecting and avoiding dangerously low oxygen levels of a patient and to detect and avoid oxygen toxicity in a patient undergoing ventilator treatment. Ex.1002, ¶¶290-295.

Such a combination would have been a predictable implementation of a known program for a ventilator microcomputer to provide known alarm condition detection and alarm generation. It would have been a predictable implementation of a known program for a ventilator microcomputer to provide known alarm condition detection and alarm generation. Ex.1002, ¶¶292-295.

4. Claim 4: The apparatus of claim 2, further comprising: an alarm unit; wherein the first means further determines whether the measured oxygen levels are outside a prescribed range; the second means further provides an alarm control signal to the alarm unit to warn of the measured oxygen level of the patient being outside a prescribed range

Carmichael, discussed *supra*, discloses ARDS treatment protocols to avoid oxygen toxicity and dangerously low levels of oxygen to avoid patient death. Ex.1004, p.11. A POSITA would have understood the Carmichael ventilators having an automated assist control mode to include an alarm unit, whereby the processor/signal generation (i.e., the first/second means) internally detect data artifacts in a patient's measured oxygen level. Ex.1002, ¶¶296-312.

Anderson discloses PaO2 "data is constantly checked for errors or disruption by comparing current readings of PaO2 with past values. If erroneous readings are detected, a warning is displayed and the erroneous values are not used in the controller." Ex.1013, p.292. Where an error or artifact is detected, "prior values" are utilized. Ex.1013, p.293.

a. The Scope Of Tehrani'268

Tehrani'268 is discussed with regard to claim 3 *supra*.

Tehrani'268 expressly discloses an alarm unit used to emit a warning when an oxygen level is outside a prescribed range as being well-known ventilator interface design. Ex.1002, ¶¶303-307.

b. A POSITA Would Have Been Motivated To Use Tehrani'268's Alarm Functionality In Anderson's Ventilator System As A Safety Measure

A POSITA would have understood Carmichael's automated ventilators having an assist control mode to include alarms or ventilator warnings to enhance operation. Ex.1004, p.9, 14; Ex.1002, ¶¶307-308.

POSITA would have recognized Carmichael's disclosed avoidance of oxygen toxicity in a patient or the patient experiencing a dangerously low oxygenation level and been motivated to include the Tehrani'268 alarm unit and alarm configuration into an automated ventilator, such as that of Anderson (*e.g.*, the Macintosh computer running the LABVIEW control program). Ex.1013, p.290.

Utilizing a well-known control scheme for a ventilator computer to detect an artifact and generate an alarm output to a clinician as taught by Tehrani'268 would have been an obvious modification to a ventilator to assist clinicians in detecting and avoiding dangerously low oxygen levels of a patient and to detect and avoid oxygen toxicity in a patient undergoing ventilator treatment. Ex.1002, ¶¶309-312.

Such a combination would have been a predictable implementation of a known program for a ventilator microcomputer to provide known alarm condition detection and alarm generation. Ex.1002, ¶¶311-312.

5. Claims 5-6

Claims 5-6 are reproduced in Ground 1 *supra.*

Anderson discloses an A/D converter for measurement data input to the Macintosh computer 36. Ex.1013, p.290, Fig.1.

Tehrani'268 also discloses A/D converters 18, 20 "coupled to the outputs 26 and 28 of an oxygen sensor 32 and a carbon dioxide sensor 30, respectively." Ex.1006, 2:64-67. Ventilators include "additional sensors and associated A/D's, if provided" so that a computer can calculate "the required ventilation and the optimum frequency for the next breath." Ex.1006, 3:58-62.

Tehrani also discloses D/A converters 50 and 52 for control signals generated by the ventilator computer to be sent to analog components Ex.1006, 2:23-24.

Carmichael teaches a bedside oximeter for measuring hemoglobin saturation levels as a substitute for an intra-arterial PaO2 monitor disclosed by Anderson (Ex.1004, p.13). The interchangeability of an oximeter and a PaO2 monitor and vice versa would have been recognized by a POSITA as predictable substitution of equivalents. Ex.1002, ¶¶313-319. Both Carmichael and Anderson disclose providing oxygen level detection data to an automated ventilator computer for

generating PEEP and FIO2 ventilator control signals, and the oxygen measurements would have been provided by any known analog oxygen sensor or any digital pulse oximeter. Ex.1002, ¶¶320-322.

6. Claim 9: The apparatus of claim 2, wherein data indicative of the patient's measured intrinsic positive end-expiratory pressure (PEEPi) is provided to the first means.

Carmichael discloses automated ventilators operating in assist control mode for monitoring and controlling PEEP. Ex.1004, pp.12-14. PEEPi would have been understood as an intrinsic component of the PEEP value provided to Carmichael's automated ventilator. Ex.1002, ¶323.

Rossi (Ex. 1015) confirms that in "Assisted modes of mechanical ventilation", measurement of "$PEEP_i$ should routinely be performed in the course of the assessment of respiratory function…" Ex. 1015, p.530, col.1:10-15. Rossi Fig. 8 illustrates "PEEP as including $PEEP_i$." *Id*., at p.532. Rossi describes that "the minimum and maximum level of PEEP are represented by $PEEP_{i,dyn}$ and $PEEP_i$." *Id.* at p.533, col.2:16-17; Ex.1002, ¶¶324-335.

7. Claim 10: The apparatus of claim 9, wherein the data indicative of PEEPi is supplied by a monitor operatively coupled to the first means.

See claim 9 *supra*. Carmichael discloses ventilators employed PEEP data which would have been understood to include a PEEPi component. Ex.1002, ¶¶336-345.

Carmichael discloses ventilators operating in an assist control mode wherein PEEP is monitored and "the average maximum applied PEEP did not exceed 25 cmH_20." Ex.1004, p.14, col.2:11-12. A POSITA would have understood $PEEP_i$ to be an intrinsic component of Carmichael's disclosed PEEP, as recognized by Rossi. Ex. 1015, pp.532-533; Fig.8; Ex.1002, ¶¶336-339. Carmichael discloses automated ventilators controlled to ensure total PEEP, and thus its $PEEP_i$ component, do not exceed an allowable maximum set by clinicians. Ex.1004, p.12; Ex. 1002, ¶¶340-45.

Anderson discloses ventilators to provide an appropriate PEEP and FiO2 to the patient. Ex.1013, p.292.

Tehrani teaches that it was well known to utilize monitors to measure such inputs (e.g. valve settings of the ventilator that control PEEP as disclosed by Anderson) for providing data related to such a parameter to a ventilator computer 36. Ex.1006, 3:8-11, 11:1-5. Tehrani teaches that ventilators commonly utilized values "supplied via the A/D converters" so that "they can also be monitored continuously." Ex.1006, 3:8-11. Anderson also teaches that the computer received PEEP measurement data from the ventilator. Ex.1013, p.290 (explaining that "important information from both the PaO2 monitor and Ventilator" were obtained "via RS232 serial ports.").

b. The Scope Of Rossi

Carmichael is discussed *supra* as maintaining PEEP between minimum and maximum values for each selected FIO2 level. Ex.1004, pp.12-14.

Rossi discloses that PEEPi is a component of PEEP that was routinely measured to define minimum and maximum levels of PEEP. Ex.1015, p.533.

c. A POSITA Would Have Been Motivated To Use Rossi's Max And Min PEEPi Settings In Anderson's Ventilator To Ensure Patient Safety

A POSITA would have understood from Anderson that the PEEP measurement data was from a PEEPi monitor. Rossi explains that in "Assisted modes of mechanical ventilation", measurement of $PEEP_i$ "should routinely be performed in the course of the assessment of respiratory function…." Ex. 1015, p.530, col.1:10-15, pp.532-533. $PEEP_i$ would have been regularly monitored because "the minimum and maximum level of PEEP are represented by $PEEP_{i,dyn}$ and $PEEP_i$." *Id.* at p.533, col.2:16-17. A POSITA would have been motivated to measure and monitor PEEPi to automate the control process for ventilator operation and ensure the PEEP provided to patient was within the defined maximum and minimum values affected by $PEEP_i$. *Id.* at p.533, col.2:16-17, Ex.1002, ¶¶340-345.

Monitors for providing PEEPi data to a ventilator computer for monitoring and evaluating PEEPi levels to determine appropriate PEEP would have been

included in a ventilator described by Anderson in view of Rossi. Ex.1002, ¶¶344-45.

8. Claim 11

Claim 11 is reproduced in Ground 1, *supra*.

Carmichael, in combination with Anderson and Tehrani'268 as discussed with regard to claim 3 *supra*, discloses an automated ventilator with a program for determining the patient arteria partial pressure oxygen (Ex.1004, pp.13-14), required FIO2, and required PEEP for a next breath to be taken. Ex.1004, p.12. Anderson discloses use of such program modules as LABVIEW software modules. Ex.1013, p.290; Ex.1002, ¶¶346-364.

9. Claim 12: The apparatus of claim 11, wherein the program means further determines, from the input data: whether there has been an artifact in the data indicative of the measured oxygen level of the patient, and wherein the program means further replaces and/or corrects the data based on the artifact and generates a warning signal in the event the artifact is determined

Claim 12 is reproduced in Ground 1 *supra*.

Carmichael, in combination with Tehrani'268 and Anderson as discussed with regard to claim 3 *supra*, discloses program modules for performing the alarm and oxygen artifact detection features of claim 12. *See* claim 3 *supra*; Ex.1002, ¶¶347-360.

10. Claim 29

Claim 29 is reproduced in Ground 1 *supra.*

Carmichael, in combination with Anderson, is discussed in Ground 2 with regard to claim 1, *supra*.

Anderson discloses an automated closed-loop ventilator control system to maintain appropriate levels of PEEP and FiO2 in patients with ARDS. Ex.1013, p.289 (Abstract):

> The computer constantly reads important information from both the PaO2 monitor and Ventilator via RS232 serial ports. This information is used to calculate new values of PEEP and FiO2 that are subsequently transmitted to the ventilator for proper adjustments in patient therapy.

Ex.1013, p.290.

A POSITA would have been motivated to implement Carmichael's disclosed FIO2 and PEEP control treatment protocol for automatic ventilator control in a ventilator as disclosed by Anderson. Such a modification would "systematically maintain appropriate levels of positive end-expiratory pressure (PEEP) and inspired oxygen (FiO2) in patients." Ex.1013, p.289 (Abstract); Ex.1002, ¶¶365-375.

11. Claim 30: The method of claim 29, wherein step (b) further comprises determining, from the data indicative of the measured oxygen level in (a), whether there has been an artifact in the measured oxygen level, and replacing and/or correcting the data signal in (a) in the event the artifact is determined.

Claim 30 would have been obvious. *See* claim 3 *supra*; Ex.1002, ¶¶376-392.

12. Claim 31

Claim 31 is reproduced in Ground 1 *supra*.

Carmichael, in combination with Anderson and Tehrani'268, is discussed in Ground 2 with regard to claim 5, *supra*.

Carmichael's automated ventilator would have converted digital control signals produced thereby to analog signals of a patient for controlling FIO2 and PEEP.

In addition, D/A converters were well-known data conversion devices included in the automated ventilators such as those reported upon by Carmichael, as evidenced by Anderson and Tehrani'268 (Ex.1006) which each disclose converters to convert digital signals to analog for controlling the ventilator. D/A and A/D conversions were commonly utilized in ventilator designs and their implementation would have been a predictable use of known elements for their known function data conversion function. Ex.1002, ¶¶393-403.

13. Claims 32-33

Claims 32-33 are reproduced in Ground 1 *supra.*

Alternately, claims 32-33 would have been obvious. *See* claim 1 of Ground 2 *supra*.

Carmichael discloses the use of pulse oximetry for measuring patient hemoglobin saturation levels (Ex.1004, p.13), and Anderson teaches the monitoring

of PaO2 by a computer for continuously controlling FiO2 and PEEP settings on a Hamilton Amadeus ventilator. Ex.1013, p.290.

Further, deriving a PaO2 value from a hemoglobin saturation value was a well-known process using oximetry data. Ex.1004, p.13-14. Such a derivation from pulse oximeter measurements was a well-known data conversion process. Ex.1002, ¶¶404-406.

14. Claim 41

Claim 41 is reproduced in Ground 1 *supra*.

Carmichael discloses the first alternate oxygen calculation of claim 41 involving a stepwise control scheme for FIO2 calculations.

As regards the second alternate, optional PID calculation of claim 41, Anderson discloses a PID technique for controlling FIO2 calculations. Ex.1013, pp.290-291. It would have been an obvious substitution to use an automated ventilator of Anderson with a PID oxygen calculation to implement the treatment protocol of Carmichael. Ex.1002, ¶407.

E. Claims 1-6, 9-12, 29-33 And 41 Would Have Been Obvious Over Taube In View Of Carmichael/ARDSNET, Clemmer, And Rossi (Ground 3)

Claims 1-6, 9-12, 29-33, and 41 are obvious in view of Taube, Carmichael/ARDSNET, Clemmer, and Rossi. Ex.1002, ¶¶408-486, Appendix 3.

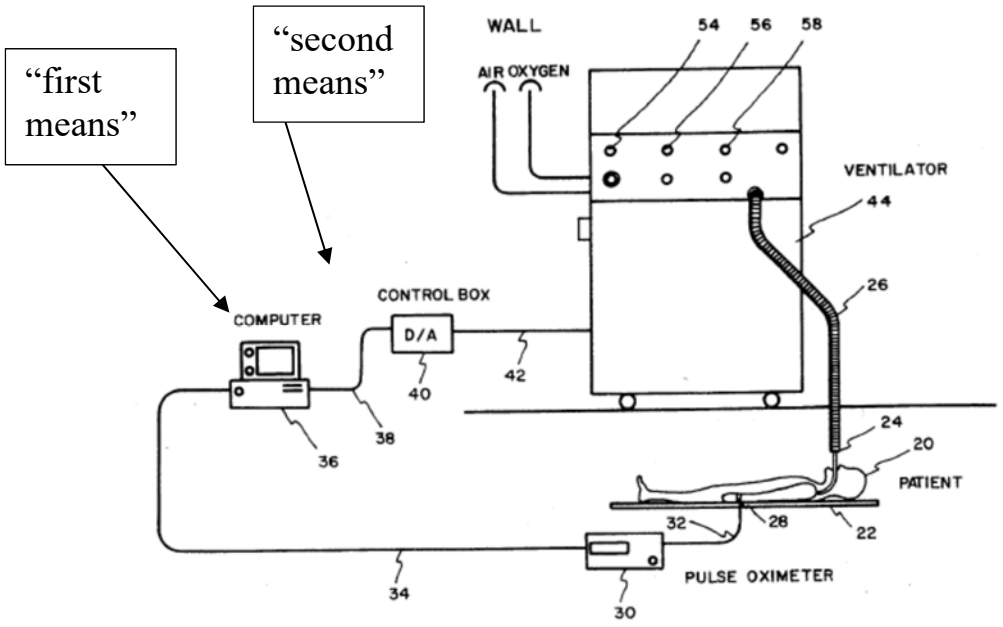
1. Claims 1-2

These claims are reproduced in Grounds 1 and 2 *supra*.

a. The Scope Of Taube

Taube, mischaracterized by Owner during prosecution of the '571 Patent to downplay its relevance, is relied upon in Ground 3 to highlight its automated closed loop control of oxygen to a desired level.

Taube discloses "the adaptive control of the inspiratory ventilation time (Tinsp), peak expiratory end pressure (PEEP), and fraction in inspired oxygen (FiO_2)". Ex.1005, 1:25-30. Figure 1 as annotated illustrates Taube's ventilation system mapped to claim 1 first and second means (Ex.1002, ¶¶409-410):



Taube discloses a first means as the input side of computer 36, and a second means as an output side signal generator module of the computer and D/A control box 40. Ex.1005, 4:30-50, 5:8-6:15. Taube discloses that computer 36 "is controlled by program modules to determine Tinsp, PEEP, and FiO_2." Ex.1005, 5:8-10;

Ex.1002, ¶411. The operation "of the Tinsp, PEEP, and FiO_2 control program" included (Ex.1005, 5:15-40):

1. The computer receives an HSAT signal from the pulse oximeter and calculates a PaO_2 value for the patient.

2. The computer then determines modification values of Tinsp, PEEP, and FiO2 from the calculated PaO2.

Corresponds to claim elements 1.1-1.3

3. The computer then determines the proportional, differential, and integral gain coefficients to develop control signals to the ventilator.

4. The computer then sends control signals to the ventilator for the modification of Tinsp, PEEP, and FiO2 values.

Corresponds to claim element 1.4

5. The patient then breaths in through a breathing tube the positive pressure air at the modified Tinsp, PEEP, and FiO2 values. The values of Tinsp, PEEP, and FiO2 are chosen by the computer to maintain a desired level of the patient's blood oxygen level.

Corresponds to claim element 1.5

Ex.1002, ¶412.

Taube's ventilator is configured to automatically control " FiO_2, PEEP, and Tinsp levels" using a patient's "hemoglobin saturation signals from the pulse oximeter 30." Ex.1005, col.6:3-5. Taube's "control mechanism is derived from the known relationship between the preset level of Tinsp, PEEP, minimum required FiO2 delivered to the patient, and predetermined lung function dynamics in order to maintain a desirable PaO_2." Ex.1005, col.1:37-41. Taube does not explicitly discuss a desired value for a hemoglobin saturation setpoint.

Carmichael, discussed *supra*, and corroborated by ARDSNET, discloses "oxygen saturations of 86% to 90%" as a desired setpoint. Ex.1004, p.14, Col.1,lines 30-34. A patient's measured oxygen saturation level obtained via "oximetry" (Ex.1004, p.14,Col.2, lines 45-54) is monitored and "increased FiO2s and incremental application of PEEP" were utilized so that the patient's hemoglobin saturation would be brought closer to the desired "oxygen saturations of 86% to 90%." Ex.1004, pp.13-14; Ex.1002, ¶¶413-418.

b. A POSITA Would Have Been Motivated To Modify Taube's Ventilator To Keep A PEEP/FIO2 Ratio Within A Prescribed Range

A POSITA would have been motivated to modify Taube's ventilator system control to keep the PEEP/FIO2 ratio within a prescribed range as disclosed by Carmichael. Ex.1004, pp.12-14; Ex.1002, ¶¶419-430.

Carmichael states that for an FIO_2 of 0.6, maximum PEEP was prescribed to thereby keep an FIO2/PEEP ratio within a prescribed range while maintaining patient hemoglobin saturation at a desired level. Ex.1004, p.12. Carmichael teaches to reduce a difference between the measured oxygen level of the patient obtained via the pulse oximeter 30 and a desired value--oxygen saturations of 86% to 90%." Ex.1004, p.14, Col.1, lines 30-34. Carmichael explains this "was desirable and should be achieved through the use of increased FiO_2s and incremental application of PEEP" so that the patient's hemoglobin saturation would be brought closer to the desired "oxygen saturations of 86% to 90%." Ex.1004, p.13, col.2, l.51–p.14, col.1, l.34; Ex.1002, ¶¶419-423.

A POSITA would have been motivated to implement the ventilator of Taube with the known PEEP/FIO2 ratio and treatment protocol disclosed by Carmichael to ensure that mechanical ventilation would improve important clinical outcomes in patients by keeping the patient's hemoglobin saturation closer to the desired "oxygen saturations of 86% to 90%" (Ex.1004, p.14, col.1, ll.30-34) while avoiding an application of PEEP that could be higher than a permissible maximum value. Ex.1004, pp.12, 14; Ex.1002, ¶¶424-430.

c. Modifying Taube's Program With Carmichael's Treatment Protocol Would Have Been Routine As Demonstrated by Clemmer

Clemmer is cited herein as evidence of the skill level in the art for programming an automated ventilator with any of a variety of treatment protocols. Ex.1008, 20:30-25:20. Clemmer illustrates exemplary protocols in Figures 2-18B and at 20:30-25:20. Ex.1002, ¶¶433-434, 438.

A POSITA would have been motivated to modify Taube's program modules to utilize the known treatment protocols of Carmichael given the routine and common practice of adopting different ventilator control treatment protocols in a ventilator program as evidenced by Clemmer. Such a modification would have involved known programming techniques and constituted a predictable, expected result. Ex.1002, ¶¶431-438.

2. Claims 3-4

Clemmer would have motivated a POSITA to incorporate an alarm unit and oxygen level artifact detection as recited in claim 3 (which is also an oxygen level outside a prescribed range as recited in claim 4), and also provide a warning related to a detected oxygen level as well-known prior art ventilator design recognized in the art. Ex.1008, 2:1-12; Ex.1002, ¶¶439-442.

A POSITA would have been motivated to include an alarm unit for Taube's ventilator computer 36 to detect and avoid dangerous oxygen levels in a patient – a

known problem from Clemmer and Carmichael. Clemmer recognizes it was common for ventilator systems "with integrated alarms and alerts" to "notify the clinician if patient parameters are not within the target range during mechanical ventilation." Ex.1008, 2:1-12 (incorporating U.S. Pat. No. 5,355,893 to Mick (Ex.1014) by reference therein).

Utilizing a well-known control scheme for a ventilator computer to detect an artifact (*e.g.*, an error) and generate an alarm for output to a clinician as taught by Clemmer would have been an obvious modification to assist clinicians in detecting and avoiding dangerous oxygen levels in a patient. This would have been a predictable implementation of a known program for a ventilator microcomputer. Ex.1002, ¶¶439-442.

3. Claims 5-6

Claim 5-6 are reproduced in Ground 1 *supra*.

Taube discloses a digital pulse oximeter 30. Taube also discloses an A/D converter for converting analog measurements to digital data for input to the computer 36.

It would have been obvious to substitute the digital pulse oximeter 30 of Taube's system with an analog oxygen sensor as disclosed by Carmichael for collecting patient arterial hemoglobin saturation data. The use of an analog device and an A/D converter for computer 36 is an interchangeable, predictable substitute

for a digital pulse oximeter 30. Ex.1004, p.13; Ex.1013, pp.291-292, Figs.1-2. This modification would have been a known adaptation to substitute analog oxygen sensors of a care facility ventilator to accommodate a larger array of possible oxygen sensors. Ex.1002, ¶¶443-449.

4. Claims 9-10

Claims 9-10 are reproduced in Ground 2 *supra*.

Taube discloses that ventilator 44 has knobs 54, 55, and 56 that "enable manual regulation by physician or operator to provide an appropriate Tinsp, PEEP, and FiO2 to the patient." Ex.1005, 5:2-10.

Clemmer teaches using monitors to measure such parameters (e.g. valve settings of the ventilator that control PEEP as disclosed by Taube) for providing data related to such a parameter to a ventilator computer 36. Ex.1008, 2:1-12.

Monitors for providing PEEPi data to a ventilator computer for use in monitoring and evaluating PEEPi levels for determining an appropriate PEEP were known. Ex.1002, ¶¶451, 455, 457, 460.

Rossi discloses that PEEPi was a well-known component of PEEP that was routinely measured to define minimum and maximum levels of PEEP. Ex.1015, pp.530-533. Rossi explains that in "Assisted modes of mechanical ventilation", measurement of $PEEP_i$ "should routinely be performed in the course of the assessment of respiratory function…" Ex. 1015, p.530, col.1:10-15, pp.532-533.

$PEEP_i$ would have been regularly monitored because "the minimum and maximum level of PEEP are represented by $PEEP_{i,dyn}$ and $PEEP_i$." *Id.* at p.533, col.2:16-17.

A POSITA would have been motivated to measure and monitor PEEPi for automated ventilator operation to ensure the PEEP provided to a patient was within the defined maximum and minimum values affected by $PEEP_i$. *Id.* at p.533, col.2:16-17.

Monitors for providing PEEPi data to a ventilator computer for monitoring and evaluating PEEPi levels to determine appropriate PEEP would have been obvious for inclusion in a ventilator taught by Taube where a PEEP signal is included. Ex.1002, ¶¶450-462.

5. Claims 11-12

*See c*laims 1, 2 *supra*. Ex.1002, ¶¶463-467.

Claim 11: Taube discloses use of program modules. Ex.1005, 5:8-6:8. Carmichael discloses a ventilator microcomputer with a program for determining the patient arterial partial pressure oxygen (Ex.1004, pp.13-14), required FIO2, and required PEEP for a next breath to be taken. Ex.1004, p.12.

Claim 12: *See* claim 3 supra. Clemmer discloses use of program modules for performing the alarm and oxygen artifact detection features of claim 12. Ex.1008, 2:1-12.

6. Claim 29

Taube in view of Carmichael and Clemmer would have rendered claim 29 obvious. *See* claim 1 *supra*.

Taube discloses that computer 36 "is controlled by program modules to determine Tinsp, PEEP, and FiO_2." Ex.1005, 5:8-10. The operation "of the Tinsp, PEEP, and FiO_2 control program" included (Ex.1005, 5:15-40):

1. The computer receives an HSAT signal from the pulse oximeter and calculates a PaO_2 value for the patient.

2. The computer then determines modification values of Tinsp, PEEP, and FiO2 from the calculated PaO2.

Corresponds to claim elements 29.1-29.3

3. The computer then determines the proportional, differential, and integral gain coefficients to develop control signals to the ventilator.

4. The computer then sends control signals to the ventilator for the modification of Tinsp, PEEP, and FiO2 values.

5. The patient then breaths in through a breathing tube the positive pressure air at the modified Tinsp, PEEP, and FiO2 values. The values of Tinsp, PEEP, and FiO2 are chosen by the computer to maintain a desired level of the patient's blood oxygen level.

Corresponds to claim element 29.4

Ex.1002, ¶469.

Taube's ventilator control process "is derived from the known relationship between the preset level of Tinsp, PEEP, minimum required FiO2 delivered to the patient, and predetermined lung function dynamics in order to maintain a desirable PaO_2." Ex.1005, col.1:37-41. A POSITA would have been motivated to modify Taube's ventilator system to utilize the FIO2 and PEEP control scheme disclosed by Carmichael for automatic control of ventilator operations. Ex.1004, pp.12-14; Ex.1002, ¶¶468-471.

Clemmer teaches that the implementation of ventilator protocols as disclosed by Carmichael on a ventilator computer 36 disclosed by Taube's would have been a routine, common application of a known technique for improving ventilator operation and performance. Ex.1002, ¶471.

7. Claim 30

Claim 30 is obvious for the same reasons as claim 3, *supra*; Ex.1002, ¶¶472-475.

8. Claim 31

Claim 31 is obvious for reasons discussed with respect to claim 5, *supra*.

Taube's D/A control box 40 converts digital signals to analog for controlling the ventilator, and Taube's digital pulse oximeter provides an internal analog to

digital conversion for providing patient oxygen level data to a computer 36. Ex.1002, ¶479.

It would have alternately been obvious to modify Taube's digital pulse oximeter to utilize an analog oximeter sensor with Taube's A/D signal converter. Ex.1002, ¶¶476-480.

9. Claims 32-33

See claims 1 and 6 *supra*.

Claim 32 recites the measuring of the oxygen level of the patient to include measuring an arterial hemoglobin oxygen saturation of the patient via pulse oximetry.

Claim 33 recites that an arterial partial pressure of oxygen is derived and the arterial hemoglobin oxygen saturation of the patient is measured by a pulse oximeter.

Taube's computer 36 receives "hemoglobin saturation (HSAT)" data from a pulse oximeter 30. Ex.1005, col.4:37-50. "The computer 36 utilizes the hemoglobin saturation" to determine "the partial pressure of arterial oxygen (PaO2) and thus the appropriate level of inspiratory ventilation time (Tinsp), peak expiratory end pressure (PEEP) of ventilation, and fraction of positive pressure inspired oxygen (FiO2) to provide to the patient." Ex.1005, col.4:40-50. Converting the HSAT value to the PaO2 value is a well-known calculation process. Ex.1008, col.19:20-20:56; Ex.1002, ¶¶481-484.

10. Claim 41

Claim 41 recites that "the required concentration of oxygen in the inspiratory gas of the patient (FIO2) is calculated by using a stepwise control scheme and/or by using a proportional-integral-derivative (PID) technique." *See* claim 1 *supra*.

Taube, as modified to perform Carmichael's treatment protocol, would have included an FIO2 calculation technique and a stepwise control scheme for FIO2 calculations. Ex.1004, p.12; Ex.1005, col.5:8-6:8; Ex.1007, Table 1; Ex.1008, col.20:30–25:20; Ex.1002, ¶¶485-486.

VIII. OTHER CONSIDERATIONS

A. Any Purported Secondary Considerations Evidence Does Not Overcome The Strong Evidence Of Obviousness

All elements of the challenged claims were known in the art, and any differences would have been obvious to a POSITA based on the applied references and the knowledge in the art. Any secondary considerations evidence Patent Owner may offer in this proceeding would be insufficient to overcome the very strong evidence of obviousness of the challenged claims. Ex.1002, ¶¶487-490.

B. §325(d) Warrants Institution

The factors recited in *Becton, Dickinson & Co. v. B. Braun Melsungen AG*, IPR2017-01586, Paper 8 at 17 (PTAB Dec. 15, 2017) (precedential) weigh in favor of institution. *Id.* at 4. In the present Petition substantially different prior art and arguments not considered by the USPTO due to material error during prosecution

warrant institution.

In evaluating discretion under §325(d), all of the non-exclusive factors favor institution:

> (a) the similarities and material differences between the asserted art and the prior art involved during examination; (b) the cumulative nature of the asserted art and the prior art evaluated during examination; (c) the extent to which the asserted art was evaluated during examination, including whether the prior art was the basis for rejection; (d) the extent of the overlap between the arguments made during examination and the manner in which Petitioner relies on the prior art or Patent Owner distinguishes the prior art; (e) whether Petitioner has pointed out sufficiently how the Examiner erred in its evaluation of the asserted prior art; and (f) the extent to which additional evidence and facts presented in the Petition warrant reconsideration of prior art or arguments.

Becton, Paper 8 at 17–18 (precedential).

1. Factors (a) through (f)

Arguments presented by Petitioner address material error of the original prosecution in its failure to consider material, non-cumulative prior art relied upon herein.

Petitioner demonstrates material differences between newly cited art and art considered during prosecution. The newly cited prior art to Carmichael, ARDSNET, and Anderson addresses key elements regarding determining of PEEP, after

determining FIO2, to keep a calculated PEEP/FIO2 ratio within a prescribed range, while keeping measured oxygen above a predefined value. These claim elements improperly led to allowance.

Further, this Petition places Taube, discussed *supra,* in a new light by highlighting material mischaracterizations made during prosecution that were relied upon by the Examiner regarding controlling a ventilator to a desired value of oxygen, and by citing to sections of Taube not previously cited to the Examiner. These mischaracterizations and overlooked citations, coupled with new, non-cumulative prior art in this Petition, highlight material errors of prosecution that warrant institution.

Owner materially mischaracterized Taube in stating:

> [t]here is simply no mechanism in place in *Taube's* algorithm for FIO2 to be determined toward reducing the difference between the measured oxygen level of the patient and a selectable desired value.

Ex.1009, 150.

According to Owner:

> the only objective stated in col. 4 of Taube regarding F_{IO2} is 'to produce the highest obtainable patient arterial blood oxygen level with a minimum of oxygen necessary to be added to the air supply [for an air supply] having a 21% oxygen concentration'

Ex.1009, pp.149-150, quoting col.4:57-50 of Taube.

This was clear and material error, as Taube specifically states that ventilator control is designed so that a:

> minimum level of FIO2, minimum level of PEEP, and maximum level of Tinsp for the patient" (Ex.1005,6:1-2) is provided "**to maintain a desired level of the patient's blood oxygen level**.

Ex.1005, col.5:12-5:38 (emphasis added). *See also* Ex.1005, Abstract and 1:31-41. Taube adjusts FIO2 to reduce the difference between the patient's measured oxygen level and a desired value so that the patient's oxygen level will converge to a desired value. Ex.1002, ¶¶33-34.

Taube, in combination with prior art cited herein, is clearly relevant to patentability of the challenged claims.

Clemmer, Rossi, Waisel, and Tehrani'268, cited during prosecution by Owner (Ex.1009, pp.366-367, 332, 264), were not fully appreciated and relied upon in any rejection. Overlooked citations from this prior art in the new combinations set forth in this Petition, raise unpatentability issues that warrant institution. *REG Synthetic Fuels, LLC v. Neste Oil, Oyj*, IPR2018-01374, Paper 11 (PTAB Feb. 19, 2019) (explaining, "it is unclear to what extent the reference was evaluated during examination, as we cannot draw any particular inference from the mere inclusion of the reference on an Information Disclosure Statement.").

IX. CONCLUSION

Claims 1-6, 9-12, 29-33 and 41 of the '571 Patent are unpatentable. Petitioners have shown a likelihood of success on the merits. Therefore, this Petition should be granted and the Board should institute trial.

Respectfully submitted,

Date: July 10, 2020

/Patrick C. Keane/

Patrick C. Keane, Esq.
Registration No. 32,858
BUCHANAN INGERSOLL & ROONEY PC
1737 King Street, Suite 500
Alexandria, Virginia 22314
Main Telephone (703) 836-6620
Direct Telephone (703) 838-6522
Main Facsimile (703) 836-2021
patrick.keane@bipc.com
Counsel for Petitioner

APPENDIX A - LIST OF EXHIBITS

EXHIBIT	DESCRIPTION
1001	U.S. Patent No. 7,802,571, issued on September 28, 2010 to Fleur T. Tehrani ("the '571 Patent")
1002	Declaration of Richard Imbruce
1003	*Curriculum Vitae* of Richard Imbruce
1004	L. Carmichael *et al., Diagnosis and Therapy of Acute Respiratory Distress Syndrome in Adults: An International Survey,* 11(2) JOURNAL OF CRITICAL CARE 9-18 (1996)
1005	U.S. Patent No. 5,388,575, issued on February 14, 1995 to John Taube
1006	U.S. Patent No. 4,986,268, issued on January 22, 1991 to Fleur T. Tehrani ("Tehrani'268")
1007	The Acute Respiratory Distress Syndrome Network*, Ventilation with Lower Tidal Volumes as Compared with Traditional Tidal Volumes for Acute Lung Injury and the Acute Respiratory Distress Syndrome*, 342(18) JOURNAL OF MEDICINE 1301-1308 (May 4, 2000) ("ARDSNET")
1008	U.S. Patent No. 6,148,814, issued on November 21, 2000 to Terry P. Clemmer *et al.*
1009	File History of U.S. Patent Application No. 10/935,446, filed on September 7, 2004
1010	D.B. Waisel *et al., PEFIOS: A PEEP-FIO_2-SPO_2 Closed Loop Controller of Arterial Oxygen Saturation*, 79(3A) ANESTHESIOLOGY A287 (1993)
1011	D.B. Waisel *et al., PEFIOS: An Expert Closed Loop Oxygenation Algorithm*, MEDINFO 95 PROC. 1132-1136 (1995)

EXHIBIT	DESCRIPTION
1012	N. R. MacIntyre, *Building Consensus on the Use of Mechanical Ventilation,* 104 (2) CHEST 334-335 (1993)
1013	J. Anderson and T. East, *A Closed-Loop Controller for Mechanical Ventilation of Patients with ARDS,* 38 BIOMED SCI. INSTRUM. 289-294 (2002) ("Anderson")
1014	U.S. Patent No. 5,355,893, issued on October 18, 1994 to Peter R. Mick
1015	A. Rossi *et al., Intrinsic positive end-expiratory pressure ($PEEP_i$)*, 21 INTENSIVE CARE MED., 522-536 (1995) ("Rossi")
1016	C. Yu *et al*., *Improvement in Arterial Oxygen Control Using Multiple-Model Adaptive Control Procedures*, BME-34(8) IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING 567-574 (1987)
1017	Declaration of Sylvia Hall-Ellis, Ph.D.
1018	U.S. Patent No. 5,705,735, issued on January 6, 1998 to Russell G. Acorn
1019	U.S. Patent No. 5,365,922, issued on November 22, 1994 to Daniel B. Raemer
1020	U.S. Patent Application Publication No. 2005/0051168, published on March 10, 2005 to Douglas F. DeVries *et al.*
1021	U.S. Patent Application Publication No. 2004/0003813, published on January 8, 2004 to Michael J. Banner *et al*.

CERTIFICATE OF COMPLIANCE WITH 37 C.F.R. § 42.24

I hereby certify that the word count for the foregoing Petition totals 13,064 in the body of the Petition and 510 words in the figures, excluding the parts which are exempted by 37 C.F.R. § 42.24(a)(1).

Date: July 10, 2020

/Patrick C. Keane/

Patrick C. Keane, Esq.
Registration No. 32,858
BUCHANAN INGERSOLL & ROONEY PC
1737 King Street, Suite 500
Alexandria, Virginia 22314
Main Telephone (703) 836-6620
Direct Telephone (703) 838-6522
Main Facsimile (703) 836-2021
patrick.keane@bipc.com
Counsel for Petitioner

CERTIFICATE OF FILING AND SERVICE

The undersigned hereby certifies that on this 10th day of July, 2020, a true and correct copy of the foregoing **PETITION FOR *INTER PARTES* REVIEW FOR U.S. PATENT NO. 7,802,571 PURSUANT TO 35 U.S.C. §§ 311-319 and 37 C.F.R. § 42.100 *et seq.*** and **EXHIBITS 1001-1021** were filed via PTAB E2E and served by UPS on the correspondence address of record for **U.S. Patent No. 7,802,571** as follows:

Mark Robert Kendrick
Kendrick Intellectual Property Law
4127 Woodcliff Road
Sherman Oaks, CA 91403
Telephone (818) 905-3211

The undersigned certifies that a courtesy copy of the foregoing documents are being served on the inventor of U.S. Patent No. 7,802,571 by UPS as follows:

Fleur Tehrani
1042 S Hanlon Way
Anaheim, CA 92808-2503

Date: July 10, 2020

/Patrick C. Keane/
Patrick C. Keane, Esq.
Registration No. 32,858
BUCHANAN INGERSOLL & ROONEY PC
1737 King Street, Suite 500
Alexandria, Virginia 22314
Main Telephone (703) 836-6620
Direct Telephone (703) 838-6522
Main Facsimile (703) 836-2021
patrick.keane@bipc.com
Counsel for Petitioner