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CLERK, U.S. DISTRICT COURT
MIDDLE DISTRICT OF FLORIDA
TAMPA, FLORIDA

UNITED STATES DISTRICT COURT
FOR THE MIDDLE DISTRICT OF FLORIDA
TAMPA DIVISION

CASE NO.: 98-2518-CIV-T-24A

UNDERSEA BREATHING SYSTEMS, INC., a Nevada corporation,

Plaintiff,

v.

RON MULLER and NITROX TECHNOLOGIES, INC., a corporation,

Defendants.
_____/

MOTION AND MEMORANDUM FOR PRELIMINARY INJUNCTION

COMES NOW, Plaintiff Undersea Breathing Systems, Inc. ("UBS"), by and through its undersigned attorneys, and moves this Court for entry of preliminary injunction prohibiting Defendants from infringing the patent at issue and in support thereof shows this Court as follows:

Factual Background

This is an action brought by UBS against Nitrox Technologies, Inc. ("NTI") for infringement of United States Patent No. 5,846,291 ("the '291 patent," Exhibit "1," hereto). The '291 patent relates to an improved method for generating "nitrox," which is air that has an enhanced oxygen content. Nitrox was developed many years ago and initially used in medical procedures. Since the early 1960s, it has been used increasingly in recreational diving. With a higher oxygen content in a diver's breathing gas, the diver can

experience longer bottom or underwater times with greater safety.

Until the invention of Mr. Delp (subsequently assigned to Plaintiff), nitrox breathing gases were produced by adding pure oxygen to the ambient air. This technique required careful compliance in cleaning and safety procedures and posed a substantial hazard, such as the risk of explosion. (See, Affidavit of William H. Delp, Exhibit "2," hereto.)

UBS entered the recreational nitrox diving market several years ago promoting its patented system. The advantages of UBS's system is that the oxygen-enriched gas is produced by passing ambient air through a gas permeable membrane. With this method, the individual operator can produce an oxygen-enriched breathing gas without the hazards previously associated with nitrox production. UBS's first patented process is outlined in United State Patents No. 5,611,845 ("the '845 patent," Exhibit "3," hereto.) Shortly after UBS began marketing its products, Defendant NTI entered the nitrox field for recreational divers. In order to preserve its patented rights, UBS filed an action on or about March 24, 1997 in the United States District Court for the Northern District of Illinois, Eastern Division, alleging patent infringement against NTI. NTI defended the action, aggressively attacking the validity of the patented technology by claiming that the process was well known or would have been obvious to those skilled in the art. An extensive trial ensued, with NTI presenting much testimony and many documents which it alleged proved that the '845 patent was invalid. After a trial, Judge Denlow held that the

'845 patent and therefore the technology it described was not known or obvious and therefore the '845 patent was valid. (See generally, Memorandum Opinion and Order of Judge Denlow dated November 20, 1997, Exhibit "4" hereto.)

However, Judge Denlow also found that NTI also did not infringe the '845 patent based upon what amounts to two limitations found in the '845 patent. Under the '845 patent, the system requires any infringing product "... to selectively heat and cool said compressed air..." and required an accused process to further have a "means for selectively distributing said oxygen enriched air...for further use." The court found that under a literal interpretation of the claims and under the doctrine of equivalents, NTI products did not contain these two limitations and therefore there was no infringement. A significant issue that was debated in the Northern District of Illinois case was whether NTI's act of reducing air pressure, which necessarily cools the air, falls within the claim language. The Judge found that under the language of the claims, there must be some separate element to cool the air, and the naturally occurring cooling during pressure regulation was not sufficient. (Exhibit "4," Order at pp. 38-39.) The Judge also found that merely having a relief valve at the end of the system did not meet the limitation of "selectively distributing the oxygen." (Exhibit "4," Order at p. 38.) Plaintiff UBS accepted the court's decision and has not appealed the matter.

Defendant's System Infringes the Patent

In the court's findings, Judge Denlow provided a detailed analysis of the features of the NTI system, which elements of the patent were found in Nitrox's system and which were not. Subsequent to the Illinois court's decision, the '291 patent issued, which provides new claim language on these two elements. The new claim language of the '291 patent clearly overcomes the limitations the court found to avoid infringement, which now is the best evidence that the NTI system infringes the patent-in-suit.

The specific heating and cooling claim language which caused the Court difficulty was the following limitation:

> Means for selectively heating and cooling said compressed air as it passes between said air supply and said permeable membrane gas separation system;

Exhibit "3," '845 patent, Claim 23, Col. 9-10

Because this language was added during prosecution history, the Court found that the limitation was used to distinguish Delp's invention from the prior art presented to the examiner and therefore narrowly construed the language. (Exhibit "4," Order at p. 21.) The Court specifically found:

> The fourth limitation of claim 23 claims a *"means for selectively heating and cooling said compressed air as it passes between said air supply and said permeable membrane gas separation system."* The Court construes the fourth limitation to correspond to the following structures and functions: the structure recited in the specification for the means for selectively heating and cooling the compressed air includes: (1) a heating and cooling heat exchanger which includes a commercially available spin vortex tube, which has a cold nitrogen gas exhaust directed towards the first coil and a hot nitrogen gas exhaust directed towards the second coil,

> and two heat exchanger lines, with the corresponding first coil along one line and second coil along another line; (2) two solenoid valves; (3) a solenoid control unit; and (4) a temperature sensor. . . . The Court concludes that the function found in this limitation includes both the ability to heat *and* to cool.

(Exhibit "4," Order at pp. 25-26.)

UBS argued that the cooling ability of a pressure regulator was an equivalent function under the doctrine of equivalents, thereby meeting the limitation of this claim language. The court found otherwise. The court found "[although a pressure regulator will cool the air passing through it as it reduces the air's pressure, the cooling is a function of the type of regulator selected and the amount of pressure drop. Defendant's pressure regulator cannot cool the compressed air passing through it in the same 'selective' manner that Plaintiff's heat exchanger can. The two devices perform their function in such a drastically different manner that no equivalence of structure and no identity of function can be found." (Exhibit "4," Order at p. 33.) The patent-in-suit no longer contains this limitation and thus there is no application of the doctrine of res judicata.

Under Claim 1 of the new '291 patent the limitation is eliminated. Claim 1 recites: "b) reducing the pressure of the gas stream, with cooling." (Exhibit "1," '291 patent, Col. 7, Line 66.) No longer does the claim language require the "selective" manner of cooling which the court found was required in the '845 patent. The NTI's system, as found by the Judge, does indeed "reduce the pressure, with cooling." (Exhibit "4," Order at p.

33.) No longer is there a requirement that the NTI system have a cooling element to selectively cool, all that is required is that the NTI system reduce the pressure with accompanying cooling, which it does.

With regard to the second element which caused Judge Denlow concern, once again the '291 patent no longer has the limitation used to avoid infringement. The '291 patent only requires an outlet for the oxygen enriched air and an outlet for the nitrogen side: "one outlet on an inlet side of the membrane system and another outlet on an opposite side of the membrane system." (Exhibit "1," '291 patent, Col. 8, Lines 5-8.) Under the '845 patent, an infringing system must have a "means for selectively distributing said [nitrox] component for further use. (Exhibit "3," Claim 23; see, Exhibit "4," Order at p. 27.) The court found this limitation required an infringing system to "allow the flow of nitrox through the feed line to be 'permitted, shut off and regulated.'" (Exhibit "4," Order at p. 27.) Because the NTI system had only a relief valve, which could not stop or vary the flow, the NTI system did not infringe. (Exhibit "4," Order at p. 34.) The patent-in-suit requires only an "outlet," which clearly the NTI system has. There is no limitation which requires the NTI system to stop or vary the flow. Under the patent-in-suit the NTI system clearly infringes.

Defendant's Infringement Has a Significant Impact

The relevant market for such systems is somewhat limited. UBS's principal customers are the approximately 1,700 shops located

in the United States. (Exhibit "2.") Of those, only about two-thirds have the financial resources to purchase a UBS system, which costs anywhere from $6,900 for a smaller system to $50,000 for the largest system. (Exhibit "2.") However, because the UBS system has an indefinite life span, there is no realistic replacement market for the system. (Exhibit "2.") Accordingly, any infringing device offered in the marketplace has a disproportionate impact on UBS. (Exhibit "2.") In such a market any infringing sales strongly affect UBS.

Infringement Has Been Admitted

The new patent has been analyzed by NTI and at least one shareholder believes the NTI system infringes. Mr. St. Claire, a principal shareholder of NTI, has acknowledged that the NTI system infringes the '291 patent. (See, Declaration of Christian St. Claire, attached hereto as Exhibit "5.") Certainly, Mr. St. Claire is intimately familiar with the NTI system and, if he admits infringement, UBS has certainly met its burden of proof. Moreover, at least one other use of an NTI system has consented to a final order of infringement. (See, Exhibit "6" hereto.)

Standard for Preliminary Injunction

In order to obtain a preliminary injunction in a patent infringement suit, the Plaintiff must establish (a) a strong probability of success on the merits, (b) irreparable injury, (c) the balance of hardships tip in UBS's and (d) the impact of the injunction would not adversely affect public interest. We Care, Inc. v. Ultra-Mark International Corp., 930 F.2d 1567, 18 USPO 2d

1562 (Fed.Cir. 1991); 35 U.S.C. §285. The standards in considering a preliminary injunction are the same in patent cases as in other areas of law. High Tech Medical Instrumentation, Inc. v. New Image Industries, Inc., 49 F.3d 1551, 33 USPO 2d 2005 (Fed.Cir. 1995). The matter of preliminary injunctive relief is committed to the sound discretion of the trial court. Oakley, Inc. v. International Tropic-Cal, Inc., 923 F.2d 167, 17 USPO 2d 1401 (Fed.Cir. 1991).

Likelihood of Success on the Merits

The burden on one who seeks a preliminary injunction in a patent suit is no different than for other kinds of intellectual property. Plaintiff must present a clear showing that the patent is valid and infringed. Atlas Powder Co. v. Ireco Chemicals, 773 F.2d 1230, 227 USPO 289 (Fed.Cir. 1985). A patent is presumed valid and the challenger has the burden of coming forward with evidence intending to show the patent is invalid. See, 35 U.S.C. §282. If the challenger presents evidence of invalidity, the burden is on the Plaintiff to show a reasonable likelihood that the attack on the validity of the patent will fail. H.H. Robertson Co. v. United Steel Deck, Inc., 820 F.2d 384, 2 USPO 2d 1926 (Fed.Cir. 1987); overruled on other grounds by Markman, 52 F.3d 967, 977, 34 USPO 2d 1321 (Fed.Cir. 1995). While it is not generally a patentee's burden to prove validity, the patentee must show the alleged infringer's defenses lack substantial merit. New England Braiding Company v. A.W. Chesterton Co., 970 F.2d 878, 23 USPO 2d 1622 (Fed.Cir. 1992). With regard to infringement, the Plaintiff must also meet a high burden. Chemical Engineering Corp. v. Marlo,

Inc., 754 F.2d 331, 222 USPO 738 (Fed.Cir. 1984). However, the patent holder is not required to prove infringement beyond all question and the proper inquiry is whether there is a substantial likelihood that the patentee will meet its burden at trial. H.H. Robinson, supra.

A. United States Patent No. 5,785,291 is Valid

By statute, a patent is presumed to be valid. 35 U.S.C. §282. In these unique factual circumstances, the accused infringer has already come forth with all known evidence to support a claim that the technology was previously known or was obvious. The patented technology has been held valid over the prior art references after an extensive trial. (See generally, Exhibit "4", Order.) What is more, substantially, if not all, of the art references identified at trial were provided to the examiner during the prosecution of the '291 patent. Thus, the examiner had the benefit of all known allegedly relevant prior art references, and the '291 patent issued. Certainly, NTI will be unable to even suggest the patent is invalid, after having presented its best case once before and the defenses being rejected. See, Northern Telecom, Inc. v. Datapoint Corp., 908 F.2d 931, 15 USPO 2d 1321 (Fed. Cir. 1990).

B. Infringement

As discussed above, much of the language has already been considered by a sister court. The only two elements which gave Judge Denlow trouble have now been eliminated as impediments to infringement. All other elements were found within the NTI system in the extremely-detailed opinion of Judge Denlow. (See generally,

Exhibit "4," Order.) Certainly, with the language now at issue in the '291 patent, there can be little doubt the NTI system infringes the '291 patent.

Irreparable Harm

The owner of a patent is generally entitled to injunctive relief against infringers. 35 U.S.C. §283. Monetary relief generally does not adequately compensate the patent owner, as limiting recovery to monetary claims would undercut the purpose of the exclusive rights granted by the patent. H.H. Robertson, supra.; Atlas Powder, supra. In situations where Plaintiff makes a strong case of validity and infringement, irreparable injury is presumed. See, Teledyne Industries, Inc. v. Windmere Products, Inc., 433 F.Supp. 710, 195 USPO 354 (S.D. Fla. 1977); Zenith Laboratories, Inc. v. Eli Lilly & Company, 460 F.Supp. 812, 201 USPO 324 (D.N.J. 1978); PPG Industries, Inc. v. Guardian Industries Corp., 75 F.3d 1558, 37 USPO 2d 1618 (Fed.Cir.1996)(the patentee's showing of infringement and validity was sufficiently strong to invoke the presumption of irreparable harm); Reebok Intern. Ltd. v. J. Baker, Inc., 32 F.3d 1552, 31 USPO 2d 1781 (Fed.Cir. 1994)(movant entitled to presumption and therefore harm based upon the strong likelihood of success on the merits); Voice Systems and Services, Inc. v. VMX, Inc., 26 USPO 2d 1106 (N.D.Okla. 1992)(when validity and infringement are established irreparable injury is presumed and the presumption can only be rebutted by clear and convincing evidence). As set forth above, this is a unique market. Any sales by NTI cause UBS significant and substantial harm. NTI's

ability to sell within the market substantially affects UBS's rights under its proprietary technology.

Balancing the Harm and Public Interest

Once a patent owner has established the elements of validity, infringement and irreparable injury, the Court remains vested with considerable discretion whether to grant or deny a motion for preliminary injunction. T.J. Smith & Nephew Ltd. v. Consolidated Medical Equipment, Inc., 821 F.2d 646, 3 USPO 2d 1316 (Fed. Cir. 1987). The discretion is to be exercised through balancing the relative hardships to the parties as well as considering the public interest. Because of the strength of UBS's claim of infringement, the public interest in protecting a patent owners' protected rights clearly predominates over any of NTI's claims of its own harm. NTI has no legal right to sell its equipment in its current configuration and cannot cry foul when required to stop. There is no public interest in permitting NTI to continue to infringe what the Patent and Trademark Office has granted to UBS.

Conclusion

UBS has conclusively proven that its patent is both valid and infringed. Through extensive court proceedings and activity in the Patent Office, UBS has secured a patent which is unassailable by NTI. The claim language is clear, unambiguous and not subject to reasonable dispute. NTI clearly infringes, and this fact is even admitted by NTI's own shareholder. Due to the limited market, it is appropriate to enter preliminary injunction. Bond in this case

should be minimal in light of the clear showing infringement, and Plaintiff suggests a bond to be set at $1,000.

WHEREFORE, Plaintiff Undersea Breathing Systems, Inc. respectfully requests this Court enter preliminary and then permanent injunction against Defendants Nitrox Technologies, Inc. and Ron Muller, with Plaintiff's bond set at $1,000, and such other and further relief as this Court deems just and proper.

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Dated: 1.8.99

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that a true and correct copy of the foregoing Motion and Memorandum for Preliminary Injunction was provided by prepaid first claim United States Mail on this the 8 day of January, 1999 to: **Ron Muller**, 216 Orion Lane, Treasure Island, Florida 33706; and **C. Douglas McDonald, Jr.**, Esq., Carlton, Fields, 777 S. Harbor Island Blvd., Tampa, FL 33602-5701 (counsel for NTI).

US005846291A

United States Patent [19]

Delp, II

[11] Patent Number: 5,846,291

[45] Date of Patent: *Dec. 8, 1998

[54] **OXYGEN ENRICHED AIR GENERATION SYSTEM**

[75] Inventor: William H. Delp, II, Lake Worth, Fla.

[73] Assignee: Undersea Breathing Systems, Inc., Lake Worth, Fla.

[*] Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

[21] Appl. No.: 822,141

[22] Filed: Mar. 17, 1997

Related U.S. Application Data

[63] Continuation of Ser. No. 518,020, Aug. 22, 1995, Pat. No. 5,611,845.

[51] Int. Cl.[6] B01D 53/22

[52] U.S. Cl. 95/8; 95/12; 95/14; 95/47; 95/54; 96/4; 96/8; 96/10; 96/397; 96/408

[58] Field of Search 95/8, 12, 14, 23, 95/45, 47, 54; 96/4, 7, 8, 10, 397, 408; 55/210, 218, 267–269

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Primary Examiner—Robert Spitzer
Attorney, Agent, or Firm—Evenson, McKeown, Edwards & Lenahan, PLLC

[57] ABSTRACT

A system for generating oxygen enriched air includes a compressed air supply for supplying compressed air and a permeable membrane gas separation system for separating a nitrogen gas component and an oxygen enriched air component from the compressed air. An oxygen analyzer is provided to detect an oxygen concentration in the oxygen enriched air component. The nitrogen gas component is divided, by a vortex tube, into a cold gas stream and a hot gas stream, and solenoid valves are actuated to modify a flow path of the compressed air through the cold gas stream and the hot gas stream in order to selectively heat and cool the compressed air. The oxygen enriched air is then selectively distributed for further use.

17 Claims, 1 Drawing Sheet

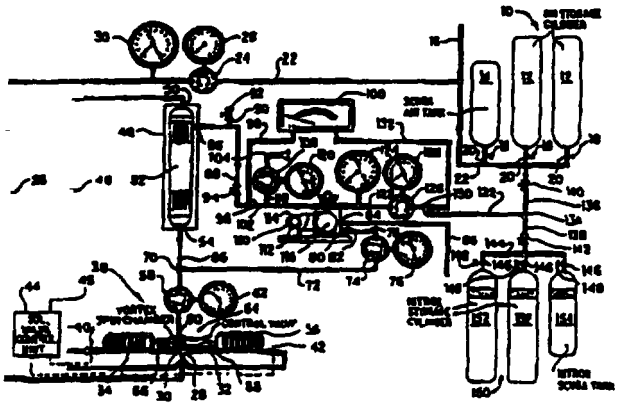

Exhibit "1"

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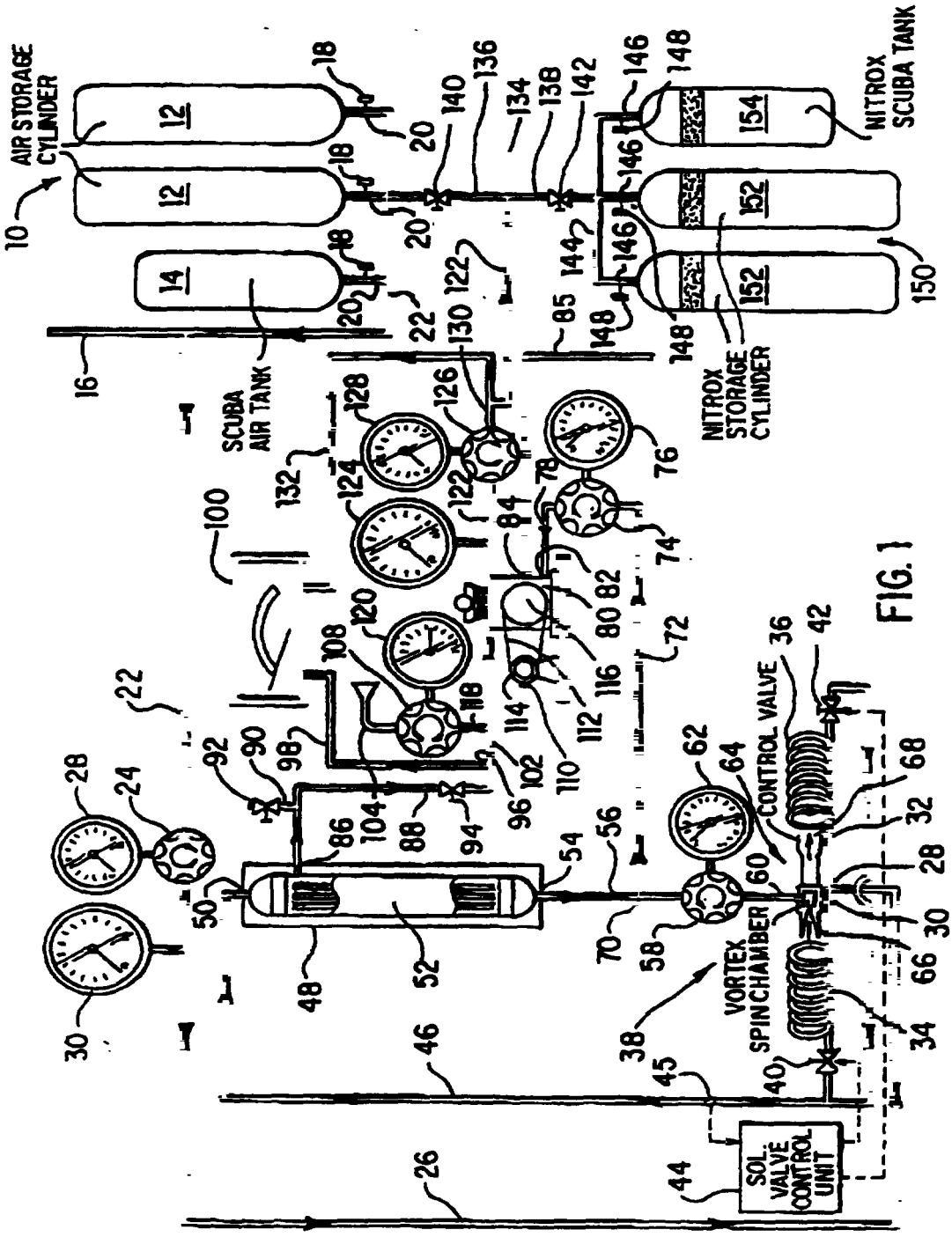
AIR STORAGE CYLINDER
SCUBA AIR TANK
NITROX STORAGE CYLINDER
NITROX SCUBA TANK
CONTROL VALVE
VORTEX SPINCHAMBER
SOL. VALVE CONTROL UNIT

FIG. 1

OXYGEN ENRICHED AIR GENERATION SYSTEM

This is a continuation of application Ser. No. 08/518,020, filed Aug. 22, 1995, now U.S. Pat. No. 5,611,845.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a particular type of oxygen enriched air generation system. A permeable membrane oxygen enriched air and nitrogen gas separation device is utilized. Although the system is particularly suitable for use by dive shops for filling scuba tanks or other types of oxygen enriched air storage vessels, applications in areas such as firefighting, climbing, flight, veterinary, medical and dental treatments, welding, etc., are apparent.

2. Description of Related Art

One known system for producing a mixture of oxygen enriched air and ambient air is disclosed in U.S. Pat. No. 4,860,803 to Wells. In this system, oxygen is injected into a stream of ambient air in order to produce an oxygen enriched air mixture. The mixture is compressed and delivered to storage or scuba cylinders for use in diving or other applications. According to this system, however, a source of oxygen appropriate for injection into the ambient air stream is needed and, therefore, a great deal of caution is required, during generation of the oxygen enriched air mixture, to avoid explosions and other problems typically associated with the use of oxygen.

SUMMARY OF THE INVENTION

It is one object of this invention to provide a suitable alternative system for generating an oxygen enriched air mixture, suitable for breathing purposes, which does not require the use of oxygen supplied from a separate oxygen source.

It is another object of this invention to provide a system which generates a gas stream which may be used by a suitable element, such as a vortex tube, to adjust the oxygen concentration of the oxygen enriched air mixture.

It is a further object of this invention to divert some of the gas stream produced so that the portion of the gas stream diverted may be used for inerting purposes such as, for example, to inert the crankcase of a compressor so that the compressor may be a standard oil-lubricated compressor rather than an oil-free compressor.

According to the present invention, these and other objects are accomplished by the provision of a system for generating oxygen enriched air which includes a compressed air supply for supplying compressed air and a permeable membrane gas separation system for separating a nitrogen gas component and an oxygen enriched air component from the compressed air. An oxygen analyzer is provided to detect an oxygen concentration in the oxygen enriched air component. The nitrogen gas component is divided, by a vortex tube, into a cold gas stream and a hot gas stream, and solenoid valves are actuated to modify a flow path of the compressed air through the cold gas stream and the hot gas stream in order to selectively heat and cool the compressed air. The oxygen enriched air is then selectively distributed for further use. A compressed oxygen enriched air storage assembly, a compressor, a compressor feed line supplying the oxygen enriched air component to a compressor inlet and an outlet line interconnecting a compressor outlet to the compressed oxygen enriched air storage assembly are provided.

The solenoid valves are used to modify the flow path of the compressed air by alternate opening and closing thereof so that the compressed air is selectively heated and cooled by the gas streams to adjust the oxygen concentration of the oxygen enriched air component to a desired oxygen concentration. An ambient air feed line admits ambient air into the compressor feed line so as to mix with the oxygen enriched air component. A regulating valve is used to regulate the amount of ambient air admitted into the compressor feed line and also permits adjustment of the oxygen concentration.

The oxygen analyzer is interconnected with the outlet line to permit monitoring of the oxygen concentration of a mixture of ambient air and the oxygen enriched air component in the outlet line. The system includes an oxygen enriched air supply line and at least one valve provided in the oxygen enriched air supply line to regulate flow of the mixture into appropriate containers for storing the mixture. The oxygen analyzer, or another oxygen analyzer, is also interconnected with an outlet of the permeable membrane gas separation system to permit monitoring of the oxygen concentration of the oxygen enriched air component passing through the outlet. A valve is used to selectively eliminate admission of the oxygen enriched air component into the compressor feed line so that only ambient air passes through the outlet line and the air supply can be recharged. Finally, a branch line for diverting some of the nitrogen gas component to a crankcase of the compressor, in order to reduce any possibility of explosion, is provided.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1, the only drawing figure provided, illustrates the overall structure of an oxygen enriched air generation system according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A compressed air supply is provided by an assembly 10 of one or more storage vessels. Such storage vessels may include one or more conventional, removable, compressed air storage cylinders 12. Other sources of compressed air, such as a known, oil-free, high pressure compressor (not shown) connected to an alternative compressed air supply branch line 16, may be provided if desired. If a compressor is not attached to the branch line 16, then the branch line 16 may be capped.

A flow control valve 18 is provided in each branch line 20 connecting an air storage cylinder 12 to a high pressure feed air line 22. A self-contained underwater breathing apparatus (scuba) air tank 14 may also be removably connected to the high pressure feed air line 22, also by a branch line 20 having a flow control valve 18 therein, for reasons which will become apparent. The compressed air is stored in the storage vessels at an initial pressure of anywhere in the range of 3000–6000 p.s.i.g. and, therefore, supplied to the high pressure feed air line 22 at such a pressure. Air flow through the line 22, and air or gas flow through each of the other lines shown in the drawing figure, occurs in the directions indicated by arrows.

The high pressure air feed line 22 leads from each of the branch lines 16 and 20 to a conventional pressure regulator controlled, by operation of a rotatable knob 24, so as to reduce the pressure of the air supplied by the feed line 22. The pressure regulator is used to reduce the pressure of the compressed air passing into the low pressure feed air line 26 so that it is lower than approximately 600 p.s.i.g. and,

typically, in the range of 50–250 p.s.i.g. Air pressure in the low pressure feed air line 26 is monitored by a low pressure side pressure gauge 28 which indicates the air pressure, in p.s.i.g., for example, in the line 26. A flow meter 30 is used to monitor the rate of air flow in the low pressure feed air line 26 and indicates the air flow rate in standard cubic feet per minute (SCFM), for example.

The low pressure feed air line 26 leads to a junction 28 from which a pair of heat exchanger lines 30 and 32 branch off. A portion of the line 30 defines a first coil 34, while a portion of the line 32 defines a second coil 36. As will become clear, the first coil 34 defines a cold coil of a heating and cooling heat exchanger, generally designated 38, while the second coil 36 defines a hot coil of the heat exchanger 38.

At the outlet of the first coil 34, a first thermostatically operated ON-OFF solenoid valve 40 is disposed. A second thermostatically operated ON-OFF solenoid valve 42 is similarly disposed at the outlet of the second coil 36. Each of the solenoid valves 40 and 42 is conventional in construction and is alternatively energized and de-energized by a conventional thermostatically operated control unit 44. Input may be provided to the control unit 44, for example, by a temperature sensor 45 or a plurality of such sensors. The control unit, otherwise, could be manually adjusted based on temperature readings obtained from an appropriately located thermometer, if desired. The solenoid valves are controlled by the unit 44 so that when the valve 40 is open to permit compressed air flow through the line 30 and the first coil 34, the valve 42 is closed to prevent compressed air flow through the line 32 and the second coil 36 and when the valve 42 is open to permit compressed air flow through the line 32 and the second coil 36, the valve 40 is closed to prevent compressed air flow through the line 30 and the first coil 34. Alternate opening and closing, i.e. "cycling", of the solenoid valves at variable cycling or oscillation periods is permitted by the control unit 44. Consequently, if more compressed air is to pass through the first coil 34 than through the second coil 36, then, for every on-off cycle period, the first solenoid valve 40 is controlled by the unit 44 so that it is open for a longer time than the second solenoid valve 42. If more compressed air is to pass through the second coil 36 than through the first coil 34, then, for every on-off cycle period, the second solenoid valve 42 is controlled by the unit 44 so that it is open for a longer time than the first solenoid valve 40. If the same amount of compressed air is to pass through the coils 34 and 36, then the solenoid valves 40 and 42 are opened for equal times. Finally, if compressed air is to flow only through the first coil 34, then only the valve 40 is opened by the control unit, while if compressed air is to flow only through the second coil 36, then only the valve 42 is opened; no valve cycling or oscillating occurs in these particular situations. The solenoid valves 40 and 42, therefore, form flow modifying means for modifying a flow path of the compressed air.

Compressed low pressure feed air exits the heat exchanger 38 through a supply line 46. The supply line 46 passes the compressed low pressure feed air to a compressed air inlet port 50 of a standard, known, commercially available, permeable membrane, oxygen enriched air (NITROX) and nitrogen gas separation system 48; such a gas separation system 48 is preferably of the type using a membrane cartridge 52 and is readily available from any of a number of companies. U.S. Pat. Nos. 4,894,068 and 5,226,931 describe such separation systems. The knob 24 is used to control the pressure of the air in the low pressure feed air line 26 so that this pressure and the corresponding rate of air flow are appropriate for, and meet the specifications of, the particular gas separation system 48 ultimately selected. Typical pressures are in the 50–250 p.s.i.g. range as mentioned previously.

A nitrogen gas (N_2) component separated from the compressed low pressure feed air supplied through the port 50 passes from the system 48 through an exit port 54 and into a N_2 carrying line 56. The N_2 carried by the line 56 primarily passes to a conventional pressure regulator controlled, by operation of a rotatable knob 58, so that the pressure of the N_2 is reduced before entering compressed gas supply line 60 of the heat exchanger 38. The pressure of the N_2 is monitored by a N_2 supply line pressure gauge 62 and dropped by the regulator so that it is somewhere in the range of approximately 80–100 p.s.i.g. and appropriate for supply to the spin chamber of a known and commercially available vortex tube 64 which forms another part of the heat exchanger 38. Vortex tubes of this type are available from EXAIR corporation of Cincinnati, Ohio, for example. The vortex tube 64 operates to divide the nitrogen gas component into a cold nitrogen gas stream and a hot nitrogen gas stream. More specifically, cold N_2 leaves the vortex tube 64 through a cold gas exhaust 66, which is directed towards the first coil 34, while hot N_2 leaves the vortex tube 64 through a hot gas exhaust 68, which is directed towards the second coil 36. In this manner, heat is supplied to the compressed air which is directed through the heat exchanger line 32 and the second coil 36, while heat is taken away from the compressed air which is directed through the heat exchanger line 30 and the first coil 34. Appropriate operation of the solenoid valves 40 and 42 by the control unit 44 permits selective heating and cooling, i.e. "temperature conditioning", of the compressed low pressure feed air passing through the heat exchanger 38 and the supply line 46 so that the temperature is appropriate for, and meets the specifications of, the particular separation system 48 selected.

After the N_2 has been used in the heat exchanger 38 for heating or cooling, it may be collected and stored for other uses if desired. Otherwise, the N_2 may be exhausted to the atmosphere as waste gas.

Some of the N_2 carried by the line 56 is diverted, at a junction 70, through a branch line 72. The branch line 72 leads to a conventional pressure regulator, controlled by a knob 74, which reduces the pressure of the N_2 monitored by a pressure gage 76 and passing into a compressor crankcase supply line 78 to somewhere in the range of approximately 1–3 p.s.i.g. Flow rates of the N_2 through the supply line 78 are about 1–3 liters per minute, which amount to approximately 1%, or less, of the N_2 leaving the exit port 54 of the system 48. The supply line 78 feeds into a standard crankcase vent 82, which otherwise would be open to the atmosphere, of a standard, oil-lubricated, high pressure compressor 80. Operation of the compressor 80 is described later. The N_2 supplied by the line 78 passes through the crankcase and exits through an exhaust port 84, provided in the crankcase, into a crankcase exhaust line 85 leading to the atmosphere. In this manner, the crankcase of the compressor 80 is inerted by the N_2 supplied in order to reduce any possibility of explosion. This permits the use of the standard, oil-lubricated compressor 80 rather than an oil-free compressor.

A directly breathable, oxygen enriched air (NITROX) component separated from the compressed low pressure feed air supplied through the port 50 passes from the separation system 48 through an oxygen enriched air exhaust port 86 and into a low pressure oxygen enriched air

feed line 88. The oxygen enriched air passing through the port 86 is a breathable mixture which may be supplied for direct inhalation. Accordingly, an optional branch line 90, leading from the feed line 88, may be provided. The oxygen enriched air can be diverted through the line 90 for any of a variety of non-diving applications. Pressure in the feed line 88 is typically quite low, i.e. in the 0.5–5 p.s.i.g. range. A conventional flow control valve 92 may be used to open and close off the optional branch line 90. A conventional flow control valve 94 is also disposed in the feed line 88 so that the flow of oxygen enriched air through the feed line 88 can be permitted, shut off and regulated.

A small amount of the oxygen enriched air component flowing through the low pressure feed line 88 is diverted, at junction 96, through a sampling line 98. The sampling line 98 leads to a conventional oxygen analyzer 100 which detects and provides a reading of the oxygen concentration of the oxygen enriched air passing through the flow control valve 94 and into a compressor feed line 102 leading to the oil-lubricated, high pressure compressor 80. The analyzer shown can provide oxygen concentration readings anywhere in the range of 0% to 50%. The temperature of the compressed low pressure feed air in the supply line 46 influences the oxygen concentration of the oxygen enriched air passing from the system 48. Appropriate cycling of the solenoid valves 40 and 42, therefore, can be used to selectively heat and cool the feed air in the supply line and adjust this oxygen concentration. As is usual, the compressor 80 is operated by an electric or gasoline powered motor 110 interconnected with the compressor 80 by a belt 112 and pulleys 114 and 116.

An ambient air intake 104 leads to a conventional ambient air flow or pressure regulation valve controlled, by operation of a rotatable knob 108, so as to modify the flow and pressure of ambient air admitted into the compressor feed line 102 through an ambient air feed line 118. A pressure gauge 120 can be used to indicate the pressure in the feed line 118 which varies depending on the degree, between 0% and 100%, to which the air flow or pressure regulation valve is opened; as shown, the gauge 120 provides readings which could vary between −15 p.s.i.g. (partial vacuum) and 30 p.s.i.g.

Oxygen enriched air (NITROX) only, ambient air only, or a combination of oxygen enriched air and ambient air may be drawn through the compressor feed line 102 to a compressor inlet when the compressor 80 is operated; typically, a mixture of the oxygen enriched air and the ambient air is drawn into the compressor. Compressed oxygen enriched air, compressed ambient air or a compressed combination of oxygen enriched air and ambient air subsequently passes through a compressor outlet and into a high pressure side outlet line 122. A conventional flow meter 124 is used to monitor the rate of air flow through the line 122 and indicates such an air-flow rate in SCFM. As shown, readings of 0–60 SCFM could be provided by the flow meter 124. The air pressure in the outlet line 122 is adjusted by a conventional pressure regulator, operated by a rotatable knob 126, to an appropriate pressure. The air pressure in the outlet line 122 is monitored by a pressure gauge 128 which is conventional in structure. The high pressure side air pressure is typically between 3000 and 6000 p.s.i.g. In the embodiment of the invention illustrated, keeping the high pressure side air pressure below 4000 p.s.i.g. is appropriate because of the capability of the pressure gauge 128.

At a junction 130, a high pressure side sampling line 132 diverts a small portion of the compressed oxygen enriched air, the compressed ambient air or the compressed combination thereof from the outlet line 122 to the analyzer 100 (or a completely separate and different oxygen analyzer if desired). A reading of the oxygen concentration of the air passing through the line 122, be it oxygen enriched, ambient or a combination of oxygen enriched and ambient, is thereby provided.

Air which has been compressed by the compressor 80 passes through the outlet line 122 to a junction 134 at which point the outlet line is divided into a first or ambient air supply line 136 and a second or oxygen enriched air supply line 138. A conventional flow regulating valve 140 is disposed in the line 136 to regulate the flow of ambient air therethrough, while a conventional flow regulating valve 142 is disposed in the line 138 to regulate the flow of oxygen enriched air therethrough. As is clear from the drawing figure, the air supply line 136 feeds into the high pressure feed air line 22. As a result, the air supply line 136 is able to supply compressed air to the line 22 and to each of the branch lines 20. Similarly, the oxygen enriched air supply line 138 feeds into a high pressure feed oxygen enriched air line 144 and any desired number of branch lines 146 associated therewith. Each branch line 146 includes a flow control valve 148, similar to the valves 18, to regulate the flow of oxygen enriched air into a compressed oxygen enriched air storage assembly 150 including one or more conventional and appropriately labeled NITROX storage vessels such as removable storage cylinders 152 or a removable NITROX scuba tank 154. Both assembly 10 and assembly 150 may be located either above water or under water. Applications other than for diving purposes, such as in firefighting, climbing, space or high altitude flight, veterinary, medical and dental treatments, welding, etc., are apparent.

A variety of operations can be performed by the system represented in FIG. 1. To provide an initial charge or a recharge to an air storage cylinder 12, or a plurality of such cylinders, or to charge a scuba air tank 14, the appropriate flow control valve or valves 18 is or are opened. The flow regulating valve 140 is opened while the flow regulating valve 142 is closed. The flow control valve 94 is closed to eliminate the admission or flow of oxygen enriched air into the feed line 102. The knob 108 is rotated to permit free flow of ambient air through the intake 104 and into the compressor feed line 102. The motor 110 is turned on to drive the compressor 80 and draw ambient air into the feed line 102. The air is compressed and then passed through the outlet line 122, the air supply line 136 and the appropriate branch line or lines 20 and into the appropriate air storage cylinder or cylinders 12 and/or scuba air tank or tanks 14.

To provide an initial charge, or a recharge, to a NITROX storage cylinder 152, or a plurality of such cylinders, or to charge a NITROX scuba tank 154, the flow regulating valve 140 is closed, while the flow regulating valve 142 is opened. If it is provided, then the flow control valve 92 is closed. The flow control valve 94 is opened to permit free flow of oxygen enriched air into the feed line 102. The knob 108 may be rotated to cause the valve associated therewith to set the flow rate of ambient air through the intake 104 and into the feed line 102 to an initial value. The motor 110 is turned on to drive the compressor 80 and draw a mixture of both ambient and oxygen enriched air into the feed line 102. The air mixture is compressed and then passed through the outlet line 122, the oxygen enriched air supply line 138 and one or more of the branch lines 146. At this point, one or more of the branch lines 146 may be left open. The oxygen concentration of the ambient and compressed oxygen enriched air mixture passing through the outlet line 122 is detected by the

c) adjusting a temperature of the reduced pressure gas stream to a preselected value;

d) introducing the pressure reduced, temperature adjusted gas stream into an inlet of a separation chamber containing a permeable nitrogen-oxygen separation membrane system and having two outlets, one outlet on an inlet side of the membrane system and another outlet on an opposite side of the membrane system;

e) withdrawing a first gas stream containing substantially nitrogen from the one outlet of the separation chamber;

f) withdrawing a second gas stream containing oxygen enriched air at a pressure from 0.5 to 5 p.s.i.g. from the other outlet of the separation chamber;

g) monitoring the oxygen content of the second gas stream;

h) controlling operating conditions of the separation chamber to obtain the second gas stream having the predetermined oxygen content; and

i) compressing the second gas stream to a high pressure.

2. Method according to claim 1, including the further step of storing the high pressure second gas stream.

3. Method according to claim 1, wherein the predetermined oxygen content of the second gas stream is about 32%.

4. Method according to claim 1, wherein the predetermined oxygen content of the second gas stream is about 36%.

5. Method according to claim 1, wherein the high pressure gas stream of air is under a pressure of 3000–6000 p.s.i.g.

6. Method according to claim 1, wherein the step of reducing the pressure of the gas stream reduces the pressure to from about 50 to about 250 p.s.i.g.

7. Method according to claim 1, including the further step of filling a scuba diving tank with the high pressure second gas stream.

8. A system for generating oxygen enriched air having a predetermined oxygen content comprising:

an air supply for supplying high pressure compressed air;

a pressure regulator for selectively reducing the pressure of the compressed air to below 600 p.s.i.g. and cooling the pressure reduced air;

a heat exchanger for adjusting the temperature of the pressure reduced air;

a permeable membrane gas separation system for separating nitrogen from temperature adjusted pressure reduced air having an inlet for temperature adjusted pressure reduced air and two outlets, one for nitrogen and the other for oxygen enriched air;

a device for detecting oxygen concentration in said oxygen enriched air;

a controller for controlling operation of said permeable membrane gas separation system so that the oxygen enriched air separated in the separation system has the predetermined oxygen content;

a compressor for compressing the oxygen enriched air to a high pressure; and

a distribution arrangement for selectively distributing the high pressure oxygen enriched air for further use.

9. A system as defined in claim 8, further comprising a compressed oxygen enriched air storage assembly, a compressor feed line supplying said oxygen enriched air to a compressor inlet and an outlet line interconnecting a compressor outlet to said compressed oxygen enriched air storage assembly.

10. A system as defined in claim 9, further comprising an ambient air feed line for admitting ambient air into said

or inlet to be compressed and a high pressure air
necting the outlet of said compressor to said air

ystem as defined in claim 8, wherein said device for
oxygen concentration is located in the vicinity of
t of said permeable membrane gas separation sys-
ne oxygen enriched air for monitoring of the oxygen
ation of said oxygen enriched air passing through
et.

ystem as defined in claim 8, wherein said device for
the oxygen concentration is located at the other
said permeable membrane gas separation system to
the oxygen concentration of said oxygen enriched
ng through said other outlet.

system as defined in claim 8, further comprising a
ar for monitoring the temperature of the tempera-
usted pressure reduced air and for controlling the
hanger in response thereto.

* * * * *

UNITED STATES DISTRICT COURT
FOR THE MIDDLE DISTRICT OF FLORIDA
TAMPA DIVISION

CASE NO.: 98-2518-CIV-T-24A

UNDERSEA BREATHING SYSTEMS, INC., a Nevada corporation,

Plaintiff,

v.

RON MULLER and NITROX TECHNOLOGIES, INC., a corporation,

Defendants.
_____/

Jury Trial Requested

AFFIDAVIT OF WILLIAM H. DELP IN SUPPORT OF MOTION FOR PRELIMINARY INJUNCTION

COUNTY OF PALM BEACH

STATE OF FLORIDA

William H. Delp, II being first duly sworn states:

1. I am the President and the Chief Executive Officer of Undersea Breathing Systems, Inc., a corporation based in Lake Worth, Florida. I also am the inventor of the invention described and claimed in U.S. Patent No. 5,846,291 ("the '291 patent") issued on December 8, 1998 and which was assigned to Undersea Breathing Systems, Inc. Except as otherwise indicated, I have personal knowledge of the matters set forth below.

2. Enriched air or Nitrox (EANx), which is a combination of oxygen and nitrogen, was first mixed by an English

Exhibit "2"

chemist over two hundred years ago. At that time it was used for medical procedures. Its first use in wet diving occurred in the late 1800s. The use of this gas in recreational diving has been much more recent, probably commencing sometime in the early 1960s.

3. The techniques used for mixing diving breathing gases, such as Nitrox, have always been extremely hazardous and require careful observance of cleaning and safety procedures in order to avoid explosions. Until my inventions, Nitrox and other mixtures used as breathing gases for diving were created by adding oxygen to ambient air. This use of a separate oxygen source required the need for observance of all the cleaning and safety procedures previously mentioned.

4. I have been involved in producing and delivering life support breathing gas mixtures for the diving industry since 1985.

5. In the period beginning in 1990, I expended considerable time, effort and money in the development of a unique system of generating oxygen enriched air. This system eliminated the need for utilizing a separate source of pure oxygen. Rather, the concept was one of passing compressed ambient air through a membrane after the air had been filtered to remove moisture, oil and any particulate carryover. Since membranes employ the principle of selective permeation of separate gases, and since each gas has a characteristic permeation rate that is a function of its ability to dissolve and diffuse through a membrane, some constituent gases flow through the membrane faster than others. In

particular, oxygen will flow through the membrane much faster than nitrogen. By eliminating a substantial portion of the slower moving nitrogen, the resulting air stream produced from passage through the membrane contains a much higher percentage of oxygen i.e., oxygen enriched air, which is then delivered to a high pressure breathing air compressor and, thereafter, to either a storage tank or a scuba tank.

6. The system, as commercially marketed, has achieved instantaneous and wide spread acceptance by dive shops and by others in the diving industry. This success has generated profit for Undersea Breathing Systems, Inc.

7. In order to protect my investment in the development of this unique system, I have filed several applications for patents, one of which is the '291 patent, issued on December 8, 1998, and the subject of this lawsuit.

8. During the prior litigation with Defendant Nitrox Technologies, Inc., I have had the opportunity to review their system closely. On reviewing the system, it was apparent that the components of its system do, in fact, meet all elements of one or more of the claims of the '291 patent.

9. The market for the sale of Plaintiff's product is unique one. The principal customers are dive shops located in the United States. At the present time, these number between 1,700 and 2,000. Of this number, approximately 30% must be considered as lacking the financial ability to purchase one of Plaintiff's systems, which range in cost from $6,900 for the smallest unit to

$50,000 for the largest unit. Further, the life of the system is indefinite.

10. The public interest will be served in enjoining defendant Nitrox Technologies, Inc. from marketing its infringing device because the principals of that company do not have any documentable experience with handling an enriched oxygen gas stream in a high pressure system. They have no field or technical experience in this area except at ambient pressure as a waste gas for disposal. The experience of the principals have been primarily in the area of inert gases, such as nitrogen, whose principal use is in killing bugs. Plaintiff's system is a life support system requiring expert understanding of the safe handling of a gas stream under pressure. The lack of expertise of Nitrox Technologies, Inc. can create safety hazards for the user of the system while producing and compressing Nitrox and to the diver who breathes the finished product.

FURTHER AFFIANT SAYETH NOT.

1/7/99
Date

WILLIAM H. DELP, II

Subscribed and sworn to before me
this 7 day of January, 1999.

Geraldine L Spyker
Notary Public
My commission expires:

GERALDINE L. SPYKER
MY COMMISSION # CC 579321
EXPIRES: September 28, 2000
Bonded Thru Notary Public Underwriters

✓ Personally known to me.

___ Provided the following identification:

___

US005611845A

United States Patent [19]

Delp, II

[11] Patent Number: 5,611,845

[45] Date of Patent: Mar. 18, 1997

[54] **OXYGEN ENRICHED AIR GENERATION SYSTEM**

[75] Inventor: **William H. Delp, II**, Lake Worth, Fla.

[73] Assignee: **Undersea Breathing Systems, Inc.**, Lake Worth, Fla.

[21] Appl. No.: **518,020**

[22] Filed: **Aug. 22, 1995**

[51] **Int. Cl.**[6] **B01D 53/22**

[52] **U.S. Cl.** **96/4**; 96/8; 96/10; 55/218; 55/269

[58] **Field of Search** 95/8, 12, 14, 23, 95/45, 47, 54; 96/4, 7, 8, 10; 55/210, 218, 267–269

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Primary Examiner—Robert Spitzer

Attorney, Agent, or Firm—Keck, Mahin & Cate

[57] **ABSTRACT**

A system for generating oxygen enriched air includes a compressed air supply for supplying compressed air and a permeable membrane gas separation system for separating a nitrogen gas component and an oxygen enriched air component from the compressed air. An oxygen analyzer is provided to detect an oxygen concentration in the oxygen enriched air component. The nitrogen gas component is divided, by a vortex tube, into a cold gas stream and a hot gas stream, and solenoid valves are actuated to modify a flow path of the compressed air through the cold gas stream and the hot gas stream in order to selectively heat and cool the compressed air. The oxygen enriched air is then selectively distributed for further use.

33 Claims, 1 Drawing Sheet

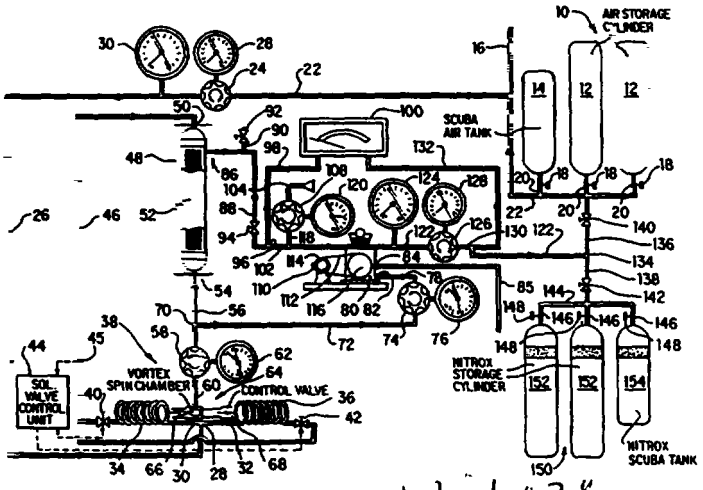

Exhibit "3"

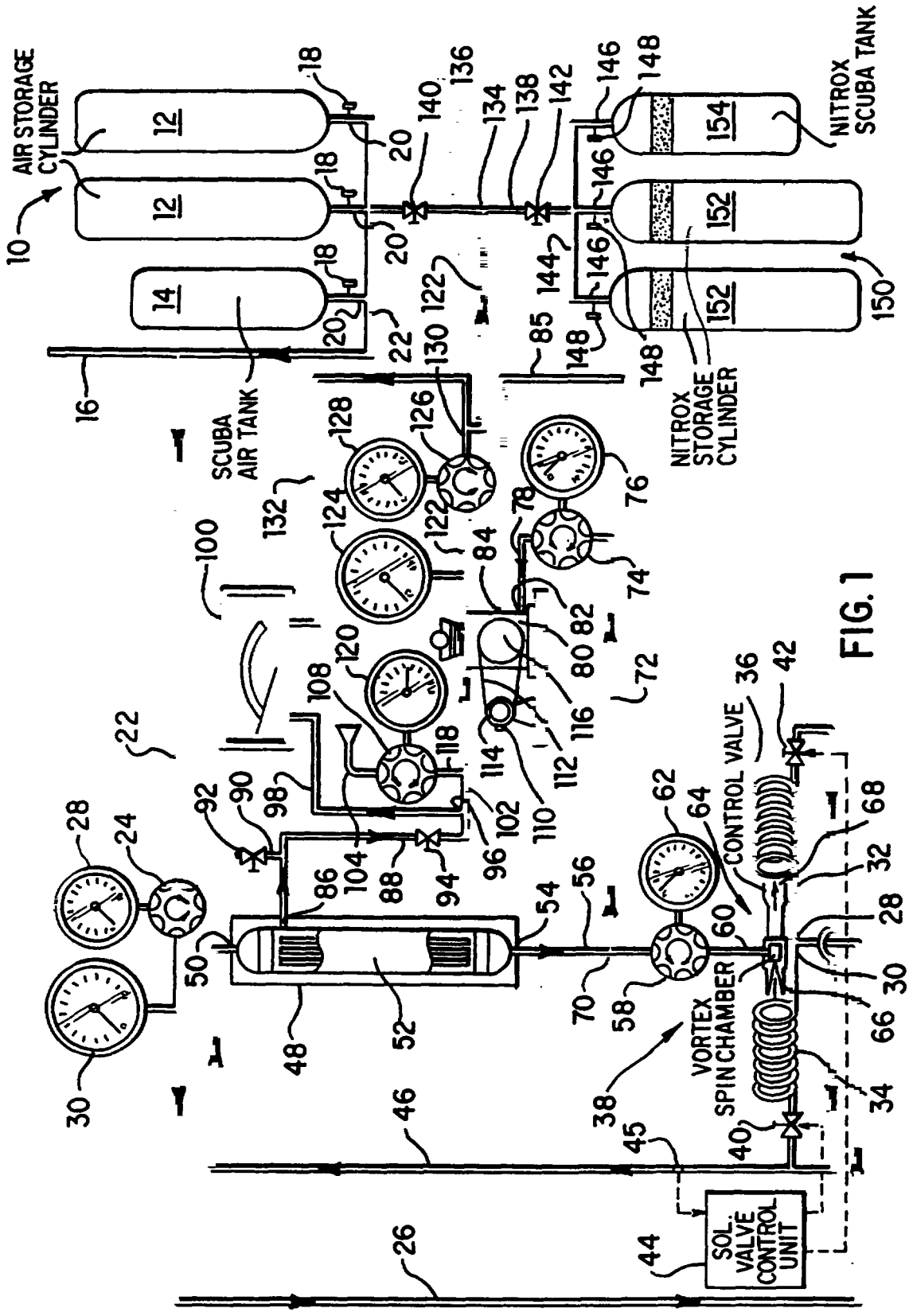
AIR STORAGE CYLINDER
NITROX SCUBA TANK
SCUBA AIR TANK
NITROX STORAGE CYLINDER
CONTROL VALVE
VORTEX SPIN CHAMBER
SOL. VALVE CONTROL UNIT

FIG. 1

OXYGEN ENRICHED AIR GENERATION SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a particular type of oxygen enriched air generation system. A permeable membrane oxygen enriched air and nitrogen gas separation device is utilized. Although the system is particularly suitable for use by dive shops for filling scuba tanks or other types of oxygen enriched air storage vessels, applications in areas such as firefighting, climbing, flight, veterinary, medical and dental treatments, welding, etc., are apparent.

2. Description of Related Art

One known system for producing a mixture of oxygen enriched air and ambient air is disclosed in U.S. Pat. No. 4,860,803 to Wells. In this system, oxygen is injected into a stream of ambient air in order to produce an oxygen enriched air mixture. The mixture is compressed and delivered to storage or scuba cylinders for use in diving or other applications. According to this system, however, a source of oxygen appropriate for injection into the ambient air stream is needed and, therefore, a great deal of caution is required, during generation of the oxygen enriched air mixture, to avoid explosions and other problems typically associated with the use of oxygen.

SUMMARY OF THE INVENTION

It is one object of this invention to provide a suitable alternative system for generating an oxygen enriched air mixture, suitable for breathing purposes, which does not require the use of oxygen supplied from a separate oxygen source.

It is another object of this invention to provide a system which generates a gas stream which may be used by a suitable element, such as a vortex tube, to adjust the oxygen concentration of the oxygen enriched air mixture.

It is a further object of this invention to divert some of the gas stream produced so that the portion of the gas stream diverted may be used for inerting purposes such as, for example, to inert the crankcase of a compressor so that the compressor may be a standard oil-lubricated compressor rather than an oil-free compressor.

According to the present invention, these and other objects are accomplished by the provision of a system for generating oxygen enriched air which includes a compressed air supply for supplying compressed air and a permeable membrane gas separation system for separating a nitrogen gas component and an oxygen enriched air component from the compressed air. An oxygen analyzer is provided to detect an oxygen concentration in the oxygen enriched air component. The nitrogen gas component is divided, by a vortex tube, into a cold gas stream and a hot gas stream, and solenoid valves are actuated to modify a flow path of the compressed air through the cold gas stream and the hot gas stream in order to selectively heat and cool the compressed air. The oxygen enriched air is then selectively distributed for further use. A compressed oxygen enriched air storage assembly, a compressor, a compressor feed line supplying the oxygen enriched air component to a compressor inlet and an outlet line interconnecting a compressor outlet to the compressed oxygen enriched air storage assembly are provided.

The solenoid valves are used to modify the flow path of the compressed air by alternate opening and closing thereof so that the compressed air is selectively heated and cooled by the gas streams to adjust the oxygen concentration of the oxygen enriched air component to a desired oxygen concentration. An ambient air feed line admits ambient air into the compressor feed line so as to mix with the oxygen enriched air component. A regulating valve is used to regulate the amount of ambient air admitted into the compressor feed line and also permits adjustment of the oxygen concentration.

The oxygen analyzer is interconnected with the outlet line to permit monitoring of the oxygen concentration of a mixture of ambient air and the oxygen enriched air component in the outlet line. The system includes an oxygen enriched air supply line and at least one valve provided in the oxygen enriched air supply line to regulate flow of the mixture into appropriate containers for storing the mixture. The oxygen analyzer, or another oxygen analyzer, is also interconnected with an outlet of the permeable membrane gas separation system to permit monitoring of the oxygen concentration of the oxygen enriched air component passing through the outlet. A valve is used to selectively eliminate admission of the oxygen enriched air component into the compressor feed line so that only ambient air passes through the outlet line and the air supply can be recharged. Finally, a branch line for diverting some of the nitrogen gas component to a crankcase of the compressor, in order to reduce any possibility of explosion, is provided.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**, the only drawing figure provided, illustrates the overall structure of an oxygen enriched air generation system according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A compressed air supply is provided by an assembly **10** of one or more storage vessels. Such storage vessels may include one or more conventional, removable, compressed air storage cylinders **12**. Other sources of compressed air, such as a known, oil-free, high pressure compressor (not shown) connected to an alternative compressed air supply branch line **16**, may be provided if desired. If a compressor is not attached to the branch line **16**, then the branch line **16** may be capped.

A flow control valve **18** is provided in each branch line **20** connecting an air storage cylinder **12** to a high pressure feed air line **22**. A self-contained underwater breathing apparatus (scuba) air tank **14** may also be removably connected to the high pressure feed air line **22**, also by a branch line **20** having a flow control valve **18** therein, for reasons which will become apparent. The compressed air is stored in the storage vessels at an initial pressure of anywhere in the range of 3000–6000 p.s.i.g. and, therefore, supplied to the high pressure feed air line **22** at such a pressure. Air flow through the line **22**, and air or gas flow through each of the other lines shown in the drawing figure, occurs in the directions indicated by arrows.

The high pressure air feed line **22** leads from each of the branch lines **16** and **20** to a conventional pressure regulator controlled, by operation of a rotatable knob **24**, so as to reduce the pressure of the air supplied by the feed line **22**. The pressure regulator is used to reduce the pressure of the compressed air passing into the low pressure feed air line **26**

so that it is lower than approximately 600 p.s.i.g. and, typically, in the range of 50–250 p.s.i.g. Air pressure in the low pressure feed air line **26** is monitored by a low pressure side pressure gauge **28** which indicates the air pressure, in p.s.i.g., for example, in the line **26**. A flow meter **30** is used to monitor the rate of air flow in the low pressure feed air line **26** and indicates the air flow rate in standard cubic feet per minute (SCFM), for example.

The low pressure feed air line **26** leads to a junction **28** from which a pair of heat exchanger lines **30** and **32** branch off. A portion of the line **30** defines a first coil **34**, while a portion of the line **32** defines a second coil **36**. As will become clear, the first coil **34** defines a cold coil of a heating and cooling heat exchanger, generally designated **38**, while the second coil **36** defines a hot coil of the heat exchanger **38**.

At the outlet of the first coil **34**, a first thermostatically operated ON-OFF solenoid valve **40** is disposed. A second thermostatically operated ON-OFF solenoid valve **42** is similarly disposed at the outlet of the second coil **36**. Each of the solenoid valves **40** and **42** is conventional in construction and is alternatively energized and de-energized by a conventional thermostatically operated control unit **44**. Input may be provided to the control unit **44**, for example, by a temperature sensor **45** or a plurality of such sensors. The control unit, otherwise, could be manually adjusted based on temperature readings obtained from an appropriately located thermometer, if desired. The solenoid valves are controlled by the unit **44** so that when the valve **40** is open to permit compressed air flow through the line **30** and the first coil **34**, the valve **42** is closed to prevent compressed air flow through the line **32** and the second coil **36** and when the valve **42** is open to permit compressed air flow through the line **32** and the second coil **36**, the valve **40** is closed to prevent compressed air flow through the line **30** and the first coil **34**. Alternate opening and closing, i.e. "cycling" of the solenoid valves at variable cycling or oscillation periods is permitted by the control unit **44**. Consequently, if more compressed air is to pass through the first coil **34** than through the second coil **36**, then, for every on-off cycle period, the first solenoid valve **40** is controlled by the unit **44** so that it is open for a longer time than the second solenoid valve **42**. If more compressed air is to pass through the second coil **36** than through the first coil **34**, then, for every on-off cycle period, the second solenoid valve **42** is controlled by the unit **44** so that it is open for a longer time than the first solenoid valve **40**. If the same amount of compressed air is to pass through the coils **34** and **36**, then the solenoid valves **40** and **42** are opened for equal times. Finally, if compressed air is to flow only through the first coil **34**, then only the valve **40** is opened by the control unit, while if compressed air is to flow only through the second coil **36**, then only the valve **42** is opened; no valve cycling or oscillating occurs in these particular situations. The solenoid valves **40** and **42**, therefore, form flow modifying means for modifying a flow path of the compressed air.

Compressed low pressure feed air exits the heat exchanger **38** through a supply line **46**. The supply line **46** passes the compressed low pressure feed air to a compressed air inlet port **50** of a standard, known, commercially available, permeable membrane, oxygen enriched air (NITROX) and nitrogen gas separation system **48**; such a gas separation system **48** is preferably of the type using a membrane cartridge **52** and is readily available from any of a number of companies. U.S. Pat. Nos. 4,894,068 and 5,226,931 describe such separation systems. The knob **24** is used to control the pressure of the air in the low pressure feed air line **26** so that this pressure and the corresponding rate of air flow are appropriate for, and meet the specifications of, the particular gas separation system **48** ultimately selected. Typical pressures are in the 50–250 p.s.i.g. range as mentioned previously.

A nitrogen gas (N_2) component separated from the compressed low pressure feed air supplied through the port **50** passes from the system **48** through an exit port **54** and into a N_2 carrying line **56**. The N_2 carried by the line **56** primarily passes to a conventional pressure regulator controlled, by operation of a rotatable knob **58**, so that the pressure of the N_2 is reduced before entering compressed gas supply line **60** of the heat exchanger **38**. The pressure of the N_2 is monitored by a N_2 supply line pressure gauge **62** and dropped by the regulator so that it is somewhere in the range of approximately 80–100 p.s.i.g. and appropriate for supply to the spin chamber of a known and commercially available vortex tube **64** which forms another part of the heat exchanger **38**. Vortex tubes of this type are available from EXAIR corporation of Cincinnati, Ohio, for example. The vortex tube **64** operates to divide the nitrogen gas component into a cold nitrogen gas stream and a hot nitrogen gas stream. More specifically, cold N_2 leaves the vortex tube **64** through a cold gas exhaust **66**, which is directed towards the first coil **34**, while hot N_2 leaves the vortex tube **64** through a hot gas exhaust **68**, which is directed towards the second coil **36**. In this manner, heat is supplied to the compressed air which is directed through the heat exchanger line **32** and the second coil **36**, while heat is taken away from the compressed air which is directed through the heat exchanger line **30** and the first coil **34**. Appropriate operation of the solenoid valves **40** and **42** by the control unit **44** permits selective heating and cooling, i.e. "temperature conditioning" of the compressed low pressure feed air passing through the heat exchanger **38** and the supply line **46** so that the temperature is appropriate for, and meets the specifications of, the particular separation system **48** selected.

After the N_2 has been used in the heat exchanger **38** for heating or cooling, it may be collected and stored for other uses if desired. Otherwise, the N_2 may be exhausted to the atmosphere as waste gas.

Some of the N_2 carried by the line **56** is diverted, at a junction **70**, through a branch line **72**. The branch line **72** leads to a conventional pressure regulator, controlled by a knob **74**, which reduces the pressure of the N_2 passing into a compressor crankcase supply line **78** to somewhere in the range of approximately 1–3 p.s.i.g. Flow rates of the N_2 through the supply line **78** are about 1–3 liters per minute, which amount to approximately 1%, or less, of the N_2 leaving the exit port **54** of the system **48**. The supply line **78** feeds into a standard crankcase vent **82**, which otherwise would be open to the atmosphere, of a standard, oil-lubricated, high pressure compressor **80**. Operation of the compressor **80** is described later. The N_2 supplied by the line **78** passes through the crankcase and exits through an exhaust port **84**, provided in the crankcase, into a crankcase exhaust line **85** leading to the atmosphere. In this manner, the crankcase of the compressor **80** is inerted by the N_2 supplied in order to reduce any possibility of explosion. This permits the use of the standard, oil-lubricated compressor **80** rather than an oil-free compressor.

A directly breathable, oxygen enriched air (NITROX) component separated from the compressed low pressure feed air supplied through the port **50** passes from the separation system **48** through an oxygen enriched air exhaust port **86** and into a low pressure oxygen enriched air feed line **88**. The oxygen enriched air passing through the

port **86** is a breathable mixture which may be supplied for direct inhalation. Accordingly, an optional branch line **90**, leading from the feed line **88**, may be provided. The oxygen enriched air can be diverted through the line **90** for any of a variety of non-diving applications. Pressure in the feed line **88** is typically quite low, i.e. in the 0.5–5 p.s.i.g. range. A conventional flow control valve **92** may be used to open and close off the optional branch line **90**. A conventional flow control valve **94** is also disposed in the feed line **88** so that the flow of oxygen enriched air through the feed line **88** can be permitted, shut off and regulated.

A small amount of the oxygen enriched air component flowing through the low pressure feed line **88** is diverted, at junction **96**, through a sampling line **98**. The sampling line **98** leads to a conventional oxygen analyzer **100** which detects and provides a reading of the oxygen concentration of the oxygen enriched air passing through the flow control valve **94** and into a compressor feed line **102** leading to the oil-lubricated, high pressure compressor **80**. The analyzer shown can provide oxygen concentration readings anywhere in the range of 0% to 50%. The temperature of the compressed low pressure feed air in the supply line **46** influences the oxygen concentration of the oxygen enriched air passing from the system **48**. Appropriate cycling of the solenoid valves **40** and **42**, therefore, can be used to selectively heat and cool the feed air in the supply line and adjust this oxygen concentration. As is usual, the compressor **80** is operated by an electric or gasoline powered motor **110** interconnected with the compressor **80** by a belt **112** and pulleys **114** and **116**.

An ambient air intake **104** leads to a conventional ambient air flow or pressure regulation valve controlled, by operation of a rotatable knob **108**, so as to modify the flow and pressure of ambient air admitted into the compressor feed line **102** through an ambient air feed line **118**. A pressure gauge **120** can be used to indicate the pressure in the feed line **118** which varies depending on the degree, between 0% and 100%, to which the air flow or pressure regulation valve is opened; as shown, the gauge **120** provides readings which could vary between −15 p.s.i.g. (partial vacuum) and 30 p.s.i.g.

Oxygen enriched air (NITROX) only, ambient air only, or a combination of oxygen enriched air and ambient air may be drawn through the compressor feed line **102** to a compressor inlet when the compressor **80** is operated; typically, a mixture of the oxygen enriched air and the ambient air is drawn into the compressor. Compressed oxygen enriched air, compressed ambient air or a compressed combination of oxygen enriched air and ambient air subsequently passes through a compressor outlet and into a high pressure side outlet line **122**. A conventional flow meter **124** is used to monitor the rate of air flow through the line **122** and indicates such an air flow rate in SCFM. As shown, readings of 0–60 SCFM could be provided by the flow meter **124**. The air pressure in the outlet line **122** is adjusted by a conventional pressure regulator, operated by a rotatable knob **126**, to an appropriate pressure. The air pressure in the outlet line **122** is monitored by a pressure gauge **128** which is conventional in structure. The high pressure side air pressure is typically between 3000 and 6000 p.s.i.g. In the embodiment of the invention illustrated, keeping the high pressure side air pressure below 4000 p.s.i.g. is appropriate because of the capability of the pressure gauge **128**.

At a junction **130**, a high pressure side sampling line **132** diverts a small portion of the compressed oxygen enriched air, the compressed ambient air or the compressed combination thereof from the outlet line **122** to the analyzer **100** (or a completely separate and different oxygen analyzer if desired). A reading of the oxygen concentration of the air passing through the line **122**, be it oxygen enriched, ambient or a combination of oxygen enriched and ambient, is thereby provided.

Air which has been compressed by the compressor **80** passes through the outlet line **122** to a junction **134** at which point the outlet line is divided into a first or ambient air supply line **136** and a second or oxygen enriched air supply line **138**. A conventional flow regulating valve **140** is disposed in the line **136** to regulate the flow of ambient air therethrough, while a conventional flow regulating valve **142** is disposed in the line **138** to regulate the flow of oxygen enriched air therethrough. As is clear from the drawing figure, the air supply line **136** feeds into the high pressure feed air line **22**. As a result, the air supply line **136** is able to supply compressed air to the line **22** and to each of the branch lines **20**. Similarly, the oxygen enriched air supply line **138** feeds into a high pressure feed oxygen enriched air line **144** and any desired number of branch lines **146** associated therewith. Each branch line **146** includes a flow control valve **148**, similar to the valves **18**, to regulate the flow of oxygen enriched air into a compressed oxygen enriched air storage assembly **150** including one or more conventional and appropriately labeled NITROX storage vessels such as removable storage cylinders **152** or a removable NITROX scuba tank **154**. Both assembly **10** and assembly **150** may be located either above water or under water. Applications other than for diving purposes, such as in firefighting, climbing, space or high altitude flight, veterinary, medical and dental treatments, welding, etc., are apparent.

A variety of operations can be performed by the system represented in FIG. **1**. To provide an initial charge or a recharge to an air storage cylinder **12**, or a plurality of such cylinders, or to charge a scuba air tank **14**, the appropriate flow control valve or valves **18** is or are opened. The flow regulating valve **140** is opened while the flow regulating valve **142** is closed. The flow control valve **94** is closed to eliminate the admission or flow of oxygen enriched air into the feed line **102**. The knob **108** is rotated to permit free flow of ambient air through the intake **104** and into the compressor feed line **102**. The motor **110** is turned on to drive the compressor **80** and draw ambient air into the feed line **102**. The air is compressed and then passed through the outlet line **122**, the air supply line **136** and the appropriate branch line or lines **20** and into the appropriate air storage cylinder or cylinders **12** and/or scuba air tank or tanks **14**.

To provide an initial charge, or a recharge, to a NITROX storage cylinder **152**, or a plurality of such cylinders, or to charge a NITROX scuba tank **154**, the flow regulating valve **140** is closed, while the flow regulating valve **142** is opened. If it is provided, then the flow control valve **92** is closed. The flow control valve **94** is opened to permit free flow of oxygen enriched air into the feed line **102**. The knob **108** may be rotated to cause the valve associated therewith to set the flow rate of ambient air through the intake **104** and into the feed line **102** to an initial value. The motor **110** is turned on to drive the compressor **80** and draw a mixture of both ambient and oxygen enriched air into the feed line **102**. The air mixture is compressed and then passed through the outlet line **122**, the oxygen enriched air supply line **138** and one or more of the branch lines **146**. At this point, one or more of the branch lines **146** may be left open. The oxygen concentration of the ambient and compressed oxygen enriched air mixture passing through the outlet line **122** is detected by the oxygen analyzer **100** and, as a result, may be closely monitored during any oxygen concentration adjustment.

It has been found that various parameters influence the concentration of oxygen in the compressed oxygen enriched air passing through the outlet line **122**. These parameters include, for example, the temperature of the feed air in the supply line **46** mentioned previously, the pressure of the air in the low pressure feed air line **26** and, of course, the rate at which ambient air is admitted into the compressor feed line **102** through the ambient air intake **104**. The concentration of oxygen in the compressed oxygen enriched air passing through the high pressure outlet line **122**, therefore, can be modified to any desired concentration by adjustment of these parameters. Such an adjustment may be made by changing the setting of the pressure regulator knob **24**, the setting of the thermostatic control of the unit **44**, the setting of the air pressure regulation valve knob **108** or the settings of two or more of these elements. For diving applications, typically desired oxygen concentrations are 32% oxygen (NOAANITROX I) and 36% oxygen (NOAA NITROX II). The parameters obviously could be adjusted so that other concentrations of oxygen in the compressed air passing through the outlet line **122** are provided.

Once a suitable oxygen concentration adjustment of the compressed oxygen enriched air and ambient air mixture in the outlet line **122** has been performed, the appropriate NITROX storage cylinders **152** or NITROX scuba tanks **154** may be connected to the branch lines **146**. The flow control valves **148** may then be operated to admit the oxygen enriched air and ambient air mixture into the NITROX storage cylinders **152** and/or the NITROX scuba tanks **154**. Appropriate pressure regulation is provided by the knob **126** and the pressure gauge **128**.

If a diversion of oxygen enriched air through the optional branch line **90** is desired, then the flow control valve **92** is opened. The oxygen enriched air leaving the separation system **48** through the port **86** is then permitted to pass through the optional branch line **90** so that it may be used in any of a variety of non-diving applications. This oxygen enriched air is directly breathable. As mentioned previously, the pressure in the feed line **88** is usually quite low (in the 0.5 to 5 p.s.i.g. range) and, as a result, the flow of air through the branch line **90** occurs at a fairly low rate. The flow control valve **94** may be left open so that some of the air passing through the port **86** is also permitted to enter the sampling line **98** and, therefore, pass to the oxygen analyzer **100**. In this manner, the oxygen concentration of the oxygen enriched air exiting through the port **86** and flowing through the branch line **90** can be monitored. Thus, the flow control valve **92** and the flow regulating valves **140** and **142**, together with the other elements used to properly route the oxygen enriched air passing through the port **86**, form means for selectively distributing the oxygen enriched air component for further use.

Variations in the embodiment described above and represented in the drawing figure may occur to these skilled in the art. It is intended to protect any such variations which do not depart from the spirit of this invention by the following claims.

What is claimed is:

1. A system for generating oxygen enriched air comprising:

an air supply for supplying compressed air;

a permeable membrane gas separation system for separating a nitrogen gas component and an oxygen enriched air component from said compressed air;

means for detecting an oxygen concentration in said oxygen enriched air component;

means for dividing said nitrogen gas component into a cold gas stream and a hot gas stream;

flow modifying means for modifying a flow path of said compressed air through said cold gas stream and said hot gas stream to selectively heat and cool said compressed air; and

means for selectively distributing said oxygen enriched air component for further use.

2. A system as defined in claim **1**, and further comprising a compressed oxygen enriched air storage assembly, a compressor, a compressor feed line supplying said oxygen enriched air component to a compressor inlet and an outlet line interconnecting a compressor outlet to said compressed oxygen enriched air storage assembly.

3. A system as defined in claim **2**, wherein the flow modifying means comprises solenoid valves which modify said flow path of said compressed air by alternate opening and closing thereof so that the compressed air is selectively heated and cooled to adjust the oxygen concentration of the oxygen enriched air component to a desired oxygen concentration.

4. A system as defined in claim **3**, and further comprising an ambient air feed line for admitting ambient air into said compressor feed line so as to mix with said oxygen enriched air component and regulating means for regulating the amount of ambient air admitted into said compressor feed line to permit further adjustment of said oxygen concentration.

5. A system as defined in claim **4**, wherein said means for detecting the oxygen concentration is interconnected with said outlet line to permit monitoring of the oxygen concentration of a mixture of ambient air and the oxygen enriched air component in said outlet line.

6. A system as defined in claim **5**, and further comprising means for storing said mixture, wherein said means for selectively distributing said oxygen enriched air component for further use comprises an oxygen enriched air supply line and at least one valve provided in said oxygen enriched air supply line to regulate flow of said mixture into the means for storing said mixture.

7. A system as defined in claim **4**, and further comprising a valve for selectively eliminating admission of said oxygen enriched air component into said compressor feed line so that only ambient air passes through said outlet line and said air supply can be recharged.

8. A system as defined in claim **2**, wherein said means for detecting the oxygen concentration is interconnected with an outlet of said permeable membrane gas separation system to permit monitoring of the oxygen concentration of said oxygen enriched air component passing through said outlet.

9. A system as defined in claim **8**, wherein the flow modifying means comprises solenoid valves which modify said flow path of said compressed air by alternate opening and closing thereof so that the compressed air is selectively heated and cooled to adjust the oxygen concentration of the oxygen enriched air component to a desired oxygen concentration.

10. A system as defined in claim **9**, and further comprising an ambient air feed line for admitting ambient air into said compressor feed line so as to mix with said oxygen enriched air component and regulating means for regulating the amount of ambient air admitted into said compressor feed line to permit further adjustment of said oxygen concentration.

11. A system as defined in claim **10**, wherein said means for detecting the oxygen concentration is interconnected with said outlet line to permit monitoring of the oxygen

concentration of a mixture of ambient air and the oxygen enriched air component in said outlet line.

12. A system as defined in claim 11, and further comprising means for storing said mixture, wherein said means for selectively distributing said oxygen enriched air component for further use comprises an oxygen enriched air supply line and at least one valve provided in said oxygen enriched air supply line to regulate flow of said mixture into the means for storing said mixture.

13. A system as defined in claim 2, and further comprising means for diverting some of the nitrogen gas component to a crankcase of said compressor in order to reduce any possibility of explosion.

14. A system as defined in claim 13, wherein the flow modifying means comprises solenoid valves which modify said flow path of said compressed air by alternate opening and closing thereof so that the compressed air is selectively heated and cooled to adjust the oxygen concentration of the oxygen enriched air component to a desired oxygen concentration.

15. A system as defined in claim 14, and further comprising an ambient air feed line for admitting ambient air into said compressor feed line so as to mix with said oxygen enriched air component and regulating means for regulating the amount of ambient air admitted into said compressor feed line to permit further adjustment of said oxygen concentration.

16. A system as defined in claim 15, wherein said means for detecting the oxygen concentration is interconnected with said outlet line to permit monitoring of the oxygen concentration of a mixture of ambient air and the oxygen enriched air component in said outlet line.

17. A system as defined in claim 16, and further comprising means for storing said mixture, wherein said means for selectively distributing said oxygen enriched air component for further use comprises an oxygen enriched air supply line and at least one valve provided in said oxygen enriched air supply line to regulate flow of said mixture into the means for storing said mixture.

18. A system as defined in claim 15, and further comprising a valve for selectively eliminating admission of said oxygen enriched air component into said compressor feed line so that only ambient air passes through said outlet line and said air supply can be recharged.

19. A system as defined in claim 13, wherein said means for detecting the oxygen concentration is interconnected with an outlet of said permeable membrane gas separation system to permit monitoring of the oxygen concentration of said oxygen enriched air component passing through said outlet.

20. A system as defined in claim 2, wherein said compressor is an oil-lubricated compressor.

21. A system as defined in claim 1, wherein said means for dividing said nitrogen gas component includes a vortex tube.

22. A system as defined in claim 1, wherein the further use is breathing.

23. A system for generating oxygen enriched air comprising:

an air supply for supplying compressed air;

a permeable membrane gas separation system for separating a nitrogen gas component and an oxygen enriched air component from said compressed air;

means for detecting an oxygen concentration in said oxygen enriched air component;

means for selectively heating and cooling said compressed air as it passes between said air supply and said permeable membrane gas separation system; and

means for selectively distributing said oxygen enriched air component for further use.

24. A system as defined in claim 23, and further comprising a compressed oxygen enriched air storage assembly, a compressor, a compressor feed line supplying said oxygen enriched air component to a compressor inlet and an outlet line interconnecting a compressor outlet to said compressed oxygen enriched air storage assembly.

25. A system as defined in claim 24, and further comprising an ambient air feed line for admitting ambient air into said compressor feed line so as to mix with said oxygen enriched air component and regulating means for regulating the amount of ambient air admitted into said compressor feed line to permit further adjustment of said oxygen concentration.

26. A system as defined in claim 25, wherein said means for detecting the oxygen concentration is interconnected with said outlet line to permit monitoring of the oxygen concentration of a mixture of ambient air and the oxygen enriched air component in said outlet line.

27. A system as defined in claim 26, and further comprising means for storing said mixture, wherein said means for selectively distributing said oxygen enriched air component for further use comprises an oxygen enriched air supply line and at least one valve provided in said oxygen enriched air supply line to regulate flow of said mixture into the means for storing said mixture.

28. A system as defined in claim 25, and further comprising a valve for selectively eliminating admission of said oxygen enriched air component into said compressor feed line so that only ambient air passes through said outlet line and said air supply can be recharged.

29. A system as defined in claim 24, wherein said means for detecting the oxygen concentration is interconnected with an outlet of said permeable membrane gas separation system to permit monitoring of the oxygen concentration of said oxygen enriched air component passing through said outlet.

30. A system as defined in claim 29, and further comprising an ambient air feed line for admitting ambient air into said compressor feed line so as to mix with said oxygen enriched air component and regulating means for regulating the amount of ambient air admitted into said compressor feed line to permit further adjustment of said oxygen concentration.

31. A system as defined in claim 30, and further comprising a valve for selectively eliminating admission of said oxygen enriched air component into said compressor feed line so that only ambient air passes through said outlet line and said air supply can be recharged.

32. A system as defined in claim 33, wherein said means for detecting the oxygen concentration is interconnected with an outlet of said permeable membrane gas separation system to permit monitoring of the oxygen concentration of said oxygen enriched air component passing through said outlet.

33. A system as defined in claim 23, and further comprising an ambient air feed line for mixing ambient air into said oxygen enriched air component and regulating means for regulating the amount of ambient air mixed into said oxygen enriched air component to permit further adjustment of said oxygen concentration.

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IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION

UNDERSEA BREATHING SYSTEMS, INC.,	)	
Plaintiff, Counter-Defendant,	)	**No. 97 C 2014**
v.	)	
	)	**Magistrate Judge Morton Denlow**
NITROX TECHNOLOGIES, INC.,	)	
Defendant, Counter-Plaintiff.	)	

MEMORANDUM OPINION AND ORDER

This patent case arises out of the issuance of a patent for an oxygen enriched air generation system designed principally for use by dive shops for filling scuba tanks. The Court conducted a bench trial from October 6-10, 1997, involving six in-court witnesses, two who testified by deposition, and numerous exhibits. The case involves two primary issues: 1) Was Plaintiff's patent infringed by Defendant? The answer is no. 2) Is Plaintiff's patent valid? The answer is yes. The following constitute the Court's findings of facts and conclusions of law pursuant to Rule 52(a) of the Federal Rules of Civil Procedure. To the extent certain findings may be deemed conclusions of law, they shall also be considered conclusions. Similarly, to the extent matters contained in the conclusions of law may be

Exhibit "4"

deemed findings of fact, they shall also be considered findings. *See Miller v. Fenton*, 474 U.S. 104, 113-14, 106 S. Ct. 445, 451-52 (1985).

FINDINGS OF FACT

I. THE PARTIES.

1. Plaintiff, Undersea Breathing Systems, Inc. ("Plaintiff") manufactures and markets oxygen-enriched air ("nitrox") generation systems for the production of divers' breathing gas. Its corporate officers are William H. Delp, II ("Delp"), Richard Rutkowski ("Rutkowski") and Dr. J. Morgan Wells ("Wells").

2. Defendant, Nitrox Technologies, Inc. ("Defendant" or "NTI") also manufactures and markets nitrox generation systems for producing divers' breathing gas. Its corporate officers are Cynthia Olson and Robert Olson ("Olson").

II. JURISDICTION AND VENUE.

3. This Court has jurisdiction over the parties and over the subject matter of this action pursuant to 28 U.S.C. §§ 1331 and 1338(a).

4. Venue is proper in this district pursuant to 28 U.S.C. §§ 1391(c) and 1400(b).

III. THE PATENT AT ISSUE.

5. United States Patent Number 5,611,845 ("the '845 patent") was issued on March 18, 1997, to Delp, as the inventor. (Px 1). Delp subsequently assigned the patent to Plaintiff. Delp filed the patent application for the system which led to the '845 patent on August 22, 1995. (Px 2).

6. The patent describes a particular type of nitrox generation system using a permeable membrane gas separation system for separating compressed air into a nitrogen gas component and a nitrox component. (Px 1).

7. The patent contains 33 claims. Claims 1 and 23 are independent claims with the remainder being dependent.

8. Plaintiff alleges that Defendant infringed independent claim 23 and dependent claims 24 and 29 of the '845 patent. Defendant denies the allegation and asserts that the '845 patent is invalid.

9. Claim 23 claims:

A system for generating [nitrox] comprising:

an air supply for supplying compressed air;

a permeable membrane gas separation system for separating a nitrogen gas component and [a nitrox] component from said compressed air;

means for detecting an oxygen concentration in said [nitrox] component;

means for selectively heating and cooling said compressed air as it passes between said air supply and said permeable membrane gas separation system; and (emphasis added)

means for selectively distributing said [nitrox] component for further use.

('845 patent, col. 9-10).

10. The principal issue with respect to Plaintiff's complaint for infringement is whether Defendant's system contains a means for selectively heating and cooling compressed air. The Court finds that Defendant's system does not contain a means for selectively heating and cooling the compressed air. In particular, the Court finds that Defendant's system lacks an equivalent structure for selectively cooling the compressed air. The Court's analysis of this issue is contained in the Conclusions of Law at Section VII.

11. Dependent claim 24 describes:

> A system as defined in claim 23, and further comprising a compressed [nitrox] storage assembly,
>
> a compressor,
>
> a compressor feed line supplying said [nitrox] component to a compressor inlet and
>
> an outlet line interconnecting a compressor outlet to said compressed [nitrox] storage assembly.

('845 patent, col. 10, lines 6-11).

12. Dependent claim 29 states:

> A system as defined in claim 24, wherein said means for detecting the oxygen concentration is interconnected with an outlet of said permeable membrane gas separation system to permit monitoring of the oxygen concentration of said oxygen enriched air component passing through said outlet.

('845 patent, col. 10, lines 35-41).

IV. BACKGROUND FACTS.

A. The Parties' Involvement in Diving and Patent Development.

13. Delp attended college and took general engineering courses but did not receive a degree. He has had a continuing interest in diving since 1962, when he was certified as a diver. Delp has been involved in commercial diving and producing life support breathing gas mixtures for the diving industry since 1985. He is certified as a hyperbaric technician. Delp recognized that a system for generating nitrox using permeable membrane technology, which eliminates the need for a separate pure oxygen source, offered substantial advantages, such as increased safety and decreased cost and effort in producing nitrox.

14. Robert Olson has a bachelor's degree in oceanography. He has been a recreational diver since 1974. Olson has previously developed and patented systems using the nitrogen stream produced by permeable membranes for applications in the transportation industry, such as inerting containers used to ship grain and produce. (Dx 10 and 11). Olson assigned his patents to his then-employer, Prolong Systems, Inc., which produced and sold nitrogen generation systems for inerting purposes. In 1994, Olson began to work on a device to create nitrox for dive shops. He installed his first nitrox generating unit in July 1996. The NTI system takes filtered, compressed air through a bundle of hollow fibers that separates the oxygen from the nitrogen using selective permeation. (Dx 25).

B. Diving.

15. When a diver's body is submerged under water, the liquid exerts pressure against the body in every direction. At sea level, the diver is subjected to normal atmospheric pressure, which can be quantified as 1 Atmosphere. The amount of pressure increases linearly as the diver submerges deeper below the water surface. For example, diving to a depth of 33 feet below sea level increases the pressure by 1 Atmosphere. Any diver, at any depth, must be in pressure balance with the forces at that depth. The body can only function normally when the pressure differences between the inside of the diver's body and forces acting outside is very small. (Px 29).

16. As pressure increases with depth, the diver's circulatory system is also compressed. If a diver surfaces too quickly, the rapid decompression can cause arterial gas embolisms, bubbles in the blood stream, to form. (Px. 47, p. 49-50, ¶¶ 9-14, U00437-38.) The bubbles of air in the blood vessels block some of the small terminal vessels, cutting off the blood supply to nerve endings. Known as decompression sickness or more popularly as the bends (and euphemistically by divers as "bubble trouble"), the consequent blockage throughout the circulatory system, can cause severe pain, temporary paralysis, permanent damage, or death.

C. Gases in Diving.

17. Divers' breathing gas is composed of eight gases, which are normally found in varying quantities in the atmosphere. These gases are oxygen, nitrogen, helium, hydrogen,

neon, carbon dioxide, carbon monoxide and water vapor. Oxygen is the most important. Normal ambient air contains approximately 21 percent oxygen, 78 percent nitrogen, and 1 percent trace gases. It is the oxygen that is actually used by the body. The other 79 percent of air serves to dilute and carry the oxygen. Pure (i.e., 100 percent) oxygen is often used for breathing in hospitals and in aircraft. However, a diver who breathes pure oxygen under pressure may experience oxygen poisoning. (Px 29). Because it imposes a significant decompression obligation, ambient air is not the "ideal" breathing mixture for diving. Decompression obligation refers to the necessity when surfacing from a dive to stop periodically and allow the diver's body to adjust to the new pressure exerted on the body to avoid the bends. Decompression obligation is dependent on the quantity of nitrogen absorbed by the body during the course of a dive. Both the rate of nitrogen absorption and the total amount of nitrogen which can be taken in by the body are determined by the nitrogen partial pressure in the breathing gas. (Px. 2, Tab 47, p. 21). Although nitrox is any combination of nitrogen-oxygen, nitrox mixtures with greater than 21 percent oxygen can offer significant advantages to many types of diving. (Px 2, Tab 47, p. 21). For the purposes of this opinion, any reference to nitrox will indicate a nitrogen-oxygen mixture which contains more than 21 percent oxygen.

18. If both the toxic and decompression obligation reducing properties of oxygen are considered, an "ideal" diving gas mixture for any depth / time combination can be produced. Such a mixture would offer the maximum decompression advantage without the

risk of oxygen toxicity. The advantages of such a mixture as compared to air are that it will either increase the allowable time on a successive dive or reduce the surface interval, the time a diver must spend at surface level between dives, or both. (Dx. 36, p.31-32.)

D. Pressure and Compression.

19. A gas mixture that is safe to breathe at the surface may not be acceptable at depths experienced by divers. The breathing gas will not flow out of its storage tank unless it is at a higher pressure than its surroundings. Because pressure increases as the diver's depth increases, the breathing gas in the diver's tank must be stored at a pressure higher than the maximum that the diver will encounter. Other components of air, such as carbon dioxide or hydrocarbon contaminants, may be tolerable at ambient pressure but dangerous at the higher pressures encountered at depth.

20. Generating and compressing nitrox for diving implicates several problems. The enhanced oxygen content increases the risk of explosion or fire, necessitating the use of special cleaning and safety procedures. Moreover, because diving time, decompression time, and surface intervals vary with the gas composition of the breathing gas used, the oxygen and other gas components must be precisely controlled.

E. Prior Nitrox Generation Systems.

21. Prior to the '845 patent, nitrox was produced in one of three ways. The first, partial pressure blending, requires the mixture of compressed pure oxygen and compressed air or pure nitrogen. The second, the continuous blending method used by the National

Oceanic and Atmospheric Administration ("NOAA"), involves the mixing of compressed pure oxygen with air at ambient pressure and the compression of the resulting nitrox for use in diving tanks. Both the partial pressure and NOAA continuous blending methods require a separate pure oxygen source and use of the precautions attendant to the use of pure oxygen. The third, the pressure swing adsorption ("PSA") method, uses a molecular sieve that selectively adsorbs nitrogen molecules during pressurization and depressurization with air. (Dx 30, p. 12). PSA technology requires cleaning and safety procedures identical to using pure oxygen. (Dx 30, p. 12).

22. During the early 1990s, researchers Rutkowski, a hyperbaric medicine specialist, and Wells, director of the NOAA Experimental Diving Unit, began experimenting with the possibility of using permeable membrane technology as a commercially viable means of producing a safe nitrox breathing gas for divers. The advantage of this technology is the elimination of a pure oxygen source requirement. Rutkowski and Wells tested membrane packages manufactured by Permea and Medal to determine whether the nitrox permeate could be safely breathed at depth and whether contaminants and trace gases might be concentrated in the permeate; they experimented with flow rates to determine the optimum pressure for the feed air.

F. Permeable Gas Membranes.

23. The system claimed by the "845 patent discloses a gas separator in the form of a hollow-fiber permeable membrane in combination with additional elements to produce

nitrox. *See e.g.*, United States Patent 4,230,463 for a multicomponent membrane for gas separations. (Dx 9).

24. Permeation results from the pressure differential across the fiber. (Dx 26, 03387.) Because a gas will always seek to reach an equilibrium pressure with its surroundings, the permeable hollow fiber membranes, filled with air at an elevated pressure, act like a "leaking" pipe. The gases that comprise air permeate, or "leak," through the fiber, as the air travels axially through the hollow fiber.

25. Each gas has a particular permeation rate; oxygen permeates faster than nitrogen. Thus, when a compressed air stream is fed to the inside of the hollow membrane fiber, the air separates into two streams: a permeate[1] stream, at atmospheric pressure, which is oxygen enriched and a nonpermeate stream, near the original, elevated pressure, which is nitrogen enriched (actually oxygen depleted). (Dx 25, 03812-13).

26. Permeable membranes have been used for gas separation since the 1970s, and hollow-fiber permeable membranes have been used since the 1980s. Their predominant use, however, is the production of nitrogen. (See Px 24 describing AVIR Gas Separation Cartridge).

27. The use of nitrogen is sometimes referred to as "inerting," that is, displacing the oxygen in an environment with nitrogen. The three points of the "fire triangle" – fuel,

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[1]"Permeate" refers to the gases, in this case primarily oxygen, which migrate out of the hollow fiber by diffusing through the cylindrical wall.

heat and oxygen – must all be present for combustion to occur. When enough oxygen is displaced by nitrogen, combustion can no longer occur. Also with no oxygen in the atmosphere, most living things can not survive.

28. Nitrogen is used in the shipping and warehousing industries to prevent combustion, preserve freshness and increase shelf life of produce, or exterminate insects through oxygen deprivation. Other uses for nitrogen include: purging lines and vessels in industrial processes, producing pressurized gas for enhanced oil recovery, pressure testing pipe systems, preventing dust explosions in silos and bins, and supplying inert atmospheres for heat treating. (Dx. 18, pp. 4-5, N00734-35).

29. In the overwhelming majority of membrane applications, the oxygen-rich permeate is considered a waste gas and discarded. In those few applications in which the permeate is used, such as the generation of nitrox for medical purposes, the permeate is used at ambient pressure. The potential use of permeable membranes to produce oxygen- enriched breathing gas for divers was first being discussed in the 1990's by those engaged in the design and manufacture of equipment for the diving industry. In 1993, Wells and Linda Moroz wrote an article regarding the application of gas separation technology in the preparation of divers' breathing gases. (Dx 6).

G. The Invention Claimed by the '845 Patent.

30. The '845 patent claims and discloses a system which is capable of generating an oxygen-enriched, safe breathing gas for use by underwater divers. Nitrox may contain

from 22 to 40 percent oxygen. Divers generally use a nitrox mixture containing 32 or 36 percent oxygen (known as Nitrox I and Nitrox II, respectively).

31. Nitrox has been used as a breathing gas by military, scientific and commercial divers for decades, and began to gain acceptance in recreational diving in the 1980s. Nitrox provides several advantages, such as reduced danger of decompression problems, increased bottom time, and decreased surface interval (the time that a diver must spend on the surface between dives).

32. In 1993 and 1994, Delp obtained permeable membranes from A/G Technology Corp. and Medal to evaluate the oxygen-rich permeate produced by separation and to determine whether the permeate would be safe and breathable for a diver at a depth where it would be supplied at elevated pressure. Delp focused on the concentrations of oxygen, nitrogen, argon, carbon monoxide, carbon dioxide, hydrocarbons and water vapors; these substances, while safe to breathe at the surface, can be toxic at elevated pressure.

33. Delp was aware that hollow-fiber permeable membranes are produced by fewer than a dozen manufacturers worldwide. These manufacturers were reluctant to have their membranes used in connection with a diving application because they considered it too dangerous and a serious liability risk. These manufacturers include Permea, Inc.; A/G Technology Corporation; Generon Systems; Air Liquide America Corp. (or Medal); and Aquila Air. Delp also realized that the membranes produced by the various manufacturers differ with respect to their optimal feed air temperature and pressure ranges and their ability

to withstand contaminants in the feed air. He therefore designed a system that could be adjusted for these differences and thus be used with any of the membranes. Delp ultimately selected a Permea membrane for use in the system that he would manufacture.

34. Delp testified that the invention claimed in the '845 patent was conceived and reduced to practice in early 1994 but offered no corroborating evidence.

35. Delp filed an application for a patent on his invention on August 22, 1995.

36. Plaintiff displayed its system at the Dive Equipment Marketing Association ("DEMA") trade shows in January 1996 and January 1997.

37. Delp was advised by the patent office in January 1997 that his claims had been allowed.

38. The '845 patent issued on March 18, 1997.

H. The NTI System.

39. Defendant manufactures a nitrox generation system which competes with the Plaintiff's system. (Px 6 and 7). The NTI system has been in existence since at least June of 1996. The NTI system takes filtered compressed air through hollow fiber membranes to produce a nitrox permeate stream. An oxygen analyzer confirms the percentage of oxygen in the stream as it is fed into the intake of a standard high pressure compressor. A flow control allows an operator to adjust the nitrox mixture up to 40 percent oxygen. (Px 6).

40. The NTI system is manufactured in the United States.

V. THE MARKET FOR THE NITROX GENERATION SYSTEMS.

41. The market for nitrox generation systems such as those sold by Plaintiff and Defendant consists primarily of dive shops located in the United States. Of these, only approximately 1,500 dive shops have the financial resources to purchase a system.

42. Plaintiff has the manufacturing and marketing capability to exploit the market.

43. The lifespan of an enriched air generation system is indefinite and depends on the life of the membrane. Therefore there is no replacement market for these systems.

44. The systems manufactured and sold by Plaintiff range in price from $6,900 for the smallest unit to $50,000 for the largest.

45. The systems manufactured and sold by Defendant range in price from $9,000 for the smallest system to $24,000 for the largest system.

46. Since the '845 patent issued, Defendant has sold at least three systems that were manufactured in the United States.

VI. THE DISPUTE.

47. Olson and Christian St. Claire, NTI's vice president of sales, displayed a bare membrane at St. Claire's booth at the DEMA show in January 1996 to ascertain whether there would be a market for a commercial product using membrane technology. Olson and St. Claire saw Plaintiff's system at that time. Delp advised Olson that he had applied for a patent on his system, and that he intended to enforce the patent upon its issuance. He threatened to sue Olson if Olson attempted to sell his device. For the remainder of the

DEMA show, Olson and St. Claire displayed Plaintiff's logo and referred all inquiries regarding the membrane to the Plaintiff's booth.

48. In early September 1996, Delp learned of the installation of the NTI system at a dive shop and advised Olson that NTIs system would infringe the '845 patent when it issued.

49. In January 1997, Delp informed Olson and St. Claire that the claims of the '845 patent application had been allowed. Olson obtained a copy of the '845 patent on the day it issued and immediately faxed it to membrane manufacturers. Olson continued manufacturing and marketing the NTI system.

50. On March 24, 1997, Plaintiff filed suit against NTI alleging direct and contributory infringement of the '845 patent. NTI filed counterclaims for a declaratory judgment of non-infringement, a declaratory judgment of invalidity and unenforceability under 35 U.S.C. §§ 102 and 103, and a declaratory judgment of patent misuse, as well as a counterclaim seeking a statutory penalty provided for by 35 U.S.C. § 292.

51. After suit was filed, Defendant obtained a written opinion from counsel that its system did not infringe Plaintiff's patent. (Dx 47).

CONCLUSIONS OF LAW

VII. INFRINGEMENT.

52. Plaintiff claims direct or, alternatively, contributory infringement. Persons who make, use or sell the patented invention are direct infringers. *Herbert F. Schwartz, Patent Law & Practice* (2nd ed. 1996) (hereafter "Schwartz"), p. 77. Contributory infringers are persons who aid and abet direct infringers without themselves making, using, offering to sell, or selling the patented invention. *Id.* The patentee carries the burden of proving infringement by a preponderance of the evidence. *Rohm and Haas Co. v. Brotech Corp.*, ___ F.3d ___, Nos. 97-1024, 97-1063, 1997 WL 643917, at *3 (Fed. Cir. Oct. 20, 1997).

53. A person infringes a patent when she "without authority makes, uses, offers to sell, or sells any patented invention, within the United States or imports into the United States any patented invention during the term of the patent . . . ." 35 U.S.C. § 271(a). A court's first step in an infringement analysis is to properly construe the claims. *Markman v. Westview Instruments, Inc.*, 52 F.3d 967, 976 (Fed. Cir. 1995), *aff'd*, 116 S. Ct. 1384 (1996). This is a question of law. *Markman v. Westview Instruments, Inc.*, ___U.S. ___, 116 S. Ct. 1384, 1389 - 96 (1996). After the claims have been properly construed, they are then compared to the accused system. *Markman*, 52 F.3d at 976. This is a question of fact. *Kagel Co., Inc. v. AMF Bowling, Inc.*, ___ F.3d ___, No. 96-1178, 1997 WL 574561, at *4 (Fed. Cir. Sep. 17, 1997).

54. Plaintiff alleges that Defendant's system infringes independent claim 23 and dependent claims 24 and 29 of the '845 patent. A dependent claim is infringed only if the independent claim on which it rests is infringed. *Wolverine World Wide, Inc. v. Nike, Inc.*, 38 F.3d 1192, 1199 (Fed. Cir. 1994).

A. Claim Construction.

55. In determining the proper construction of a claim, the court has numerous sources that it may properly utilize for guidance. These include both intrinsic evidence (*e.g.*, the patent claims, specification, and prosecution history) and extrinsic evidence (*e.g.*, expert testimony). *Vitronics Corp. v. Conceptronic, Inc.*, 90 F.3d 1576, 1582 (Fed. Cir. 1996). In most situations, an analysis of the intrinsic evidence alone will resolve any ambiguity in a disputed term. *Id.* at 1583. Unless the specification or the file history indicates that the inventor intended another meaning, a claim term will be accorded its "ordinary and accustomed meaning." *Wolverine World Wide, Inc.*, 38 F.3d at 1196. "Ultimately, the court must construe the claim language according to the standard of what those words would have meant to one skilled in the art as of the application date." *Weiner v. NEC Electronics, Inc.*, 102 F.3d 534, 539 (Fed. Cir. 1996).

56. Under the doctrine of claim differentiation, claims should be presumed to cover different inventions; therefore, the court should avoid an interpretation of a claim that would make one claim read like another. *Laitram Corp. v. Rexnord, Inc.*, 939 F.2d 1533, 1538 (Fed. Cir. 1991).

B. Construction of Means Plus Function Language.

57. Claim 23 contains means-plus-function language. If construed literally, a means plus function claim element would be construed to cover every conceivable structure that could perform the recited function. This broad construction of means plus function elements has been restricted by 35 U.S.C. § 112, ¶ 6 which allows a patentee to claim an element of his invention in means-plus-function language but also "provide[s] a standard to make the broad claim language more definite." *Valmont Industries, Inc. v. Reinke Mfg. Co., Inc.*, 983 F.2d 1039, 1042 (Fed. Cir. 1993). Section 112, ¶ 6 states:

> An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.

Paragraph six directs a court to construe means-plus-function language by turning to "the specification and interpret[ing] that language in light of the corresponding structure, materials, or acts described therein, and equivalents thereof, to the extent that the specification provides such disclosure." *In re Donaldson*, 16 F.3d 1189, 1193 (Fed. Cir. 1994).

58. A claim using means-plus-function language must still " 'particularly point out and distinctly claim' the invention." *In re Donaldson*, 16 F.3d at 1195 (quoting 35 U.S.C. § 112, ¶ 2). Although the patentee need not recite "structure, material, or acts" in a claim's

means-plus-function element, to satisfy the enablement requirement, "the patent specification must describe some structure which performs the specified function." *Valmont Industries, Inc.*, 983 F.2d at 1042. However, "there is and can be no requirement that applicants describe or predict every possible means of accomplishing that function." *In re Hayes Microcomputer Products, Inc. Patent Litigation*, 982 F.2d 1527, 1535 (Fed. Cir. 1992) (internal quotations omitted).

59. A limitation containing means-plus-function language is "not rendered open-ended by the presence of another claim specifically claiming the disclosed structure underlying the means-plus-function clause or an equivalent of that structure." *Laitram Corp.*, 939 F.2d at 1538. The statute expressly provides that the patentee is entitled to a claim covering equivalents as well as the disclosed structure. *D.M.I., Inc. v. John Deere & Co.*, 755 F.2d 1570, 1574 (Fed. Cir. 1985).

C. Prosecution History of the '845 Patent.

60. Delp's original patent application contained 24 proposed claims, three independent claims and 21 claims all dependent on what was to become independent claim 1 of the patent. (Px 2A, U00134). In a PTO Examiner's Action on May 28, 1996, the examiner allowed independent claim 1 and rejected for obviousness the two other independent claims, claims 23 and 24 of the original application. (Px 2A, U00196-97).

61. The original, proposed independent claim 23 attempted to claim:

> A process for generating breathable [nitrox] comprising the steps of:
>
> > supplying compressed air;
> >
> > separating a nitrogen gas component and [a nitrox] component from said compressed air through the use of a permeable membrane gas separation system;
> >
> > detecting an oxygen concentration in said [nitrox] component; and
> >
> > selectively distributing said [nitrox] component for breathing.

(Px 2A, U00158-59).

62. Similarly, proposed independent claim 24 attempted to claim the analog system to proposed process claim 23 as follows:

> A system for generating *breathable* [nitrox] comprising:
>
> > an air supply for supplying compressed air;
> >
> > a permeable membrane gas separation system for separating a nitrogen gas component and [a nitrox] component from said compressed air;
> >
> > means for detecting an oxygen concentration in said [nitrox] component; and
> >
> > means for selectively distributing said [nitrox] component for breathing. (emphasis added).

(Px 2A, U00159).

63. The examiner found that both the proposed process and system claims were unpatentable because of obviousness over U.S. Patent Number 4.950,315 ("Gollan patent") in light of U.S. Patent Number 5,053,058 ("Mitariten patent"). (Px 2A, U00197). The proposed claims were different from Gollan because Gollan did not disclose the use of a concentration detector on the permeate outlet line of the permeable gas membrane separator system. However, the examiner noted that Mitariten teaches such use of the concentration detector and, therefore, concluded that the combined teachings of the prior art references rendered the proposed claims obvious. (Px 2A, U00197).

64. In response to the examiner's action, Delp filed on August 22, 1996, an amendment to his application which canceled the two proposed independent claims rejected by the examiner and which added claims 25 through 35. (Px 2A, U00100). In a Notice of Allowability on October 25, 1996, the examiner allowed these added claims, which became claims 23 through 33 in the patent. (Px 2A, U00185).

65. Only two differences are evident between proposed independent claim 24 and what eventually became independent claim 23 in the patent. Claim 23 omits the word *breathable* from the preamble of the claim, and claim 23 adds the following limitation: *"means for selectively heating and cooling said compressed air as it passes between said air supply and said permeable membrane gas separation system."* (Px 1, U00171). The Court finds that the additional limitation distinguishes Delp's invention from the prior art presented to the examiner.

D. Other Claims in the '845 Patent.

66. Independent claim 1 of the '845 patent contains four limitations that are identical to those found in independent claim 23. Claim 1 contains two other limitations not found in claim 23: (1) a *"means for dividing the nitrogen gas component into a cold gas stream and a hot gas stream;"* and (2) a *"flow-modifying means for directing the compressed feed air through the two gas streams to selectively heat and cool the feed air."* ('845 patent, col. 8, lines 1-6.) The structures recited in the specification which accomplish these functions are the vortex tube and the two solenoid valves. ('845 patent, col. 4, lines 20-23 and col. 3, lines 54-56, respectively).

67. Claim 23 includes, besides the four identical limitations, one other limitation: a *"means for selectively heating and cooling said compressed air as it passes between said air supply and said permeable gas separation system."* ('845 patent, col. 10, lines 1-3). Thus, the doctrine of claim differentiation directs that the selective heating and cooling means claimed in independent claim 23 not be construed to carry the same functional meaning as the two different limitations in claim 1.

68. The limitation in claim 23 recites a function (to selectively heat and cool the compressed feed air) which is more broad than the combined functions in claim 1: (1) to divide the nitrogen gas into two components; and (2) to direct the compressed feed air through the two components to selectively heat and cool the compressed feed air.

69. Dependent claim 27 is a system as defined in dependent claim 26[2] but contains a further limitation on the means for selectively distributing the nitrox for further use: "wherein said means for selectively distributing said [nitrox] component for further use comprises [a nitrox] supply line and at least one valve provided in said [nitrox] supply line to regulate flow of said mixture into the means for storing said mixture." ('845 patent, col. 10, lines 25-30.)

70. Rather than adding an additional limitation, dependent claim 27 narrows a limitation by providing a location within the system for certain elements of its structure. In so doing, claim 27 indicates the types of structure that are included within this limitation, that is, supply lines and valves. Therefore, similar structures should also be contained within the "means for selectively distributing the nitrox permeate" limitation found in claim 23.

E. Construction of the Disputed Claims in the '845 Patent.

71. The parties vigorously dispute the meaning of the limitations containing means-plus-function elements in claim 23. In particular, the parties dispute the meaning of

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[2] Dependent claim 26 is a system as defined in claim 25 but contains a further limitation on the means for detecting an oxygen concentration: "wherein said means for detecting an oxygen concentration is interconnected with said outlet line [of the compressor] to permit monitoring of the oxygen concentration of a mixture of ambient air and the [nitrox] component in said outlet line." ('845 patent, col. 10, lines 19-23.)

Dependent claim 25 is a system as defined in claim 24 that further comprises an ambient air feed line placed before the compressor inlet recited in claim 24 to allow the mixing of the nitrox permeate and ambient air and a regulating means to regulate the amount of ambient air mixing with the nitrox permeate to permit further adjustment of the oxygen concentration in the mixture. ('845 patent, col. 10, lines 12-18.)

the word "selectively" in the third limitation of claim 23. The Court will construe in turn the three claims at issue.

F. Independent Claim 23.

72. Claim 23 is an independent claim that defines a system for generating oxygen enriched air which contains five limitations, three of which contain means-plus-function elements: (1) an air supply to supply compressed air; (2) a permeable membrane gas separation system to separate air into nitrox and nitrogen; (3) means for detecting an oxygen concentration in the nitrox permeate; (4) means for selectively heating and cooling compressed air before it enters the permeable membrane; and (5) means for selectively distributing the nitrox permeate. ('845 patent, col. 9-10).

73. The court construes the first limitation of claim 23, "*an air supply for supplying compressed air,*" as follows: The air supply is either one or more storage vessels of compressed air or an oil-free air compressor. ('845 patent, col. 2, lines 40-48.) The limitation is further narrowed by specifying a function for the element, namely to supply compressed air.

74. The court construes the second limitation of claim 23, "*a permeable membrane gas separation system for separating a nitrogen gas component and [a nitrox] component from said compressed air,*" as follows: The structure for the separation system is a standard, commercially available, permeable membrane, nitrox and nitrogen gas separation system.

('845 patent, col. 3, lines 60-66.) The limitation is further narrowed by specifying a function for the element, namely to separate the compressed air into nitrogen and nitrox components.

75. The third limitation of claim 23 claims a "*means for detecting an oxygen concentration in said [nitrox] component.*" The Court construes the third limitation to correspond to the following structures and functions: the structure recited in the specification for the means for detecting an oxygen concentration includes a junction; a sampling line; and a conventional oxygen analyzer. (*See* '845 patent, col. 5, lines 12-15.) The concentration detector detects and provides a reading (typically, anywhere from 0% to 50%) of the nitrox permeate's oxygen concentration as it passes through a flow control valve and into a compressor feed line leading to an oil-lubricated, high pressure compressor. (*See* '845 patent, col. 5, lines 16-21.)

76. The fourth limitation of claim 23 claims a "*means for selectively heating and cooling said compressed air as it passes between said air supply and said permeable membrane gas separation system.*" The Court construes the fourth limitation to correspond to the following structures and functions: the structure recited in the specification for the means for selectively heating and cooling the compressed air includes: (1) a heating and cooling heat exchanger which includes a commercially available spin vortex tube,[3] which has

[3] A spin vortex tube uses compressed gas as a power source, has no moving parts, and generates hot gas from one end and cold gas from the other. A valve built into the hot gas exhaust adjusts the volume and temperature of the hot and cold streams. The spin vortex tube can create temperatures as low as -40°F and as high as +200°F. (Dx 33, p. 8). One widely accepted theory regarding how a vortex tube works explains the

a cold nitrogen gas exhaust directed towards the first coil and a hot nitrogen gas exhaust directed towards the second coil, and two heat exchanger lines, with the corresponding first coil along one line and second coil along another line; (2) two solenoid valves; (3) a solenoid control unit; and (4) a temperature sensor. (*See* '845 patent, col. 4, lines 9-36.) The Court concludes that the function found in this limitation includes both the ability to heat *and* to cool.

77. The interpretation of the term "selectively" is critical to the construction of this limitation and to whether Defendant's system infringes the '845 patent. The means for *selectively* heating and cooling the compressed air requires the "appropriate operation of the solenoid valves by the control unit permits selective heating and cooling, *i.e.*, 'temperature conditioning' of the compressed low pressure feed air passing through the heat exchanger and the supply line so that the temperature is appropriate for, and meets the specifications of, the particular separation system selected." ('845 patent, col. 4, lines 34-37.) Cycling the solenoid valves can be used to selectively heat and cool the feed air in the supply line and,

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dynamics of the phenomena as follows:

> Compressed air is supplied to the vortex tube and passes through the nozzles that are tangent to an internal counterbore. These nozzles set the air in a vortex motion. This spinning stream of air turns 90° and passes down the hot tube in the form of a spinning shell, similar to a tornado. A valve at one end of the tube allows some of the warmed air to escape. What does not escape heads back down the tube as a second vortex inside the low-pressure area of the larger vortex. This inner vortex loses heat and exhausts thru [sic] the other end as cold air. (Dx 33, p. 8 - 9.)

therefore, adjust the oxygen concentration in the nitrox permeate because the concentration is dependent, *inter alia*, on input temperature. ('845 patent, col. 5, lines 24-27).

78. The Court concludes that in this limitation "selectively" indicates an ability to choose a specific point along a continuous range of possible temperatures and to control the temperature of the compressed air by directing it along the "hot route" to heat it and / or along the "cold route" to cool it until it reaches the optimum operating temperature. The ability to control the temperature during operation is central to the concept of "selectively heating and cooling."

79. The fifth limitation of claim 23 claims a "*means for selectively distributing said [nitrox] component for further use*." The Court construes the fifth limitation to correspond to the following structures and functions: the structure recited in the specification for the means for selectively distributing the nitrox permeate includes: a low-pressure nitrox permeate feed line and a conventional flow control valve disposed in the feed line; and optionally a branch line and a conventional flow control valve disposed in the optional branch line. The Court finds that the means for selectively distributing the nitrox permeate allow the flow of nitrox through the feed line to be "permitted, shut off and regulated." (*See* '845 patent, col. 5, lines 9-11.) The Court finds that the word "selectively" is used consistently in the fourth and fifth limitations to denote the situation where the means can control the function in a continuous manner.

G. Dependent Claim 24.

80. Claim 24 is a dependent claim that defines a system as defined in claim 23 and contains four additional limitations: (1) a compressed nitrox storage assembly; (2) a compressor; (3) a compressor feed line to supply the nitrox permeate to the compressor inlet; and (4) a compressor outlet line to connect the compressor outlet to the compressed nitrox storage assembly. The court construes claim 24 to include every limitation found in independent claim 23 as construed earlier in this opinion.

81. The court construes the first additional limitation of claim 24, "*a compressed [nitrox] storage assembly*," as follows: the assembly contains as many conventional storage vessels (such as a nitrox storage cylinder or a scuba tank) as the operator of the system desires, and it contains an identical number of branch lines, one branch line for each storage vessel. (*See* '845 patent, col. 6, lines 20-28.)

82. The second additional limitation of claim 24 describes "*a compressor.*" Although the specification, indicates that "a standard, oil-lubricated, high pressure compressor" could be used in the invention, ('845 patent, col. 4, lines 52-53), the use of such a compressor is predicated on using the nitrogen gas component to inert the crankcase of the compressor. ('845 patent, col. 4, lines 42-52.) However, claim 24 contains no limitation requiring the use of the nitrogen gas component in such a manner. Accordingly, the court construes "*a compressor*" in this limitation as follows: a compressor, either oil-free or oil-lubricated, capable of compressing and delivering air at least at 3000 p.s.i.g.

83. The court construes the third additional limitation of claim 24, "*a compressor feed line supplying said [nitrox] component to a compressor inlet*," as follows: a line which connects the permeate outlet of the permeable membrane gas separator to the inlet of the immediately above-described compressor.

84. The court construes the fourth additional limitation in claim 24, "*an outlet line interconnecting a compressor outlet to said compressed [nitrox] storage assembly*," as follows: a line which connects the outlet end of the compressor to the nitrox storage assembly.

H. Dependent Claim 29.

85. The Court construes claim 29, which is dependent on dependent claim 24, to include every limitation found in dependent claim 24 as construed earlier in this opinion with the exception that the third limitation, "*means for detecting an oxygen concentration in said [nitrox] component*," which is further narrowed by the following:

> *said means for detecting the oxygen concentration is interconnected with an outlet of said permeable membrane gas separation system to permit monitoring of the oxygen concentration of said [nitrox] component passing through said outlet.*

('845 patent, col. 10, lines 34-39.)

86. The Court finds that the structure recited in the specification for the "*means for detecting the oxygen concentration*" is the same as for claims 23 and 24.

87. The Court finds the third limitation is narrowed: (1) by adding a further description of the location in the system of the means-for-detecting-an-oxygen-concentration element: it is connected to the permeate outlet of the permeable membrane gas separation system; and (2) by further specifying the element's function: it monitors the oxygen concentration of the nitrox permeate as it passes through the permeate outlet of the gas separation system.

I. Direct Infringement.

88. Direct infringement is found where each and every limitation of an asserted claim is found in the accused device either literally or under the doctrine of equivalents. *Intellicall, Inc. v. Phonometrics, Inc.*, 952 F.2d 1384, 1389 (Fed. Cir. 1992). The absence of a single limitation is enough to negate infringement of the claim. *Laitram Corp.*, 939 F.2d at 1535.

J. Literal Infringement.

89. An accused system literally infringes a claimed invention when "every limitation recited in the claim is found in the accused device, *i.e.*, when the properly construed claim reads on the accused device exactly." *Cole v. Kimberly-Clark Corp.*, 102 F.3d 524, 532 (Fed. Cir. 1996).

90. To determine whether the claim's limitation with means-plus-function language literally reads on the accused device, the Court must "compare the accused structure with the disclosed structure, and must find equivalent structure as well as identity

of claimed function for that structure." *Pennwalt Corp. v. Durand-Wayland, Inc.*, 833 F.2d 931, 934 (Fed. Cir. 1987). Means-plus-function language does not extend the scope of the element to cover equivalent functions. *Johnston v. IVAC Corp.*, 885 F.2d 1574, 1580 (Fed. Cir. 1989). 35 U.S.C. § 112, ¶ 6 does not allow finding that a limitation containing a means-plus-function element is met literally "where the function part of the element is not literally met in an accused device." *Id.*, 885 F.2d at 1580 (Fed. Cir. 1989).

K. The Accused Device.

91. The Court finds that Defendant offered to sell a system which included *inter alia*: (1) a cabinet-style enclosure that holds a permeable membrane gas separation system for separating compressed air from a compressed air supply into a nitrogen gas component and a nitrox component, a conventional oxygen analyzer as an identical means for detecting and measuring oxygen concentration which is connected to the permeate outlet of the membrane to detect the oxygen concentration in the nitrox component, a heater, and a digital temperature controller to regulate the heater; (2) an external high pressure-reducing regulator, located on the input side of the cabinet, to reduce the pressure in the compressed air fed to the membrane housed inside the cabinet; and (3) a flexible air line, located on the output side of the cabinet which is connected at one end to the nitrox permeate outlet of the membrane and which could be connected at the other to a compressor. (See Dx 12, N00143).

92. The Court finds that Defendant's system does *not* include: (1) an air supply for supplying compressed air; (2) a nitrox storage assembly; (3) a compressor; (4) a line which

connects the compressor output to the nitrox assembly; or (5) a flow control valve disposed on the nitrox permeate, outlet end of the permeable membrane.

L. Comparison of the Accused Device to the Claims.

1. Claim 23 Is Not Literally Infringed.

93. The Court concludes that Defendant's system does not literally infringe claim 23 because it does not include: (1) an air supply to supply compressed air; (2) an identical or equivalent structure which selectively heats and cools compressed air before it enters the permeable membrane; or (3) an identical or equivalent structure which selectively distributes the nitrox permeate.

94. First, the Court finds that the limitation "an air supply to supply compressed air" is not found in Defendant's system. Defendant's sales brochure depicts an air supply, either as a compressor or compressed air storage cylinders, in use with the cabinet system; however, Defendant does not offer to sell the air supply. Although Defendant's flow schematic reveals that an air supply is necessary, (Dx 13, N00191), it does not list an air supply in the bill of materials.

95. Second, the Court concludes that Defendant's system does not contain an identical or equivalent structure which selectively heats and cools compressed air before it enters the permeable membrane. The Court finds that Defendant's electric, resistive heater that can be set to heat the compressed air to a particular temperature with the digital temperature controller is structurally equivalent to the heating aspect of the heat exchanger

in Plaintiff's system. Both operate by indirectly heating the compressed air, and both can be operated at a continuous range of temperature settings. The heater in Defendant's system performs the identical function as the "hot" side of Plaintiff's claimed heat exchanger.

96. However, the Court finds that Defendant's pressure regulator, regulating the pressure of the compressed air entering the membrane, is not structurally identical or equivalent to the "cool" side of Plaintiff's heat exchanger. An attendant physical phenomena of reducing a gas' pressure is reducing its temperature. Although a pressure regulator will cool the air passing through it as it reduces the air's pressure, the cooling is a function of the type of regulator selected and the amount of pressure drop. Defendant's pressure regulator cannot cool the compressed air passing through it in the same "selective" manner that Plaintiff's heat exchanger can. The two devices perform their functions in such a drastically different manner that no equivalence of structure and no identity of function can be found.

97. Third, the Court finds that no structure in Defendant's device performs a function identical to the fifth limitation, a "*means for selectively distributing the nitrox component.*" Defendant's sales brochure makes no mention of any structure which acts as a means for selectively distributing the nitrox permeate. Defendant's flow schematic reveals a flow control valve disposed at the nitrogen outlet end of the permeable membrane, (Dx 13, N00191, item 10), but no corresponding flow control valve appears on the nitrox permeate outlet end. Rather, a vacuum relief valve and a pressure relief valve are disposed at the end

the nitrox end. (Dx 13, N00191, items 17 and 18.) Neither of these relief valves can perform a function identical to that described in Defendant's limitation, namely to *selectively distribute the nitrox permeate*. The relief valves can act to limit a characteristic but cannot act to stop or vary the flow.

2. Claim 24 Is Not Literally Infringed.

98. Because the Court finds that independent claim 23 is not infringed, dependent claim 24 is not infringed. *See Wolverine World Wide*, 38 F.3d at 1199. However, assuming *arguendo* that every limitation in claim 23 read on Defendant's system, the Court holds that Defendant's system does not literally infringe claim 24 because it does not include a nitrox storage assembly; a compressor; or a line which connects the compressor output to the nitrox assembly. The Court makes this and other alternative findings for the sake of providing a full and complete record in the event of an appeal. In this way the Court and the parties may avoid the possible expense and delay of a retrial to resolve these issues.

99. The Court does find, however, that Defendant's system includes a flexible air line which acts as a compressor feed line to supply the nitrox permeate to a compressor inlet.

3. Claim 29 Is Not Literally Infringed.

100. The Court concludes that Defendant's system does not literally infringe claim 29 because it fails to infringe independent claim 23 and dependent claim 24, upon both of which claim 29 depends. *See Wolverine World Wide*, 38 F.3d at 1199.

101. However, assuming *arguendo* that the Court had found that claims 23 and 24 were infringed, then the Court would have found claim 29 infringed because the conventional oxygen analyzer connected to the permeate outlet of the membrane in Defendant's device does satisfy the narrowed limitation found in dependent claim 29 for the means for detecting and measuring oxygen concentration in the permeate nitrox.

M. Doctrine of Equivalents.

102. Having found no literal infringement, the Court now considers whether infringement exists under the doctrine of equivalents. The accused device may infringe the patented invention under the doctrine of equivalents "if it performs substantially the same function in substantially the same way to obtain substantially the same result." *Graver Tank & Mfg. Co. v. Linde Air Prods. Co.*, 339 U.S. 605, 608, 70 S. Ct. 854, 856 (1950).

103. Infringement analysis under the doctrine of equivalents is not the same as an analysis of literal infringement under 35 U.S.C. § 112, ¶ 6, equivalents. *Pennwalt Corp. v. Durand-Wayland, Inc.*, 833 F.2d 931 (Fed. Cir. 1987). The doctrine of equivalents expands the protection of a patent claim to "[prevent] a copyist from evading patent claims with insubstantial changes." *Valmont Industries, Inc.*, 983 F.2d at 1043. Under ¶ 6, "an equivalent results from an insubstantial change which adds nothing of significance to the structure, material, or acts disclosed in the patent specification. A determination of § 112, ¶ 6 equivalence does not involve the equitable tripartite test of the doctrine of equivalents." *Id.*

104. On the one hand, § 112, ¶ 6 narrows the potentially broad implications of claim limitation with a means-plus-function element by finding literal infringement only where the accused device possesses an identical or equivalent structure, material, or act recited in the patent specification and where it performs an identical function. *Id.* at 1043-44. On the other hand, the doctrine of equivalents equitably expands claims by finding infringement where an accused device possesses only insubstantial differences from the invention. *Id.* To avoid conflicting with "the definitional and public-notice functions of the statutory claiming requirement," the Supreme Court held that "each element contained in a patent claim is deemed material to defining the scope of the patented invention, and thus the doctrine of equivalents must be applied to individual elements of the claim, not to the invention as a whole. It is important to ensure that the application of the doctrine, even as to an individual element, is not allowed such broad play as to effectively eliminate that element in its entirety." *Warner-Jenkinson Co., Inc. v. Hilton Davis Chemical Co.*, ___ U.S. ___, 117 S. Ct. 1040, 1049 (1997). Moreover, the range of equivalents under the doctrine of equivalents cannot "ensnare the prior art." *We Care, Inc. v. Ultra-Mark Int'l Corp.*, 930 F.2d 1567, 1570 (Fed. Cir. 1991). By viewing the role of each limitation against the backdrop of the entire claim, the Court is able to decide "whether a substitute element matches the function, way, and result, of the claimed element, or whether the substitute element plays a role substantially different from the claimed element." *Warner-Jenkinson*, 117 S. Ct. at 1054.

105. The doctrine of prosecution history, or file wrapper, estoppel "bars the patentee from recapturing subject matter that was surrendered by the patentee during prosecution in order to promote allowance of the claims." *Regents of the Univ. of California v. Eli Lilly and Co.*, 119 F.3d 1559, 1573-74 (Fed. Cir. 1997)(internal quotations omitted). If a claim has been narrowed by an amendment to avoid a prior art rejection, the patentee may not argue that the surrendered subject matter is within the range of equivalents. *Warner-Jenkinson*, 117 S. Ct. at 1049-51.

106. Because determining whether the accused device infringes the claimed invention under the doctrine of equivalents involves deciding whether a claimed element is equivalent to an element in the accused device, "the proper time for evaluating equivalency - and thus knowledge of interchangeability between elements - is at the time of infringement, not at the time the patent issued." *Warner-Jenkinson*, 117 S. Ct. at 1053. Also, a skilled practitioner's knowledge of the interchangeability between the claimed and accused elements is relevant to the extent that it "provides content to, and limits on, the concept of 'equivalence.' " *Id.* at 1049.

N. Claim 23 Does Not Infringe Under the Doctrine of Equivalents.

107. The Court finds that Defendant's system does not directly infringe claim 23 under the doctrine of equivalents because it does not include an equivalent for each element of the claimed invention. The Court finds that Defendant's system includes elements equivalent to the claimed permeable membrane gas separation system and the claimed means

for detecting an oxygen concentration. However, Defendant's system does not include an air supply to supply compressed air; an equivalent means to selectively distribute the nitrox permeate; or an equivalent means to selectively heat and cool the compressed air before it enters the permeable membrane.

108. The Court finds that Defendant's system does not include *any* element which could be equivalent to an air supply.

109. The Court finds that Defendant's system does not include elements equivalent to a means for selectively distributing the nitrox permeate. The relief valves located on the nitrox permeate outlet end of Defendant's system do not perform substantially the same function as a control valve. In other words, the relief valves cannot allow the flow of nitrox permeate to be "permitted, shut off and regulated." (See '845 patent, col. 5, line 11).

110. The Court finds that Defendant's system does not include elements equivalent to a means for selectively heating and cooling the compressed air before it enters the permeable membrane.

111. Plaintiff's patent specification teaches that a conventional pressure regulator "is used to reduce the pressure of the compressed air passing into a low pressure feed air line so that it is lower than approximately 600 p.s.i.g., and, typically, in the range of 50-250 p.s.i.g." ('845 patent, col. 2, line 66 - col. 3, line 2). The compressed, low-pressure air passes into the heat exchanger where it is selectively heated and cooled by the cycling of the solenoid valves as directed by the control unit. ('845 patent, col. 3, lines 2-23). In

Defendant's system compressed air passes through a pressure regulator to reduce the pressure. (Dx 13, N00192). The compressed, low-pressure air is subsequently heated by a heater, which is regulated by a temperature controller. (Dx 13, N00192).

112. The two systems do not perform substantially the same function, "temperature conditioning," with substantially the same result. Plaintiff's system selectively heats and cools. Defendant's system only selectively heats. The Court notes that other prior art references contain the functional combination of a pressure regulator and a heater in the same configuration as found in Defendant's system. (Dx 3; Dx 18; Px 2A, U00248). The Court, in equitably extending the scope of Plaintiff's claimed invention, is precluded from "ensnar[ing] the prior art." *We Care*, 930 F.2d at 1570. Therefore, whatever structure may be said to be equivalent to means for selectively heating and cooling under the doctrine of equivalents, it is clear that the combination of a pressure regulator and a heater or heat exchanger would not qualify.

113. The Court finds that persons of ordinary skill in the art would not recognize the combination of a pressure regulator and a heating element as interchangeable, and thereby equivalent, with the structure disclosed in the '845 patent specification as a means of selectively heating and cooling the feed air. The Court finds the testimony of Defendant's expert, Professor Benny D. Freeman as credible on this point and rejects Plaintiff's expert's testimony.

O. Claim 24 Does Not Infringe Under the Doctrine of Equivalents.

114. The Court concludes that Defendant's system does not directly infringe claim 24 under the doctrine of equivalents because the Court finds that independent claim 23 is not infringed and that Defendant's system does not include *any* element which could be equivalent to a nitrox storage assembly; a compressor; or a line which connects the compressor output to the nitrox assembly.

P. Claim 29 Does Not Infringe Under the Doctrine of Equivalents.

115. The Court concludes that Defendant's system does not directly infringe claim 29 under the doctrine of equivalents because independent claim 23 and dependent claim 24, on which claim 29 depends, are not infringed.

116. Assuming arguendo that claims 23 and 24 are infringed, then claim 29 would be infringed because Defendant's system includes an equivalent means for detecting oxygen which is located at the nitrox permeate outlet of the permeable membrane.

Q. Contributory Infringement.

1. Principles.

117. Contributory infringement exists when anyone sells or offers to sell:

> "a component of a patented machine, manufacture, combination, or composition, or a material or apparatus for use in practicing a patented process, constituting a material part of the invention, knowing the same to be especially made or especially adapted for use in an infringement of such patent, and not a staple article or commodity of commerce suitable for substantial noninfringing use."

35 U.S.C. § 271(c).

118. The contributory infringement doctrine "exists to protect patent rights from subversion by those who, without directly infringing the patent themselves, engage in acts designed to facilitate infringement by others." *Dawson Chemical Co. v. Rohm & Haas Co.*, 448 U.S. 176, 188, 100 2601, 2609, 65 L.Ed.2d 696 (1980). Contributory infringement protects a patentee "where enforcement against direct infringers would be difficult, and where the technicalities of patent law make it relatively easy to profit from another's invention without risking a charge of direct infringement." *Id.*

119. However, contributory infringement exists only when "the fact or intention of a direct infringement" is established. *Deepsouth Packing Co. v. Laitram Corp.*, 406 U.S. 518, 526, 92 S. Ct. 1700, 1706 (1972). If no one *directly* infringes the patent, there can be no *contributory* infringer. *Aro Mfg. Co. v. Convertible Top Replacement*, 365 U.S. 336, 341, 81 S. Ct. 599, 602 (1961). Further, in an effort to balance the competing doctrines of contributory infringement and patent misuse, section 271(c) "adopts a restrictive definition of contributory infringement that distinguishes between staple and nonstaple articles of commerce. It also defines the class of nonstaple items narrowly." *Dawson Chemical*, 448 U.S. at 200, 100 S. Ct. at 2615.

2. Application.

120. The Court notes that even if a customer attached the missing elements which correspond to the unsatisfied claim limitations, the customer would not directly infringe the patented invention because Defendant's system does not literally or equivalently read on the

means for selectively heating and cooling the compressed air limitation. Unless a customer changed the internal components found inside the Defendant's cabinet enclosure (a situation beyond Defendant's control or contemplation), this limitation would not be satisfied and thus the customer would not directly infringe the patented invention.

121. Therefore, in conducting the contributory infringement analysis, the Court will assume *arguendo* that the means for selectively heating and cooling; the means for detecting an oxygen concentration, and the permeable membrane gas separation system limitations have been satisfied and will limit its consideration to those elements from the claim limitations which are not found in Defendant's system.

122. Plaintiff did not prove that any of Defendant's customers had ever purchased a system and subsequently used it in a way that would infringe Plaintiff's patented invention. Defendant's sales contracts show that Defendant sold his system; they do not indicate how a customer used Defendant's system. Therefore, the Court will only conclude Defendant contributorily infringed the patented invention if it can find Defendant intended a customer to use its system in an infringing manner.

123. Defendant's sales brochure depicts three installation options. (Dx 12, N00145). The options depict different flow charts for the operation of Defendant's system. The Court finds that these flow charts are persuasive in demonstrating how Defendant's intended customers to use their cabinet system.

124. Option 1 depicts a straight-line process where the system includes, on the input side of Defendant's cabinet system, a high-pressure compressor which fills a bank of compressed air cylinders. This tandem is an air supply. The air from the storage cylinders can then flow through a high-pressure regulator (external to Defendant's cabinet system), and subsequently the compressed, low-pressure air enters Defendant's cabinet. On the output side of the cabinet, a second high-pressure compressor can be connected to a fitting located on the cabinet, (see Dx 13, N00191, item 12), which connects the compressor inlet to the nitrox permeate outlet of the permeable membrane (located inside the cabinet). The second compressor's outlet, which pumps compressed nitrox, is connected to either a bank of nitrox storage cylinders or nitrox scuba tanks. The bank of nitrox cylinders is a nitrox storage assembly.

125. Option 2 also depicts a straight-line process but changes the elements on the input side of Defendant's cabinet. In option 2, a low-pressure compressor acts directly as the air supply and pumps compressed, low-pressure air into an external pressure-reducing regulator (*not* a *high-pressure* regulator). All the elements on the output side of the cabinet are the same as in option 1.

126. Option 3 shows a circular process which more closely reads on the patented invention as it is described in the specification. On the input side of the cabinet is a bank of air storage cylinders as the air supply which sends high-pressure, compressed air through a high-pressure regulator and then into the cabinet. On the output side of the cabinet, the flow

chart shows an ability to mix the output nitrox with ambient air and to direct the consequent mixture to the inlet of a high-pressure compressor. The outlet of the compressor is connected to a nitrox storage assembly and to the air supply located on the input side of the cabinet, thus completing the circle. This flow chart suggests that in this configuration Defendant's cabinet system can be used to create compressed nitrox (which may be mixed with ambient air) and that the external compressor can be used to fill the air supply to supply compressed air.

a. Claim 23.

127. The Court concludes that Defendant does not contributorily infringe claim 23 because Plaintiff did not meet its burden in showing by a preponderance of the evidence that Defendant intended its customer to use its cabinet system with a means for selectively distributing the nitrox.

128. The Court finds that Defendant's sales brochure demonstrates Defendant intended a customer to use Defendant's cabinet system with a compressed air supply. However, the Court found nothing offered into evidence which indicated that Defendant intended a customer to use, or that a customer actually used, a means for selectively distributing the nitrox.

b. Claim 24.

129. The Court concludes that Defendant does not contributorily infringe claim 24 because independent claim 23, upon which claim 24 depends, is not infringed.

130. Assuming *arguendo* that independent claim 23 is infringed, the Court would conclude that Defendant contributorily infringes claim 24. The Court finds that Defendant's sales brochure demonstrates Defendant intended a customer to use Defendant's cabinet system with a compressed air supply, a nitrox storage assembly and a compressor with lines connecting it between the nitrox permeate outlet line of Defendant's cabinet and the nitrox storage assembly.

c. Claim 29.

131. The Court concludes that Defendant does not contributorily infringe claim 29 because independent claim 23 and dependent claim 24, upon which claim 29 depends, are not infringed.

132. Assuming *arguendo* that independent claim 23 and 24 are infringed, the Court would conclude Defendant *directly* and *contributorily* infringes claim 29.

R. Willful Infringement.

133. When a potential infringer has notice of another's patent rights, he has an affirmative duty to exercise due care to determine whether he is infringing that patent. *Underwater Devices, Inc. v. Morrison-Knudsen Co., Inc.*, 717 F.2d 1380, 1389-90 (Fed. Cir. 1983).

134. The Court holds that Defendant acted properly in contacting counsel to obtain legal advice and at all times exercised due care to avoid infringing the '845 patent. Even if

the Court had found that Defendant's system was infringing, the Court finds that Defendant's conduct does not constitute willful infringement.

VIII. PATENT VALIDITY.

135. A patent is presumed valid, and each claim, whether independent or dependent, shall be presumed valid without regard to the validity of other claims. 35 U.S.C. § 282. The party attacking validity bears the burden of proving invalidity by clear and convincing evidence. *Magnivision, Inc. v. Bonneau Co.*, 115 F.3d 956, 958 (Fed. Cir. 1997). The Court finds that Defendant has failed to meet its burden of proving the '845 patent or its claims invalid.

A. Anticipation under 35 U.S.C. § 102.

136. Infringement and anticipation are interrelated, or mirror images, in the sense that "[t]hat which infringes, if later, would anticipate, if earlier." *Knapp v. Morss*, 150 U.S. 221, 228, 14 S. Ct. 81, 84 (1893). Anticipation is a question of fact. *Electro Medical Systems, S.A. v. Cooper Life Sciences, Inc.*, 34 F.3d 1048, 1052 (Fed. Cir. 1994). To establish anticipation under section 102, Defendant must prove by clear and convincing evidence that a single prior art discloses each and every element of the claimed invention.[4]

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[4] To serve as an anticipation when the reference is silent about a particular characteristic found in the accused patent's claim limitation, "such gap in the reference may be filled with recourse to extrinsic evidence. Such evidence must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill . . . . Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient." *Continental Can Co. USA*

Kegel Co., 1997 WL 574561 at *9. The absence of even a single claim element from a prior art reference precludes anticipation by that reference. *Minnesota Mining & Mfg. Co. v. Johnson & Johnson Orthopaedics, Inc.*, 976 F.2d 1559, 1572 (Fed. Cir. 1992).

137. Whether deciding infringement or patent validity, a court must give the same interpretation and the same meaning to the patent claims. *Kegel Co.*, 1997 WL 574561 at *9. When an invention is claimed in means-plus-function language, the prior art reference does not anticipate the claimed invention if it does not disclose a structure which is capable of performing the functional limitation claimed in the "means" element. *RCA Corp. v. Applied Digital Data Systems*, 730 F.2d 1440, 1444 (Fed. Cir. 1984).

1. § 102(a) and (b).

138. Title 35 U.S.C. §102(a) states:

> A person shall be entitled to a patent unless --
>
> (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for patent.

139. Section 102(b) defines a different statutory bar:

> "A person shall be entitled to a patent unless--
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

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v. Monsanto Co., 948 F.2d 1264, 1268-69 (Fed. Cir. 1991)(internal quotations omitted).

140. The section 102(a) inquiry asks three basic questions:

> (1) whether the date of the reference precedes invention;
> (2) whether the reference is accessible to the public; and
> (3) whether the contents of the reference put the invention into the hands of the public.

141. "The general purpose behind section 102(b) bars is to require inventors to assert with due diligence their right to a patent through the prompt filing of a patent application." *LaBounty Mfg., Inc. v. United States Int'l Trade Comm'n*, 958 F.2d 1066, 1071 (Fed. Cir. 1992). Courts have articulated several factors which weigh against the inventor and in favor of the statutory bar's enforcement including the policies of "1) protecting the public in its use of the invention where such use began prior to the filing of the application, 2) encouraging prompt disclosure of new and useful information, 3) discouraging attempts to extend the length of the period of protection by not allowing the inventor to reap the benefits for more than one year prior to the filing of the application." *TP Laboratories, Inc. v. Professional Positioners, Inc.*, 724 F.2d 965, 968 (Fed. Cir. 1984).

142. Priority of invention "goes to the first party to reduce an invention to practice" unless another can show that it first conceived the invention and exercised reasonable diligence in later reducing the invention to practice. *Mahurkar v. C.R. Bard, Inc.*, 79 F.3d 1572, 1577 (Fed. Cir. 1996)(internal quotations omitted). To prove actual reduction an inventor must show that the invention actually works. *Estee Lauder, Inc. v. L'Oreal, S.A.*, ___ F.3d ___, No. 96-1512, 1997 WL 693028, at *4 (Fed. Cir. Nov. 3, 1997). Constructive

reduction to practice occurs when a patent application for the claimed invention is filed. *Hybritech Inc. v. Monoclonal Antibodies, Inc.*, 802 F.2d 1367, 1376 (Fed. Cir. 1986) (citations omitted).

143. For a prior art reference to be a "printed publication" under 35 U.S.C. §§ 102(a) or (b), it must have been "sufficiently accessible to those skilled in the art; dissemination and public accessibility are the keys to a legal determination whether a prior art reference was 'published'." *In re Cronyn*, 890 F.2d 1158, 1160 (Fed. Cir. 1989). If the reference is not sufficiently accessible to those skilled in the art, it is not prior art within the purview of section 102.

144. Prior art embodied in a printed publication must be enabling, "thus placing the allegedly disclosed matter in the possession of the public." *In re Epstein*, 32 F.3d 1559, 1568 (Fed. Cir. 1994). To be enabling a prior art reference "must provide a description sufficient to teach a person of ordinary skill in the art how to make and use the apparatus or process." *Beckman Instruments, Inc. v. LKB Produkter Ab*, 892 F.2d 1547, 1550 (Fed. Cir. 1989). However, to satisfy the enablement requirement, the invention disclosed in a publication need not have been actually made. *In re Donohue*, 766 F.2d 531, 533 (Fed. Cir. 1985).

2. Reduction to Practice of Plaintiff's Invention.

145. Delp filed the patent application for the system which led to the '845 patent on August 22, 1995. He did not furnish any satisfactory evidence of an earlier invention date. The Court finds that Delp's invention was constructively reduced to practice on the date of

his patent application. Therefore, only prior art existing before August 22, 1995, can be considered. The critical date for statutory bar considerations is August 22, 1994. Any publication, use or sale of the claimed invention before that date bars the patentee's right to a patent monopoly.

3. Prior Art.

146. Defendant alleges that the following prior art references anticipated the invention claimed in the '845 patent. These references will be considered in light of every subsection under section 102.

a. The '781 Patent.

147. United States Patent Number 5,355,781 ("the '781 patent"), issued October 18, 1994, to Liston et al., entitled "Controlled Atmosphere Storage System," was not disclosed by Delp or his patent prosecution counsel to the PTO during the prosecution of the application that eventually issued as the '845 patent. (Dx 3).

148. The '781 patent discloses the combination of a compressor to provide a compressed air supply; a finned tubing heat exchanger to cool the compressed air after it leaves the compressor; a high pressure relief valve to prevent the cooled, compressed air from exceeding 125 p.s.i.g.; an electric heater to heat the compressed air; a gas separation means, comprising a hollow fiber permeable membrane, to separate air into a nitrox permeate stream and a nitrogen product stream; an exit port to deliver the nitrogen stream into a

storage container; and an oxygen sensor to detect the oxygen concentration in the storage container.

149. The '781 patent teaches the use of a permeable gas membrane as a nitrogen generation device for maintaining a controlled oxygen atmosphere of five percent oxygen or less within a transport container vessel.

150. The Court finds that the '781 patent does not include: (1) a means for detecting an oxygen concentration in the nitrox permeate because the oxygen concentration is detected in the storage container and is located on the nitrogen product stream; (2) a means for *selectively* heating and cooling the compressed air before it enters the permeable membrane because the combination of the finned tubing heat exchanger to cool and the electric heater to heat the compressed air does not allow for any selection in the presence or absence of the two functions, *i.e.*, one cannot select only heating or only cooling; (3) a means for selectively distributing the nitrox permeate because no structure exists to perform that function (Figure 3 of the '781 patent refers to the nitrox permeate as "[oxygen] discharge"); (4) a compressed nitrox storage assembly; (5) a compressor feed line to supply the nitrox permeate to a compressor inlet; or (6) a compressor outlet line to connect the compressor outlet to the compressed nitrox storage assembly. Therefore, the Court finds that the '781 patent does not anticipate the invention described in claim 23, 24 or 29 of the '845 patent.

b. '937 Patent.

151. United States Patent Number 5,125,937 ("the '937 patent"), issued June 30, 1992, to Sadowski et al., entitled "Reversible Membrane Plant," was not disclosed by Delp, or his patent prosecution counsel to the PTO during the prosecution of the '845 patent. (Dx 4). The Court notes that the same primary examiner, Robert Spitzer, reviewed both the '937 and the '845 patents.

152. The '937 patent discloses the combination of a compressor to provide compressed air; an air chiller to cool the compressed air; a pressure regulator, placed at the end of a compressed air conduit, to control the pressure of the cooled, compressed air; a permeable membrane gas separation system to separate the regulated, cooled, compressed air into a nitrogen product and a nitrox permeate; a valve means operable either to locate port 1 or 2 of the membrane as the input port, and the other as the output port of the membrane; an electrical heating device to heat one end of the membrane; and a product gas conduit to collect the nitrogen product or to supply the nitrogen to an apparatus in which it is used.

153. The '937 patent teaches that the permeable membranes's life can be extended by using a four-port, two-way valve which allows the user to periodically alternate the input and output ends. A disproportionate amount of contaminants are located at the input end and tend to negatively affect the membrane's performance. The ability to reverse the input end avoids this situation.

154. The Court finds that the '937 patent does not include: (1) a means for detecting an oxygen concentration in the nitrox permeate; (2) a means for selectively heating and cooling the compressed air *before* it enters the permeable membrane; (3) a means for selectively distributing the nitrox permeate because no structure exists to perform that function; (4) a compressed nitrox storage assembly; (5) a compressor feed line to supply the nitrox permeate to a compressor inlet; or (6) a compressor outlet line to connect the compressor outlet to the compressed nitrox storage assembly. Therefore, the Court finds that the '937 patent does not anticipate the invention described in claim 23, 24 or 29 of the '845 patent.

c. '331 Patent.

155. United States Patent Number 5,306,331 ("the '331 patent"), issued April 26, 1994, to Auvil et al., entitled "Process for Cooling the Feed Gas to Gas Separation Systems," was not disclosed by Delp or his patent prosecution counsel to the PTO during the prosecution of the '845 patent. (Dx 5). The Court notes that the same primary examiner, Robert Spitzer, reviewed both the '331 and the '845 patents.

156. The '331 patent discloses that conventional membrane separation of air into its components involves (1) compressing air, (2) passing the compressed air through an after-cooler which uses water or air, and (3) preheating the compressed air using external sources such as electrical heaters to minimize moisture condensation prior to (4) directing the compressed air to a permeable membrane gas separation system. The claimed process

operates by: separating air into nitrox and nitrogen streams using this permeable membrane gas separation system; cooling water by evaporation with either stream; cooling the compressed air being fed into the permeable membrane by direct contact (such as with a cooling tower) or indirect contact (such as with a heat exchanger) with the cooled water; heating, electrically, the cooled, compressed air; and recovering the other stream of gas that was not used in cooling the water.

157. The '331 patent teaches that one stream from a permeable membrane gas separation unit can be used in an evaporation cooler to provide cool water which can cool, by direct or indirect contact, the compressed air supply before it enters the membrane.

158. The Court finds that the '937 patent does not include: (1) a means for detecting an oxygen concentration in the nitrox permeate because no structure is recited which could detect oxygen; (2) a means for selectively distributing the nitrox permeate because no structure exists to perform that function; (3) a compressed nitrox storage assembly; (4) a compressor feed line to supply the nitrox permeate to a compressor inlet; or (5) a compressor outlet line to connect the compressor outlet to the compressed nitrox storage assembly. Therefore, the Court finds that the '937 patent does not anticipate the invention described in claim 23, 24 or 29 of the '845 patent.

d. Wells' 1991 System.

159. In 1991, Wells was employed the NOAA where he developed a system for generating nitrox. The Wells system essentially consisted of the NOAA continuous blending

system (as described in his patent, U.S. Patent No. 4,860,803), where the permeate stream from a permeable membrane was substituted for the separate pure oxygen source. This experimental unit was not publicly shown, but was described in a September 1993 NOAA publication titled, "Applications of Gas Separation Technology in the Preparation of Diver's Breathing Gases and Hyperbaric Atmospheres." (Dx 6). The publication does not depict any system which incorporates a permeable membrane but indicates that a generic NOAA Continuous Nitrox Mixer can use a membrane "as a replacement for the oxygen source." (Dx 6, U01291). The publication does not disclose how the membrane can act as the replacement for the pure oxygen source. Also, although the publication indicates that a working model of the continuous mixer with the permeable membrane option exists, no specific details were available regarding what it entailed.

160. Accordingly, although it is unable to determine what exactly makes up the Wells system, the Court finds that the Wells system disclosed in the September 1993 publication does not include a means for selectively heating and cooling the compressed air before it enters the permeable membrane. Also, the Court finds that the publication depicting Wells' system is not enabling because it does not "provide a description sufficient to teach a person of ordinary skill in the art how to make and use the [system]." *See Beckman Instruments, Inc.*, 892 F.2d at 1550. Therefore, the Court finds that the Wells system does not anticipate the invention described in claim 23, 24 or 29 of the '845 patent.

e. Rutkowski's 1994 System.

161. In January 1994, Richard Rutkowski developed a system for generating nitrox as a diver's breathing gas. This system comprised a combination of a compressed air supply; a pressure regulator to regulate the pressure of the compressed air; a heater to regulate the temperature of the compressed air; a permeable membrane gas separation module to separate the compressed air into a nitrox component and a nitrogen gas component; an oxygen analyzer to detect the oxygen content of the nitrox component; and means to selectively distribute the nitrox stream to a storage tank. Rutkowski displayed his system in January 1994 at the DEMA show, a diving industry trade show open to the public to determine potential sales and public demand for such a product in the United States.

162. During the time he experimented with permeable membranes, Rutkowski produced nitrox for diving applications by using established systems that required a separate oxygen source: the NOAA continuous blending method and the partial pressure method. His experiments with permeable membranes were conducted at one atmosphere, *i.e.*, ambient pressure.

163. The Court finds the Rutkowski system does not include: (1) a means for selectively heating and cooling the compressed air before it enters the permeable membrane because there is no structure that cools the compressed air before it enters the permeable membrane; (2) a compressed nitrox storage assembly; (3) a compressor; (4) a compressor feed line to supply the nitrox permeate to a compressor inlet; or (5) a compressor outlet line

to connect the compressor outlet to the compressed nitrox storage assembly. Therefore, the Court finds that the Rutkowski system does not anticipate the invention described in claim 23, 24 or 29 of the '845 patent.

f. Permea's 1986 Commercially-Marketed System.

164. In 1986, Permea developed and commercially sold an air separation system comprising in combination a compressed air supply; a pressure regulator to regulate the pressure of the compressed air; a heater to regulate the temperature of the compressed air; a permeable membrane gas separation module to separate the compressed air into a nitrox component and a nitrogen component; an oxygen analyzer to detect the oxygen content of the nitrogen gas component or the nitrox component; and delivery valves to deliver the nitrogen stream to a nitrogen storage tank. (Dx 18).

165. The Court finds the Permea system does not include: (1) a means for selectively heating and cooling the compressed air before it enters the permeable membrane because no structure is recited which could selectively cool the compressed air before it enters the permeable membrane; (2) a means for selectively distributing the nitrox permeate; (3) a compressed nitrox storage assembly; (4) a compressor; (5) a compressor feed line to supply the nitrox permeate to a compressor inlet; or (6) a compressor outlet to connect the compressor outlet to the compressed nitrox storage assembly. Therefore, the Court finds that the Permea system does not anticipate the invention described in claim 23, 24 or 29 of the '845 patent.

g. The Garms British Patent Office Application.

166. On August 4, 1993, Michael Garms filed an application with the British Patent Office disclosing a nitrox generation system for supplying nitrox breathing gas comprising a combination of a compressing means to compress atmospheric air to provide a compressed air supply; a thermostatically controlled heating device to regulate the temperature of the feed air; a permeable membrane gas separation system to separate the compressed air into a nitrox component and a nitrogen gas component; an after-cooler coil to cool the nitrox permeate component; and a supply conduit to deliver the nitrox to a nasal canula. (Dx 7).

167. Even if this patent application was sufficiently accessible to those skilled in the art, the Garms patent application does not recite any structure which can detect an oxygen concentration in the nitrox permeate. Also the Garms patent application does not recite any structure which could selectively cool the compressed air *before* it enters the permeable membrane. The after-cooler coil cools the nitrox permeate, not the compressed air.

168. The Court finds that the Garms patent application does not include: (1) a means for detecting an oxygen concentration in the nitrox permeate *before* it enters the permeable membrane; (2) or a means for selectively heating and cooling the compressed air *before* it enters the permeable membrane; (3) a compressed nitrox storage assembly; (4) a compressor feed line to supply the nitrox permeate to a compressor inlet; or (5) a compressor outlet line to connect the compressor outlet to the compressed nitrox storage assembly. Therefore, the

Court finds that the Garms patent application does not anticipate the invention described in claim 23, 24 or 29 of the '845 patent.

h. The '251 Patent.

169. United States Patent Number 4,758,251 ("the '251 patent"), issued July 19, 1988, to Swedo et al., entitled "Separation of Gases Through Gas Enrichment Membrane Composites," was not disclosed by Delp or his patent prosecution counsel to the PTO during the prosecution of the application for the '845 patent. (Dx 8). The Court notes that the same primary examiner, Robert Spitzer, reviewed both the '251 and the '845 patents.

170. The '251 patent discloses that a gas can be separated into its component parts by passing a feed stream of the gas across the surface of a permeable membrane. The '251 patent discloses specific uses for nitrox, such as breathing systems for submarines and other underwater stations, improved heart-lung machines, other lung assist devices, and to provide oxygen enrichment for life support systems in an aircraft.

171. The Court finds that the '251 patent describes a permeable membrane gas separation system. The Court finds that to the extent that the '251 patent discloses any particular application of the permeable membrane, any such disclosure is not enabling. Therefore, the Court finds that the '251 patent application does not anticipate the invention described in claim 23, 24 or 29 of the '845 patent.

172. Thus, the Court concludes that none of the prior art relied upon by Defendant establishes that the invention claimed by the '845 patent was invented by another because no prior art reference contains every element of the '845 patent.

B. Obviousness under 35 U.S.C. § 103.

173. Obviousness is governed by Section 103 which states:

> A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

35 U.S.C. § 103(a).

174. Obviousness must be proven by clear and convincing evidence. *Para-Ordinance Mfg., Inc. v. SGS Importers Int'l, Inc.*, 73 F.3d 1085, 1087 (Fed. Cir. 1995). Obviousness is a question of law that turns on a number of factual inquiries. *Graham v. John Deere Co.*, 383 U.S. 1, 17, 86 S. Ct. 684, 694 (1966). The factual backdrop for determining obviousness includes determining: "the scope and content of the prior art, the differences between the prior art and the claims at issue, and the level of skill in the relevant art." *Id.* Secondary considerations further clarify the circumstances at the time of the invention and include whether the claimed invention: has enjoyed commercial success, has satisfied a long-felt but unsolved need, has succeeded where others have failed, or has been copied.

175. Obviousness is decided by determining what the prior art references would have meant to a person of ordinary skill in the field of the claimed invention. *In re Gorman*,

933 F.2d 982, 986 (Fed. Cir. 1991). Reconstruction performed today, through the benefit of hindsight's enhanced clarity, may make a solution to a problem easy or "obvious." After all, answering a question is easy if the answer is known in advance. Therefore, the "invention must be viewed not after the blueprint has been drawn by the inventor, but as it would have been perceived in the state of the art that existed at the time the invention was made." *Sensonics, Inc. v. Aerosonic Corp.*, 81 F.3d 1566, 1570 (Fed. Cir. 1996).

176. It is not enough that the party challenging validity show that the individual elements of the claimed invention appear in various prior art references; instead, the challenger must establish some teaching, suggestion or incentive in the prior art that those elements should be combined. *Gorman*, 933 F.2d at 986. Whether a suggestion in the prior art need be explicit or only fairly inferred depends on the totality of circumstances viewed in light of the prior art and its relationship with the claimed invention. *Id.*

1. Scope and Content of the Prior Art.

177. The scope of the prior art includes references "reasonably pertinent to the particular problem with which the inventor was involved." *In re GPAC Inc.*, 57 F.3d 1573, 1577 (Fed. Cir. 1995)(internal quotations omitted). In considering what is pertinent, a court can consider whether the prior art reference is in an art where one skilled in the art of the invention would search for a solution to the problem that the invention solves. *Id.* at 1578. The hypothetical person of ordinary skill in the field of invention is presumed to have knowledge of prior art in the same or analogous fields. *Gorman*, 933 F.2d at 986.

178. The Court finds that the relevant art is the design and manufacture of equipment employed in diving and related activities, such as equipment for the production of breathing gases and divers' life support systems. In determining whether the '845 patent is invalid because the prior art renders it obvious, the Court will consider prior art cited by Delp to the examiner during the patent prosecution and prior art referenced by Defendant in this action.

2. Differences between the Prior Art and the Claims at Issue.

179. Although *Graham* directs that differences between the prior art and the claims at issue should be considered, the issue in deciding obviousness is not "whether the differences themselves would have been obvious" but "whether the claimed invention as a whole would have been obvious." *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 1537 (Fed. Cir. 1983).

180. The Court refers to the discussion of anticipation, *supra*, and incorporates here those findings which indicate the differences between the prior art and the invention as described in claims 23, 24, and 29.

3. Level of Ordinary Skill in the Pertinent Art.

181. The obviousness of the invention must be evaluated through the eyes of one of ordinary skill in the art, rather than the inventor, who may have been of exceptional skill. *Motorola, Inc. v. Interdigital Technology Corp.*, 121 F.3d 1461, 1472 (Fed. Cir. 1997). Accordingly, the inventor's educational level does not conclusively establish the level of

ordinary skill in the art of the invention but rather is one factor to consider along with, *inter alia*, "the type of problems encountered in the art; prior art solutions to those problems; rapidity with which innovations are made; sophistication of the technology; and the educational level of active workers in the field." *In re GPAC Inc.*, 57 F.3d at 1579.

182. The Court finds that the level of one of ordinary skill in the art is that of a person having practical experience with basic mechanical engineering, permeable membrane gas separation systems, and diving equipment and apparatus to support diving operations.

4. Secondary Considerations.

183. When deciding obviousness, the trial court should always consider any "secondary consideration" evidence presented and give it the appropriate weight, not just when the existing prior art makes resolution of the issue uncertain. *Stratoflex*, 713 F.2d at 1538-39. The secondary considerations provide evidence of "how the patented device is viewed by the interested public: not the inventor, but persons concerned with the product in the objective arena of the marketplace." *Arkie Lures, Inc. v. Gene Larew Tackle, Inc.*, 119 F.3d 953, 957 (Fed. Cir. 1997). However, to receive substantial weight, secondary-consideration evidence must demonstrate a nexus between the merits of the claimed invention and the evidence offered. *Stratoflex*, 713 F.2d at 1539.

184. Before the '845 patent, no other nitrox generation system could achieve the same combination of economic efficiency and safety. The dive shops that comprise the market for Plaintiff's system are reluctant to produce nitrox using the partial pressure,

continuous blending or pressure swing adsorption methods because of the safety and maintenance considerations attendant to the use of pure oxygen and the expense associated with the use of a molecular sieve. Also, although Wells and Rutkowski may have attempted to forecast or conceptualize how a nitrox generation system using a permeable membrane gas separation module might operate, they were unable to do so. Where others had failed, only Delp was able to reduce the concept to practice.

185. Plaintiff's nitrox generation system has been a commercial success. Since the system's introduction to the market, Plaintiff has sold more than 100 systems in the United States and overseas. However, the nexus between the commercial success of the commercial embodiment and the merits of the invention is not satisfactorily established because often the commercial embodiment of the invention replaces the heat exchanger with an in-line heater to heat the compressed air as it passes between the compressed air supply and the permeable membrane gas separation system. Consequently, the probative value of Plaintiff's market success is reduced.

5. Teaching Away.

186. In *Arkie Lures*, the defendant invented a fishing lure made from salt-impregnated plastisol. 119 F.3d at 954. Because of the lure's salty taste, a fish kept it in its mouth longer than other lures, increasing the fisherman's chances of landing the fish. *Id.* The prior art disclosed the use of salty bait, plastisol lures, and organic fish attractants in plastisol lures to catch fish. *Id.* at 956. However, before the invention, skilled workers in the

relevant art strongly doubted that salt would be a feasible additive to plastisol because it would roughen the surface texture of the lure, reduce the tensile strength of the plastic, and possibly be unsafe to manufacture since mixing a salt with a plastic can cause violent explosions. *Id.* at 955. In reversing the district court's judgment of invalidity based on obviousness, the Federal Circuit noted that the issue was not whether salt could be used as an additive but rather whether the invention was obvious in light of the "relevant knowledge at the time of [the defendant's] activities, including concern for the quality of the product, the warnings, and the perceived manufacturing difficulties, all manifested in the widespread skepticism that [the defendant] encountered among those of skill in the field." *Id.* at 958.

187. When Delp was in the preliminary stages of his invention, he visited Permea, a permeable membrane manufacturer. Rather than encourage him to explore alternative applications for its product, the Permea representative expressed to Delp a great deal of concern regarding the compression of the nitrox permeate and did not recommend Delp's trying his experiments with Permea's product. The same was true for other membrane manufacturers contacted by Delp. The volatility of the predominantly oxygen-concentrated nitrox dissuaded many from exploring alternative applications even when the nitrox was not to be compressed. In fact, in most applications using a permeable membrane, the nitrox permeate is considered a waste product.

188. Each of the elements of the invention claimed in the '845 patent appear in the prior art. Nowhere in the prior art, however, is there any art which combines these elements

to produce a system for generating safe nitrox to be compressed for use as a diver's breathing gas. None of the references relating to the use of permeable membranes for the production of nitrox for breathing at ambient pressures suggest that it be compressed for use as a diver's breathing gas; on the contrary, membrane manufacturers and users consciously avoided such a use. Therefore, the Court concludes that Defendant has failed to meet its burden of proving that the '845 patent is invalid on the basis of obviousness.

C. Enablement.

189. 35 U.S.C. § 112, ¶ 1 states:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Enablement, the inventor's quid pro quo for the limited monopoly granted by the patent, is intended to place the subject matter of the claims in the public sphere and should be gauged by the knowledge of one of ordinary skill in the art. *Glaxo, Inc. v. Novopharm, Ltd.*, 52 F.3d 1043, 1050 (Fed. Cir. 1995). To satisfy the enablement requirement, a patent must "contain a description that enables one skilled in the art to make and use the claimed invention." *Atlas Powder Co. v. E.I. DuPont DeNemours*, 750 F.2d 1569, 1576 (Fed. Cir. 1984). A patent may be enabling even though experimentation is necessary to make or use the invention as long as the experimentation is not "unduly extensive." *Id.*

190. The Court finds that the '845 patent enables one skilled in the art to make and use the claimed invention without unduly extensive experimentation. Substantially all of the witnesses agreed that the '845 patent provided sufficient information to one skilled in the art to make and use the claimed invention.

IX. PATENT MISUSE.

191. Defendant, the party asserting patent misuse, has the burden of proof. *Novo Industri A/S v. Travenol Labs., Inc.*, 677 F.2d 1202, 1210 (7th Cir. 1982). To prevail on its claim seeking a declaratory judgment that the '845 patent is unenforceable for patent misuse, Defendant must establish that Plaintiff has "impermissibly broadened the 'physical or temporal scope' of the patent grant with anticompetitive effect." *National Presto Industries, Inc. v. Black & Decker (U.S.) Inc.*, 760 F. Supp. 699, 702 (N.D. Ill. 1991) (quoting *Windsurfing Int'l, Inc. v. AMF, Inc.*, 782 F.2d 995 (Fed. Cir. 1986)). Generally, claims of patent misuse are measured by conventional antitrust principles, and are confined to a few specific anti-competitive practices, such as tying arrangements coupled with market power, covenants not to deal and mandatory package licensing. *Id.*

192. 35 U.S.C. § 271(d) states:

> No patent owner otherwise entitled to relief for infringement or contributory infringement of a patent shall be denied relief or deemed guilty of patent misuse or illegal extension of the patent right by reason of his having done one or more of the following:
> (1) derived revenue from acts which if performed by another without his consent would constitute contributory infringement of the patent;

(2) licensed or authorized another to perform acts which if performed without his consent would constitute contributory infringement of the patent;
(3) sought to enforce his patent rights against infringement or contributory infringement.

193. Congress enacted 35 U.S.C. § 271 to codify certain aspects of the judicially-developed doctrine of patent misuse. *Dawson Chemical Co. v. Rohm & Haas Co.*, 448 U.S. 176, 179, 100 S. Ct. 2601, 2605 (1980). Section 271(d) "specifies conduct of the patentee that is *not* to be deemed misuse." *Id.* at 181, 100 S. Ct. at 2605.

194. The Court finds that Plaintiff has not engaged in patent misuse. Although Plaintiff brought this action almost as soon as the patent issued, the patentee can seek to enforce his patent rights, or his limited monopoly granted by the patent, against infringement or contributory infringement. No other anti-competitive practice has been proven by Defendant. Therefore, the '845 patent is not rendered unenforceable under the doctrine of patent misuse.

X. INEQUITABLE CONDUCT.

195. To demonstrate that a patent was obtained through inequitable conduct requires clear and convincing evidence that a material fact was intentionally misrepresented or withheld from the PTO. *Hupp v. Siroflex of America, Inc.*, 122 F.3d 1456, 1465 (Fed. Cir. 1997). A fact is material if it satisfies the objective or subjective "but for" test; the "but it may have been" test;" or " '37 C.F.R. § 1.56(a), *i.e.*, whether there is a substantial likelihood that a reasonable examiner would have considered the omitted or false information important

in deciding whether to allow the application to issue as a patent.' " *Atlas Powder*, 750 F.2d at 1578. "On sale" information, like prior knowledge or use, is particularly material because the PTO has no way of knowing of the existence of any such prior art. *Paragon Podiatry Laboratory Inc. v. KLM Laboratories, Inc.*, 984 F.2d 1182, 1193 (Fed. Cir. 1993).

196. Evidence that prior art was not disclosed to the PTO which demonstrates only "negligence, oversight, or an erroneous judgment made in good faith" is not sufficient to render the patent unenforceable. *Orthopedic Equipment*, 707 F.2d at 1383. However, where the materiality of the non-disclosed prior art is high, the lower the level of intent needed to be proven. *Undersea Industries, Inc. v. Dacor Corp.*, 833 F.2d 1551, 1559 (Fed. Cir. 1987).

197. The Court has carefully reviewed and considered all of the material which Defendant claims Plaintiff intentionally withheld from the primary examiner during the patent production. Even if the prior art references cited by Defendant are material, the Court finds that in the context of the disclosures Plaintiff did make to the primary examiner, Defendant has failed to meet its burden of proving by clear and convincing evidence that Plaintiff *intentionally* withheld material information from the PTO.

XI. DEFENDANT'S COUNTER-CLAIM FOR STATUTORY PENALTY.

198. 35 U.S.C. § 292 imposes a civil penalty upon any person who improperly uses the word "patent" or a similar phrase implying patent protection where none exists:

> Whoever marks upon, or affixes to, or uses in advertising in connection with any unpatented article, the word "patent" or any word or number importing that the same

> is patented, for the purposes of deceiving the public . . . shall be fined not more than $500 for every such offense.

199. Defendants point to two occasions where Delp prematurely indicated that his invention was patented: in a brochure advertising his device in which Delp refers to the device as patented before the patent issued and in a flyer released to the public for an open house held on August 26 and 27, 1995, just a few days after the patent application was filed.

200. In the former instance, Delp asserts that the printer made a mistake and that once he became aware of the error he corrected it. The brochure was not introduced into evidence. The Court finds that the first incident was an inadvertent error.

201. In the latter incident, the invitation to the open house indicates that Plaintiff "developed and patented" the nitrox system. (Dx. 41.) Coming right on the heels of the patent application, the Open House was an opportunity to publicly display the invention and is an advertisement for Plaintiff's system. "Patented" may be a loose way of describing the act of applying for a patent, but in the context of the flyer it unmistakably deceives the public.

202. The Court finds that the Open house invitation violates 35 U.S.C § 292 because its use of the word "patented" deceives and leads the public to conclude that the system had already been patented. Accordingly, the Court fines Plaintiff $500.

XII. CONCLUSION.

The Court holds that the product made, manufactured and sold by Defendant does not infringe any of the claims of the '845 patent. The Court holds that Defendant has failed to prove that the '845 patent is invalid. The Court holds that Defendant has failed to prove that the '845 patent is unenforceable under the doctrines of patent misuse and inequitable conduct. The Court holds that Plaintiff violated 35 U.S.C. § 292 and will be assessed the statutory penalty of $500.

SO ORDERED THIS 20th DAY OF NOVEMBER, 1997.

Morton Denlow

MORTON DENLOW
UNITED STATES MAGISTRATE JUDGE

Copies Have Been Delivered in Open Court or Mailed to:

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DECLARATION OF CHRISTIAN ST. CLAIRE

Under penalty of perjury, I, Christian St. Claire, declare the following as being true and correct:

1. My name is Christian St. Claire. I am a 25 percent owner of Nitrox Technologies, Inc. with my wife, Susan G. St. Claire, owning an additional 25 percent. I have been in the diving business for many years and am familiar with Nitrox products and the technologies described in United States Patent 5,846,291 (the "'291 patent").

2. I have carefully reviewed the claims of the '291 patent and compared the claims with the Nitrox Technologies, Inc. products.

3. It is my opinion and belief that the Nitrox Technologies, Inc. products, as operated for their intended purposes, infringe the '291 patent.

4 As a principal shareholder of Nitrox Technologies, Inc., I have no good-faith defenses to the claims of infringement and would vote as a shareholder to cease offering for sale Nitrox Technologies, Inc.'s products in order to avoid substantial liability to the owner of the '291 patent.

CHRISTIAN ST. CLAIRE
Date Signed: 980104
990104

Exhibit "5"

UNITED STATES DISTRICT COURT

FOR THE SOUTHERN DISTRICT OF FLORIDA

CASE NO.: 98-8902-Ferguson

UNDERSEA BREATHING SYSTEMS, INC., a Nevada corporation,

Plaintiff,

v.

INTERNATIONAL ASSOCIATION OF NITROX DIVERS, INC., a Florida corporation, a/k/a INTERNATIONAL ASSOCIATION OF NITROX AND TECHNICAL DIVERS, INC.,

Defendant.
_____/

STIPULATION FOR ENTRY OF CONSENT FINAL ORDER

COMES NOW Plaintiff Undersea Breathing Systems, Inc. and Defendant International Association of Nitrox Divers, Inc., through their respective undersigned counsel, and stipulate to the entry of a Consent Final Order in the form appended hereto as attachment A.

Exhibit "6"

A "clean" original of Attachment A accompanies this Stipulation for the convenience of the Court.

For Plaintiff:
UNDERSEA BREATHING SYSTEMS, INC.

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Post Office Box 3791
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Florida Bar No. 114126

For Defendant:
INTERNATIONAL ASSOCIATION OF NITROX DIVERS, INC.

William J. Purbeville, Esquire
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UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF FLORIDA

CASE NO.: 98-8902-Ferguson

UNDERSEA BREATHING SYSTEMS, INC., a Nevada corporation,

Plaintiff,

v.

INTERNATIONAL ASSOCIATION OF NITROX DIVERS, INC., a Florida corporation, a/k/a INTERNATIONAL ASSOCIATION OF NITROX AND TECHNICAL DIVERS,

Defendant.
_____/

CONSENT FINAL ORDER

Based upon the Consent and Stipulation of Plaintiff Undersea Breathing Systems, Inc. ("Plaintiff UBS") and Defendant International Association of Nitrox Divers, Inc. ("Defendant IAND"), the Court enters this Final Order:

1. This Court has jurisdiction over the subject matter and the parties.

2. Plaintiff UBS is the owner of United States Patent No. 5,846,291 ("the `291 patent") issued on December 8, 1998. In this lawsuit, Plaintiff UBS contends that a certain NITROX

production system manufactured by Nitrox Technologies, Inc. ("NTI") installed at Defendant IAND's Miami Shores facility infringes the `291 patent.

3. Defendant IAND and this Court have been made aware of a previous ruling by the United States District Court for the Northern District of Illinois, in an action styled ***Undersea Breathing Systems, Inc. v. Nitrox Technologies, Inc.***, Case No. 97C2014 (herein "the previous UBS-NTI litigation"). The `291 patent, however, contains patent claims not at issue in the previous UBS-NTI litigation.

4. While Defendant IAND asserts that it has not infringed the `291 patent, Defendant IAND does not assert in this lawsuit that the `291 patent is invalid, unenforceable or not infringed by the NTI system installed at Defendant IAND's Miami Shores facility.

5. Until a further Order is entered by this Court, Defendant IAND shall refrain from using, offering for sale, selling or displaying any NTI NITROX production system including the one NTI system presently installed at Defendant IAND's Miami Shores facility. Defendant IAND shall not, however, be precluded from returning that system to NTI.

6. Each party shall bear its own attorneys' fees and costs.

DONE and ORDERED this _____ day of _____, 199__ at _____ o'clock __.m. at Miami, Florida.

_____
United States District Judge