

[54] FLOW CONDITIONER  
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[21] Appl. No.: 34,114  
[52] U.S. Cl.: 128/142, 128/147, 128/203, 128/212  
[51] Int. Cl.: A62b 7/06  
[58] Field of Search: 128/142, 142.2, 142.6, 128/145.8, 146-146.7, 212, 147, 142.3, 203, 202; 55/387, 484, 516, 518, 529, DIG. 33, DIG. 35

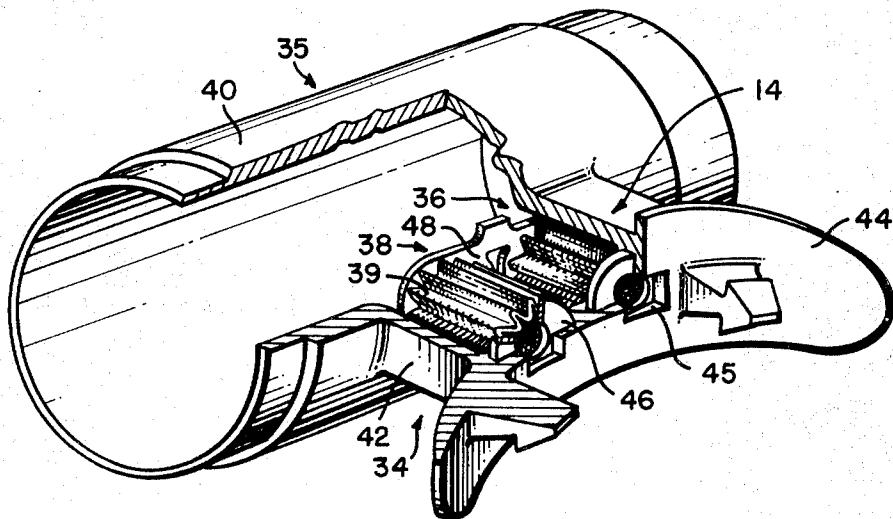
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[57] **ABSTRACT**  
A respiratory gas flow conditioner for providing biologically required heat and moisture to gas flows for a respiring user has high thermal efficiency and low resistance to respiratory flow. The flow conditioner comprises a cylindrically shaped, hollow, high surface area heat and moisture regenerator having a relatively large orifice at one longitudinal end. Exhaled gases having relatively high heat and moisture content pass into the orifice, expand omnidirectionally, pass uniformly through the regenerative material comprising the sides of the cylinder and give out heat and moisture thereto; inspiratory gases at relatively low humidity and temperature take up the moisture and heat retained by the regenerator and pass to the respiratory organs of the user at biologically desirable humidity and temperature levels.

5 Claims, 7 Drawing Figures



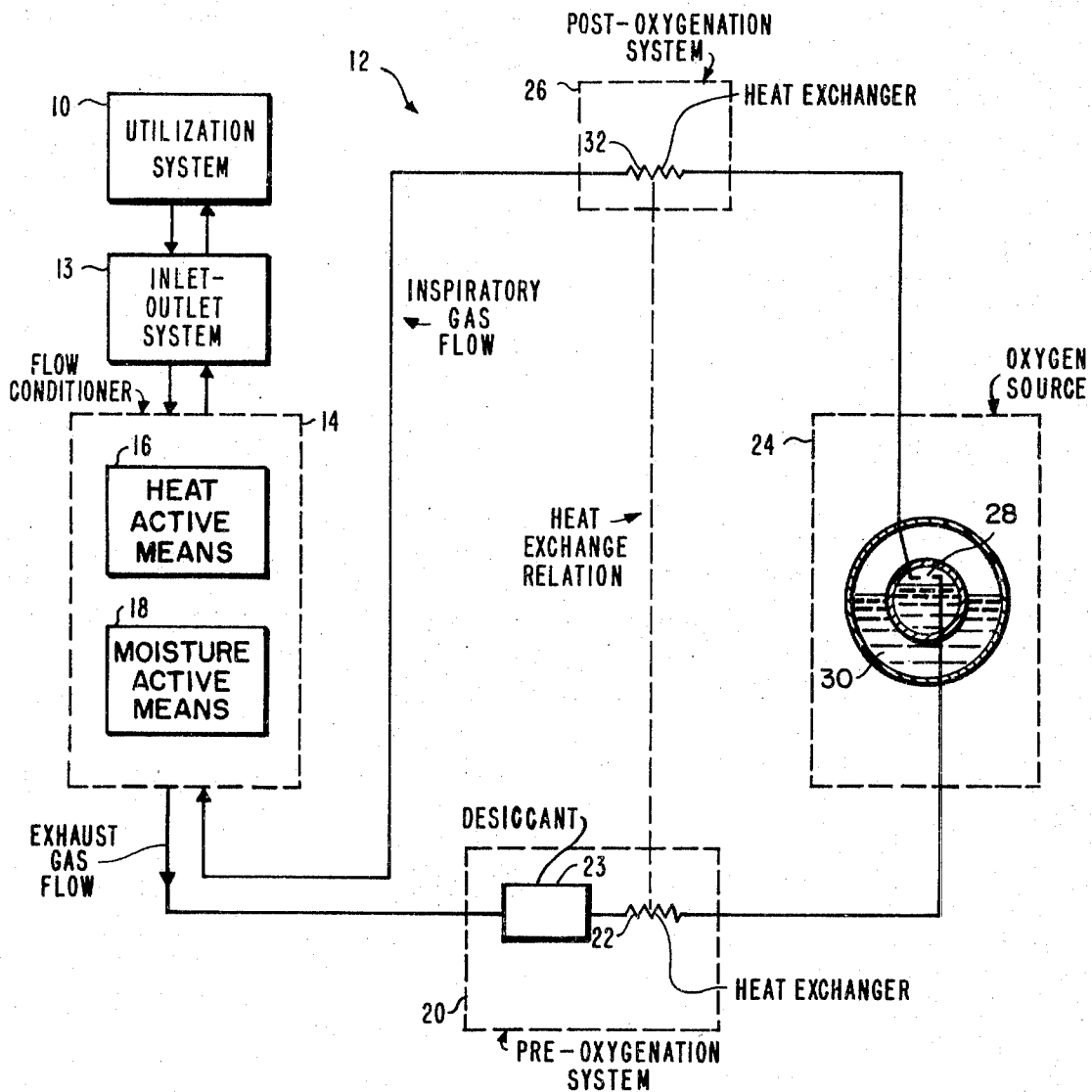


FIG. -1

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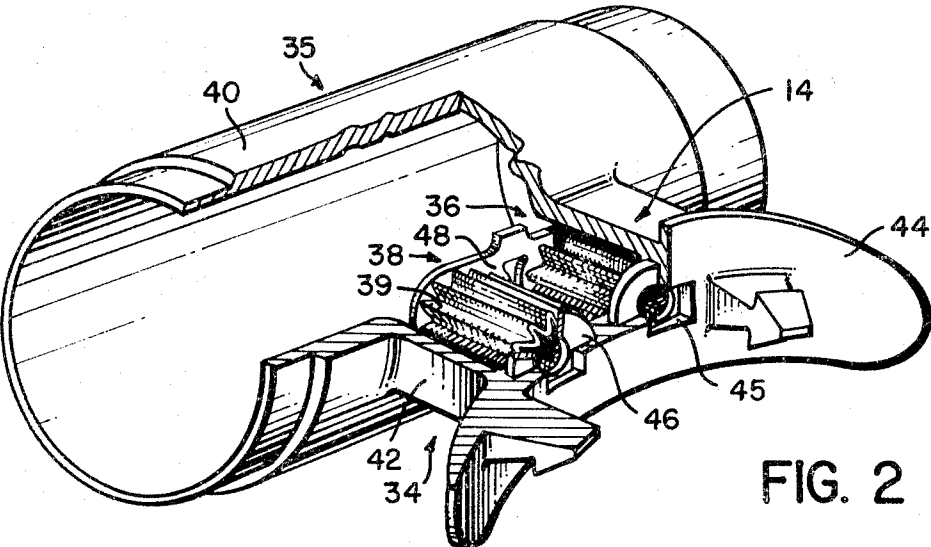


FIG. 2

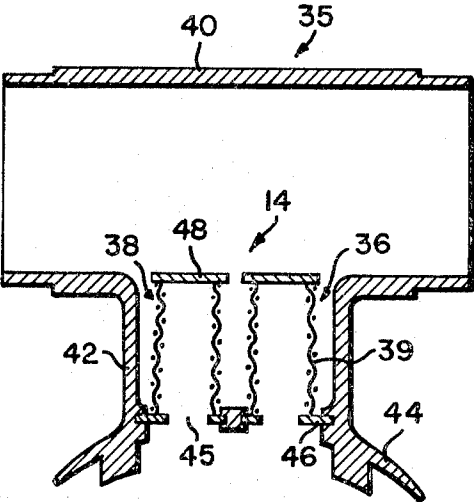


FIG. 3

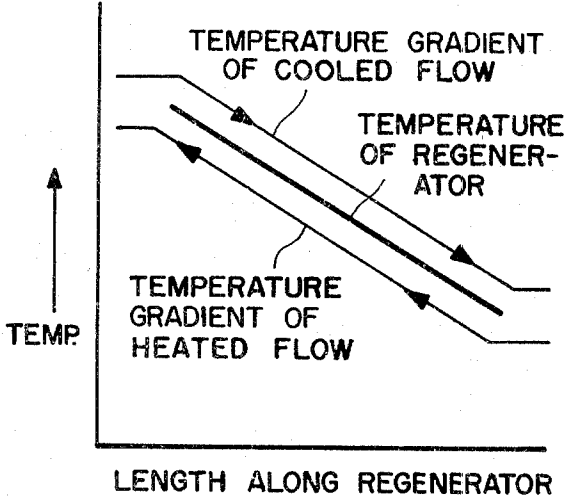


FIG. 5

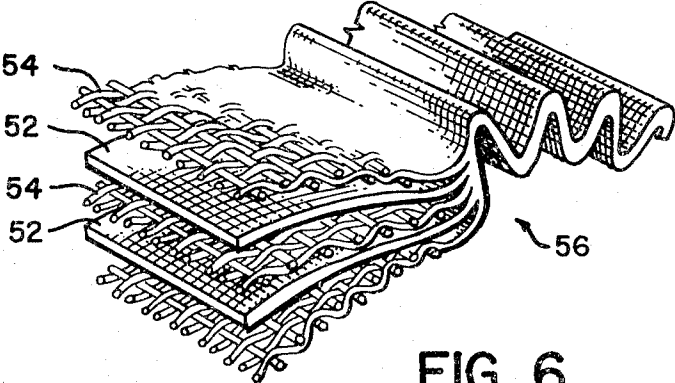


FIG. 6

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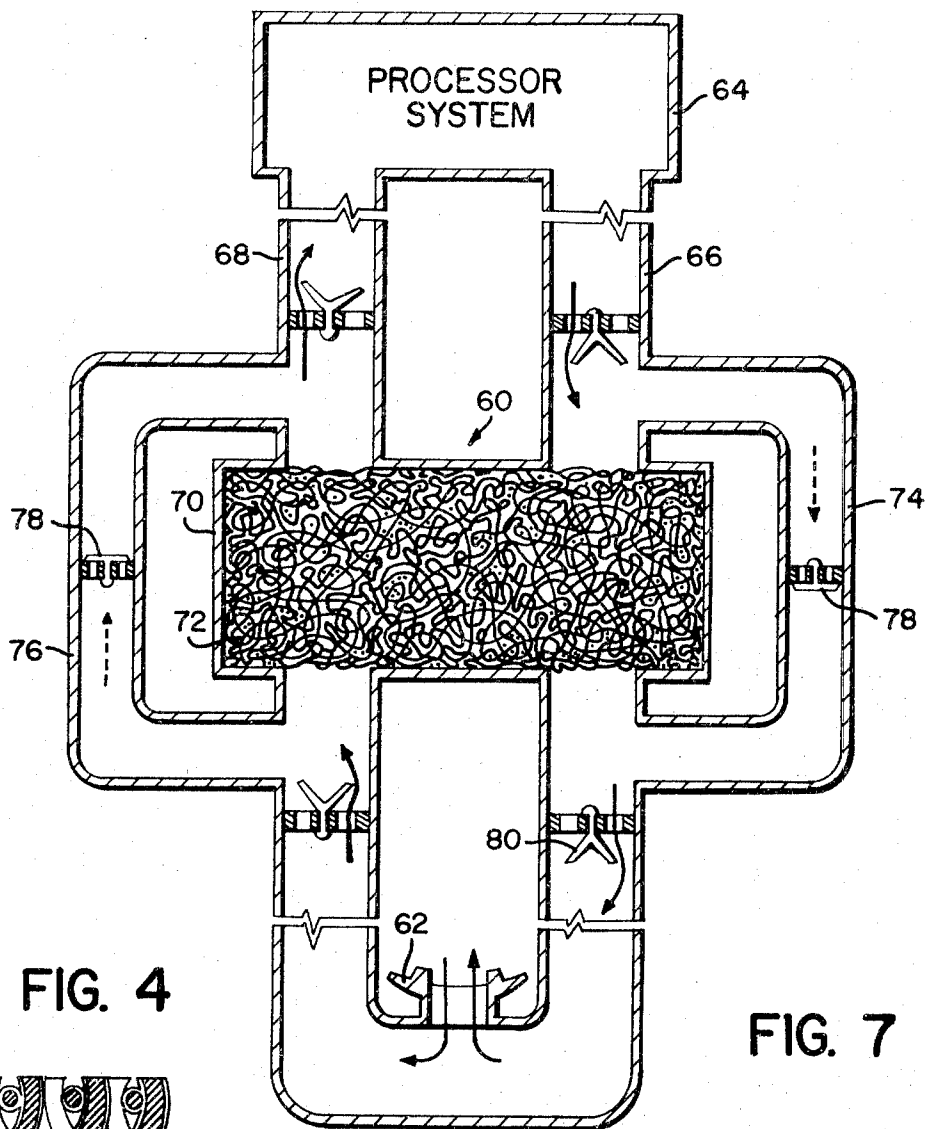
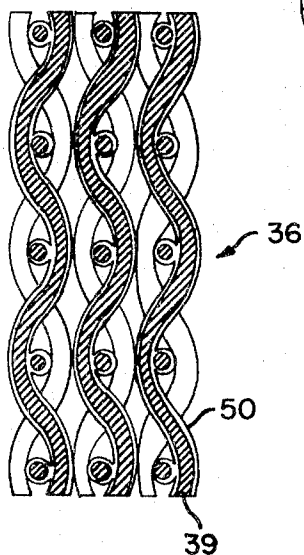


FIG. 4

FIG. 7



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## FLOW CONDITIONER

## BACKGROUND OF THE INVENTION

## 1. Field of the Invention

This invention relates to means for treating fluid flows, particularly for conditioning and improving gas flows in life support systems where gases flow to and from a respiring user.

## 2. Description of the Prior Art

Means for supporting respiration in hostile environments have assumed increasing importance particularly because of increasing scientific, industrial, and military activity relating to undersea, high altitude, and contaminated environments. Undersea exploration, for example, has recently assumed substantial scientific and economic significance. In undersea operations, life support systems have been developed to a substantial level of sophistication with respect to the function of supplying oxygen for divers' respiration. An example of such a life support system is the traditional deep sea diver system wherein the oxygen supply is maintained on the surface, and oxygen is pumped down to the diver through a conduit system extending through substantial depths. Expiratory exhaust gases are pumped through the conduit system to the environment and expelled from the system. The more recently developed self-contained underwater breathing apparatus (SCUBA) utilizes an oxygen supply carried by the diver. A highly sophisticated system recently developed and the subject of patent application Ser. No. 623,616 (filed Mar. 13, 1967), assigned to the assignee of the present invention, utilizes a recirculating gas flow whose oxygen content is maintained at a desired level by passage in contact with a liquid oxygen source at cryogenic temperatures.

During all of this development and across a broad spectrum of systems exemplified by the classical deep sea diver's system, the SCUBA system, and the cryogenic system, users have generally had to accept the fact that the life supporting gas mixture supplied to the diver deviates substantially from biological requirements of heat and moisture content. Such deviation may have deleterious effects ranging from simple inconvenience and minor efficiency loss to substantial danger to the health and safety of the diver, who may be losing substantial quantities of biologically vital heat and moisture with every breath. At suboceanic depths of 300 feet, this type of heat loss may account for 20-30 percent of total heat loss by the diver's body.

In the conventional deep sea diving system, the incoming gas supplied to the user is generally dry and cold partially because of its initial condition when it is injected into the respiratory gas flow and partly because of its passage through the long conduit distance between the surface and the diver, during which passage heat is lost to the undersea environment whose temperature may range below 50° F. Heat is similarly lost from the expired gas flows in the passage of the flows through the conduits to the surface. SCUBA systems also encounter such problems. The SCUBA system may inject oxygen gas at a fixed rate necessary to compensate for oxygen consumed by the diver and maintain mass balance by expulsion to the environment of some expiratory flow, thus losing heat and moisture. Oxygen added to the system gas flow is generally at the environment temperature and is of relatively low humidity. A cryogenic system, on the other hand, requires

removal of heat and moisture from the system gas flow preliminarily to passage of the flow through the liquid oxygen supply for reoxygenation. Hyperefficient heat exchangers are utilized to return the system gas flow to biological temperatures; however, under all conditions improvement in performance can be expected with decrease of the heat transfer load on a heat exchange element and under some circumstances this may prove critical. In the conventional SCUBA and deep sea diving systems heat and moisture may be supplied to compensate for respiratory heat and moisture requirements. Bulky and heavy apparatus may be required for such heat and moisture conditioning, comprising for example sensors or other regulator means as well as relatively complex injection means. Such apparatus is not only costly and complex but is inefficient from a system point of view since at one point heat and moisture in the expiratory flow from the user are expelled from the system and at another point heat and moisture are added with the aid of cumbersome apparatus.

Similar problems, arising from the deviation of inspired life supporting gases from biological norms for optimum performance and safety, are experienced by those within environments having adequate oxygen content to support life but deviating substantially from biological standards of temperature and humidity. Such environments are encountered, for example, in desert and Arctic regions or by firefighters in the course of their activities. Continuing inspiration from the atmosphere in such environments may result in serious damage to the respiratory system and other organs of the user through exposure to the extremes of temperature and humidity of the environment.

A further source of inefficiency in life support systems is in their mouthpiece that is, structures which immediately connect the respiratory system of the user to external life support elements. Such mouthpieces generally comprise merely passive conduits for the passage of the life supporting as flows incoming to, and outgoing from the user's respiratory system.

## SUMMARY OF THE INVENTION

The objectives and purposes of the present invention are realized, in a gas flow system connecting a respiring user and external elements, by a flow conditioner comprising a regenerator matrix for transferring usable components, such as heat and moisture, from one fluid flow to another in regenerative fashion. Preferably such a regenerator matrix is disposed within a mouthpiece connecting the respiring user with external life supporting elements. The matrix may comprise extended filamentary surfaces for removing usable contents from one gas flow by contact through conduction, absorption, adsorption or condensation; retaining the components; and surrendering them to another contacting gas flow. The matrix is disposed in exchange relation with the gas flow path and may be heat or moisture active or active with respect to other flow components. The matrix surfaces may be compacted together or extended over a substantial length.

When life supporting gases are added at temperature and humidity levels falling below biological levels heat is removed through conduction by the matrix from expired respiratory gases flowing in contact with the matrix. Heat is retained by the matrix and surrendered by conduction to the cold life support gases incoming to the user. Moisture is removed from the expired flow by

condensation, adsorption and absorption, retained, and surrendered to the incoming dry gas mixture, in an analogous manner.

An further aspect of the invention relates to the provision of highly efficient means for extracting, retaining, and adding heat and moisture. Folded wire mesh layers may be arrayed to define at least one hollow cylinder having a small orifice and presenting a large surface for heat and moisture transfer and retention while comprising a low impedance path for gas flow. Gas passing along or through the mesh layers to the orifice tends to expand and contact the mesh uniformly, promoting efficient heat distribution. In one form of the system, the regenerator matrix volume may receive bidirectional flows, whereas in another system opposite flows may be directed through different parts of the matrix.

Another aspect of the invention relates to an improved diver's mouthpiece incorporating at least one regenerator matrix to utilize efficiently, and for a significant function, mouthpiece volume that otherwise would serve only as a passive conduit for flows of life supporting gases. In a specific example, an improved mouthpiece structure includes a pair of flow conditioners, each comprising a hollow fluted cylinder of multilayered heat conductive mesh having hygroscopic surface layers. The cylinders are disposed adjacent the mouthpiece orifice within and along the gas flow conduit, and are of short length but extremely high surface area. The interior ends of the cylinders are closed, so that inspiratory and expiratory gases pass relatively uniformly through the available surface area of the conditioners between the mouthpiece and the conduit. Separately or in conjunction with the flow conditioner system, a bypass arrangement may be disposed to provide freer flow when high flow rates are needed.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram and schematic representation of a life support system utilizing a flow conditioner in accordance with the invention;

FIG. 2 is a perspective view, simplified and partially broken away, of a flow conditioner in accordance with the invention;

FIG. 3 is a sectional view of the flow conditioner of FIG. 1 taken along the line 2—2;

FIG. 4 is a fragmentary view of a portion of the flow conditioner of FIG. 2;

FIG. 5 is a graphical representation of temperature vs. position along a regenerator matrix, useful in explaining operation of flow conditioners in accordance with the invention;

FIG. 6 is a fragmentary view of a portion of an alternative flow conditioner in accordance with the invention; and

FIG. 7 is a simplified sectional view of yet another flow conditioner in accordance with the invention.

#### DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 illustrates an example of a flow conditioner in accordance with the invention, operating with a gas flow system. A utilization system 10 is connected to an external flow path system 12 through flow paths including an inlet-outlet conduit system 13 and a flow conditioner 14 (described in detail below). The conditioner 14 may generally be disposed at any system point between the utilization system 10 and an oxygen source

24 (discussed below), but for a life support system is preferably adjacent, or integral with the inlet-outlet conduit system 13. The oxygen source 24 may be included in the system as with a conventional SCUBA or in the life support system of copending application Ser. No. 623,616. Alternatively, the oxygen source 24 may comprise an environment containing life supporting levels of oxygen. A gas mixture is exhausted from the utilization system 10 (one or a group of users in a life support system) and passes in contact with the conditioner 14, which includes passive elements for retaining selected constituents or properties of the gas flow, retaining the constituents, and adding the constituents to a subsequent gas flow incoming to the conditioner 14. In the life support context these are shown generally as a heat active means 16 and a moisture active means 18, although these may be advantageously combined, or other types of flow constituents may be transferred by such means.

A pre-oxygenation system 20 may be disposed between the utilization system 10 and the oxygen source 24. In systems in accordance with the invention disclosed in copending application Ser. No. 623,616 cited above, the pre-oxygenation system 20 comprises a heat exchanger 22—reducing temperature of the exhaust gas flow from the biological range to the near cryogenic range—and a desiccant chamber 23 for removing moisture from the flow. Thus, the demands upon the preoxygenation system 20 are substantially lessened by the heat and moisture transferring means 16, 18 in the flow conditioner 14. In other life support systems the pre-oxygenation means may operate differently, as in the conventional SCUBA, or such means may not be used, as in systems drawing oxygen from the environment.

The flow then circulates to the oxygen source 24, which comprises means for maintaining the respiratory gas flow at a life supporting concentration of oxygen. In specific examples, the oxygen source may comprise a cryogenic processor (as in the invention of the copending application cited above wherein an oxygen liquid vapor system 28, maintained at a desired temperature by a cryogen 30, adds oxygen to the appropriate partial pressure), an arrangement for adding oxygen as in the conventional SCUBA, or merely the environment, among others. A post-oxygenation system 26 may be disposed between the utilization system 10 and the oxygen source 24 for operating upon the oxygenated gas flow prior to entry into the conditioner 14 (in the cryogenic system, the post-processing system 26 comprises a post-processor for warming the processed flow to biological temperature and contains a heat exchanger 32 in thermal relation with the heat exchanger 22 for the purpose). Total gas pressure, including oxygen and inert gas partial pressures is maintained by appropriate means varying with the specific system. In partial recirculation systems the inert gas may be continuously added with the oxygen. In complete recirculating systems, like the cryogenic processor system, routine loss of inert gas does not occur and adjustment of partial pressure to changed conditions is effected by conventional valve, sensor and storage arrangements. In non-oxygen supplying systems connected with the atmosphere, of course, no such inert gas problems arise.

The gas flow then passes to the utilization system 10 through the flow conditioner 14 and the inlet-outlet system 13. In the flow conditioner 14, flow constituents

such as heat and moisture removed from the flow by the means 16, 18 and retained therein are surrendered to the incoming gas mixture.

The path taken by the flow through the oxygen source 24 may be viewed as the principal path. Thus, usable flow constituents such as heat or moisture which would otherwise have been discarded from the outgoing exhaust flow and omitted from, or subsequently readmitted from external sources to the incoming oxygenated flow, are instead extracted from the exhaust flow, retained and surrendered to the incoming flow for reuse without passing through the principal path including other elements of the system. In effect the flow conditioner 14, which transfers particular flow constituents between the respective flows, comprises a shunt flow path and storage only for these flow constituents such as heat and moisture. The shunt path bypasses or is parallel to the principal flow path, and other flow constituents are not diverted. As indicated above the principal path need not be closed.

Though flow conditioners in accordance with the invention comprise shunt paths for particular flow constituents, such flow conditioners comprise purely passive elements operating through contact with system gas flow and utilizing basic physical and chemical principles and processes without the complexities of structural requirements imposed upon active elements, as shown below.

FIGS. 2 to 4 illustrate in detail an example of a flow conditioner in accordance with the invention, as used for an underwater life support application. A flow conditioner 14 enclosed by a housing 34 is connected with external elements including an oxygen source (not shown) and a user (not shown), through a conduit system 35, for respiratory gas flows (the conduit system 35 may, of course, be of any appropriate shape and is shown as T-shaped for clarity). The conditioner 14 comprises a pair of adjacent heat and moisture active flow conditioner regenerator matrices 36, 38. The conduit system 35 includes a principal cross-arm conduit 40 having colinear and communicating ends for receiving and transmitting inspiratory and expiratory flows respectively, associated system elements not being shown. Also included in the conduit system 35 is a base leg conduit 42 which comprises a respiratory passage extending from the cross-arm conduit 40 and terminating in a diver's mouthpiece 44, including a breathing orifice 45 and comprising a fluid connection to the respiratory system of the diver. Other arrangements permitting inflow and outflow of gas to the respiratory system of the user in operative relation to the flow conditioner 14 may also be employed in accordance with the invention. The matrices 36, 38 may, for example, be disposed transversely or longitudinally within the mouthpiece 44 in the absence of a respiratory passage 45. In the example shown, the matrices 36, 38 are of cylindrical form, and disposed axially within and along the base leg conduit 42 as best seen in the perspective and sectional views of FIGS. 2 and 3 respectively. The matrices are preferably disposed axially as shown, but may also be in other orientations with respect to the mouthpiece or the respiratory flows, e.g., transversely. As shown also in FIG. 4, the cylindrical matrices 36, 38 comprise multi-layer bodies having their central axes spaced apart but parallel to the central axis of the base leg conduit 42. The matrices 36, 38 are alike in this example, although they may be of different sizes and

shapes for particular installations (they may, for instance, comprise packs of stacked screens). Each is shown as peripherally multi-fluted or corrugated longitudinally to maximize operative surface area and minimize bulk. The matrices comprise separate layers 39 in contacting and conforming relation to one another to define the porous-walled, fluted cylindrical shape. In one specific matrix 36, the layers 39 are mounted at their opposite ends in mountings 46, 48, the mounting 46 being adjacent the orifice 45 and fixed to the inner wall of the base leg conduit 42 and having an open central portion. The mounting 48 at the free end of the matrix 36 comprises a transverse closure member and is hermetically sealed to the layers 39, blocking gas flow from entering the matrix cavity directly from the conduit 40.

Referring now specifically to FIG. 4, each mesh layer 39 of a given matrix 36 comprises in this example a fine woven screen of highly heat conductive material, such as copper. The filaments of the screen are coated with a hygroscopic layer of an activated molecular sieve material 50, such as activated charcoal. In the particular example being discussed, approximately 10 layers 39 of 200 mesh copper screen were employed in the flow conditioner, which was designed for operation at approximately 600-foot depth and with a helium-oxygen mixture. A desired total surface area of the matrix 36 was provided within a 0.8 inch diameter section approximately 1 inch long. This configuration was sufficient in surface area and total volume to permit operation with a pressure drop of approximately 0.1 inch of water or less. The total volume of the matrix 36 is preferably substantially smaller than the average volume of the average breath of the diver, to avoid problems related to mixing of inspiratory and expiratory flows, and may preferably range between 10-100 cc.

In the specific example of operation of the flow conditioner in conjunction with a cryogenic life support system, therefore, inspiratory flow passes from one side of the cross-arm conduit 40 to the mouthpiece 44 through the matrices 36, 38, and expiratory flows are directed again through the matrices 36, 38 to the other end of the cross-arm conduit 40. These flows pass essentially radially through the porous layers 39 of the matrices 36, 38 and are distributed evenly over their entire surface areas. One way or check valves (not shown) may be disposed in the conduits or elsewhere for flow control in the system.

The regenerator matrices 36, 38 are in operative heat and moisture relation with the respiratory gas flows. Heat is transferred through condensation. Moisture is transferred through condensation and evaporation accompanying the heat transfer, and through the separate action of the molecular sieve. In underwater operation, where extremely high pressures are involved and where the oxygen supply for respiration is cold and dry, both heat and moisture are rapidly extracted from the outgoing expiratory flows by the matrices 36, 38. Moisture is absorbed by the molecular sieve material 50, and moisture condenses upon the layers 39 through the cooling of the gas flow. The heat and moisture are thus diverted into a separate shunt path that does not act upon other flow constituents of the gas, and are retained or stored by the matrix for surrender to a subsequent incoming flow. The subsequent inspiratory flow enters the cross-arm conduit 40, and absorbs heat and moisture retained by the matrices 36, 38. Heat ex-

tracted by the matrices 36, 38 is evenly distributed over the mesh layers 39 because of their high thermal conductivity and because of the expansion of the gases to occupy the entire cavity in which the matrices 36, 38 are contained, and thus to contact substantially all of the mesh layers 39. Heat exchange with a surrounding gas is therefore highly efficient, and augmented by heat transfer along the length of the layers 39. Pressure drop is extremely small because of the thinness of the layers 39 (for the 200 mesh screen previously referred to, the total thickness of 10 layers was approximately 0.040 inch).

For specificity, the invention has been discussed within the context of life support and particularly as related to temperature and humidity. Such particular aspects are not necessary to the invention which may be employed generally and may be active with respect to heat or moisture singly or in combination, or to other properties.

Though the regenerator matrix 36 is preferably of coated wire mesh, it may comprise other configurations allowing intimate intermingling of the gas flow and the matrix elements such as various arrangements of spatially separated filamentary elements—woven or unwoven—apertures in an otherwise integral structure, as well as intermingled, or separated, adjoining layers of porous or permeable moisture and heat active materials or a single moisture and heat active material. Fluid permeable materials such as copper wool may be utilized also.

The activated molecular sieve material 50 may comprise heat treated activated charcoal or other well known comparable materials. The sieve 38 is disposed upon the mesh 37 by conventional procedures as by applying a charcoal-containing paint or applying finely divided charcoal to an adhesive coated upon the mesh 37.

Where large temperature differentials exist, the adsorptive process may be relatively unimportant. In situations, however, where such differentials do not exist or where the temperature at the oxygen source is higher than the body temperature of the user, the adsorptive process may become more significant. The interaction of the moisture content of the respiratory gas flow with the regenerator matrix 36 is essentially analogous to that of the heat content in accordance with well known principles of thermodynamics and chemistry; thus, moisture is retained and surrendered by the matrix 36 in a manner similar to that described above for heat, and the matrix 36 serves as a regenerator for moisture as well as heat.

It should be noted that the regenerator matrix 36 is not confined to use in situations where the source of life supporting gas is at a lower temperature of humidity level than required for biological processes. The regenerator matrix 36 may be used in situations where there is a difference in any direction of the characteristics of the oxygen source from biologically favorable levels of temperature and humidity. For example, where the oxygen source—as in the desert environment—is at an elevated temperature level and a depressed humidity level, the regenerator matrix 36 with the molecular sieve material 50 operates as described above with respect to the moisture content of the respiratory gas flow while operating in a reverse manner with respect to thermal content of the respiratory gas flow.

FIG. 6 depicts another specific example of a flow conditioner in accordance with the invention. Alternating layers 52, 54 of moisture active and heat active materials respectively are disposed adjacent one another, to form a regenerator matrix 56. The layers 52 are shown to comprise separated filaments or mesh of a hygroscopic moisture active material such as fibrous carbon or leached silica.

The layers 54, as in the example of FIG. 4, comprise filaments or mesh of highly heat conductive material such as copper. The disposition and configuration of the layers 52, 54 are similar to those of FIG. 4. The layers 52, 54 are thermally insulated from the housing and may be removably connected thereto.

The operation of the example of FIG. 6 is similar to that of the example of FIG. 4 except that here the respiratory gas flows pass through twice as many separate mesh layers in each respiratory cycle as in the previous example, and the storage effects take place in different elements.

In a different arrangement in accordance with the invention as shown in FIG. 7, a flow conditioner 60 may be positioned at a remote location between a mouthpiece 62 and a processor system or other life support means or oxygen source 64. The term "remote" does not indicate that a substantial spacing is necessarily required, only that the flow conditioner 60 may be disposed somewhere along a preexisting or specially adapted inspiratory conduit 66 and expiratory conduit 68 instead of being disposed adjacent to or as a part of a mouthpiece apparatus. In this arrangement, the flow conditioner 60 comprises a housing 70 containing a matrix 72 comprising a plurality of heat conductive elements, specifically a mass of copper wool. Bypass conduits 74, 76 shunt the housing 70, each conduit including a pressure responsive valve 78. The bypass valve 78 may be set adjustably to respond to any desired pressure differential across it, to open so as to permit free flow in response to a selected pressure differential. Check valve 80 insures proper flow direction of the regenerating flows. It should be noted that the bypass arrangement may be employed with the mouthpiece regenerator as such.

In the operation of the system of FIG. 7, the primary function of flow conditioning is effected within the separate inspiratory conduit 66 and expiratory conduit 68 by the copper wool body 72. Heat taken into the mass 72 during the expiratory cycle is readily conducted throughout the mass within the housing 70, and given up to the inspiratory flow. Moisture is accumulated within the copper wool mass 72, migrating on successive exhalations into the region of the inspiratory conduit 66. Thus, a substantially greater storage volume is made available for both heat and moisture retention and release, and the structure not only provides an interchange between the incoming and outgoing flows but an averaging or integration of the characteristics of the flows.

The invention is not to be considered to be confined in scope or construction to the specific examples illustrated above but rather is to be considered to embrace all variations and modifications within the scope of the invention as set out in the following claims.

What is claimed is:

1. Apparatus for adjusting the temperature and humidity levels of respiratory gas flows for a respiring user

successively expelling expiratory gases and inspiring inspiratory gases, said apparatus comprising:

a housing having a fluid sealing connection adapted to be connected to a user and defining an orifice for passage of said respiratory gases to and from said user; and

a flow conditioner comprising at least one thermal regenerator matrix comprised of a permeable material, said matrix defining at least one cylinder having a central cavity and defining an orifice at one longitudinal end thereof and including means providing a transverse seal at the other longitudinal end thereof, said cylinder being disposed axially and internally with respect to the housing, said cylinder and said seal being spaced from said housing whereby gas is allowed to flow through said matrix along the inner walls of said housing and past said seal.

2. The invention as set forth in claim 1 wherein said at least one matrix comprises a plurality of adjacently disposed layers of highly heat conductive filaments configured in a peripherally multi-fluted cylinder having a central cavity.

3. The invention as set forth in claim 2 wherein said

at least one matrix has a total volume of approximately 10-100 cc and wherein the thickness of said plurality of layers comprises approximately 0.040 inch, and said layers comprise copper wire screen of approximately 200 mesh, there being at least 10 layers thereof.

4. The invention as set forth in claim 3 including hygroscopic means having an extended surface for moisture exchange with said gas flows, said hygroscopic means comprising an activated molecular sieve material coating upon at least one of said plurality of layers.

5. The invention as set forth in claim 4 wherein said flow conditioner comprises a pair of like adjacent cylinders disposed axially with respect to the gas flows, and including an open end adjacent said orifice and a closed interior end, such that gas flows pass substantially radially through the layers thereof with respect to the central axis of each cylinder, and substantially uniformly across the entire surface area of each cylinder, and wherein in addition said hygroscopic means is substantially uniformly disposed on all said layers and comprises activated charcoal powder and means adhesively binding said powder to said layers.

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UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION

Patent No. 3,747,598 Dated July 24, 1973

Inventor(s) Kenneth W. Cowans

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 35, after "mouthpiece" and before "that" insert a comma --,--; line 39, for "as" read --gas--.

Column 3, line 4, after "An" and before "aspect" delete "further".

Column 7, line 33, for "sieve 38" read --sieve material 50--; line 34, for "mesh 37" read --mesh layers 39--; line 37, for "mesh 37" read --mesh layers 39--.

Signed and sealed this 5th day of February 1974.

(SEAL)

Attest:

EDWARD M. FLETCHER, JR.  
Attesting Officer

RENE D. TEGTMEYER  
Acting Commissioner of Patent