Sept. 9, 1952 N. E. PHILLIPS 2,610,038

THERMAL RESPIRATOR

Filed March 29, 1949

3 Sheets-Sheet 1

FIG. 1

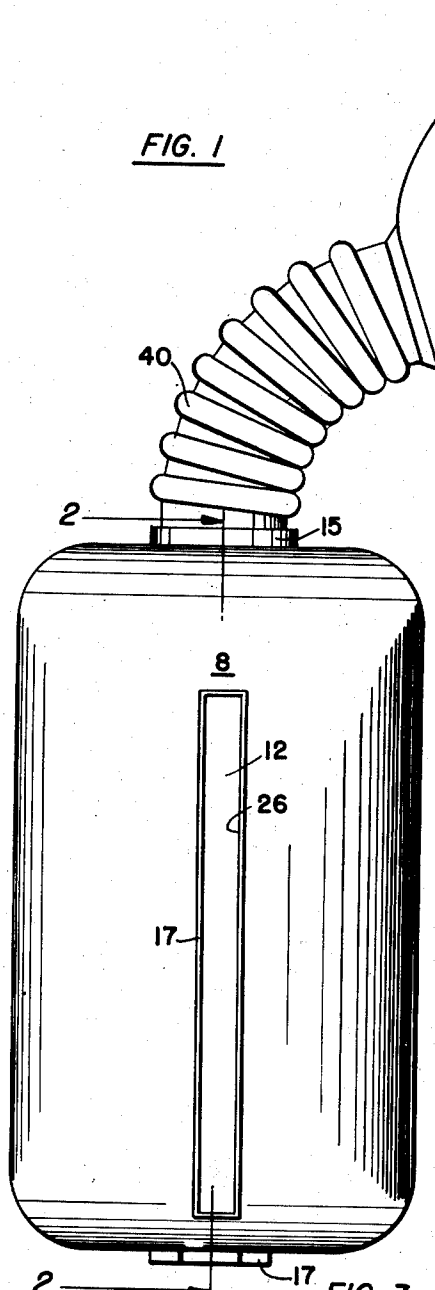


FIG. 2

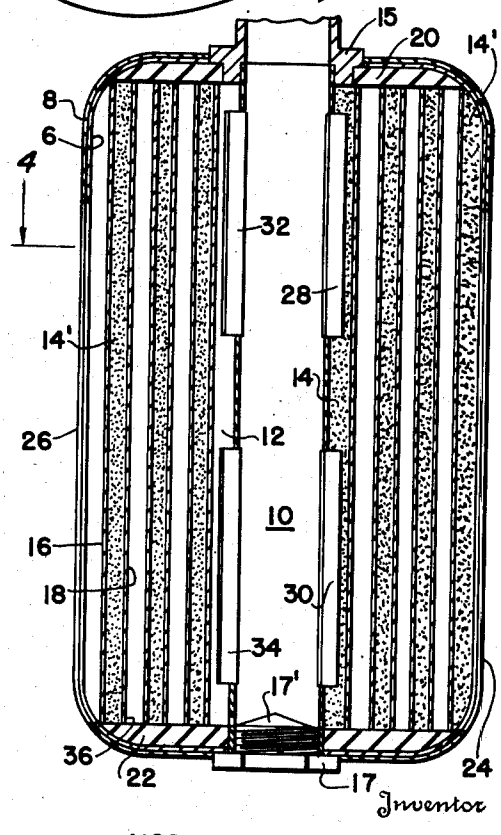
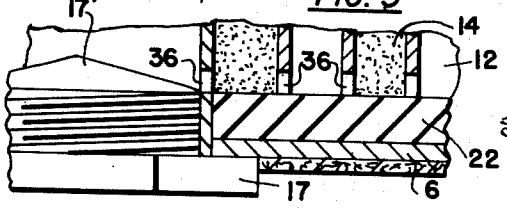


FIG. 3



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FIG. 4

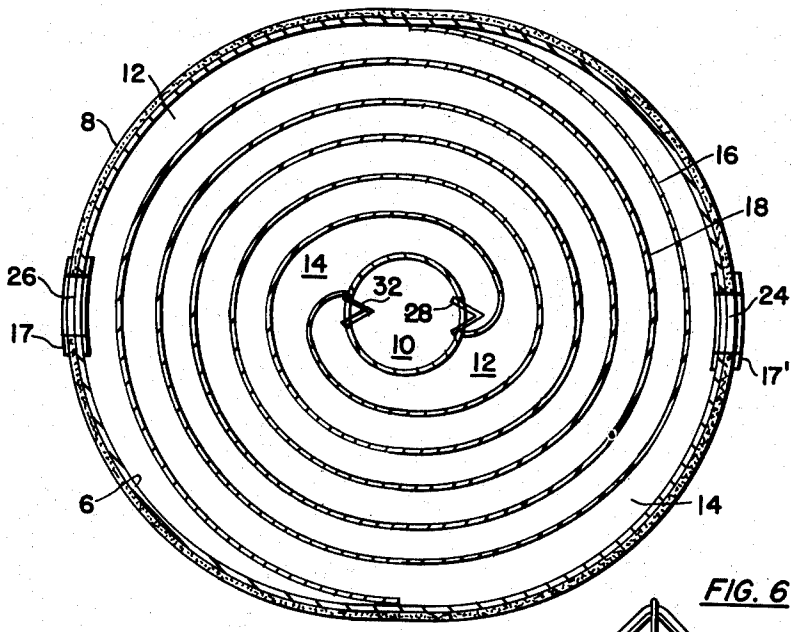


FIG. 5

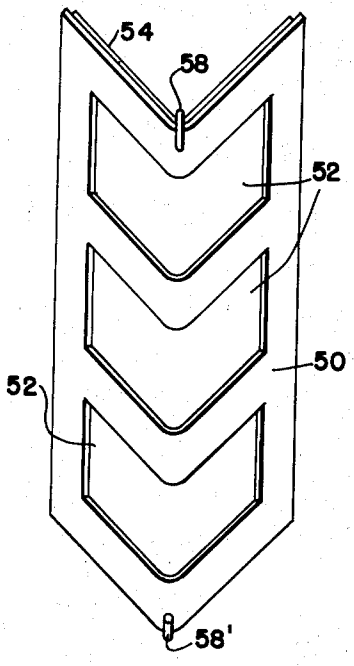
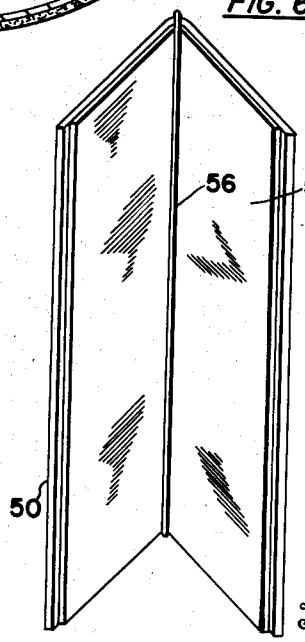


FIG. 6



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FIG. 7

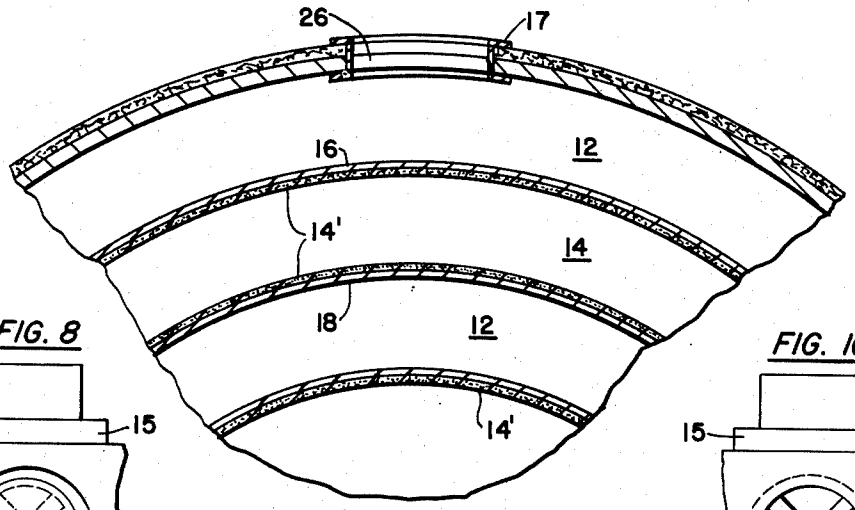


FIG. 8

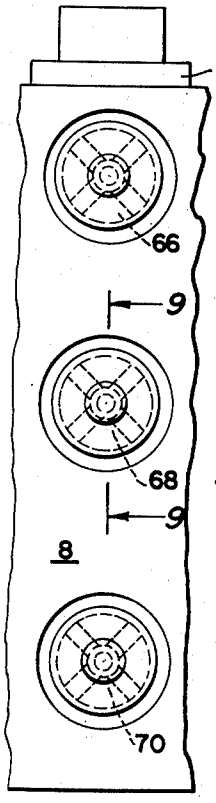


FIG. 9

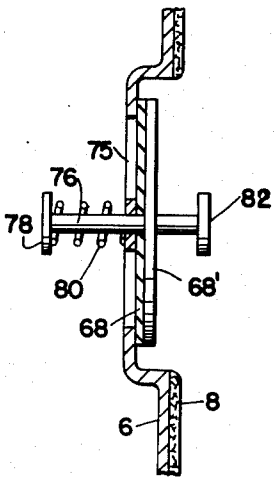


FIG. 11

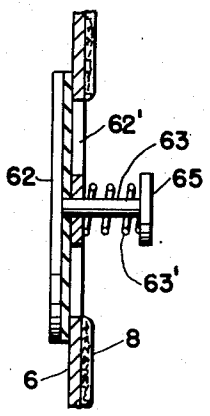
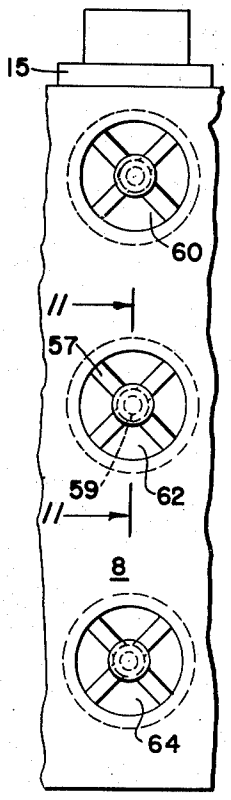


FIG. 10



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UNITED STATES PATENT OFFICE

2,610,038

THERMAL RESPIRATOR

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Application March 29, 1949, Serial No. 84,093

6 Claims. (Cl. 257—245)

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This device relates broadly to a heat exchange apparatus and is particularly designed as a portable air conditioning unit for use as a breathing aid in extremely cold surroundings such as are encountered in the arctic and antarctic regions and at high altitudes.

Cold air has a low moisture content and the inhaling thereof has many harmful effects upon the individual. Among some of the more serious effects encountered are frost-bite of the respiratory tract and excessive fatigue. This not only causes loss of efficiency of the individual, but may possibly cause serious injury and prolonged illness to those operating under these unusually cold conditions. The loss of efficiency is to a great extent due to the loss of energy experienced incident to warming of the air and the loss of moisture from the body which later is expired. Each breath of the cold inhaled air goes through the same process of being heated and taking up moisture from the body which continually drains the body of its energy and subjecting it to many other ill effects. The present apparatus and method are particularly designed for reconditioning this cold air by raising its temperature and moisture content from the heat and moisture contained in the expired air.

In its broader sense the principal object of the invention is to provide a simple and efficient heat exchange unit which is capable of transferring heat and moisture from one portion of a fluid to another portion as they are circulated in close proximity through the unit.

Another object of the invention is to provide a unit of compact construction which will be light in weight and occupy a minimum amount of space.

Still another object of the invention is to provide means for moving the heated fluid portion and the unheated portion through separate channels and transferring the heat carried by the heated portion of the fluid through the channel wall to the unheated fluid.

A further object of the invention is to provide a structure which may be easily and economically manufactured and of several detachable parts which may be detached for cleaning or replacement.

While several specific objects of the invention have been briefly pointed out, other objects and advantages will be apparent as the nature of the invention is more fully disclosed consisting of the novel construction, combination and arrangement of parts shown in the accompanying drawings and described in the detailed description

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forming a part of the specification and in which:

Figure 1 is a vertical side view of the unit together with an attached face mask.

Figure 2 is a vertical sectional view taken along the line 2—2 of Figure 1.

Figure 3 is an enlarged fragmentary sectional view of a small section of the unit taken along the bottom of the unit similar to the sectional view shown in Figure 2.

Figure 4 is an enlarged sectional view taken along the line 4—4 of Figure 2.

Figure 5 is an enlarged perspective view of one form of valve member.

Figure 6 is a view similar to Figure 5 of the opposite side of the valve.

Figure 7 is an enlarged fragmentary sectional view of the unit similar to that shown in Figure 4.

Figure 8 is a fragmentary view of a unit showing a modified form of fluid outlet valve.

Figure 9 is an enlarged sectional view taken along line 9—9 of Figure 8.

Figure 10 is a view similar to Figure 8 showing a modified form of fluid intake valve.

Figure 11 is an enlarged sectional view taken along the line 11—11 of Figure 10.

Referring to the drawings, the novelty of the invention resides principally in the canister which is provided with a thin outer wall or shell 6 and a relatively thin insulating outer cover 8. The interior of the canister is provided with a centrally located tube 10. Surrounding the tube 10 and connected therewith are spiral channels 12 and 14. These channels are formed by one or more spiral separators or walls of relatively thin sheet material 16 and 18 and are preferably constructed of sheet metal or any suitable material having the required properties of high heat conductivity. These channels extend longitudinally of the canister and are hermetically sealed adjacent the top and bottom and are insulated from the top and bottom by insulation 20 and 22. Each of the channels 12 and 14 are provided with outer openings 24 and 26 respectively leading through the outer casing 6. One of the channels will contain the inlet valves 28 and 30 and be known as the inspiratory channels, and the other channel will contain the outlet valves 32 and 34 and be known as the expiratory channels.

The wall members have adjacent their lower areas a plurality of small holes or openings 36 of such size as to allow a liquid to pass from one channel to the other, and covered with such a material, or designed in such a fashion that the free passage of gases is reduced to a minimum.

The side walls of the inspiratory channel 14, equipped with the intake valves 28 and 30, carry an absorbent material 14' having capillary qualities for attracting moisture over the walls of the channel. The channel 12 equipped with the outlet valves 32 and 34, is of a plain surface in order that the wall surface may immediately absorb the heat of the exhausting fluids transferring it to the incoming fluids in channel 14.

The tube 10 is provided with openings equipped with the valves. These opening connect the channels 12 and 14 to the inside of the tube. While these valves are shown carried within the openings of the tube 10 and adjacent the center of the canister, they may be located adjacent the outer wall as shown in Figures 8 and 10. As a matter of fact, the valves may be any place along the channels. However, it is preferable to locate the valves adjacent the center of the canister because it has been found that the valves will have a more uniform and dependable action than if located adjacent the outside of the canister where the temperature may run as low as 60 to 70 degrees below zero, which in some instances tends to affect the operation of the valve if constructed of a pliable material such as rubber, leather, plastic or the like. The air to be conditioned is injected and expelled into and out of the single central passage or tube 10 and is directed through the channels by the valves. While the central passage is shown in the form of a tube, it may take any other convenient shape, size or design. For example, the separator walls are shown as consisting of two separate elements 16 and 18. They may be made of a single sheet by slotting the tube 10 longitudinally and allowing the sheet to extend through the tube to form a second separator on the opposite side of the tube. In this case the central section is divided and the respective valves are in the half sections.

For servicing and replacement purposes the tube 10 may be removable from the canister. It is shown as being receivable within appropriate openings within the top and bottom of the canister and having a hollow shoulder member 15, attached to its upper end for contacting the upper end of the canister. The lower end of the tube is provided with an internal thread for receiving a threaded plug 17. The plug is provided with a tapered inner end portion 17'. The head of the plug is adapted to bear against the bottom portion of the canister, fixably securing the tube within the canister.

Secured to the upper end of the canister through the hollow shoulder member 15 is one end of a flexible breathing tube 40, the other end of which is connected with a face mask 42. The mask may be of any suitable design, but preferably one covering both the nose and mouth of the wearer. If under certain circumstances it is more convenient to the wearer, the canister may be attached directly to the mask, eliminating the tube 40 altogether.

The valves may take any desired form. One type which has proven to be most practical is shown in Figures 5 and 6. This particular valve may be used both as an intake and outlet valve by simply reversing it. The valve is constructed of an elongated V-shaped rigid member 50; formed in the member 50 are openings or windows 52. Lying within the V member is a flexible sheet member 54, such as rubber, leather or similar material. Along the apex of the member 50 is a small rod 56 having its ends clamped

over the ends of the V member as shown at 58 and 58' for holding the sheet member in contact with the openings. By this arrangement it can be seen that the fluid will be only allowed to travel through the openings 52 in the direction of the flexible sheet.

A modified form of valve is shown in Figures 8 to 10, and are shown located on the outer surface of the sheet or cover. The inlet valves are arranged as shown at 60, 62 and 64 in Figure 10, while the outlet valves are shown at 66, 68 and 70 in Figure 8. The device may be constructed with more than two channels with suitable valves, or fluid directing means, provided for each channel.

For example, the intake valve 62 is provided with a packing or washer 62', a stem 63, and a head 65. This type valve is one of the well-known conventional types in which the valve is kept normally closed by a suitable spring 36'.

The outlet valves are constructed in substantially the same manner and operated in substantially the same manner, the difference being that in the outlet valve 68 the valve operates on the opposite side of the valve opening, and the stem 76 extends inwardly on which is carried a cap 78. Between the valve opening and the cap 78 there is a spring 80 for keeping the valve normally closed. The stem 76 also extends outwardly for a short distance and carries a cap 82 for manually testing its operation.

It may be desirable to mold the canister from one of the well-known plastics. Also, the separators themselves may be made from an absorbent, or porous, material which would convey the liquid through the walls of the inspiratory channel as previously described for the absorbing material but which would effectively prevent the rapid diffusion of gases from one channel to the other. One of the most important features of the canister is that the channels 12 and 14 must provide for easy breathing by not being too narrow to set up undue resistance, but the width of the channel plus the length of the channel must be such that there will be substantially a complete transfer through the separator walls 16 and 18 of the heat contained in the exhaled air to the air to be inhaled.

In operation, the mask 42 or mouthpiece is placed securely over the nose and/or mouth. As air is breathed into the mask, it moves through the tube 40, the tube 10 and through the valves 32 and 34 into the expiratory channel 12 forcing the air of the previous expiration out of the canister through the outside opening 26. The heat contained in the exhaled air will be transferred through the separators 16 and 18 into the air being conveyed through the inspiration channel 14.

The heat contained in the immediately expired air is conducted through the separator walls into the inspiratory channel 14. The air in the inspiratory channel 14 was partially warmed by the heat of the previous expiration and is now further warmed by the heat of the above immediate expiration. Upon inhalation this warned air is drawn from channel 14 through the valves 28 and 30 to the central tube 10 and through the tube 40 and into the mask 42. As air is being inspired from channel 14 an equal volume of cold air is being drawn into channel 14 through the opening 24, and being partially warmed by the residual heat from channel 12.

Each channel should have a total volume of such a magnitude that the transfer of heat from

expired to inspired air will be optimum taking into consideration such factors as change in tidal volume due to exercise, altitude, and other physiological conditions, and also such physical factors as volume changes due to changes in temperature and pressure.

To the extent to which optimum operation of the device makes it necessary, insulation and/or coating with heat absorbing or radiating surfaces externally or internally arranged may be adequately provided.

As previously mentioned, the outside air entering the inspiration channel **14**, if of low temperature is practically devoid of moisture, while the exhaled air forced into the channel **12** contains a considerable amount of moisture. This moisture is condensed as it is cooled by loss of heat to the incoming air and drops to the bottom of the canister in the form of a liquid where it seeps through the holes **36** in the separator wall into the inspiratory channel and there is absorbed by the absorbent material attached to or incorporated in the walls of the channel, and by capillary action is conveyed over the walls of the channel to be taken by the incoming air as it becomes heated, thereby supplying to the incoming air moisture, which otherwise would be taken from the body when this air is again exhaled.

While the device is primarily constructed for use as a thermal respirator, it may have other new and novel uses as a heat transfer unit. For example, a modification of the device may be used in installations where a breathing action takes place, such as exists in the base of an internal combustion engine. Such a device would act to heat the incoming air by the heat taken from the exhausted air and aid in keeping the oil in the crankcase from being cooled by the extreme cold air direct from the outside, another example being that in an air conditioning system, the fresh air can be heated by the exhausted warm air and thereby prevent considerable heat loss. While several alternate uses for the device have been mentioned, there are probably many other uses and advantages to which the principles of the device could be put which are not readily apparent at this time.

While the device has been illustrated and described in its simplest form, it is not intended to be limited thereto as its shape, size and design may be altered or changed to suit specific problems and conditions. For example, under certain circumstances the channel separator or separators may not be provided with the apertures **36**, or the capillary walls as described for the inspiratory channels. The channel separators would then be constructed of a high heat transfer material and separate means would be provided for exhausting the condensation of the moisture collected in the expiratory channels, or allowing it to be blown from the channels in the normal course of breathing in the form of small snow-like flakes. On the other hand it may be advantageous and/or desirable to provide means for supplying fresh moisture to the incoming air. Another modification may reside in moving the fluids in the adjacent chambers in the same direction which may be accomplished by allowing the separate portions of the fluid or fluid bodies, to enter either the outer or inner ends of the adjacent channels in the same direction and leaving the opposite ends in the same manner. The various modifications depend largely upon whether the device is to be used for long or short intervals. Therefore, what I claim as new and desire to secure by Letters Patent is best defined in the appending claims.

I claim:

1. In a thermal breathing apparatus comprising a canister having a plurality of spaced spiraled separators providing side walls for adjacent spiraled air channels, the outer ends of which are open to the atmosphere, each alternate channel having intake and outlet valves respectively, the canister being provided with a single passage at its center with which the spiraled channels are connected, relatively small openings formed in the lower portions of the separators for admitting a small portion of a fluid to pass through the separators to the channels, means for conveying the said fluid over the side walls of the channel provided with the inlet valves one end of the canister having an opening leading to the central passage for connecting the central passage with a breathing mask.

2. In a thermal respirator comprising a canister having a plurality of separators forming side walls for adjacent narrow channels having their outer ends open to the atmosphere, each alternate channel being provided with intake and outlet valves, the canister being provided with an opening at its center into which the inner openings of the channels are connected, the separators having small openings formed in the lower portions thereof, means associated with the channel walls provided with said intake valves for conveying the fluid over the channel walls by capillary attraction, and means for connecting the central opening in the canister with a breathing mask.

3. In a thermal respirator comprising a canister having a plurality of spaced separators for forming a plurality of adjacent spiraled narrow channels, the channels being provided with separate openings in the outer surface of the canister for admitting and exhausting air therethrough, each alternate channel having air intake and outlet valves adjacent their outer openings, a relatively large passage formed at the center of the canister with which the inner ends of the several channels are connected, small openings formed in the channel separators along the bottom of the channel separators adjacent the central passage for admitting condensed moisture to pass through the channel walls of the canister, the surface of the channels provided with the inlet valves being of such a character as to have capillary attraction for the moisture for distributing the same over the side wall thereof, and means for connecting a breathing mask with the central passage.

4. In a breathing mask having a canister associated therewith, said canister having spaced separator walls of relatively thin high heat transfer material for forming a plurality of adjacent narrow inspiratory and expiratory channels, the channels having separate openings in the outer surface of the canister for admitting and exhausting air therethrough, each alternate channel having air intake and outlet valves, the canister having a relatively large opening with which the inner openings of the several channels are connected, means for transferring moisture through the channel walls to the several channels, the surfaces of the channels provided with the inlet valves being of such a character as to provide capillary attraction for the moisture for distributing the same over the side walls of the

said channels and means for connecting the central opening of the canister with a breathing mask.

5. In a thermal breathing apparatus comprising a canister having a plurality of spaced spiraled separators providing side walls for adjacent spiraled air channels, the outer ends of which are open to the atmosphere, each alternate channel having intake and outlet valves respectively, the canister being provided with a single passage at its center with which the spiraled channels are connected, one end of the canister having a single opening leading to the central passage for connecting the central passage with a breathing mask.

6. In a breathing apparatus for raising the temperature of cold air comprising a container having a top and bottom and means extending between the top and bottom for forming adjacent spiral channels within the container, each channel having an opening to the atmosphere adjacent their outer ends, and an opening at their inner ends leading into a centrally located single

passage within the container, air valves associated with the channels for allowing the air to pass in only opposite directions in adjacent channels, the top cover having a single opening leading to the central single passage and means associated with the opening in the top cover for connecting the cover opening with a breathing mask.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,298,404	Ramanoff	Mar. 25, 1919
1,930,879	Linderoth et al.	Oct. 17, 1933
1,966,034	Hensler	July 10, 1934
2,060,440	Rosenblad	Nov. 10, 1936
2,142,679	Seifert	Jan. 3, 1939
2,360,739	Strom	Oct. 17, 1944