

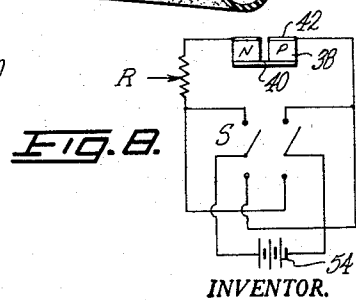
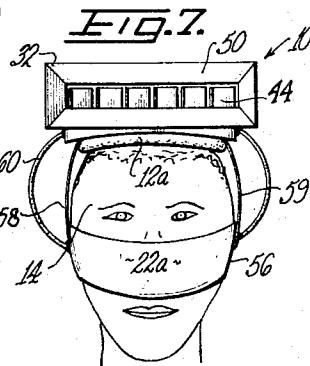
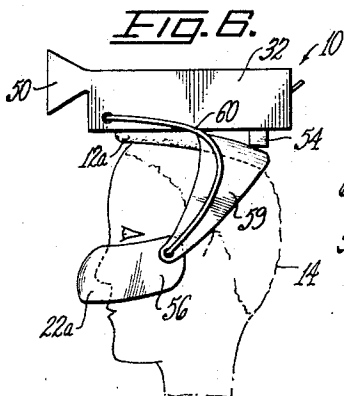
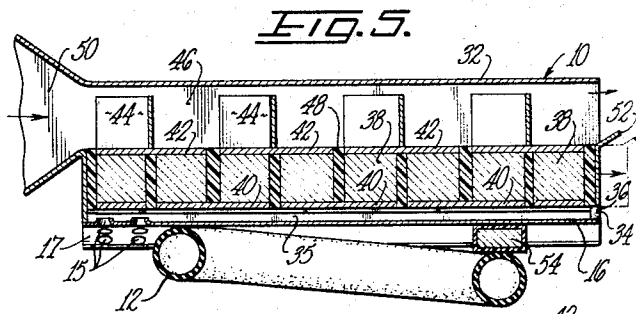
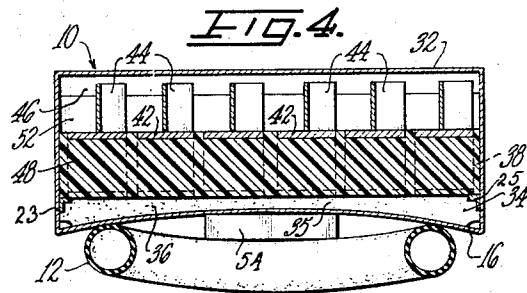
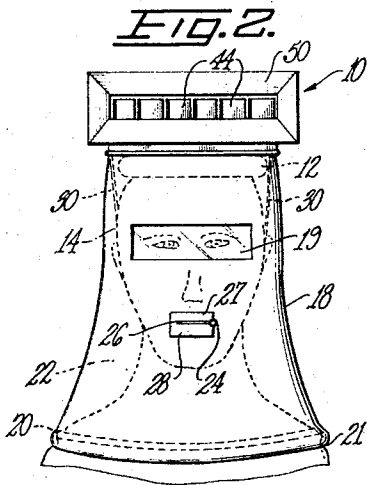
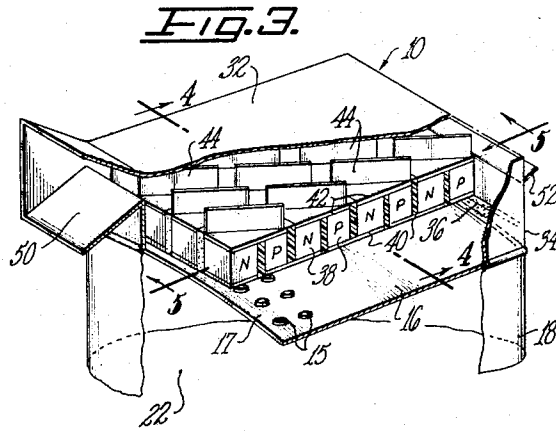
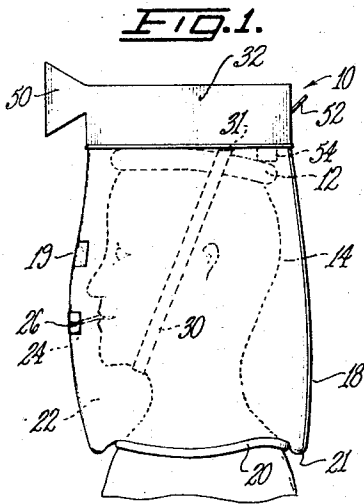
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3,295,522

WEARABLE COOLING RESPIRATORY DEVICE

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1

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WEARABLE COOLING RESPIRATORY DEVICE

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This invention relates to a readily wearable, cooling respiratory device having self-contained means (typified by a battery-operated Peltier thermocouple) for cooling an external air intake stream before it is drawn into the lungs by the normal respiratory action of the wearer. It thus provides an attachable breathing unit which a person (or animal) can wear to cool the air he breathes as he goes about his normal activities in an overheated atmosphere.

It is an object to provide such a portable or wearable unit which does not require any inanimate air circulating mechanism but enables the wearer's own breathing action to draw in air over cooling elements in a unidirectional flow, and alternately directly to breath external air if the "refrigerated" air momentarily becomes too cold. Such respiratory pattern is effected by the wearer's nostrils (which are disposed in a chamber of cooled air overlying part or all of the face) deliberately being used only for inhalation, and by then exhaling thru his mouth directly to the atmosphere. Another advantage of this arrangement is thus to leave the wearer free to speak directly to the exterior without his voice being muffled by any intervening mask or partition; likewise he can eat or drink while wearing the device so that its use can be continued thru the entire day as the user goes about his normal activities whether sitting, walking or riding, indoors or out.

Another object of the invention is to provide two specific forms of such a device which are embodied respectively in an easily mounted and demounted (1) space helmet extending to the wearer's shoulders, or (2) breathing mask, with the connected cooling assembly in either case supported atop the crown of the head like a hat. Alternately the cooling unit can be attached to the torso or arms and merely connected to the respiratory chamber in front of the face by an air conduit. However a particular advantage of the space helmet form is that a continuous cooling environment is thus provided around the entire head and neck. In addition, the head can still be moved freely within the helmet, with the mouth still capable of direct communication with the exterior.

By using either form, body perspiration is reduced to a minimum due to maintenance of lowered body temperature and expiration of moisture from the lungs, so that the need for the body to evaporate water from the skin for cooling is thus diminished. This likewise decreases the loss of salt from the body which would be otherwise excreted with much sweat. Accordingly by use of the present device the wearer is not required to envelop his whole body in a confining insulated garment in an attempt to provide a complete refrigerated environment around him. In contrast to such a confining suit which restricts his normal movement, by use of the present small device the wearer can wear the usual lightweight clothing (or go without when the absence of sun's rays, dust storms and insects permit) and be unrestricted in ordinary body movements such as bending and running. In addition, the present device may incorporate an air filter to remove dust, pollen and other irritants; it can also reduce the amount of water vapor inhaled when working in a humid atmosphere.

Other objects and advantages will become apparent as the description proceeds, having particular reference to the accompanying drawings illustrating two presently preferred embodiments of the invention wherein

2

FIGURE 1 is a side elevational view of the shoulder-length helmet-hood form of my device shown mounted on a wearer;

FIGURE 2 is a front elevational view of the same;

5 FIGURE 3 is a perspective view of the cooling assembly with parts broken away;

FIGURE 4 is a transverse view of the cooling assembly along the line 4-4 of FIGURE 3;

FIGURE 5 is a longitudinal view along the line 5-5;

FIGURE 6 is a side elevational view of a breathing mask form of my device shown mounted on a wearer;

FIGURE 7 is a front elevational view thereof; and

FIGURE 8 is an electrical diagram applicable to either form.

In the form illustrated in FIGURES 1-2, the refrigerant or coolant-containing unit 10 is secured to a dependent, generally annular or elliptical (tubular) ring 12 of deformable material such as sponge or foam rubber or other plastic, which ring can be pressed down conformingly around the crown of a wearer's head 14 so as to support the unit 10 balanced thereabove. From the periphery of the generally horizontal floor 16 of the unit, a flexible, transparent sheath 18 descends loosely, in folds, to a flexible (weighted) shoulder loop 20 which is disposed to cling conformingly to the wearer's skin (when exposed) atop his shoulders and across his chest and back. The sheath 18 may be formed of plastic sheet material, or alternately of closely woven fabric with a transparent window 19 in front of the eyes; and due to its origin along the overhanging edges of the floor 16, the encircling side walls of the sheath are spaced outward from the wearer's head, face and neck so as to define a respiratory enclosure or air chamber 22 completely surrounding the person above the shoulders and from which chamber the wearer may inhale thru his nostrils in a normal manner.

By reason of the fullness of the sheath material and in particular the bottom peripheral fold 21 which normally cascades over the resting shoulder loop 20, the wearer can turn his head freely from side to side without disturbing the position of the loop or rupturing the air seal which is formed between it and the wearer. In other words the top unit 10 turns with the wearer's head; the shoulder loop 20 does not; the connecting sheath 18 twists horizontally the maximum amount at the top and the minimum amount at the bottom. The excess material of the fold 21 also allows the wearer to tip his head forward or back. However it is not necessary that an absolute hermetic seal be maintained between the shoulder loop 20 and the wearer; a little air leakage in either direction is of no great significance; no pressure differential is intended and the main purpose of the chamber 22 is to allow a reservoir of cooled air to be accumulated.

For purpose of direct exhalation from the mouth, there is provided an air tube 24, the outer end of which fixedly traverses the sheath 18 and the inner end of which is adapted to be held between the wearer's closed lips like an empty cigarette holder. The length of the tube 24 may be either flexible or rigid but it should retain its tubular nature so that the user can exhale (and occasionally inhale) thru it at will. The rectangular area of the sheath in front of the wearer's mouth is provided with a horizontally directed mouth slit 26, and the parallel lengths above 27 and below 28 the slit each carry a layer of adhesive on their inner surface adapted to yieldingly stick to the wearer's skin when lightly pressed thereagainst. Thus when the wearer wishes to open his mouth to talk, eat or drink, he first presses the length of a finger against the adhesive strips 27, 28, or slides the end of a finger along this area overlying upper and lower lips. When the strips are thus adhered to the skin area en-

3

circling the mouth, they will separate along the bisecting mouth slit 26 as the wearer opens and closes his mouth, without the air seal of the chamber 22 being broken. He can leave such adhering seal clinging to his skin for an indefinite time after initially eating, drinking or smoking, or he can loosen the strips from his skin (with his fingers) and the slit 26 will automatically position itself closed due to the resilience of the adjacent lengths of material 27, 28. For more positively securing the unit to the head of the wearer, particularly for use when engaging in work or action which requires lowering the head (e.g., shoveling or cultivating a field or road) there may be provided a chin strap 30 similar to that of an ordinary helmet, having its upper ends 31 anchored along the side margin of the floor 16.

A suitable pressure-sensitive adhesive for yielding attachment of the lip strips 27, 28 to the human skin without irritating the latter may be the type used by actors for attaching false mustaches and the like, or such as used on adhesive bandages (see U.S. Patent 2,734,503). It will vary somewhat with the particular material (or inner facing) of the sheath 18.

The housing 32 which forms a shell about the refrigerant unit 10 may be formed of plywood, molded plastic or other relatively rigid, nonelectrical-conducting material. The floor member 16 is bowed centrally upward along its longitudinal axis, which axis is also slanted descendingly rearward a small amount so that moisture condensing from the indrawn air along the forward portion 17 of the floor, may drain to either side of the floor surface 16 and thence move along the side edges toward the air inlet 34. The cooling unit proper is removably mounted within the shell 32 on edge rails 23, 25 (FIG. 4) so as to divide the housing interior into three parallel, generally horizontal, stacks or levels, vertically separated above the fixed floor 16. The shallow, lowermost level or space 35 forms a respiratory air inlet passage immediately above the curved face of the floor 16. External air is drawn in thru a transverse, generally vertical, dust and pollen filter 36 disposed across the entry 34, and passes to the foremost cross area 17 which is vertically apertured by upthrust perforations 15 in order to convey (cool) air thence into the respiratory chamber 22 beneath.

The medial layer in the stack is composed of longitudinal rows of series-connected, alternate P-type and N-type semiconductor elements 38. Successive elements in each row are electrically connected along their respective upper and lower junctions by copper or other metal strips 42, 40. The underfaces of the lower strips 40 form a cold surface for contact cooling the indrawn air as it moves forward along the passage 35. The upper strips 42 connect adjacent hot junctions of successive pairs of Peltier elements 38, each hot strip 42 supporting an upstanding, metallic, heat-conducting fin 44 disposed diagonally to the path of a rearward air flow which passes from front to back in the uppermost chamber level 46. Lateral intersections 48 between semiconductor elements 38 are filled by insulating material such as varnish, elastomeric paste or plastic foam. Electric power for the circuit (which may include a rheostat R and reversing switch S) is provided by a portable battery 54 or other source such as a thermoelectric generator or a solar battery (for use in the sunlight).

The chamber 46 is a longitudinal passage wherein the natural flow of external air in contact with the fins 44 serves thereby to dissipate the heat produced by the current at the hot junctions of the thermoelectric units. The forward end of the housing 32 adjacent the horizontal passage 46 is provided with a scoop-shaped vestibule 50 which is adapted to give a venturi effect to incoming air scooped into the passage by action of the wearer moving forward through the atmosphere (as by walking or running on foot, or by riding in the open). At the rear of the passage 46, an upslanted ledge 52 along the bottom of the ventilating outlet 53 serves to deflect the

4

issuing air current upward and away from the lower, breathing air inlet 34; in addition, the warmed, expanded air from the outlet 53 naturally tends to rise.

Alternately if the direction of electric current or E.M.F. is reversed from that just described, the lower plates 40 will then connect hot junctions of the thermoelectric elements 38 and the indrawn air in the passage 35 will be heated instead of cooled. In such case the upper plates 42 and fins 44 would present cold surfaces to the air flow in passage 46. Such a heated respiratory hood might find use in regions of extreme cold such as the Arctic and Antarctic, and the sheath 18 would be made of heat-insulating fabric.

Especially when using the device in a hot humid climate, the incoming air will be cooled below its dew point so as to condense moisture therefrom along the forward (coldest) area 17. This chilled air, after descending through the openings 15, is then warmed somewhat (by dilution) in the chamber 22 before it is inhaled, so that accordingly it can absorb more water vapor from the lungs (where additionally its saturation temperature is further raised by body heat). Thus the device produces both cool and "dry" air from a hot humid atmosphere, as well as evaporates moisture from the body without excessive sweating and indirectly cools the blood through the medium of the lungs (and more directly by heat exchange with blood in the carotid artery of the neck).

The form of the device illustrated in FIGURES 6-7, employs the same head-supported, refrigeration unit but uses a respiration chamber 22a of much smaller capacity which overlies only the nasal and frontal areas of the face so that the mouth, neck and the remainder of the head are completely exposed. The breathing mask 56 is held in peripheral contact with the face by side straps 58, 59 secured to the respective sides of the deformable headcrown 12a. An air supply tube 60 extends along one or both side straps to connect the chamber 22a inside the mask 56 with the cool end of the refrigeration unit 10.

There are numerous pairs of chemicals for semiconductor elements 38 available. Thus such elements can be composed of mercury telluride, lead telluride or bismuth telluride with an appropriate doping agent to give them the required N-type conductivity and P-type conductivity. Or the junctions may be formed of bismuth telluride and metallic bismuth; metallic germanium and N-type germanium; the corresponding antimony compounds, etc. Another available thermoelectric component is made of "Neelium" (quaternary alloy of tellurium, bismuth, antimony and selenium). For other examples see Patent 2,896,005.

While the space within the housing 32 which is above the air passage 35 is here shown occupied by the structure of the Peltier unit, the latter may be replaced in such a respiratory device by other portable but shorter-lived cooling (or heating) components such as liquid carbon dioxide (Dry Ice), or containers of frozen (or heated) liquids (e.g. water) or solids (e.g. silica gel). The stored or inserted substance (including the Peltier unit) may be generically designated as heat-transferring material whether intended to warm or cool the air and in any event the added material serves to effect a heat exchange with the current of filtered, indrawn air moving along the passage 35 into the breathing chamber 22. With such use, passage or counterflow of external air thru the upper chamber 46 would be eliminated by blocking one or both of the openings 50, 53, by the forward end of a rectangular tray inserted on the rails 23, 25 and carrying the cooling (or heating) component as stored in a refrigerator.

I claim:

1. A portable and wearable, cooling respiratory device of the character described, comprising in combination: walls having a deformable contact edge adapted to be placed against a wearer's skin or clothing to

5

define a closed air chamber overlying at least the wearer's nostrils for inhalation of air from said chamber;

attachment means adapted to removably retain the chamber in functional alignment on the wearer;

a storage unit containing a supply of heat-transferring material connected to said chamber and an air inlet passage connecting said chamber with external air, said unit being disposed to effect heat exchange between indrawn air and the heat transferring material;

unidirectional conduit and flow restriction means positioned in said inlet passage and adapted to inhibit substantial counter movement of air along the passage to the exterior, whereby a wearer may effect intermittent air intake into the chamber by inhaling cooled air therefrom and by exhaling to the exterior through his mouth in an otherwise normal respiratory manner actuated essentially by his own lungs;

and a housing containing said heat-transferring material, which material comprises electrically connected, thermoelectric elements having successive hot junctions and cold junctions, the external air indrawn through said air inlet passage being disposed to give up heat to the cold junctions; and externally projecting, heat dissipating means disposed normally in contact with external air flow upon the wearer moving about, so as thereby to transfer heat from the hot junctions to the external air; said housing being formed with a ventilating passage for external air circulation having disposed therein fins thermally connected to said hot junctions, said fins comprising said heat dissipating means, said housing including forwardly diverging, scoop-shaped inlet walls forming the throat of said ventilating passage whereby external air may move thru the passage and effect heat exchange with the fins in response to forward movement thru the external air of a wearer using the device.

2. The combination comprising a generally concave, wearable facial mask formed with a contact-deformable peripheral edge adapted to frictionally register with a wearer's skin and thus to dispose the concave mask arched outward therefrom to define a sealed chamber adapted to overlie at least the nasal area of the wearer and being formed to permit the wearer to exhale through his mouth to the atmosphere; head attachment means adapted to removably retain the mask in functional alignment on the wearer so as to permit the latter to walk about while wearing it; an air inlet passage traversing said mask, and associated unidirectional conduit means adapted to permit entrance of external air to said chamber in response to nasal inhalation of the wearer; and wearable receptacle means adapted to position a supply of heat-transferring material for heat exchange with indrawn air, whereby a stream of air drawn intermittently thru the passage essentially by nasal inhalation of the wearer may be warmed or cooled by said heat-transferring material before being drawn from the chamber into the wearer's lungs, from whence it may be expelled thru his mouth outside the chamber by action of his own lungs in a continuous cycle.

3. The combination of the preceding claim 2 which includes a housing containing thermoelectric elements for cooling by means of the Peltier effect, said housing enclosing said air inlet passage and being formed with a fore to aft air ventilating passage having a scoop-shaped vestibule for channeling air into said passage in response to forward movement of the wearer, the moving external air in said ventilating passage being thus adapted to effect heat exchange with a thermoelectric element of said receptacle means which is opposite the direction of heat exchange between the inlet passage air and the respective thermoelectric element.

6

4. A cooling respiratory device of the character described, comprising in combination: a shoulder length helmet comprising a crown adapted to be supported atop a wearer's head and having encircling flexible side walls descending loosely from said crown to the wearer's shoulders to form a closed air space surrounding the head and neck of a wearer, said walls being light transmitting at least in an optic area to an extent permitting the wearer to look out, said walls also being formed with a normally closed mouth-slit having adhesive surfaces adjacent upper and lower areas of its inner surface adapted for selective pressure attachment around the mouth of a wearer so that the latter may speak and exhale directly to the exterior thru the slit without thereby admitting air inside the helmet; a flexible loop forming the lower margin of the side walls and adapted to conformingly overlie the tops of the wearer's shoulders and clingingly extend across his back and chest so as, in conjunction with the flexible side walls, to seal said air space and permit free movement of the wearer's head (without directly admitting external air) within the sealed enclosure thus formed by the mounted helmet; receptacle means retaining a heat-transferring material; and walls defining an air inlet passage located immediately adjacent said heat-transferring material so as to be warmed or cooled thereby, said passage being disposed to admit external air into the enclosure formed by the mounted helmet from which enclosure it may be inhaled thru the nostrils of the wearer and thence expelled thru his mouth to the exterior, the lung action of the wearer thus effecting unidirectional intermittent circulation of air thru the enclosure which is formed about the wearer's head and neck by the mounted helmet.

5. The device of the preceding claim 4 which additionally contains an air exhaust tube traversing said helmet and having an outlet external thereto, and an inward projecting, open end adapted to be held in the wearer's mouth to permit his exhaling therethru when the attachment area about the mouth-slit hangs loose from his mouth.

6. The device of the preceding claim 4 wherein said receptacle means contains thermoelectric elements for cooling by means of the Peltier effect.

7. The device of the preceding claim 6 which contains a housing disposed atop said crown and containing both said receptacle means and said air inlet passage, said housing being formed with a fore to aft air ventilating passage having a forward scoop-shaped vestibule for channeling air into said passage in response to forward movement of the wearer, the moving external air in said ventilating passage being thus adapted to effect heat exchange with a thermoelectric element of said receptacle means which is opposite the direction of heat exchange between the inlet passage air and the respective thermoelectric element.

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