

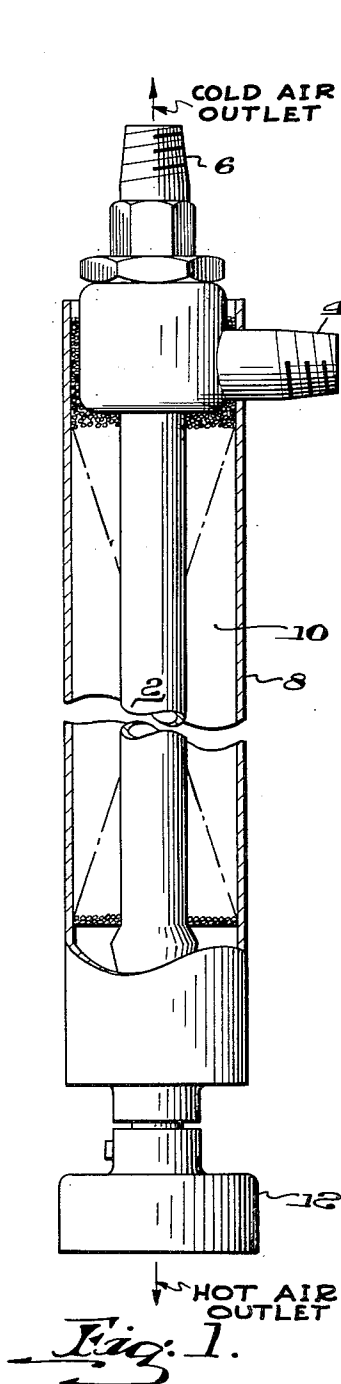
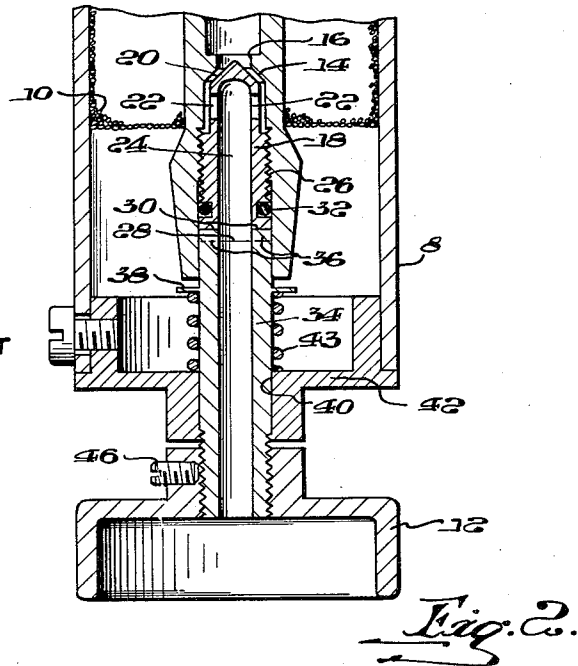
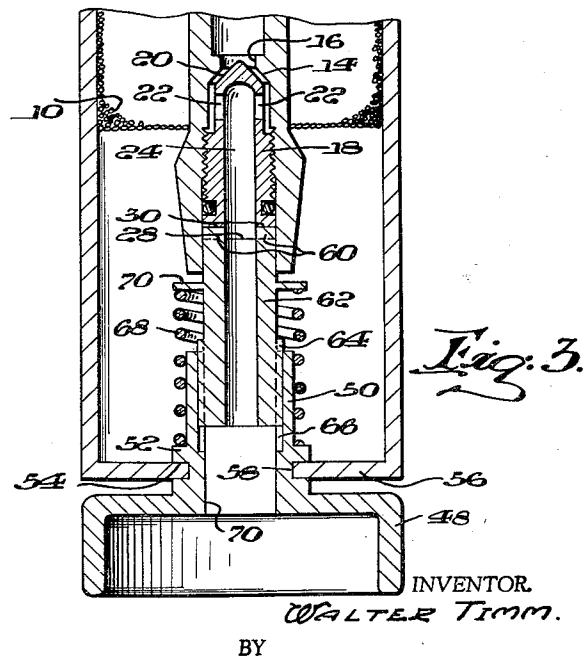
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AIR COOLER FOR PROTECTIVE SUITS

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1

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AIR COOLER FOR PROTECTIVE SUITS
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This invention relates to an air cooler for air fed protective clothing and more particularly to a small, portable vortex tube cooler suitable to be carried or worn by the individual using the protective clothing.

Although there is considerable disagreement regarding the theory of operation of a vortex tube, it is well known that if a gas is supplied to the tube under pressure two fractions of gas may be obtained from the tube having temperatures above and below that of the supplied gas. The supply gas is introduced tangentially near one end of the tube to create a swirling flow or vortex within the tube. The cold fraction is withdrawn from a central outlet at the supply end of the tube and the hot fraction is withdrawn from an outlet at the other end of the tube. By adjusting the outlet flows, the volume and temperature of the hot and cold fractions can be adjusted; generally the cold fraction outlet is a fixed orifice and flow adjustment is accomplished by valving the hot fraction outlet. A small, efficient vortex tube accommodating high gas flow rates is commercially available from Fulton Cryogenics, 440 Beechtree Drive, Cincinnati, Ohio, in which the hot air outlet valve is positioned within the body of the vortex tube so that it can be adjusted only with a screwdriver or similar tool.

It is an object of this invention to provide an air cooling unit for protective clothing utilizing a vortex tube having an internal hot air outlet valve. Another object is to provide a housed vortex tube having an internal hot air outlet valve that is simply and readily adjusted from outside the housing. Other objects will be apparent from the following description, including the accompanying drawings, in which:

FIG. 1 is a plan view of the air cooler of this invention with a portion of the housing cut away;

FIG. 2 is a section view of the hot air discharge portion of the cooler shown in FIG. 1; and

FIG. 3 is an enlarged section view of a modified hot air discharge portion of an air cooler.

Referring to FIG. 1, a vortex tube 2 having an air inlet 4 and a cold air outlet 6 is spaced from housing 8 by foam insulation 10, such as polyurethane rigid, cellular foam. The air inlet is connected to any suitable source of compressed air and the cold air outlet is connected to a manifold distributing air to a protective suit (not shown). The light, small air cooler is conveniently carried as a front or back pack by the wearer of the suit and may be supported by the suit manifold or by carrying straps.

The hot air from the vortex tube is discharged through an opening in adjusting knob 12, as shown in FIG. 2. Referring now to FIG. 2, a seat 14 defining opening 16 is formed in the end portion of the vortex tube remote from the inlet. Valve 18, having a seat 20, ports 22, and a central air passage 24, is moved by threads 26 to open and close opening 16 when it is rotated. The outer edge 28 of the valve has radial grooves 30. The valve is sealed to the body of the vortex tube by O-ring 32. Tubular valve operator 34 has radial ribs 36 which engage radial grooves 30 and an outwardly extending flange 38. The tubular operator extends through opening 40 in end wall 42 of the housing 8. Spring 43 is in compression between flange 38 and end wall 42 urges the end of the operator against the end 28 of the valve. Adjusting knob

2

12 is secured against angular displacement with respect to operator 34 by set screw 46.

In the operation of the apparatus shown in FIG. 2, valve 18 is rotated to open and close opening 16 to adjust the flow of hot air, thereby adjusting the flow and temperature of air discharged to the protective suit through cold air outlet 6. Manual turning of knob 12 turns valve operator 34, which in turn rotates the valve because of the engagement of grooves 30 and ribs 36. The force of spring 43 maintains the valve and operator in engagement throughout the travel of the valve. When the valve is open, hot air is discharged to the outside atmosphere through opening 16, ports 22, passage 24, and tubular operator 34.

In the apparatus of FIG. 3, the adjusting knob is close to the housing and does not travel axially when the valve is opened or closed, thus reducing the chance or snagging the adjusting knob. The vortex tube and valve are the same as in FIG. 1. Adjusting knob 48 has an inwardly extending sleeve 50 and a shoulder 52 having a circumferential groove 54 that engages the portion of the housing end wall 56 defining opening 58. For convenient assembly the housing is formed of two halves, each half having a notch defining half of opening 58; the two housing parts are positioned in groove 54 and then secured together. Radial ribs 60 on one end of tube 62 engage the radial grooves 30; lengthwise ribs 64 on the other end portion of the tube slidingly engage grooves 66 in the sleeve 50. Spring 68, compressed between shoulder 52 and flange 70, maintains the tube in engagement with the valve. Rotation of the adjusting knob will open or close the valve due to the rib and groove keying of the knob to the tube 62 and of the tube to the valve. The hot air discharge flow, when the valve is open, is through valve passage 24, tube 62, and opening 70 in the knob 48.

The insulated housing protects personnel from contact with the main body of the vortex tube because unprotected tubes are frequently hot enough to cause painful burns. Alternatively, the vortex tube may be held by insulating supports in a housing having a plurality of openings to allow outside air to circulate around and cool the vortex tube. The cooling air output to the protective clothing such as a hood or complete suit, is controlled by simple adjustment of the knob outside the housing.

According to the provisions of the patent statutes, I have explained the principle and mode of practicing my invention and have described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

I claim:

1. An air cooler comprising:
 - a vortex tube having an air passage;
 - a tubular valve within said vortex tube having an outlet passage in communication with and in axial alignment with said air passage and being adapted to open and close communication between said passages on rotation thereof on the axis of said outlet passage, said valve means having an outer end, at least one radial groove in said outer end;
 - a housing having side walls and an end wall spaced from said vortex tube, an opening in said end wall in alignment with said outlet passage;
 - a tubular valve operator having an air passage in communication with said outlet passage and the outside of said housing through said opening, one end of said valve operator engaging said valve end and having at least one radial rib adapted to engage said at least one radial groove;

3

means to urge said valve operator against said valve;
and
means outside said housing to rotate said valve operator.

2. An air cooler comprising:

a vortex tube having air passage;
a valve within said vortex tube having an outlet passage in communication with and in axial alignment with said air passage and being adapted to open and close communication between said passages on rotation thereof on the axis of said outlet passage, said valve having an outer end, at least one radial groove in said outer end;

a housing having side walls and an end wall spaced from said vortex tube, an opening in said end wall in alignment with said outlet passage;

a tubular valve operator communicating with said outlet passage, one end of said operator having at least one radial rib adapted to engage said at least one radial groove and the other end extending through said opening, an outwardly extending flange on said operator within said housing and spaced from said vortex tube;

spring means between said flange and said end wall to urge said one operator end against said outer valve end; and

a knob outside said housing and surrounding said operator adapted to rotate said operator.

3. An air cooler comprising:

a vortex tube having air passage;
a valve within said vortex tube having an outlet passage in communication with and in axial alignment with said air passage and being adapted to open and close communication between said passages on rotation thereof on the axis of said outlet passage, said valve having an outer end, at least one radial groove in said outer end;

a housing having side walls and an end wall spaced from said vortex tube, an opening in said end wall in alignment with said outlet passage;

a manually rotatable knob outside said housing having

4

a sleeve extending within said housing and a circumferentially grooved shoulder, said groove being adapted to receive said end wall portion, an axial discharge passage through said knob;

a tube in communication with said outlet passage and said discharge passage, one end of said tube having at least one radial rib adapted to engage said at least one radial groove, the other end of said tube being slideably engaged in said sleeve, means to maintain said tube and said sleeve in angular alignment, an outwardly extending flange on said tube spaced from said vortex tube and said sleeve; and

spring means between said shoulder and said flange to urge said one tube end against said valve end.

4. An air cooler comprising:

a vortex tube having an air passage;

a tubular valve within said vortex tube having an outlet passage in communication with and in axial alignment with said air passage and being adapted to open and close communication between said passages on rotation thereof on the axis of said outlet passage;

a housing having side walls and an end wall spaced from said vortex tube, an opening in said end wall in alignment with said outlet passage;

a tubular valve operator having an air passage in communication with said outlet passage and the outside of said housing through said opening;

means engaging said valve operator and said valve in fixed angular relation; and

means outside said housing to rotate said valve operator.

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