United States Patent

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[33] **Japan**
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Mar. 10, 1969, Japan, No. 44/17536; Mar. 10, 1969, Japan, No. 44/17537; Mar. 10, 1969, Japan, No. 44/17538; May 17, 1969, Japan, No. 44/38212

[54] **INDIVIDUAL COOLING DEVICE**
5 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** **62/5,** 62/259
[51] **Int. Cl.** **F25b 9/02**
[50] **Field of Search** 62/5, 259

[56] **References Cited**

UNITED STATES PATENTS

2,819,590	1/1958	Green	62/5
3,103,104	9/1963	Shackson	62/5
3,129,075	4/1964	Anliot	62/5
3,291,126	12/1966	Messick	62/5

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ABSTRACT: Device for cooling particular individual workers in a hot workshop or other working place by means of the expansion of air, a heat exchanger and the separation of portions at different temperatures.

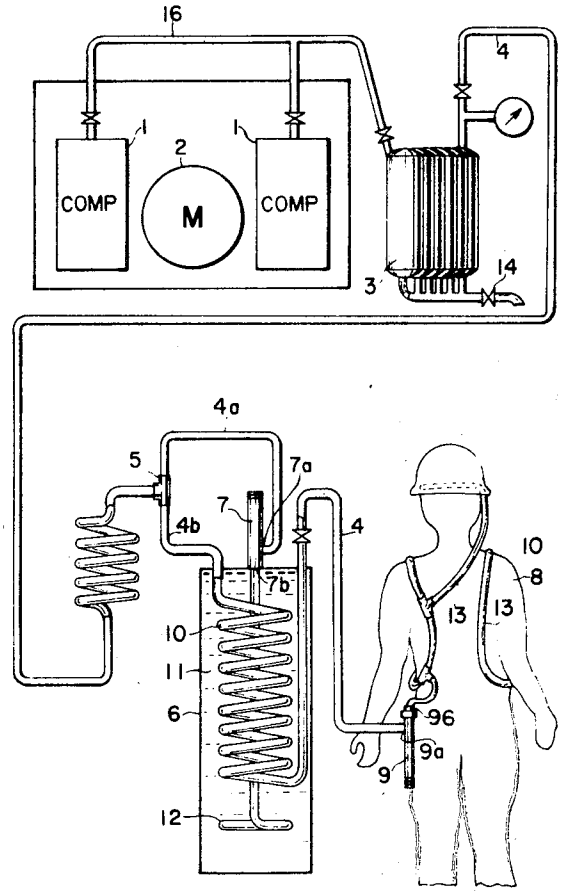
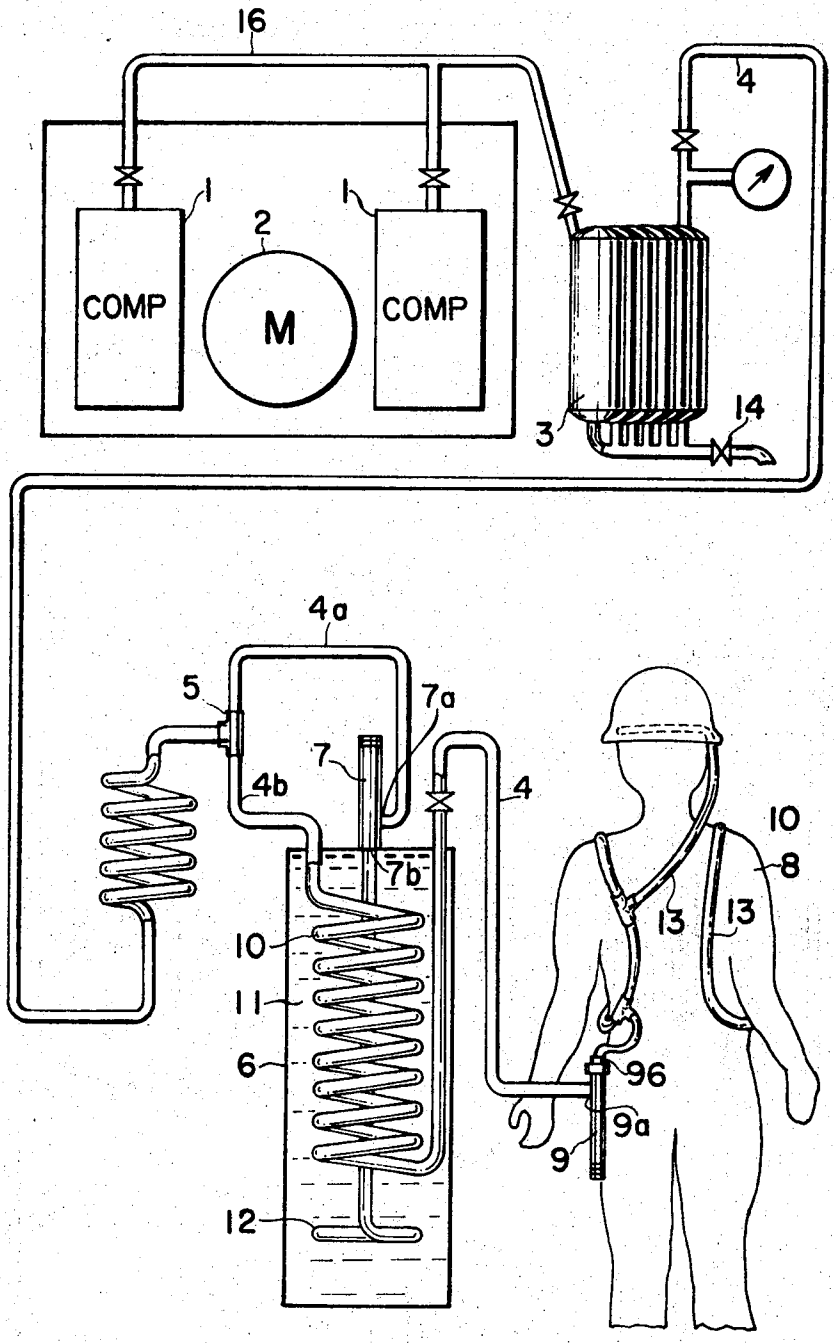


FIG. 1



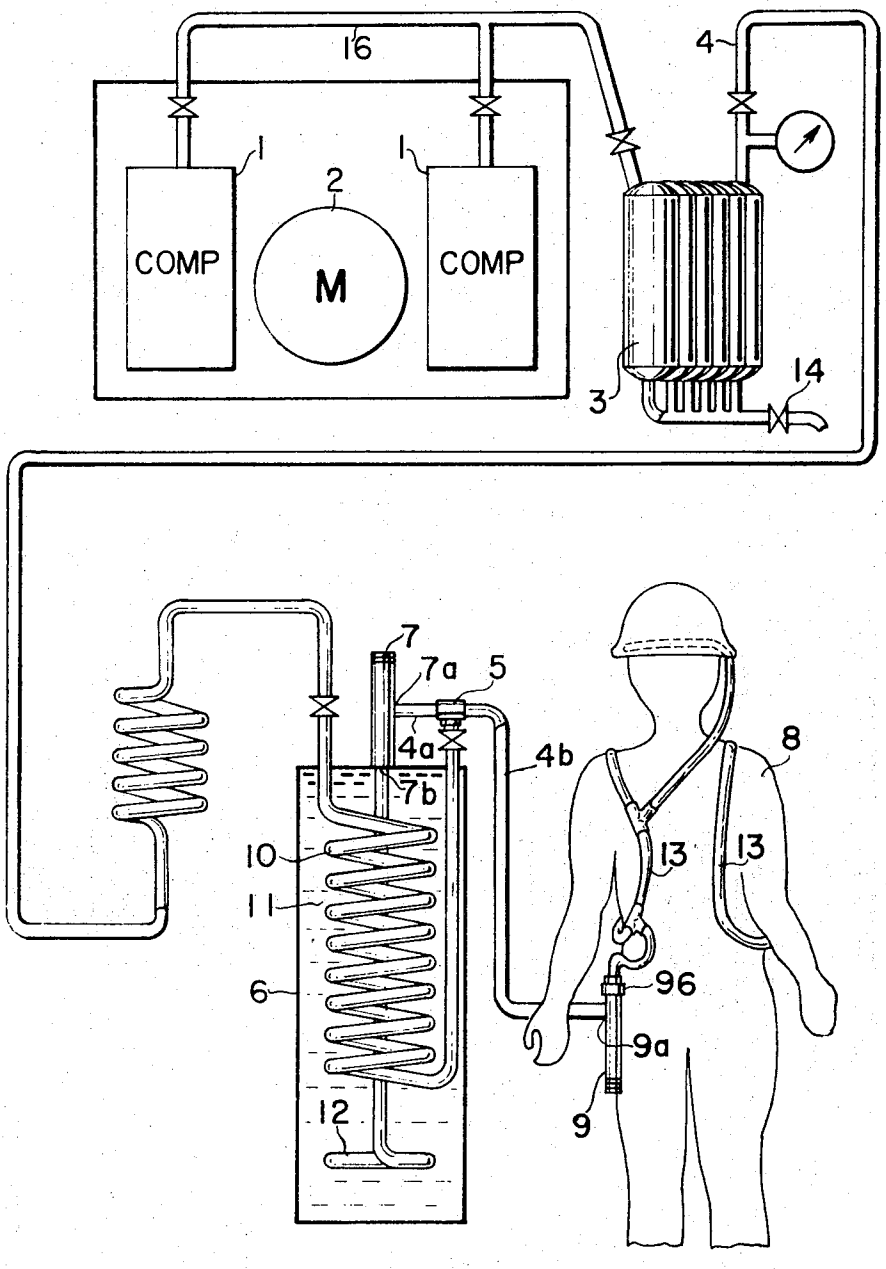
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FIG. 2



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FIG. 3

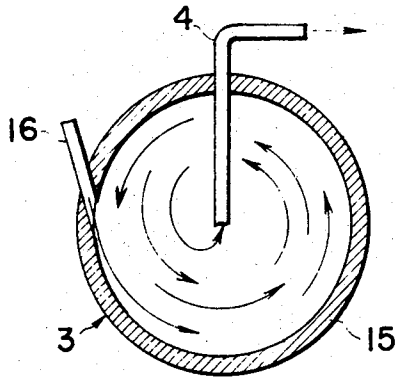


FIG. 4

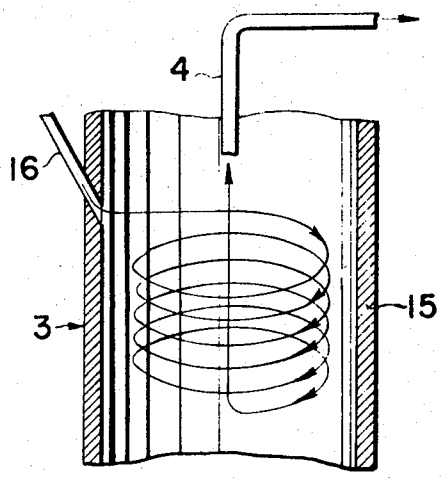


FIG. 5

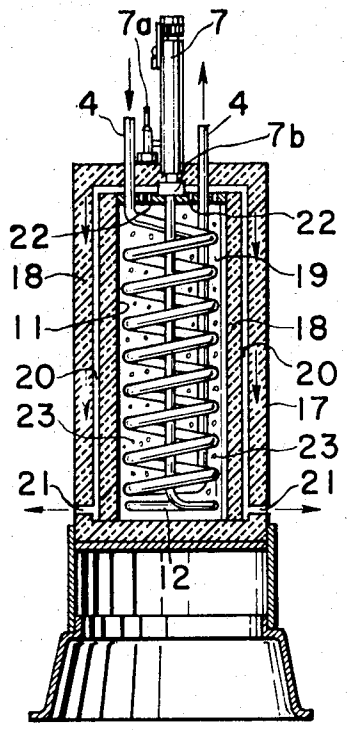
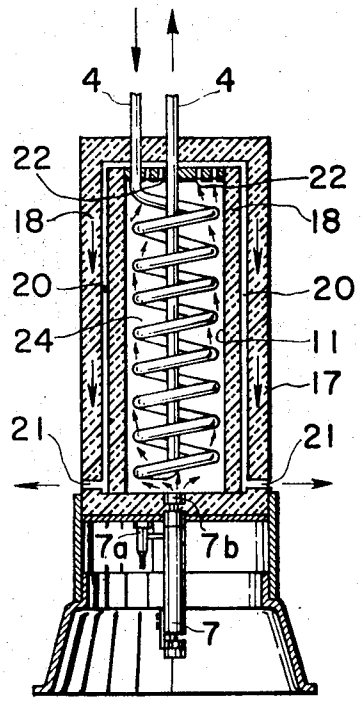


FIG. 6



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INDIVIDUAL COOLING DEVICE

BACKGROUND OF THE INVENTION

The present invention relates to a device for cooling individual workers in a hot workshop, factory or other working places.

THE PRIOR ART

The presently available cooling devices of this type are constructed so that compressed air compressed by a local compressed air generating device such as a compressor is directly fed into a vortex tube (in which compressed air is ejected from a jet nozzle provided in contact with the tubes inside its face to form a vortex in the tube and the fed compressed air is thereby separated into cold air and warm air) which each individual worker carries with him, and the separated cold air is released into the interior of the working clothes. However, in such cooling devices, in case the ambient temperature around the compressor or other compressed air generating means is raised higher than normal temperature due to more heat present in the working place, the temperature of the compressed air discharged from the compressor is also raised correspondingly. For example, the temperature of the air compressed when the ambient temperature around the compressor is 60° C. will amount to as much as about 190° C. Also, in the case of cooling the operator in the operator's room of a moving machine such as a crane, the compressor must be mounted in or on the moving machine, and, as a consequency, the distance between the compressor and the vortex tube carried by the operator is inevitably shortened, allowing the high heat within the compressor to pass directly to the vortex tube. In either case, it is hardly possible to effectively separate cold air having a temperature suited for cooling in the vortex tube from the compressed air at high temperature, with consequent poor heat-separating effect in the vortex tube.

OBJECT OF THE INVENTION

The present invention is designed to eliminate defects inherent in conventional devices and contemplates a construction arranged so that the air compressed in a compressor or other similar means is precooled before it is supplied to a vortex tube carried by each individual worker.

SUMMARY OF THE INVENTION

Generally speaking, the present invention contemplates a device for cooling one or more individual workers comprising a compressed air generating means providing compressed air, a cooling device, or cooling devices for cooling the compressed air, and a vortex tube receiving this cool compressed air, carried by each individual worker so that colder air separated therein is diffused into the working clothes carried by each worker.

Other objects and advantages of the invention will be more readily apparent from the following detailed description when taken together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a circuitry connection diagram of one embodiment of the present invention.

FIG. 2 is a circuitry connection diagram of another embodiment of the present invention.

FIG. 3 is a cross-sectional view of an air tank used in the above-mentioned two embodiments.

FIG. 4 is a partial longitudinal sectional view of an air tank used in the above-mentioned two embodiments.

FIG. 5 is a sectional view of a heat exchanger used as a cooling tank in the aforementioned two embodiments.

FIG. 6 is also a sectional view of a heat exchanger used as a cooling tank in the aforementioned two embodiments.

DETAILED DESCRIPTION

Referring first to FIG. 1, in which one embodiment of the present invention is diagrammatically illustrated, 1 denotes a pair of compressors, 2 a motor for driving said compressors, 3 an air tank for receiving and preserving compressed air introduced from the compressors 1, and 4 a compressed air supply pipe connected to the compressor 1 through the air tank 3, and pipe 16. Said pipe 4 is bifurcated at 5 with its one branch line 4*a* being connected to a compressed air feed port 7*a* of a vortex tube 7 mounted in a cooling tank 6 and the other branch line 4*b* being connected to a compressed air feed port 9*a* of a vortex tube 9 carried by the individual worker 8 working in a hot workshop. It will be noted that the middle portion 10 of the branch line 4*b* is coiled spirally so as to elongate as much as possible the path of that compressed air which passes through the interior of the cooling tank 6 thereby to maximize the cooling effect. Twelve denotes a cooling pipe having its one end connected to a cool air outlet port 7*b* of the vortex tube 7 and its other end inserted into the interior 11 of the cooling tank 6 and being arranged so as to diffuse the cool air separated by the vortex tube 7 into the interior 11 of the cooling tank 6. 13 is a distributor tube for releasing the cool air, separated in the vortex tube 9, into the interior of the working clothes that the worker 8 wears, and 14 a drain cock provided on the air tank 3, primarily for water.

Another embodiment involves a partial change in the connecting circuit of the compressed air supply pipe 4 of the first embodiment. Both embodiments have two compressors provided with valves in the circuitry for the compressed air so one may be shut down without interrupting the supply of compressed air to the air tank 3. The motor may also be shut down for a time by closing a valve in that portion 16 of the air supply pipe that lets air into air tank 3.

In the second embodiment, as shown in FIG. 2, the middle portion 10 of the compressed air supply pipe 4 connected to the air tank 3 is coiled spirally and inserted into the inside 11 of the cooling tank 6 in that state. This pipe 4 is bifurcated at the point 5 where the pipe has just passed the cooling tank 6, with one branch line 4*a* being connected to the compressed air feeding port 7*a* of a vortex tube 7 mounted on the cooling tank 6 and cooling it and the other branch line 4*b* being connected to the compressed air feeding port 9*a* of a vortex tube 9 carried by the worker. The construction of both embodiments is otherwise the same.

In the second embodiment, as compared with the first embodiment, the compressed air from the air tank 3 is precooled in the cooling tank 6 and then fed into the vortex tube 7, so that the cold air separated and released from the cold air outlet 7*b* has a lower temperature than that of the cold air obtained in the first embodiment where the compressed air in the air tank 3 is directly fed into the vortex tube 7. Thus, the cooling efficiency of the cooling tank 6 is enhanced in the second embodiment, under like conditions otherwise. The matter is further clarified in the more detailed drawings.

Referring now to FIGS. 3 and 4, there are shown the detailed operational illustrations of the air tank 3 used in each of the preceding embodiments. The tank body 15 is circular in section, and the compressed air supply pipe 16 connecting the compressor 1 with the air tank 3 is joined with the tank body so as to eject the compressed air into the tank body 15 substantially tangentially to the circular section of the tank body 15. As will also be noted, the compressed air supply pipe 4 used in each of said embodiments is connected to the center of the tank body 15. The tank body 15 is not limited to only one, but several may be used in combination, especially if the said tank bodies are in series connection. In such a case, piping arrangements are made so that the compressed air is ejected from the tangential direction against the circular section of each tank body 15 so that said air is released from the central part of each tank body 15. Radiation is effected at each stage, made more effective, if desired, by fins on the tanks, and the compressed air released from the central part of the tank body 15 at the tail end is forwarded to the cooling tank 6.

With the air tank being constructed as described above, the compressed air, compressed and highly heated by the compressor 1, produces a vortex while being uniformly brought into contact with the cylindrical wall of the tank body 15, so that said compressed air radiates its heat through the wall face and rises along the vacuum portion formed in the center of the tank body, causing some reduction of the temperature of the compressed air. When using a plurality of tank bodies 15 is series combination, the compressed air temperature is successively reduced in temperature each time radiation is effected by each tank body 15, so that the highly heated compressed air produced by the compressor 1 is considerably reduced in its temperature by the air tank 3 and then delivered to the compressed air supply pipe.

FIGS. 5 and 6 illustrate the detailed construction of the heat exchangers used as the cooling tank 6 in the respective embodiments shown above. In FIG. 5, 17 denotes generally a sealed tank of which the wall is composed in part of a heat-insulating material 18, such as asbestos. The inside 11 of the tank is filled with cooling liquid 19 such as water, and the vortex tube 7 mentioned in each said embodiment is mounted on top of the sealed tank 17. A cooling pipe 12 connected to the cold-air inlet port 7*b* is inserted into the cooling liquid 19 in the tank, said cooling pipe having its end portion annularly bent and opened near the bottom of the tank. It will also be noted that the compressed air supply pipe 4 used in each embodiment is inserted into the sealed tank 17 in a spirally bent form so that it extends for the longest possible distance within the cooling liquid 19. 20 denotes air eduction passages extending from top of the sealed tank 17 downwardly along both sides of the tank wall and opened outwardly at the bottom of the tank 17, and 22 indicates vent holes formed at the top of the sealed tank 17, through which the cold air released into the tank interior 11 is discharged to the eduction passages 20.

In the above-described construction, the compressed air from the compressor 1 passes through the air tank 3, and thereafter one portion thereof is supplied to the vortex tube 7 where it is deprived of some of its heat. This cold air which passes downwards through the cooling pipe 12 and is released from its end near the bottom of the sealed tank 17 into cooling liquid 19 in the form of bubbles 23 which in turn rise up through cooling liquid 19 while cooling it and are discharged from the vent holes 22 into the eduction passages 20 through which the air moves downwards while cooling the tank wall and is finally discharged outside of the tank from the discharge ports 21 formed at the bottom of the tank. The remaining compressed air is cooled while it passes through the compressed air supply pipe 4 inserted in a spirally bent form in the sealed tank 17 and then is supplied to the vortex tube 9 carried by the worker 8, where the air is again deprived of some of its heat to be rendered still cooler air, which is then diffused from the distributor pipes 13 into the interior of the working clothes worn by the worker 8.

Since the heat exchanger is arranged so that the cold air released into the sealed tank is discharged through the eduction passages provided along the tank wall, said said air can perform both the cooling actions of cooling the cooling liquid, as well as the tank wall, thus appreciably enhancing the heat-insulating effect of the sealed tank to achieve sufficient cooling of the tank interior.

The heat exchanger shown in FIG. 6 has the same construction as the one shown in FIG. 5, except that a space 24 is formed in the interior of the sealed tank 17. The vortex tube 7 is arranged so that its cold-air outlet 7*b* communicates with the tank interior 11 at the bottom of the sealed tank 17 so as to facilitate diffusion of cold air into the entire space of the tank interior 11.

This heat exchanger, as described above is constructed in such a manner that the interior of the sealed tank forms the space 24, so that cold air deprived of some of its heat in the vortex tube 7 can be readily diffused into the entire space in the tank, thus promoting cooling efficiency in the tank. Further, double cold-air layers are formed each in the tank interior and in the tank wall as in the case of the heat exchanger shown in FIG. 5 whereby the heat-insulating effect of the sealed tank is appreciably enhanced, permitting sufficient cooling within the tank.

If the air tank and the cooling tank having the above-described construction are connected between the compressor in the present device and the vortex tube carried by the worker, the compressed air obtained from the compressor is effectively cooled at each stage and fed into the vortex tube carried by the worker, so that even if the ambient temperature around the compressor is above the normal temperature, or if heat above that of the ambient, produced by the compressor should be transferred to the vortex tube carried by the worker, it is possible to obtain suitably cooled air always and supply it into the interior of the clothes worn by the worker. An additional feature of the present invention is that all the parts constituting the assembled structure of the present apparatus can be operated by compressed air obtained from the compressor, so that operation of the apparatus is made at high performance.

What is claimed is:

1. In a device cooling one or more individuals individually having compressed air generating means (1); a cooling device (6) connected to said compressed air generating means for cooling said air; and, a vortex tube (9) carried by each individual (8) supplied with said cooled air so that cold air separated therein is diffused into the interior of the working clothes worn by said individual or individuals, the improvement therein comprising a bifurcated compressed air supply pipe connected to said compressed air generator means (1) with one of the branched pipes (4*a*) connected to a compressed air feeding port (7*a*) of a vortex tube (7) mounted to a cooling tank (6) and the other branched pipe (4*b*) being connected to a compressed air feeding port of a vortex tube (9) carried by said individual or individuals (8); a cooling pipe (12) connected to a cold-air outlet port (7*b*) of said vortex tube (7) extended into said cooling tank (6) and opened therein; and distributor tubes (13) adapted to diffuse cold air into the inside of the working clothes worn by each worker (8) connected to a cold-air outlet (9*b*) of said vortex tube.

2. In a device cooling one or more individuals individually having compressed air generating means (1); a cooling device (6) connected to said compressed air generating means for cooling said air; and, a vortex tube (9) carried by each individual (8) supplied with said cooled air so that cold air separated therein is diffused into the interior of the working clothes worn by said individual or individuals, the improvement therein comprising a compressed air supply pipe (4) connected to said compressed air generator means (1) inserted into the inside of a cooling tank (6), said supply pipe being bifurcated at a point where it just passed the tank inside, with one branch(4*a*) thereof being connected to a compressed air feeding port (7*a*) of a vortex tube (7) mounted to said cooling tank (6) and the other branch (4*b*) being connected to a compressed air feeding port (9*a*) of a vortex tube (9) carried by said individual or individuals (8); a cooling pipe (12) connected to a cold-air outlet port (7*b*) of said vortex tube (7) inserted into the inside of said cooling tank (6) and opened therein; and cold-air distributor tubes (13) adapted to diffuse cold air into the interior of the working clothes worn by said individual or individuals (8) connected to a cold-air outlet (9*b*) of said vortex tube (9).

3. In a device cooling one or more individuals individually having compressed air generating means (1); a cooling device (6) connected to said compressed air generating means for cooling said air; and, a vortex tube (9) carried by each individual (8) supplied with said cooled air so that cold air separated therein is diffused into the interior of the working clothes worn by said individual or individuals, the improvement therein comprising one or more air tank bodies (15) connected between a compressed air generator means (1) and a cooling tank (6) so formed as to have a circular sectional shape, and piping connection arranged such that compressed air is ejected from the tangential direction against the circular

section of each tank body (15) so that compressed air is taken out from the central portion of each tank body (15), with compressed air released from the central portion of the rearmost tank body (15) being forwarded to said cooling tank (6).

4. In a device cooling one or more individuals individually having compressed air generating means (1); a cooling device (6) connected to said compressed air generating means for cooling said air; and, a vortex tube (9) carried by each individual (8) supplied with said cooled air so that cold air separated therein is diffused, into the interior of the working clothes worn by said individual or individuals, the improvement therein comprising having said vortex tube (7) mounted in a sealed tank (17) filled with cooling liquid (19), with a cooling pipe (12) connected to a cold-air outlet of said vortex tube inserted into said tank and opened therein, said heat exchanger also having air eduction passages through which cold air released into the inside of the tank is passed along the heat-insulating tank wall and discharged outside of the tank, and, piping arranged such that compressed air cooled through said heat exchanger is supplied into said vortex tube carried by said individual or individuals (8).

5. In a device cooling one or more individuals individually having compressed air generating means (1); a cooling device (6) connected to said compressed air generating means for cooling said air; and, a vortex tube (9) carried by each individual (8) supplied with said cooled air so that cold air separated therein is diffused into the interior of the working clothes worn by said individual or individuals, the improvement therein comprising a heat exchanger arranged such that a vortex tube (7) into which compressed air is supplied from a cold-air generator means (1) in which cold air is separated, is mounted in a sealed tank (17) having a space therein with a cooling pipe (12) connected to a cold-air outlet of said vortex tube being inserted into said tank and opened therein, said heat exchanger also having air eduction passages through which cold air released into the inside of the tank is passed along a heat-insulating tank wall and discharged outside of the tank, and piping arranged such that compressed air cooled through said heat exchanger is supplied into a vortex tube carried by each individual or individuals (8).

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