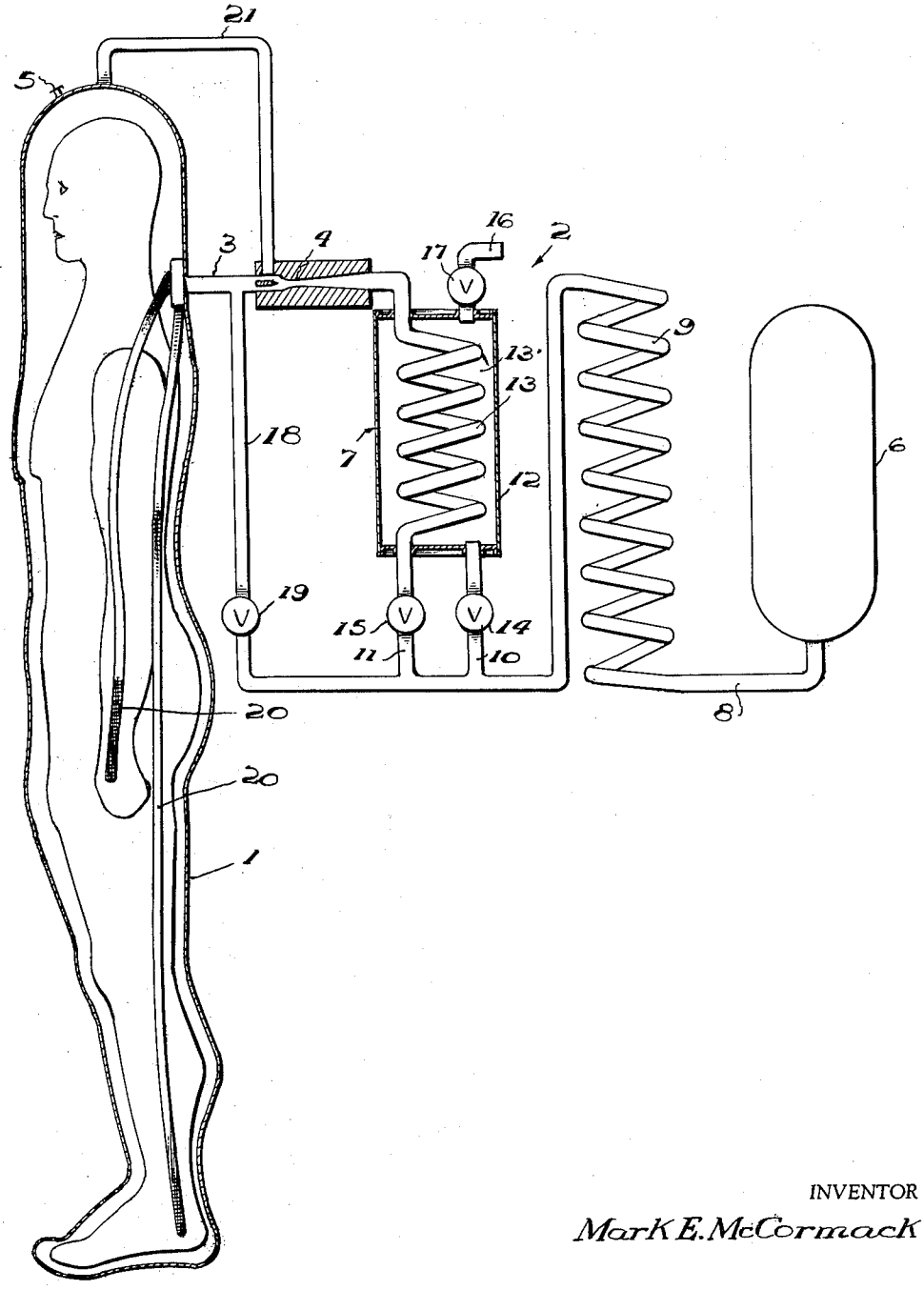
Dec. 15, 1964 M. E. McCORMACK 3,161,192

AIR-CONDITIONED PROTECTIVE GARMENT AND AIR-SUPPLY-AND-CONDITIONING APPARATUS FOR THE SAME

Filed Dec. 6, 1960




INVENTOR

*Mark E. McCormack*

BY *W. J. Eccleston*

ATTORNEY

United States Patent Office 3,161,192
Patented Dec. 15, 1964



3,161,192

# AIR-CONDITIONED PROTECTIVE GARMENT AND AIR-SUPPLY-AND-CONDITIONING APPARATUS FOR THE SAME

Mark E. McCormack, Southboro, Mass., assignor to the United States of America as represented by the Secretary of the Army

Filed Dec. 6, 1960, Ser. No. 74,207
8 Claims. (Cl. 126—204)
(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein, if patented, may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

The present invention relates to protective garments and more particularly to a protective garment that is air conditioned and to a self-contained air-supply and air-conditioning apparatus for supplying conditioned air to such a garment and for other purposes.

An object of the invention is to provide a new and improved protective garment which is air impervious and completely encapsulates the wearer in combination with improved apparatus to supply conditioned air to the interior of the garment for breathing by the wearer of the garment and for warming the body of the wearer.

A further object of the invention resides in associating with an air-impervious garment a tank of liquid air or oxygen, and combining therewith a heat exchanger operated by pyrophoric material to condition the liquid air or oxygen for breathing and body warming purposes after the temperature of the air has been raised sufficiently by passage through an ambient air-heated evaporator to vaporize the same, but not sufficiently for ultimate use.

A still further object of the invention resides in providing a garment as defined in the foregoing object, including distribution ducts for suitably directing the conditioned air to various parts of the wearer's body for warming the same and for supplying breathing air and a venturi tube whereby the confined air is continuously circulated and recirculated through the garment and duct system.

Another object of the invention is to provide a new and improved self-contained air-supply and air-conditioning apparatus for supplying conditioned air to the interior of a closed space.

Other objects and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawing which is a diagrammatic side elevational view of the improved garment and air-supply-and-conditioning apparatus of the present invention.

Referring to the drawing in greater detail and by reference numeral, the present invention comprises a garment indicated generally by the numeral 1 which is designed to envelop entirely a wearer and which is formed of air-impervious material. Associated with this garment is an air-supply-and-conditioning unit which is indicated generally by the numeral 2. The interior of the garment 1 is connected with the air-supply-and-conditioning unit 2 by means of a pipe 3. A venturi tube 4 discharging into the tube 3 creates a circulation of air within the garment, and the garment is provided with a check or dump valve 5 through which air may be permitted to escape from time to time when the pressure within the garment increases above a predetermined amount.

The air-supply-and-conditioning unit 2 includes a tank 6 for containing a supply of liquid air or oxygen and a heat exchanger indicated generally by the numeral 7 connected to the lower end of the tank 6 by a pipe 8 provided with an evaporator coil 9 and terminating in a pair of branches 10 and 11. The heat exchanger 7 includes a casing or container 12. Branch 10 of pipe 8 opens into the container 12 of the heat exchanger, and the other branch 11 communicates with the lower end of a heat exchanger comprising a pipe coil 13 positioned within the container 12, so as to be surrounded by and in close contact with a supply of pyrophoric material 13' filling the container. The evaporator coil 9 is exposed to the ambient air and provides for the initial vaporization of the liquid air leaving the tank 6. A pair of valves 14 and 15 serve to proportion the amounts of air entering the container 12 and the heat exchanger coil 13. The valve 14 is to be adjusted, of course, to admit only that amount of fluid necessary to oxidize the pyrophoric material 13', and hence raise the temperature of the same sufficiently to complete the vaporization of the air or oxygen from tank 6, and to heat it to the desired degree as it passes through the heat exchanger coil 13.

The upper end of the container 12 is provided with an exhaust pipe or vent 16 controlled by a valve 17, and the upper end of coil 13 communicates with the inlet to the venturi 4 and thence through the pipe connection 3 with the interior of the garment 1. The outlet end of the pipe connection 3 is connected with a plurality of ducts 20 for distributing conditioned air to various parts of the garment, so as to warm different parts of the wearer's body. If desired, a by-pass line 18 controlled by a valve 19 may be employed for tempering the treated air passing through the pipe connection 3. In other words, if conditions are such that air would be heated to a temperature too high for comfort in passing through the heating coil 13, a portion of the unheated air leaving evaporator coil 9 may be by-passed around the heating coil 13 directly to the inlet pipe 3 for the garment 1 by adjusting the by-pass valve 19.

In order to provide for a suitable circulation of the air within the encapsulating garment 1, a return air duct 21 communicates with the upper end of the garment and with the suction inlet of the venturi tube 4.

Although the operation of the invention has been described in part in connection with the description of the various structural details, it is deemed desirable to more fully describe the operation of the various parts in sequence. The tank 6 is first charged with liquid air or oxygen and the container 12 of the heat exchanger is charged with any preferred pyrophoric material 13', such as pyrophoric iron or iron sulphide, for example. The garment 1 being donned by the wearer, the various valves 14, 15, 17 and 19, if need be, are adjusted to provide air at the desired temperature. This is brought about by the fact that liquid air from the tank 6 is partly or completely vaporized in the evaporator coil 9 which, as indicated in the drawing, is exposed to the temperature of the ambient air. By virtue of this fact, the temperature of the air leaving the evaporator 9 is still below that desired, and the purpose of the heat exchanger 7 is to raise it to the desired temperature. The air leaving the evaporator coil 9 is divided into two fractions by the proportioning valves 14 and 15 in the branches 10 and 11 connected to the interior of the container 12 and to the pipe coil 13, respectively. The air passing over and through the bed of pyrophoric material causes the latter to oxidize thereby producing heat to heat the walls of the pipe coil 13 and the air passing therethrough. The air then passes through the venturi 4, pipe connection 3, and ducts 20 into the space enclosed by the garment 1. Passage of air through the venturi tube 4 generates suction in the well-known manner, thereby drawing air from garment 1 through the return pipe 21, and thus inducing a circulation and recirculation of air in the garment. Excess pressure in the garment is discharged through the

pressure relief or dump valve 5, and exhaust gases in container 12 are discharged to the atmosphere through valve 17 and exhaust vent 16.

Any suitable harness or suspending means may be used to secure the garment 1 on a wearer. The air-supply-and-conditioning apparatus 2 is intended to be carried on the back of a wearer by any suitable harness or suspending means, and when one unit becomes exhausted by reason of the consumption of the liquid air or oxygen, the entire unit may be exchanged for a fully charged unit. In some cases, it even may be desirable to exchange both the garment 1 and the air-supply-and-conditioning apparatus 2 when the oxygen supply of the latter apparatus becomes exhausted.

From the foregoing description taken in connection with the accompanying drawing, it will be seen that I have devised a rather simple and inexpensive air-conditioned protective garment which is relatively light in weight, has no moving parts other than the manually-operated valves, incorporates therein a novel type of air-supply-and-conditioning apparatus, and provides for automatic and continuous recirculation of properly warmed air in the space enclosed by the garment.

In accordance with the patent statutes, I have described what I now consider to be the preferred form of the invention, but inasmuch as various minor changes may be made in structural details without departing from the spirit of the invention, it is intended that all such changes be included within the scope of the appended claims.

I claim:

1. In combination, an air-impervious garment, and an air-supply-and-conditioning unit associated therewith, said unit comprising a container, pyrophoric material in the container, a pipe coil in the container in contact with the pyrophoric material, a liquid air-supply tank, a pipe leading from the tank and provided with two branches, one leading to the lower end of the pipe coil and the other emptying into the bottom of the container of pyrophoric material, and a pipe connection between the opposite end of the coil and the interior of said garment.

2. In combination, an air-impervious garment, and an air-supply-and-conditioning unit associated therewith, said unit comprising a container, pyrophoric material in the container, a pipe coil in the container in contact with the pyrophoric material, a liquid air-supply tank, a pipe leading from the tank and provided with two branches, one leading to the lower end of the pipe coil and the other emptying into the bottom of the container of pyrophoric material, a pipe connection between the opposite end of the coil and the interior of said garment, and an exhaust vent in the upper end of the container.

3. In combination, an air-impervious garment, and an air-supply-and-conditioning unit associated therewith, said unit comprising a container, pyrophoric material in the container, a pipe coil in the container in contact with the pyrophoric material, a liquid air-supply tank, a pipe leading from the tank and provided with two branches, one leading to the lower end of the pipe coil and the other emptying into the bottom of the container of pyrophoric material, a pipe connection between the opposite end of the coil and the interior of said garment, an exhaust vent in the upper end of the container, and a dump valve in the upper portion of said garment.

4. In combination, an air-impervious garment, and an air-supply-and-conditioning unit associated therewith, said unit comprising a container, pyrophoric material in the container, a pipe coil in the container in contact with the pyrophoric material, a liquid air-supply tank, a pipe leading from the tank and provided with two branches, one leading to the lower end of the pipe coil and the other



emptying into the bottom of the container of pyrophoric material, a pipe connection between the opposite end of the coil and the interior of said garment, and distribution ducts leading from said connection for carrying the conditioned air to various parts of the space within said garment.

5. In combination, an air-impervious garment, and an air-supply-and-conditioning unit associated therewith, said unit comprising a tank of liquid air, a heat exchanger comprising a container, pyrophoric material in the container, a pipe coil in the container in contact with the pyrophoric material, a pipe leading from the bottom of the tank and provided with two branches one leading to the lower end of the pipe coil and the other emptying into the bottom of the container, a pipe connection between the opposite end of the coil and the interior of said garment, a venturi tube in said pipe connection, and a second pipe leading from the interior of said garment to the venturi tube.

6. In combination, an air-impervious garment, and an air-supply-and-conditioning unit associated therewith, said unit comprising a tank of liquid air, a heat exchanger comprising a container, pyrophoric material in the container, a pipe coil in the container in contact with the pyrophoric material, a pipe leading from the bottom of the tank and provided with two branches one leading to the lower end of the pipe coil and the other emptying into the bottom of the container, a pipe connection between the opposite end of the coil and the interior of said garment, a venturi tube in said pipe connection, a second pipe leading from the interior of said garment to the venturi tube, and a dump valve in said garment.

7. An air-supply-and-conditioning apparatus comprising a tank of liquid air, a heat exchanger including a container for pyrophoric material, a pipe coil in the container in heat exchange relation with said pyrophoric material, and a pipe means carrying a portion of the liquid air to the pipe coil and another portion to the pyrophoric material.

8. An air-supply-and-conditioning apparatus comprising a tank of liquid air, a heat exchanger including a container for pyrophoric material and a pipe coil in said container in heat exchange relation with said pyrophoric material, valve controlled piping means carrying liquid or partially vaporized air from said tank to said heat exchanger and apportioning the flow thereof to said pipe coil and the pyrophoric material in said container, and a valve controlled by-pass means between the inlet and outlet ends of said pipe coil.


**References Cited by the Examiner**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 311,984 | 2/85 | Heinzerling | 44—3 |
| 2,670,728 | 3/54 | Smith | 126—208 |
| 2,943,459 | 7/60 | Rind | 62—514 X |
| 2,980,103 | 4/61 | Scribner et al. | 126—263 |
| 2,983,116 | 5/61 | Makowski et al. | 62—514 X |
| 2,984,994 | 5/61 | Hankins | 62—259 X |
| 2,989,049 | 6/61 | Crouzet | 126—208 |
| 2,990,695 | 7/61 | Leffingwell | 128—144 |
| 3,064,448 | 11/62 | Whittington | 128—155 X |
| 3,117,426 | 1/64 | Fischer et al. | 62—514 |

FOREIGN PATENTS

| | | |
|---|---|---|
| 498,552 | 10/19 | France. |



JAMES W. WESTHAVER, *Primary Examiner.*

ROBERT E. MORGAN, PERCY L, PATRICK, *Examiners.*