The invention relates to an inhalator and more particularly to an inhalator for treatment of the respiratory ducts of a patient with heated and medicated air.

In a portable inhalator of the type described, it is desirable to make the heating device, which commonly consists of an electric resistance heater as small and as efficient as possible. It is furthermore desirable that such a device be rugged and capable of withstanding rough handling. It is further necessary that it be safe and that the user be protected from accidental contact with the heating element or with any portion of the inhalator heated to a high temperature.

It is therefore a primary object of the invention to provide an inhalator the accessible portions of which remain cool during operation of the inhalator.

Another object is the provision of such an inhalator which utilizes to its fullest possible extent the thermal energy supplied by the heater.

It is a further object of the invention to use the inhaled air or other gas as an insulating means for keeping the outside of the inhalator at a safe, low temperature.

An additional object of the invention is the provision of such an inhalator which is readily disassembled for cleaning, sterilization, or repair.

Yet another object is the provision of an inhalator in which exhaled gas is substantially completely vented to the atmosphere and replaced by fresh gas substantially without mixing.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and as to its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 shows a side elevation, partly in axial section, of a preferred embodiment of the inhalator of the invention;

FIG. 2 is a sectional view of a detail of the apparatus of FIG. 1 taken along line II—II of FIG. 1;

FIG. 3 illustrates a portion of the device of FIG. 2;

FIG. 4 is a side elevation, largely in axial section, of a modified embodiment of the invention, with a portion broken away; and

FIG. 5 is a section through the device of FIG. 4 in a plane along line 5—5.

Referring now to the drawings and particularly to FIG. 1, there is shown a face mask 10 of resilient material shaped to fit a human face in a substantially gas-tight manner. The face mask 10 is releasably fastened to a connecting member 11 which connects the face mask to a handle portion 14 of an inhalator containing a heating element 12 arranged in a heating chamber 19. The heating chamber is enclosed by a cylindrical container 17 communicatively one end by an axial opening with the connecting member 11. Heating chamber 19 communicates by radial openings 16 in the cylindrical wall of container 17 adjacent the end thereof remote from the aforementioned axial opening with an annular insulating space 13 which extends substantially over the entire length of container 17 and is bounded radially outward therefrom by a wall 15 of cylindrical shape which constitutes the outer wall of the handle portion of the inhalator.

Insulating space 13 communicates with the atmosphere by means of radial openings 16 in outer wall 15 which are longitudinally spaced from openings 18 in container 17 and serve as air inlets, the air flowing downward through insulating space 13, as shown in FIG. 1, passing through openings 18 in to the heating chamber 19 and flowing upward therein past the heating element 12 countercurrent to the flow of gas in space 13 to leave the heating chamber through the axial opening in the top thereof, thereby heating container 17 from the inside. Air flowing downward in insulating space 13 prevents any heat from being transmitted from the outer surface of container 17 to the outer wall 15 of handle portion 14.

A bottom member 46 of heat-insulating material seals insulating space 13 and heating chamber 19 from the atmosphere. Openings 19 in the wall of container 17 are spaced a small distance from bottom member 46 so that a radially inward flow of relatively cool air is maintained above the surface of insulating bottom member 46 and the outer surface of bottom member 46 remains cool during operation of the inhalator. The temperature differential between the inner and outer surfaces of bottom member 46 is small, heat losses through the bottom are negligible. Any heat transmitted from the heating chamber 19 through the cylindrical wall of container 17 is practically in its entirety utilized to preheat the air entering the inhalator through inlet opening 16 and flowing through insulating space 13.

A thermostatic switch 23 is arranged in heating chamber 19 to control the flow of current from line cord 22 to heater element 12 so as to maintain the temperature of the air leaving the heating chamber substantially constant.

Switch 23 which may for example be of the bimetallic temperature-sensitive element of adjustable tension may be set for a variety of actuating temperatures by a setting knob 22 connected to the switch for adjustment of the tension of the bimetallic temperature-sensitive element of the switch.

Heated air leaving the heating chamber 19 passes through a check valve 24 spring-biased towards the closed position and opened by a pressure drop existing in a direction from heating chamber 19 towards the cavity 20 of connecting member 11. Check valve 24 is thus normally closed and is opened when air is inhaled through face mask 10. A portion of check valve 24 is clamped between opposite faces of connecting member 11 and handle portion 14 in the assembled condition of the inhalator. When connecting member 11 is separated from the handle portion 14 by unscrewing, the check valve 24 is released for cleaning, sterilization, or other maintenance operations.

A second check valve 25 is arranged over an opening 27 in connecting member 11 which communicates with the atmosphere. Check valve 25 is releasably fastened to connecting member 11 by means of a threaded cap 26 and is spring-biased towards the closed position in such a manner that it will vent connecting member 11 to the atmosphere when the pressure in cavity 20 exceeds atmospheric pressure by a predetermined amount, as during exhalation into the face mask 10 thus substantially preventing mixing of exhaled and inhaled air.

The air drawn in by inhalation through the handle portion 14 passes from cavity 20 to face mask 10 through openings 21 in the connecting member. The inhaled air may be medicated by means of a medication carrier 28 best seen in FIG. 2 and comprising a perforated tube 34 filled with absorbent material (not shown) such as cotton wool saturated with volatile medication. Tube 34 is inserted into cavity 20 through an opening 31 in connecting member 11, the opening extending into an outwardly
threaded nipple 32 which is closed by a threaded cap 30 to which one end of perforated tube 34 is axially fastened. The other end of tube 34 is tapered to form an open portion 29 of very small internal diameter.

Cap 30 may be unscrewed from nipple 32 and engaged with the threaded neck of a medicine bottle 33 in such a manner that a carrier 28 extends into the bottle as indicated by dot-and-dash lines in FIG. 3. Medication may thus be absorbed in the material contained in tube 34 through the perforations and through the small opening in the narrow portion 29.

The embodiment of the invention illustrated in FIG. 4 is structurally somewhat modified from that of FIGS. 1, 2 and 3, but functions in an analogous manner.

Air enters the handle portion of the device through two concentric annular insulating spaces 35, 36, then enters a heating chamber 39 through openings 37 in the wall thereof. The double rings of insulating spaces swept by the incoming air holds the outer surface of the handle virtually at room temperature. After passing over a heating element 38, the air enters a resilient duct 40 which forms a conduit of a reinforced hose of corrugated elastic material. It passes into a connecting member 42 through a check valve permitting passage of gas only in the direction from the duct into the connecting member. A medication carrier 44 causes mixing of volatile medication with the flowing gas which is then compressed by a face mask 41 which is equipped with a check valve 45 of a structure analogous to that of valve 25 of FIG. 1 to permit escape of exhaled gas.

Whereas threaded releasable connections were generally employed between the several elements of the inhalator of FIG. 1 to permit their disassembly for cleaning purposes and the like, only face mask 10 being resiliently held by friction fit in connecting member 11, resilient and frictional engagement is utilized in the assembly of the several portions of the device of FIG. 4. Duct 40 thus is held in a tubular extension of the handle portion of the inhalator, and itself resiliently envelops 35, 36, of connecting member 42, thereby holding in place the check valve 43 and the medication carrier 44 which is inserted in connecting member 42 through an opening in the wall thereof which is sealed by the overlying end portion of duct 40. Face mask 41 is held by friction in connecting member 42 and check valve 45 may be held in place on the face mask by a resilient cap.

Instead of a single adjustable thermostatic switch, the embodiment of the invention illustrated in FIG. 4 is equipped with three switches 23, peripherally spaced about heating element 38 and each set for a fixed temperature to actuate individual sections of heating element 38. The three thermostatic switches 23 cooperate with a three-way switch in a well known manner to permit stepwise adjustment of the temperature of the heated air.

While the device of the invention has been illustrated in specific embodiments, employing a face mask and utilizing atmospheric air as the heated gas, it will be understood that the inlet openings of the device may be connected to any other source of a gas that is desired to be heated prior to introduction into the respiratory ducts of a patient. Passage of the gas through the apparatus of the invention need not be actuated by the negative pressure created at the outlet of the apparatus by inhalation, but may equally be actuated by positive pressure applied at the inlet side of the device. The scope of this invention also is not limited to an inhalator employing a face mask, but any other outlet means communicating with the heating chamber of the inventive device may be utilized for conveying a gas heated in said chamber to the respiratory ducts which are intended to be treated.

When the invention has been illustrated and described as embodied in a portable inhalator, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without outing features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalency of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. An inhalator for treatment of the respiratory ducts of a patient, comprising in combination: a heating chamber; heating means in said chamber for heating a gas passing through said chamber, said heater means being in the form of a tubular body; thermostat means in said heating chamber and operatively connected to said heating means for automatically regulating the latter to maintain a preselected temperature in said heating chamber; a hollow member substantially enveloping said chamber and having a wall spaced from the inner face of said chamber for forming therein an insulating space; inlet means on said hollow member for connecting said space to a source of gas; conduit means spaced from said inlet means for connecting said insulating space to said chamber; a hollow connecting member connectable to an outlet means communicating with said chamber at a portion thereof coaxial with said tubular heating means; first check valve means interposed between said connecting member and said chamber to permit flow of gas substantially only in the direction from said chamber to said connecting member; a medication carrier adapted to hold volatile medicative and releasably arranged in said connecting member downstream of said first check valve means; and second check valve means communicating with said connecting member for venting the latter to the atmosphere when the gas pressure on the inner face of said second check valve means exceeds a predetermined value, so that upon inhalation through said outlet means said gas is drawn in sequence through said insulating space and said heating chamber, whereby the temperature of said wall is held below the temperature of the outside of said chamber as said gas is being heated, and gas exhaled into said connecting member through said outlet means is vented to the atmosphere.

2. An inhalator for treatment of the respiratory ducts of a patient, comprising in combination: a heating chamber; heater means in said chamber for heating a gas passing through said chamber, said heater means being in the form of a tubular body; thermostat means in said heating chamber and operatively connected to said heating means for automatically regulating the latter to maintain a preselected temperature in said heating chamber; a hollow member substantially enveloping said chamber and having a wall spaced from the outside of said chamber and defining therewith an insulating space; inlet means on said hollow member for connecting said space to a source of gas; conduit means spaced from said inlet means for connecting said insulating space to said chamber; a hollow connecting member connectable to an outlet means communicating with said chamber at a portion thereof coaxial with said tubular heating means; first check valve means interposed between said connecting member and said chamber to permit flow of gas substantially only in the direction from said chamber to said connecting member; a medication carrier adapted to hold volatile medicative and releasably arranged in said connecting member downstream of所述 first check valve means; said second check valve means communicating with said connecting member for venting the latter to the atmosphere when the gas pressure on the inner face of said second check valve means exceeds a predetermined value, so that upon inhalation through said outlet means said gas is drawn in sequence through said insulating space and said heating chamber, whereby the temperature of said wall is held below the temperature of the outside of said chamber as said gas is being heated, and gas exhaled into said connecting member through said outlet means is vented to the atmosphere.
exceeds a predetermined value, so that upon inhalation through said outlet means said gas is drawn in sequence through said insulating space and said heating chamber, whereby the temperature of said wall is held below the temperature of the longitudinal of said chamber, as said gas is being heated, and over said medication carrier for volatilizing a portion of said medication.

3. An inhalator for treatment of the respiratory ducts of a patient, comprising in combination: an elongated, tubular holding handle; heating chamber means in said holding handle; heater means in said chamber means for heating a gas passing through said chamber, said heater means being in the form of a tubular body; thermostat means in said heating chamber and operatively connected to said heating means for automatically regulating the latter to maintain a preselected temperature in said heating chamber; a hollow member substantially enveloping said chamber means and having a wall spaced from the outside of said chamber means and spaced from the inner surface of said tubular handle, said wall defining with said tubular handle a first annular space closed at opposite ends thereof and with said heating chamber means a second annular space closed at opposite ends thereof; inlet means on said tubular handle for connecting said first annular space to a source of gas; conduit means spaced from said inlet means for connecting said second annular space to said chamber means; passage means through said wall and space in longitudinal direction from said inlet and said conduit means to provide communication between said annular spaces; a hollow connecting member releasably fastened to said handle and communicating with said chamber means at a portion thereof coaxial with said tubular heating means; and outlet means on said connecting member, so that upon inhalation through said outlet means all of the gas entering through said inlet means is drawn in sequence through said annular spaces and said heating chamber means to be gradually heated while the surface temperature of said handle is held below the temperature of the outside of said chamber means.

4. An inhalator for treatment of the respiratory ducts of a patient, comprising in combination: an elongated, tubular holding handle; heating chamber means in said holding handle; heater means in said chamber means for heating a gas passing through said chamber means, said heater means being in the form of a tubular body; a hollow member substantially enveloping said chamber means and having a wall spaced from the outside of said chamber means and spaced from the inner surface of said tubular handle, said wall defining with said tubular handle a first annular space closed at opposite ends thereof and with said heating chamber means a second annular space closed at opposite ends thereof; inlet means on said tubular handle for connecting said first annular space to a source of gas; conduit means spaced from said inlet means for connecting said second annular space to said chamber means; passage means through said wall and spaced in longitudinal direction from said inlet and said conduit means to provide communication between said annular spaces; a hollow connecting member releasably fastened to said handle and communicating with said chamber means at a portion thereof coaxial with said tubular heating means; and a face mask communicating with said connecting member, so that upon inhalation through said face mask all of the gas entering through said inlet means is drawn in sequence through said annular spaces and said heating chamber means to be gradually heated while the surface temperature of said handle is held below the temperature of the outside of said chamber means.

5. An inhalator as defined in claim 4, and including duct means interposed respectively between said handle and said connecting member, and between the latter and said face mask, at least one of said duct means being flexible.

6. An inhalator for treatment of the respiratory duct of a patient, comprising, in combination, an elongated heating chamber; heater means in the form of a tubular body in said chamber for heating a gas passing through said chamber; a first elongated hollow member substantially enveloping said chamber and having a first wall spaced from the outside of the chamber and defining therewith a first insulating space; a second elongated hollow member substantially enveloping said first hollow member and having an outer wall spaced from said first wall and defining therewith a second insulating space; inlet means for connecting said first insulating space to a source of gas; first passage means spaced in longitudinal direction from said inlet means for providing communication between said first and second insulating space; second passage means spaced in longitudinal direction from said first passage means for providing communication between said first insulating space and said heating chamber; and outlet means communicating with said chamber and spaced in longitudinal direction from said second passage means so that upon inhalation through said outlet means all of the gas entering through said inlet means is drawn in sequence and countercurrently through said second insulating space, said first insulating space and said heating chamber to be gradually heated while the temperature of said outer wall is held below the temperature of the outside of said chamber.

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