GAS NEBULIZING APPARATUS

Inventor: James A. Huggins, c/o James A. Huggins & Associates, 551 W. Park Ave., Libertyville, Ill. 60048

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Apparatus for administering nebulized gas to a patient includes a connector having a tubular nozzle communicating with an oxygen supply, a tubular spike portion, and a smaller diameter water supply tube within the spike portion and extending beyond the end of the spike portion for first piercing the stopper in an intravenous solution bottle. The spike portion enlarges the hole pierced by the water supply tube. The oxygen supplied through the nozzle creates a vacuum in the water supply tube, drawing water from the bottle into the oxygen stream. The oxygen and water mixture impinges against a small sphere, nebulizing into a fog of small water droplets within a chamber. A flexible tube connected to the chamber delivers the nebulized fog to the patient. A rotatable valve structure controls the entrance of ambient air to enter the nebulizing chamber. By rotating one of the valve elements different concentrations of nebulized oxygen can be administered to the patient.

8 Claims, 10 Drawing Figures
GAS NEBULIZING APPARATUS

BACKGROUND OF THE INVENTION

The invention relates to improvements in apparatus for gas nebulizing systems, particularly systems for nebulizing oxygen prior to delivery to a patient.

It is well known that the oxygen in conventional supply tanks used by hospitals has a relative low humidity. In most instances, therefore, oxygen cannot be directly administered to the patient. As a result, the oxygen is frequently passed through humidifiers or nebulizers prior to being delivered through a flexible tube to the patient. The nebulized oxygen has a visible fog of tiny droplets for treating the patient.

In order to maintain sterility, a standard intravenous solution bottle should be used as the water source in humidification. The intravenous solution bottle has the advantage that it contains its own sterilized supply of water or medicated solution. Also, the bottle is disposed of after use. Thus, assuming proper handling procedures, sterility is preserved.

Present practice of filling an empty nebulizer container with sterile water, capping it with the cover containing the nebulizer, connecting the nebulizer to an oxygen supply and the container to a flexible tube to the patient, takes time and care in order to maintain sterility. Moreover, the nebulizer containers require storage space, which is a premium in the hospital.

OBJECTS AND SUMMARY OF THE INVENTION

An object of this invention is to provide a gas nebulization system that utilizes standard intravenous solution bottles having standard stoppers therein, whereby the hospital does not need to inventory bottles with sterile water for nebulization or to inventory empty nebulizer containers requiring filling procedures before use.

A further object of this invention is to provide a novel connector which forms part of the system and which serves as the principal component that facilitates the use of conventionally stoppered intravenous solution bottles in the system.

It is a further and more specific object of the present invention to provide a connector of the type and for the purpose stated that is adapted to puncture a conventional intravenous solution bottle stopper, and wherein the connector prevents accidental removal thereof from the bottle stopper while also permitting the bottle to be suspended from the connector.

It is a further and important object of the present invention to provide a connector of the type and for the purpose stated that is adapted to provide additional air to regulate the oxygen concentration in the nebulization system.

In accordance with the foregoing objects the connector of the present invention comprises a body with a first tubular means for connection to gas supply, such as the outlet of a metering valve. The gas is typically oxygen, but it may be air or air modified with oxygen. The first tubular means has a nozzle for the oxygen. The body also includes a second tubular means which is a spike portion for piercing the stopper or like closure for the container. A third tubular means is comprised of a water supply tube of smaller diameter than that of the tubular spike portion and is telescoped therein. The water supply tube extends outwards beyond the puncturing end of the spike portion a sufficient distance so that when the connector is in proper position on the stopper, the lower end of the water supply tube will be near the bottom of the solution bottle. The free end of the water supply tube is constructed to perforate initially the bottle stopper following which the spike portion enlarges the hole made by the water supply tube and seats on the top of the stopper. Barbs on the spike portion retain the latter in place and also permit the stoppered bottle to be suspended from the spike.

The body also includes a fourth tubular means which has a chamber for nebulized gas. The outlet of the chamber connects to a flexible tube to carry the nebulized gas to the patient. In one embodiment of the invention the top end of the fourth tubular means is open and surrounds the first tubular means. The first tubular means has a flange containing openings. Furthermore, the fourth tubular means is rotatably suspended from the flange so that the fourth tubular means and parts carried thereby can be turned to position one or more of the openings over the open end of the fourth tubular means. This regulates the ambient or additional air into the nebulizer chamber and thus regulates the oxygen concentration.

In another form of the invention the fourth tubular means is Y-shaped and has, on one of the legs of the Y, a cap-shaped valve arrangement for controlling the additional air.

The oxygen under pressure as it goes through the nozzle, creates a vacuum in the water supply tube. Water is drawn into the jet of oxygen, and the mixture is impinged on a small sphere or bulb and thus nebulized into a fog of tiny droplets in the nebulizing chamber.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 is a perspective view of a gas nebulizing apparatus constructed in accordance with and embodying the present invention;

FIG. 2 is an enlarged fragmentary sectional view taken along line 2—2 of FIG. 1;

FIG. 3 is a fragmentary sectional view showing the manner of inserting the water supply tube through the stopper of the intravenous solution bottle in accordance with the manner of setting up the apparatus for use;

FIG. 4 is a fragmentary vertical sectional view taken approximately along line 4—4 of FIG. 2;

FIG. 5 is a fragmentary sectional view taken along line 5—5 of FIG. 4;

FIG. 6 is a fragmentary sectional view, on an enlarged scale, taken along line 6—6 of FIG. 4;

FIG. 7 shows an arrangement of a portion of FIG. 4;

FIG. 8 is a fragmentary vertical sectional view of a modified form of apparatus;

FIG. 9 is a fragmentary sectional view taken approximately along line 9—9 of FIG. 8; and

FIG. 10 is a view, partially in section, as seen from line 10—10 of FIG. 9.

DETAILED DESCRIPTION

Referring now in more detail to the drawings, there is shown a gas nebulizing apparatus comprising a connector 2 having a body with two rotatably connected body portions 4, 6. The body portions 4, 6 are each preferably formed of high density polyethylene or an acrylonitrile-butadiene-styrene copolymer resin. The upper body portion 4 comprises a first tubular member 8,
having an upper end 10 that is internally threaded for coupling onto the externally threaded tubular end 12 of a gas (e.g. oxygen) supply outlet 14. This outlet 14 may, by way of example, be a right angle fitting as shown in FIG. 1 and may project from the wall of the hospital room such that the axis of the tube end 12 is vertical. Furthermore, the outlet 14 may suitably include or be part of a conventional, adjustable metering valve. To facilitate manually threading the upper end 10 onto the thread of the end 12 the upper end 10 may be provided with opposed wings 16, 16. Furthermore, the upper end 10 is formed with a conical surface 18 which mates with a like conical surface in the bore 20 of the outlet 14 so as to form a gas-tight seal between the outlet 14 and the upper end 10. Gas will then flow from the bore 20 to the bore 22 of the tubular member 8.

The body portion 6 has a tubular section 24 the upper end of which has an annular bead 26 for snap-fitting engagement with the peripheral part or rim 28 of a horizontal flange 30 that is integral with the tube member 8. The plastic is sufficiently yieldable to permit the snap fit when the bead is axially pressed into the rim 28. Furthermore, the tube member 8 is centered with respect to the flange 30 and the tubular section 24 whereby the body portion 6 may be rotated to various positions about the axis of the bore 22, as shown in dotted lines in FIG. 2, and for purposes more fully appearing.

Centrally thereof tubular section 24 has a sleeve 32 for rotatably receiving the tube 8. The bore of the sleeve 32 and the external surface of the tube 8 may each be downwardly tapered. Joining the sleeve 32 and the wall of the tubular section 24 are ribs or splines 34, 34 that are diametrically opposed. These splines 34, 34 thus bisect the tubular section 24 to provide a half-cylinder or half tube 36. This half-cylinder 36 may optionally have a wad of filtering material 38 packed therein.

The flange 30 is formed with a number of radiating ribs 40 that provide a series of circumferentially spaced openings 42. These openings 42 provide a grill running for 180°, leaving a solid or imperforate part 44 extending over the remaining 180° of the flange 30. Thus, the body portion 6 may be rotated to various positions so that a selected portion of the grill formed by the openings 42 will be presented to the open upper end of the tubular section 24. This controls the amount of air intake into the tubular section 24 for mixing with the nebulized gas as will be hereinafter more fully explained. The half tube 36 can also be closed off by rotating the body portion 6 until the imperforate part 44 of the flange 30 closes off the upper end of the half tube 36.

The body portion 6 also includes an upwardly angled tubular section 46 which provides a nebulizing chamber 48. This tubular section 46 is joined to the tubular section 24 so as to provide communication between the interior or bore 50 of the half tube 36 and the nebulizing chamber 48. To permit such communication the ribs 34, 34 do not extend below the junction of the tube sections 24, 46. Furthermore, it will be noted from FIG. 4 that an upper part of the tubular section 46 blocks off the lower end of the half tube portion 52 that is opposite to the half tube 36. Consequently, there is no communication between the upper open end of the tube portion 52 and the nebulizing chamber 48.

The lower end of the body portion 6 is integrally formed with a second tubular member in the form of a depending spike 54 having a beveled end 56 that provides a piercing or penetrating lower end. Upwardly from this lower end the spike 54 is externally provided with barbs 58. The distance between the barbs 58 and the lower surface 60 of the body portion 6 is a predetermined amount to facilitate gripping and sealing with a conventional intravenous solution bottle stopper 62.

Rigidly mounted within the body portion 6 is a third tubular member 64 that constitutes a liquid supply tube adapted to be immersed in the liquid 63 and through which solution is withdrawn from the intravenous solution bottle 66. The solution is mixed with the flowing stream of gas from the outlet 14. The tube 64 is of substantially smaller diameter than that of the bore 68 of the spike 54, thus providing communications between the nebulizing chamber 48 and the interior of the bottle 66 through the bore 50, an opening 70 at the bottom of the tubular section 24, and the bore 68. The tube 64 has a lower beveled end 72 which provides a lower penetrating or piercing point for piercing the bottle stopper 62, as shown in FIG. 3.

The tube 64 is supported in a section 74 of the body portion 6 that is offset from the axis of the tube 8 and also positions the tube 64 so that it is tangent to the inner wall of the bore 68. The tube 64 is frictionally held in place within the offset section 74, and in addition there are ribs 76, 76, 76 in the bore of the spike tube 54 that help retain the tube 64 in position. The upper end of the tube 64 abuts a horizontal shoulder 78 at the lower end of the tube member 8, as best seen in FIG. 7, but without closing off the opening at the upper end of the tube 64. It is seen from FIGS. 4 and 6 that the diameter of the section 74 is small compared to that of the section 24 so that communication between the interior 50 and the nebulizing chamber 48 around the section 74 is relatively unobstructed.

With continuing reference to FIG. 7 there is shown a passage-forming arrangement that provides communication between the nebulizing chamber 48 and the gas and solution supply where the mixture of gas and liquid can be caused to flow into the nebulizing chamber 48. More particularly, the lower end or base of the tube 8 has a nozzle with an opening 80 that communicates with a frusto-conical mixing chamber 82. This mixing chamber 82 is in communication with the open upper end of the liquid supply tube 64 through a cavity 84. Below the mixing chamber 82 is an orifice 86 which is in alignment with a bulb in the nebulizing chamber, the bull having a spherical surface 88.

Assuming that the connector is coupled to the gas supply and that the connector is also mounted on the intravenous solution bottle stopper 62, all as shown in FIG. 4, the gas pressure is set at a suitable magnitude, for instance 8 or 10 pounds per square inch. The gas flows through the bore 22 and through the nozzle opening 80 and into the mixing chamber 82. This creates a vacuum in the cavity 84 and hence a vacuum in the liquid supply tube 64. Consequently, liquid is drawn upwardly from the bottle 66 and into the tube 64 and flows into the mixing chamber 82. The mixed gas and liquid flows through the orifice 86 and strikes the spherical surface 88 causing the mixture to nebulize, namely to break up into a fog of tiny droplets. A flexible hose 90 is telescoped over the upper end of the tu-
bular section 46 for conveying the nebulized gas to the patient. The concentration of the gas can be readily adjusted by simply rotating the body portion 6 (together with the parts suspended therewith) on the flange 30. In doing so a greater or lesser number of openings 42 will be presented to the open upper end of the half tube 36. Consequently, the amount of ambient air drawn into the bore 50 and the nebulizing chamber can be adjusted for mixing with the nebulized gas. This makes it a relatively simple matter to control the concentration of the gas that is delivered to the patient. The interfit between the bead 26 and the peripheral part 28 should be snug enough so that the position of the body portion 6 relative to the body portion 4 cannot readily be disturbed accidentally. Nevertheless, the body portion 6 should be able to be rotated manually with a modicum of force.

In any nebulizing system there is a certain amount of rainout that is caused by condensation within or adjacent to the nebulizing chamber. This rainout will drain downwardly due to the incline of the tubular section 46. Furthermore, the rainout finds an easy flow path through the opening 70 and the bore 68 for return to the solution bottle while still preserving the sterility of the rainout solution. The vacuum formed in the bottle aids in sucking the rainout back into the bottle.

The bottle 66 is typically a glass container that constitutes a reservoir for the liquid, which may be sterile water, or medicated solution. At its upper end, the bottle 66 is of standard construction. There is an opening 92 of standard size for receiving the stopper 62. The stopper is of rubber or rubber-like material and is held in place by a metal clamping ring 94 that underlies the top bead 96 of the bottle and overlies the peripheral flange 98 of the stopper. The stopper also conventionally includes a central cylindrical hole 100 which opens at the bottom of the stopper but is closed off at its top to provide a membrane 102 that is adapted to be pierced when access to the solution within the bottle is desired. If the exposed part of the stopper is not covered to preserve sterility, the top of the membrane 62 may be wiped with an alcohol swab immediately prior to piercing the same. The external diameter of the tube 64 is substantially less than the diameter of the hole 100 whereas the external diameter of the spike tube 54 between the bars 58 and the surface 60 is preferably slightly greater than the diameter of the hole 100. Also the distance between the bars 58 and the surface 60 is preferably slightly less than the overall thickness of the stopper.

Thus, in mounting the connection 2 onto the intravenous solution bottle, the tapered end 72 of the liquid supply tube 64 is first caused to pierce the membrane 102, as shown in FIG. 3. Subsequently, the spike 54 enlarges the hole made by the water supply tube so that only the one opening is formed in the stopper and this opening is approximately the size of the membrane 62. When the spike seats in its final position as shown in FIG. 4, a seal is formed between the spike and the stopper. The bars 58 prevent the spike tube from being pulled out of the stopper.

FIGS. 8-10 show a modified form of nebulizing apparatus and wherein parts similar to those previously described are identified by the same reference characters. In this form of the invention the upper body portion 4a includes a tubular member 8a that is in communication with the gas supply outlet 14. The tubular member 8a has an annular bead 104 that snap fits into a correspondingly shaped annular recess near the upper open end of a sleeve 106 formed centrally of the lower body portion 6a. This arrangement retains the tube 8a telescoped within the sleeve 106. The lower portion 6a is generally Y-shaped and included a tubular section 46a and an offset tubular section 108 that cooperate to define a nebulizing chamber 48a. The spike 54 forms the vertical leg of the “Y” and, as before, receives the water supply tube 64 and is mounted in the bottle stopper 62.

At the junction of the tubular sections 46a, 108, there is an enlargement 110 having a bore 112 for receiving and fractionally retaining the water supply tube 64. The enlargement 110 also integrally includes the spherical surface 88. The upper end of the water supply tube 64 is in communication with a cavity 114, which, in turn, communicates with the mixing chamber 82a. Consequently, when the gas flows through the nozzle opening 80 and into the mixing chamber 82 a vacuum is created in the cavity 114, thereby drawing liquid upwardly from the solution bottle and into the mixing chamber 82. The mixture is then passed through the orifice 86 after which the mixture strikes the surface 88 and is nebulized. Rainout drains downwardly from both tubular sections 46a, 108 and flows into the bore 68 for returning to the solution bottle.

In order to control the amount of ambient air entering the nebulizing chamber 48a a cap valve arrangement is provided on the open upper end of the tubular section 108. More particularly, the end of the tubular section 108 is formed with opposed notches 116, for receiving opposed tabs 118 that are on a disc 120. A wad of filter material 123 may be inserted in the tubular section 108 underneath the disc 120. The engagement of the tabs 118 with the notches 116 prevents the disc 120 from rotating. This disc 120 has generally sector shaped holes 122, 122 that provide openings into the tubular section 108. Disposed over the disc 120 is a cap 124 also having generally sector shaped holes 126, 126. The cap 124 is rotatable on the tubular section 108 whereby the holes 126 in the cap 124 may be positioned so that they overlies, in whole or in part, the holes 122 in the disc 120 for varying the amount of ambient air taken into the nebulizing chamber 48a. Of course, the cap 124 may be rotated so that its imperforate regions completely cover the holes in the disc 120.

The connector unit may be packaged sterile with both body portions assembled. The water supply tube tip is exposed by peeling open the package such that the package maintains sterility while the connector is being mounted on the solution bottle.

1. A connector for use in a gas nebulizing system that includes a container with liquid and an opening with a closure therein, said connector comprising a body having first tubular means for connection to a gas supply, second tubular means having an end portion shaped for piercing the container closure, third tubular means for immersion in the liquid of the container, said third tubular means being telescoped within said second tubular means, said second tubular means having a spike of larger external diameter than the external diameter of said second tubular means so as to enlarge the opening formed upon piercing said closure by said end portion, said spike being barbed to prevent accidental withdrawal of the connector from the closure, fourth tubu
lar means having a nebulizing chamber, passage-
forming means providing communication between said
nebulizing chamber and said first and third tubular
means, said passage-forming means including a nozzle
and a mixing chamber such that gas from said first tu-
bular means will flow through said nozzle and into said
mixing chamber and liquid from said third tubular
means will flow into said mixing chamber due to vac-
uum created by the flowing gas, means in said nebuliz-
ing chamber for breaking up the flowing gas and liquid
mixture into a mass of droplets, adjustable air valve
means providing communication between the exterior
of said body and said fourth tubular means for regulat-
ing the concentration of said gas in said chamber, and
means for carrying rainout liquid from said chamber to
said container.

2. A connector according to claim 1 in which said
means for carrying the rainout liquid includes said sec-
ond tubular means and by-passes said third tubular
means.

3. A connector according to claim 1 in which said
means for breaking up the mixture comprises a bulbous
member that is spaced from said mixing chamber and
against which the flowing mixture impinges.

4. A connector according to claim 1 in which said ad-
justable air valve means comprises a flange over an
opening in said fourth tubular means, said flange being
integral with said first tubular means and having open-
ings over a portion of its area and being imperforate
over another portion of its area, said flange and fourth
tubular means being relatively rotatable whereby the
openings and imperforate area of the flange serve to
control the amount of the opening in said fourth tubu-ular means that is exposed to ambient air.

5. A connector according to claim 1 in which said
fourth tubular means has a section with an opening off-
set from said first tubular means, said opening having
a disc therein with spaced holes, and a cap over said
disc with spaced holes, the cap being rotatable relative
to said disc to control the amount of overlap of the
holes in the disc and cap and thereby vary the amount
of the opening in said fourth tubular means that is ex-
posed to ambient air.

6. A connector for use in a system that supplies nebu-
lized gas to a patient and which includes a container
with liquid and an opening with a closure therein, said
connector comprising a body having means for connec-
tion to a gas supply and having nozzle means, a tubular
spike member with an end having means for piercing
the closure to insert said tubular spike member through
said closure, a tube in communication with said gas
supply connecting means and being joined to said body,
said tube being within and extending beyond said end
of the tubular spike member for immersion into the liq-
uid to carry liquid therefrom to said nozzle means,
means forming a nebulizing chamber within said body for
receiving a mixture of the gas and liquid, adjustable
air valve means to add additional air to said chamber,
and drain means to carry rainout liquid from said nebu-
lizing chamber back into said container; said adjustable
air valve means comprising a flange on said gas supply
connection means, said flange having openings over a
portion of its area and being imperforate over another
portion of its area, said flange having means for rotat-
ably suspending said body at an open end thereof that
communicates with said chamber.

7. A connector for use in a gas nebulizing system
comprising a body having means for connection to a
gas supply, tubular means for immersion into a liquid,
means cooperative with liquid and gas for producing in
a chamber of said body a nebulized mixture of the gas
and liquid, additional tubular means forming an open-
ing in said body for communication with said chamber
to admit ambient air into said body for mixture with the
nebulized gas, and valve means for controlling the ef-
efective size of said opening; said valve means compris-
ing a flange on said gas supply connection means in ro-
tatable connection with said additional tubular means,
said flange being disposed across said opening, said
opening being formed by only a fractional part of the
cross section of an end of said additional tubular
means, and said flange having perforations over only a
fractional portion of its area such that in one position
of the flange relative to the opening the valve is in a
fully opened condition and in a second position of the
flange relative to the opening the valve is fully closed,
said positions being 180° apart.

8. Apparatus for administering nebulized gas to a pa-
tient comprising a container with liquid and having an
opening with a closure thereacross, a connector having
a body with a chamber and means for connection to a
gas supply, a tubular member in said body having
means at one end for piercing the closure and project-
ing through said stopper, a liquid supply tube in said tu-
bular member and being in communication with said
gas supply connection means, said liquid supply tube
extending beyond said end of the tubular member and
being immersed in said liquid, said tube having an end
with piercing means whereby the closure is first pierced
thereby and then the hole is enlarged by the piercing of
the closure by said tubular member, means for creating
nebulized gas in said chamber, said means including
nozzle means communicating with the said gas supply
means and said liquid supply means, said chamber sur-
rounding the said gas supply means, valve means for
controlling additional air to regulate the concentration
of gas, means for conveying rainout liquid in the said
chamber back into the said container, said valve means
including a perforated flange on said gas supply con-
nection means and means for rotatably suspending said
body and said container from said gas supply connec-
tion means such that the relative orientation of said
body and container determine the amount of opening
of said valve means, and means to convey the nebulized
gas out of said chamber.