Jan. 6, 1953 S. Y. GIBBON 2,624,337

EQUIPMENT FOR TREATMENT OF RESPIRATORY AILMENTS

Filed May 15, 1950 2 SHEETS—SHEET 1

Fig. 1.

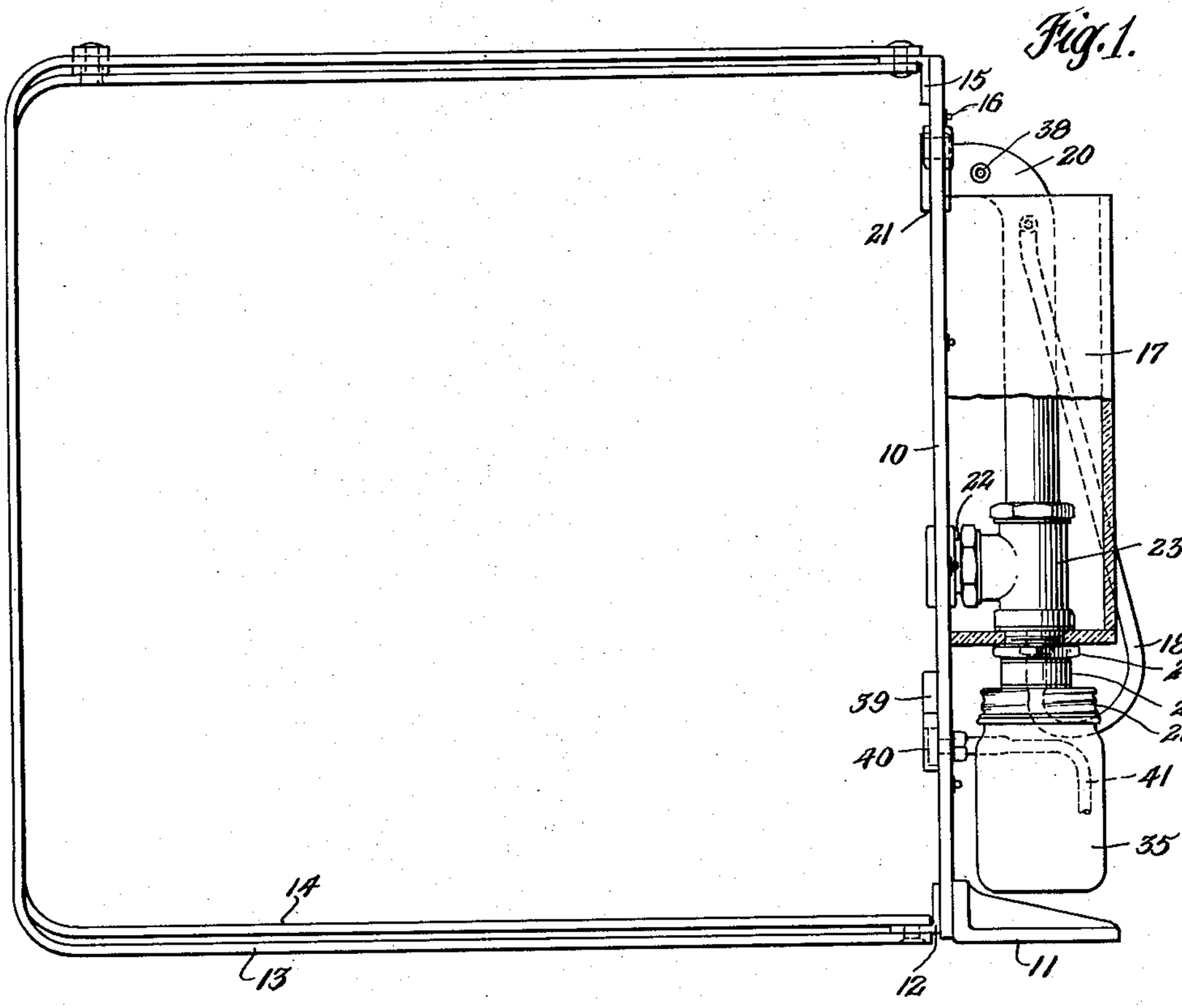

Fig. 5

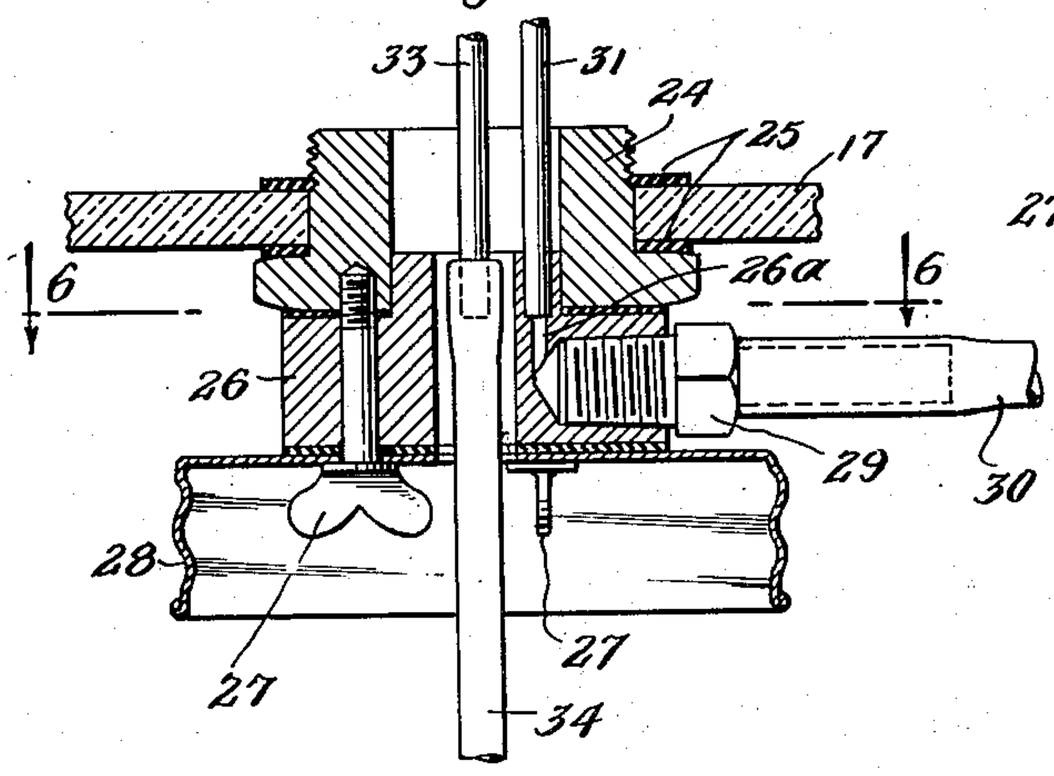

Fig. 6.

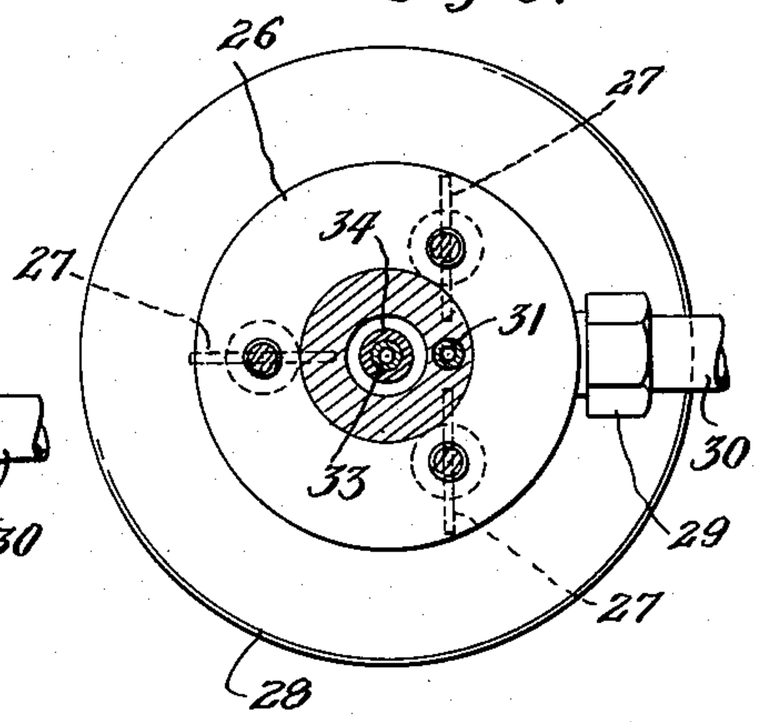

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Fig. 3.

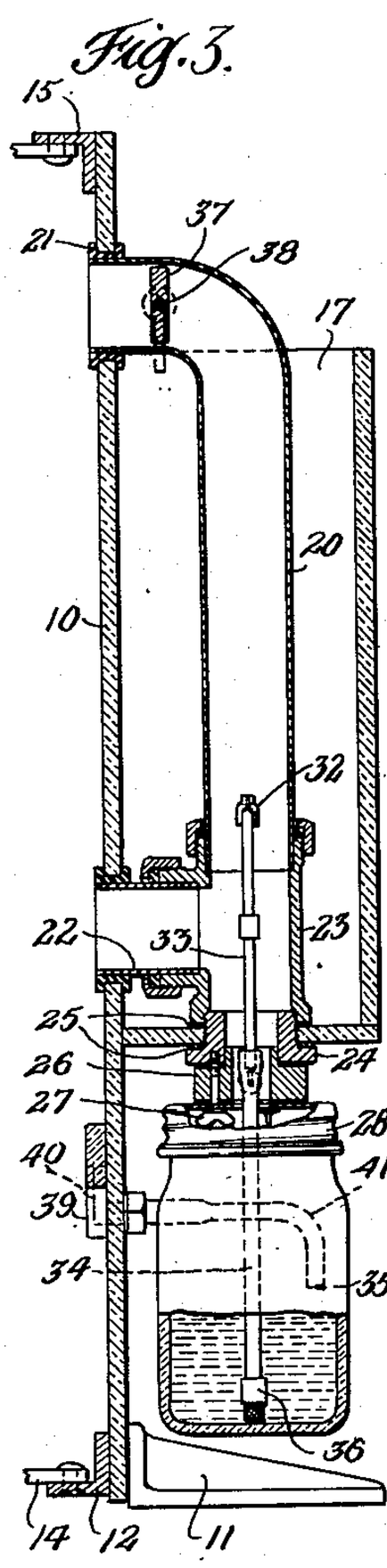
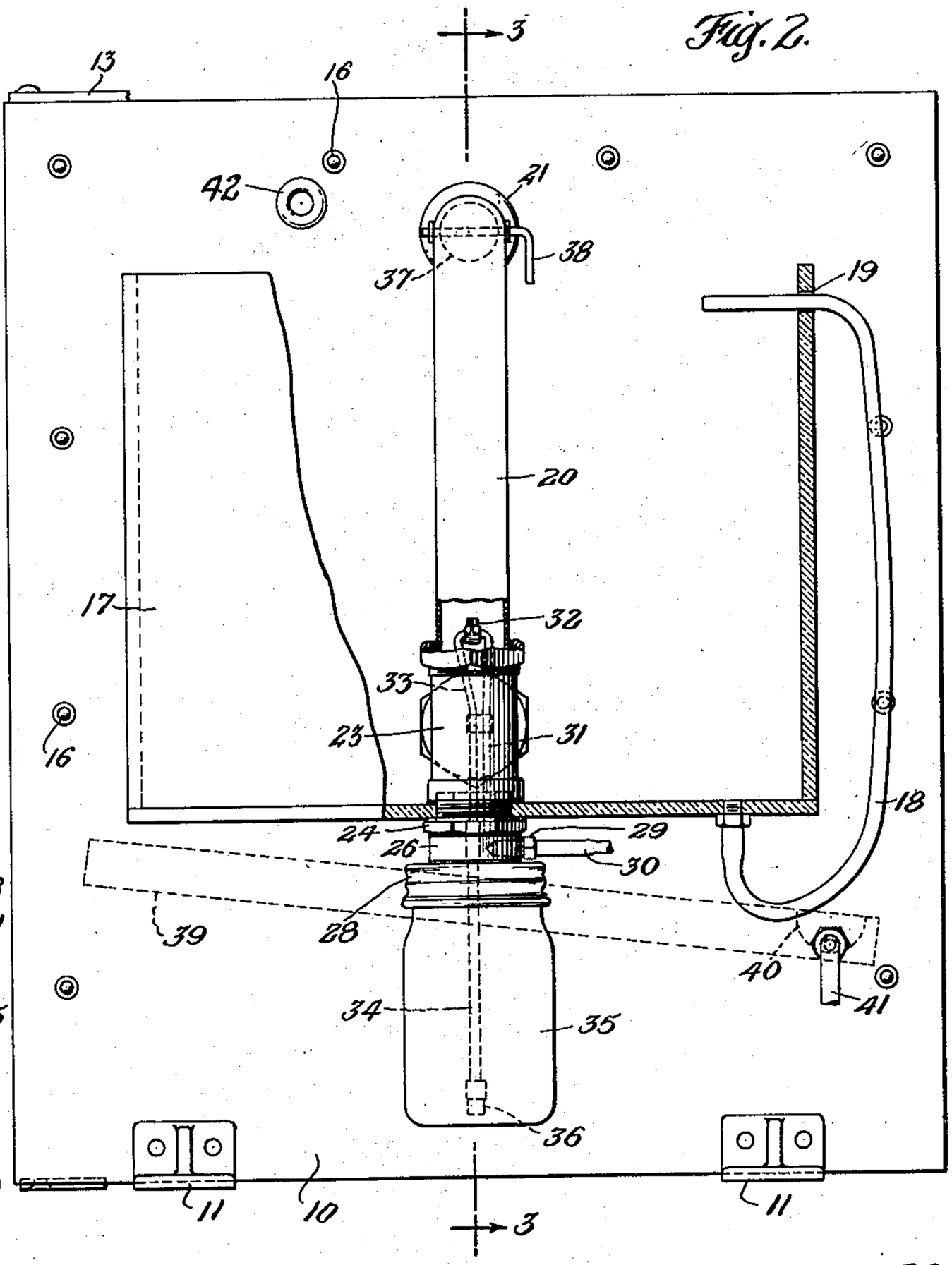


Fig. 2.



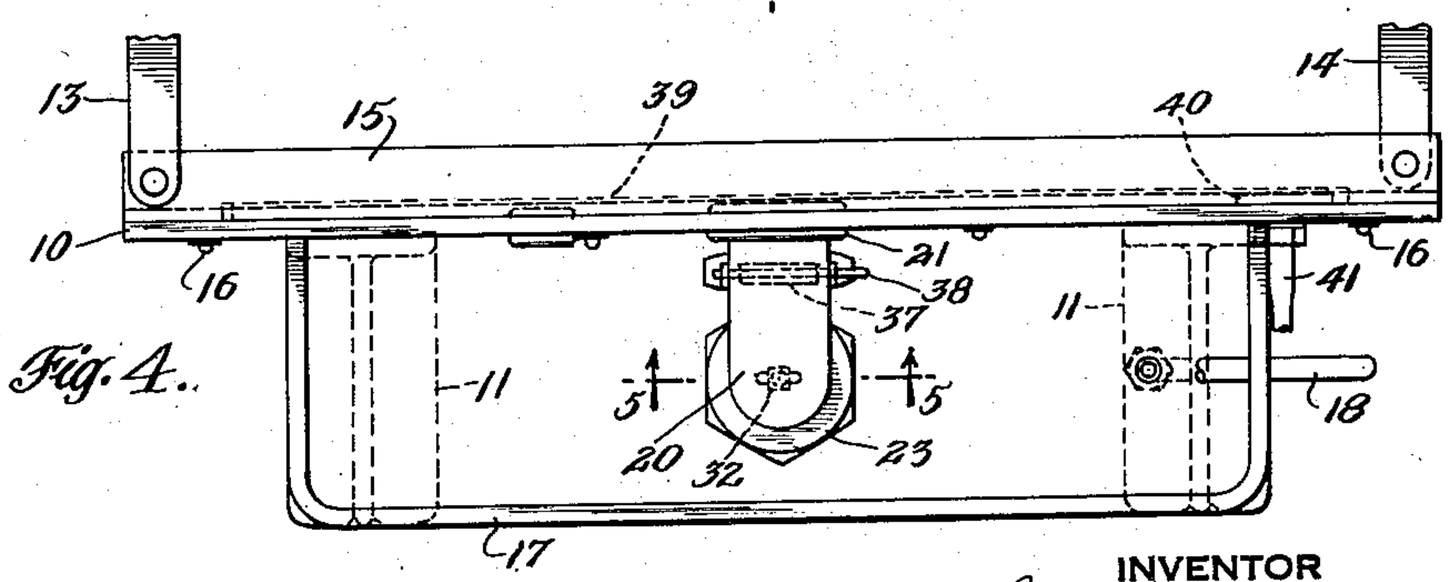


Fig. 4.

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EQUIPMENT FOR TREATMENT OF RESPIRATORY AILMENTS

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10 Claims. (Cl. 128—186)

1

This invention relates to apparatus for providing high humidification of an atmosphere for use in connection with respiratory ailments such as croup and the like.

In many respiratory ailments it is desirable to provide an atmosphere for the patient which has an extremely high humidity, often as high as 90 or 95 percent being desired. With humidifying equipment in general use, it has been difficult to obtain humidities of this extent without having a great deal of excess moisture present in the form of droplets of water which dampened the clothing of the patient. The present invention has as one of its primary objects the provision of apparatus which will provide a high percentage of humidity for an enclosed space in which the patient is located by supplying water vapor in an extremely fine form to prevent undesirable wetting action. This invention represents a further improvement over the equipment disclosed in my copending application, Serial No. 60,846, filed November 19, 1948, now Patent 2,593,134, issued April 15, 1952.

With ailments of the type under consideration it is often desirable to supply increased oxygen content for the air which the patient breathes. The present apparatus is arranged to supply the desired concentration of oxygen in a fashion which uses the minimum amount of oxygen flow and at the same times utilizes this flow to produce the circulating and humidifying functions of the equipment.

In apparatus in which a special atmosphere is provided for a patient it is customary to incorporate a limited enclosed space around the upper portion of the body of the patient. In the present apparatus this takes the form of a framework over which a transparent flexible cover may be placed to isolate the conditioned atmosphere from the air of the room. In an enclosed space of this nature the temperature tends to rise above that of the air temperature in the room for the reason that heat given off by the patient is retained within the enclosure. This produces an uncomfortable condition for the patient. The present invention has as an object the provision of a cooling medium for cooling both the compartment by direct action thereon and the atmosphere being supplied to the compartment.

It is a specific object of the present invention to provide for recirculation of a part of the atmosphere of the compartment for the purpose of providing higher humidity and improved oxygen utilization in the compartment.

It is also an object of the present invention to

2

provide improved and simplified control mechanism for determining the rate of flow and recirculation in the system, thereby providing for control of the humidity.

A further object of the invention is the provision of simplified humidification system including improved apparatus for holding and delivering the water used in the humidifying process.

In view of the fact that a cooling system is used with the apparatus of the present invention a portion of the wall of the equipment is kept at a low temperature. As a result, because of the high humidity of the atmosphere in contact with the inside wall of the enclosure, condensation will occur on the cold areas of the wall. The present invention provides a simple structure for handling the collection and disposal of condensation which forms upon the wall.

How the foregoing and other objects and advantages of the invention are accomplished will be clear from the following description of the drawings in which—

Figure 1 is a side elevational view of the apparatus of the present invention, the enclosure frame being shown in extended position, and part of a wall being cut away.

Figure 2 is a rear elevational view of the apparatus drawn to an enlarged scale, with a wall partly removed.

Figure 3 is a sectional view taken in the direction of arrows **3—3**, Figure 2.

Figure 4 is a plan view of the apparatus.

Figure 5 is a sectional view to an enlarged scale taken in the direction of arrows **5—5**, Figure 4, through the lower portion of the apparatus.

Figure 6 is a view taken in the direction of arrows **6—6**, Figure 5.

The general arrangement of the apparatus is illustrated in Figure 1, where it will be seen that the main wall **10** forms the support for the humidifying and distributing equipment. Attached at the lower edge of wall **10** are brackets **11** which extend to support the wall and equipment. An angle bracket **12** extends across the lower edge of the wall to which is attached the foldable frame members **13** and **14**. A similar angle member **15** is located at the upper edge of the wall **10** to pivotally support the frame members **13** and **14** in a fashion which permits folding these members against the wall **10** for convenience and compactness in storing the apparatus when not in use. Normally, transparent flexible sheet material such as plastic is used to cover the framework and extend around the edge of the wall **10** where it is fastened by means of snap fasteners

16 to provide a reasonably tight joint. This arrangement gives an enclosure of sufficient size to enclose the patient's head and shoulders when the apparatus is placed upon a bed with the wall 10 near the patient's head.

Figures 2 to 4 show the details of construction of the humidifying and cooling apparatus. Attached to the outer side of wall 10 is a compartment 17 which covers a considerable portion of the wall. This compartment 17 is open at the upper side and is adapted to hold the cooling medium which may be in the form of pieces of ice or cold water. A drain tube 18 is provided for drawing off the cooling medium after it has served its purpose. Tube 18 is made long enough so that it may be returned to the upper portion of the container 17, where it may be inserted through an opening 19. In this fashion the tube is held in a position which prevents leakage from the outlet opening in the bottom of the tank. Drainage of the tank is thus taken care of merely by lowering the end of the tube 18 into a container held at an elevation below the bottom of the tank 17.

Supported on the wall of the apparatus is a vertical standpipe 20 having an elbow at the upper end connecting to the wall of the compartment at 21, thus providing entry into the space occupied by the patient. Connected to the lower end of the standpipe 20 near the bottom of the tank 17 is a short duct 22 which opens from the occupant's side of the wall 10 into the standpipe 20. A suitable T-connection fitting 23 is provided for making the connection between the pipe 22 and the vertical standpipe 20. The connecting unit 23 also extends to attach to the bottom of the tank 17, a suitable nut device 24 being utilized to provide a watertight joint at this point. This joint is more clearly shown in Figure 5 where it will be observed that suitable gaskets such as shown at 25 are used to assure tightness of the joint.

In order to connect the humidifying reservoir and the pipes for supplying the air or oxygen for the system an adapter member 26 is attached to the connecter nut 24 by means of wing-bolts 27 which also retain jar cover 28. The adapter 26 is provided with an opening to receive a fitting 29 to which may be attached a piece of rubber tubing 30. The tube 30 may be attached to an oxygen tank or air pump to supply the oxygen or other respiratory gas to the system. Also supported in the connecter 26 is the upright tube 31 of the atomizer unit, tube 31 being in communication with the fitting 29 by means of hole 26*a* so that the respiratory gas may be transmitted to the tube or pipe 31.

As will be seen in Figures 2 and 3, the atomizer tube 31 leads upwardly to the head or nozzle 32. A second tube 33 is also connected to the nozzle 32 and extends downwardly therefrom approximately parallel to the tube 31. A connecting tube 34, which may be of rubber in order to provide the desired flexibility, extends downwardly from the tube 33, through the adapter unit 26 and the lid member 28 into the jar 35. The tube 34 extends to a point near the bottom of the jar 35 and is equipped with a small strainer unit 36 to prevent the entrance of dirt into the system, thus preventing malfunctioning of the atomizer nozzle due to clogging.

At the upper end of the delivery pipe 20 a throttling valve 37 is located. This valve is pivoted about a horizontal axis with an axis

member 38 which extends through the tube 20 and is bent to form a handle for operation of the valve. Valve 37 is somewhat smaller in diameter than the inside diameter of the delivery duct 20 so that in closed position, flow conditions representing the minimum requirements may occur. Opening of the valve 37 to various degrees provides for control of the amount of air recirculated from the enclosure through return pipe 22 and duct 20, and thus controls the degree of humidity since with increased flow an increase in the humidity will result. In closed position of the valve 37, much of the moisture contacts the valve and condenses, after which the droplets return through the duct 20 to the reservoir. By recirculation of air from the compartment which already has a high moisture content, the provision of increased humidity is accomplished more readily.

On the inside or occupant's side of wall 10 below the elevation of the tank 17, a strip of material as indicated at 39 is fastened to the wall. Wall 10 may preferably be made of transparent plastic material and the strip 39 may be of the same material cemented in position. The strip 39 is placed at a slight inclination and at the lower end a depression or well 40 is formed. Connected to the well 40 is a drain tube 41 which extends outside the wall 10 to a convenient point for catching the drip which occurs when the condensation from the inside of the wall is directed by means of the strip 39 to the well 40.

In operation, the equipment is set up in the fashion previously indicated to enclose the patient's head and shoulders. Water to supply the humidity is placed in the jar 35 and it is screwed into position on the lid 28. The respiratory atmosphere which may be air delivered through a small compresser, or oxygen from an oxygen tank, is delivered through tube 30 to the atomizer unit. The gas is preferably supplied at a pressure of approximately 8 to 10 pounds per square inch in order to supply the desired flow and give good operational characteristics to the atomizer unit. The flow of gas through the atomizer head causes water to be drawn from the jar 35 through the tube 34 and delivered in the form of an extremely fine mist into the tube 20 where the mixture of respiratory gas and water particles is delivered to the occupant's side of the wall 10. During passage through the tube 20, which preferably has a length several times its diameter, the larger particles of water impinge upon the walls of the duct 20 and return to the reservoir 35. This removal of undesired particles is further facilitated by the elbow which changes the direction of flow. This directional change causes the heavier particles to contact the wall surface and condense. The location of the valve structure also assists in this elimination of "wet" particles as has been described above.

When cooling action is required ice is placed in the tank 17 and this causes cooling of the enclosed compartment both directly through the wall 10 and also by cooling the air flowing through the duct 20 which is entirely surrounded by the cooling medium.

The flow from the atomizer through the delivery tube creates a Venturi effect which causes air to be sucked into the duct through the inlet tube 22. Recirculation of the air from the compartment in this fashion is of considerable benefit in producing a high degree of humidity since

the recirculated air is already highly humidified. Therefore, only the addition of a small amount of water vapor is needed to maintain high humidity. It has also been found that desired oxygen concentrations may be maintained with lower delivery flow. The reason for this improved oxygen utilization is believed to be that any unused oxygen in the occupant's compartment tends to settle to the bottom of the compartment. With the recirculating arrangement the lower strata are removed from the occupant's compartment and recirculated, thus salvaging the unused oxygen and providing for improved distribution of high oxygen concentrations throughout the occupant's enclosure.

It will be noted that a grommet **42** is provided near the upper edge of wall **10** to permit insertion of a tube to deliver medicament such as aerosol, to the inside atmosphere when desired.

From the foregoing, it will be evident that I have provided improved apparatus for use in delivering humidified air to a patient. This apparatus delivers air having a high degree of humidity by an arrangement of a simple delivery duct which provides for mixing the mist from an atomizer with the flow of air or gas through the duct. The duct proportions permit any large water particles to separate and form droplets on the wall of the delivery duct for return to the reservoir. The valve at the inlet to the occupant's space provides for an effective and simple means of controlling the moisture delivered to the occupant's space. Recirculation of the atmosphere from the lower portion of the occupant's space is induced by the return air opening located at the lower end of the vertical delivery duct. This recirculation feature provides for improved humidity maintenance with reduced vaporization requirements and also allows improved oxygen concentrations with a relatively low rate of oxygen flow. Efficient cooling assures increased comfort of the occupant by means of the cooling compartment attached to the wall and surrounding the delivery pipe. The readily replaceable transparent jar to hold the water which provides humidification may be refilled with a minimum of effort. In addition, the folding frame allows the complete apparatus to be stored in a compact space when not in use.

I claim:

1. Apparatus for treatment of respiratory ailments including a rigid wall structure, equipment supported thereon including an upright duct having a passage through the upper portion of the wall structure, an enclosed recirculation connection having an opening through said wall into the lower portion of said duct, and an atomizer having its delivery head located in the lower portion of said duct.

2. Equipment for providing a humidified atmosphere for use in the treatment of respiratory ailments including a wall member, an atmosphere delivery duct mounted on the outside of said wall extending from an upper portion to a lower portion thereof and having a delivery opening through said wall at the upper end of said delivery duct, a duct for recirculation of air from the inside of said wall connecting into the lower end of said delivery duct, an atomizer unit supported with its delivery head in the lower portion of said delivery duct, a water vessel attached to the lower end of said delivery duct, a connecting channel leading from the head of said atomizer downwardly into said vessel and a gas delivery channel connected to said atomizer head and leading downwardly through said delivery duct to a point above said vessel.

3. Apparatus for providing a humidified atmosphere for use in the treatment of respiratory ailments including an enclosure wall, a large diameter generally upright delivery duct supported on the outer side of said wall and having an elbow and an opening at its upper end leading to the inner side of said wall, a recirculating duct located near the other end of said delivery duct leading from the inner side of said wall, and an atomizer device for introducing respiratory atmosphere and water vapor into said delivery duct, the head of said atomizer device being located at a point near the connection of said recirculation duct to said delivery duct.

4. Equipment for providing humidified respiratory atmosphere for use in the treatment of respiratory ailments including an enclosure wall structure, equipment supported on said wall structure including a vertical delivery duct, a delivery connection at the upper end of said duct leading to the inner side of said wall, a recirculating connection near the lower end of said duct leading from the inner side of said wall to said delivery duct, and an atomizer device for introducing respiratory gas into said duct, the delivery head of said atomizer device being located slightly above the point of attachment of said recirculating connection.

5. Apparatus for use in the treatment of respiratory ailments including an enclosure wall, an upright atmosphere delivery duct supported on the outer side of said wall and having an opening at its upper end leading to the inner side of said wall, a recirculation duct connecting to said delivery duct from the inner side of said wall near the lower end of said delivery duct, an atomizer device located near the lower end of said delivery duct for introducing respiratory gas and water vapor to said duct, and a throttle valve located in said duct near the upper end thereof to control the rate of flow, said valve providing for a minimum area opening to provide for minimum delivery requirements when the valve is in closed position.

6. Apparatus for treatment of respiratory ailments including a wall structure, a vertical delivery duct located on the outer side of said wall and extending parallel thereto with an opening from the upper end of said duct to the inner side of said wall, a tank attached to said wall and surrounding the major portion of said duct, said tank being adapted to hold a cooling medium such as ice cubes, an atomizer device located in said delivery duct, a water vessel located below said tank and connected to the lower end of said delivery duct, and a connection to said atomizer for the delivery of respiratory gas thereto, said connection being located below said cooling tank.

7. Apparatus for the treatment of respiratory ailments including an enclosure wall, an upright atmosphere delivery duct mounted on the outer side of said wall, a cooling tank mounted on the outer side of said wall and surrounding a major portion of said delivery duct, a water vessel supported at the lower end of said delivery duct and an atomizer device having its nozzle located near the lower end of said delivery duct and having channel connections for the delivery of water from said vessel to said nozzle and for the delivery of respiratory gas to said nozzle.

8. Apparatus for the treatment of respiratory ailments including an enclosure wall, a large diameter generally upright pipe located adjacent

said wall for the delivery of respiratory gas to the enclosure, a cooling compartment attached to said wall and surrounding the major portion of said pipe, the lower end of said pipe being connected to provide a passage through the bottom of said compartment, an adapter member at the lower end of said pipe, an atomizer unit for delivering respiratory gas and vapor to said delivery pipe, said atomizer being supported on said adapter, and a container lid attached to said adapter.

9. Apparatus for the treatment of respiratory ailments including an enclosure wall, a substantially vertical delivery duct supported on said enclosure wall, an atomizer unit supported in said duct near its lower end, said atomizer having a nozzle member and two rigid connecting pipes extending downwardly from said nozzle to the bottom of said duct, a jar lid supported at the lower end of said duct, a jar for support in said lid, and a flexible extension tube extending from the lower end of one of said rigid atomizer pipes to the bottom of said jar.

10. Apparatus for the treatment of respiratory ailments including an enclosure wall, a substantially vertical gas delivery duct supported on said wall with a delivery opening through said wall at the upper end thereof, a recirculating connection from the inner side of said wall to said duct located near the lower end of said duct, an adapter part at the lower end of said duct for attachment of a water container, an atomizer device located near the lower end of said duct and supported on said adapter part, said atomizer device having a nozzle unit and two connecting tubes, one of which extends to the lower part of said water vessel, and an external connection in said adapter part to deliver gas under pressure to the other tube of said atomizer device.

SAMUEL Y. GIBBON.

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