March 10, 1942. A. S. LANGSDORF 2,275,534

ANAESTHESIA APPARATUS

Filed Sept. 27, 1940

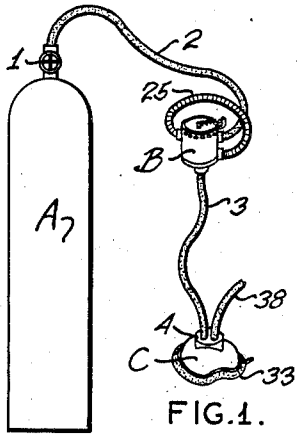


FIG. 1.

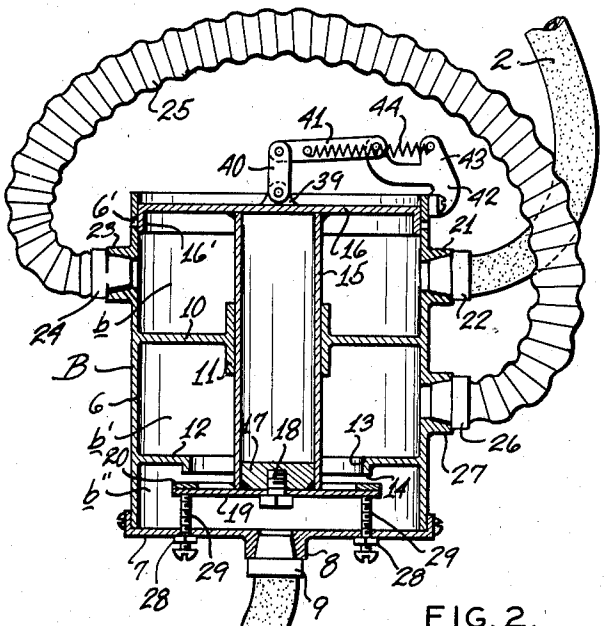


FIG. 2.

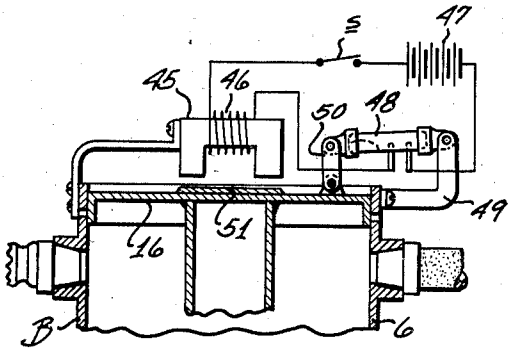
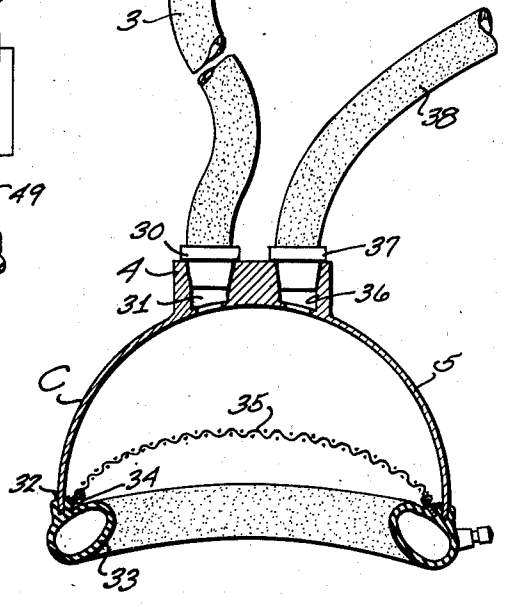


FIG. 3.



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ANESTHESIA APPARATUS

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13 Claims. (Cl. 128—188)

This invention relates generally to anesthesia apparatus.

There are on record numerous instances where patients undergoing surgical operations have suffered fatal accidents caused by explosions of inflammable or explosive fluids or gases used for anesthetic purposes. Whatever the cause of the explosion, whether an electric spark due to static charges, or to an open flame, or to an incandescent cauterizing instrument, the injury to the patient in many of these cases has involved a rupture of the trachea, bronchi, or lungs caused by the pressure wave transmitted through the rubber tube and facial mask of the anesthetic-administering apparatus.

My invention hence relates more particularly to a certain new and useful improvement in the safety factors of such apparatus and has for its primary object the provision of anesthetic-administering apparatus so uniquely constructed as to automatically prevent the transmission to the lungs and respiratory organs of a patient of pressure waves or flames resulting from explosions of the anesthetic fluid or gas.

My invention has for a further object the provision of apparatus of the type and for the purpose stated which may be readily constructed, which is positive and substantially automatic in operation, and which is highly efficient in the performance of its intended functions.

And with the above and other objects in view, my invention resides in the novel features of form, construction, arrangement, and combination of parts presently described and pointed out in the claims.

In the accompanying drawing—

Figure 1 is a diagrammatic perspective view of anesthesia apparatus constructed in accordance with and embodying my present invention;

Figure 2 is a broken longitudinal sectional view of the apparatus; and

Figure 3 is a fragmentary sectional view of a slightly modified form of safety valve forming part of the present apparatus.

Referring now in more detail and by reference characters to the drawing, which illustrates practical embodiments of my invention, the apparatus includes a conventional cylinder or other vessel A for the storage of the particular anesthetic gas, which is adapted for supply communication through a conventional control-valve 1 and conduit 2 with a safety-valve structure B connected, in turn, by means of a feeder-tube 3 to the intake fitting 4 of the body-portion or hood 5 of an applying-member usually in the form of a facial mask C, all as best seen in Figure 1.

The valve-structure B comprises a preferably metallic tubular shell 6 preferably detachably provided at its one or so-called lower end, reference being made to Figure 2, with a suitable closure-cap 7 having an outlet, as at 8, in its end wall for accommodating a tubular or other suitable connector 9 of the feeder-tube 3.

Suitably located within the shell 6 intermediate its opposite ends, is a fixed transverse diaphragm 10 having a preferably integral centrally disposed tubular piston or valve guide 11; and preferably integral with or otherwise fixed to the cylindrical wall of the shell 6 and suitably located intermediate the diaphragm 10 and the end-cap 7, is a ring-shaped second wall 12, the opening 13 of which is substantially larger in diametral size than that of the guide 11, the wall 12 being formed concentrically about the periphery of opening 13 with a valve-seat 14 presented laterally toward the end-cap 7.

Snugly fitting for free reciprocation in and through the guide 11, is a nicely balanced tubular piston-rod or valve-stem 15, fixed to and upon which at its one or so-called upper end, reference being again made to Figure 2, is a head or piston 16 provided or formed upon its outer periphery with a laterally presented annular flange or skirt 16' having at its outer face an easy sliding fit relatively to the inner face of the shell 6 for normally closing an annular series of shell-perforations or outlet orifices 6'.

Fixed in the opposite or lower end of the stem 15, which projects freely through the aperture 13 of wall 12, is a suitable plug 17, and fixed, as by means of a screw or the like 18 to the plug 17, is a valve-disk 19 sized to seat upon the flange or ring 14, an annular gasket 20 being preferably fixed on the disk 19 for closure sealing engagement with the seat 14, as best seen in Figure 2.

Thus, as will be evident, the shell or cylinder 6 is divided by the diaphragm 10 and ring-wall 12 into an intake compartment or chamber *b*, an intermediate compartment or chamber *b'*, and an outlet compartment or chamber *b''*, all as best seen in Figure 2 and for purposes presently fully appearing.

Formed in and upon the wall of the shell or cylinder 6 between the diaphragm 10 and valve or piston-head 16 and having communication with the intake-chamber *b*, is a tubular boss 21 for receiving the connector-fitting 22 of the intake conduit 2.

Likewise formed in and upon the wall of shell 6 between the diaphragm 10 and piston-head 16 and also having communication with the chamber *b*, is a second tubular boss 23 for receiving the fitting 24 of a suitable intermediate flexible conduit 25 disposed or coiled around the cylinder or shell 6 for connection at its opposite end by means of a fitting 26 with a third tubular boss 27 formed in and upon the wall of the shell 6 between the diaphragm 10 and ring-wall 12 and opening into the intermediate chamber *b'*, the chambers *b*, *b'*, being thus in constant communication through the suitably elongated intermediate conduit or tube 25.

Thread-seated in the end-cap 7 to project into the shell-chamber *b''*, and secured, as by lock-nuts 28, in selected or adjusted position, is a pair of set-screws or the like 29 for engagement with the valve-disk 19, so that normally the stem 15 and associated piston-head 16 will be supported in its selected downwardly disposed or "open position," in which the disk 19 will be shifted from the seat 14 for permitting free communication between chambers *b'* and *b''* through aperture 13, and the orifices 6' will be covered and closed by the flange 16', all as best seen in Figure 2 and for purposes presently more fully appearing.

At its lower end, the feeder-tube 3 has communication by means of a connector 30 with the intake duct 31 of the tubular boss or fitting 4 of the dome-shaped or hemi-spherical hood or body-portion 5 of the applying-member or facial mask C; and preferably detachably engaged, as at 32, with the peripheral margin of hood 5 and forming part of the mask C, is an inflatable face-ring 33 sized and shaped for comfortably fitting around the nose and mouth of the particular patient, the face-ring 33 being equipped with an elastic band, not here specifically shown, for yieldingly and removably engaging the head of the patient for securing the mask C in place. Preferably embedded in or otherwise forming substantially an integral part of the face-ring 33, is an annular metallic-member 34, and marginally soldered or otherwise fixed to the member 34, and disposed transversely within the hood 5 between the inlet-opening 31 and the face-ring 33, is an upwardly convexed preferably copper-gauze screen 35 of very small or fine mesh, the facial mask C being conventionally vented through an outlet duct 36 formed in the fitting 4 for receiving the connector 37 of an outlet or exhalation tube 38, all as best seen in Figure 2 and for purposes presently more fully appearing.

For purposes presently appearing, the piston 16 is provided upon its upper face with a pair of upstanding ears 39 for pivotal engagement with one end of a link 40, in turn, at its upper end, pivotally connected to a transverse link 41 rockably mounted at its opposite end upon a clevice-shaped bracket 42 having an arm 43 for supporting engagement with one end of a tension spring 44 connected at its other end to the link 41 in the formation of a toggle-type valve supporting-mechanism.

In use, the ethylene, cyclopropane, or other anesthetic gas will under normal conditions flow from the cylinder A through the tube 2 into the chamber *b* of the shell 6. Since the piston-stem 15, head 16, and valve-disk 19 are nicely balanced, so that the orifices or relief ports 6' are closed by the piston-flange 16' and the disk 19 is unseated, the entering gas will flow freely from the chamber *b* through the intermediate tube 25 into the chamber *b'* and thence through the valve-aperture 13 into the discharge chamber *b''* and from chamber *b''*, through the tube 3, for application by the mask C to the patient.

Now in the event of an explosion ahead of the valve-structure B, where, experience shows, the explosion usually occurs, the resulting pressure wave traveling through the tube 2 and into chamber *b* will immediately produce an expansive force within the chamber *b*, causing the piston-head 16 to travel upwardly and thereby not only seat the valve-disk 19 upon the ring 14 and close the safety valve B, but also shift the flange 16' to open the outlet orifices 6' for venting the chamber *b* to atmosphere. At the same time, the link 41 will rock upwardly, carrying the spring 44 past "dead center," the piston 16 being thereby held in upwardly disposed position, the valve-aperture 13 accordingly remaining closed and the relief ports 6' remaining open.

Part of the pressure wave entering the chamber *b* will flow or escape into the flexible tube 25. However, the tube 25 is of such length that, by the time such escaping portion of the pressure-wave enters the chamber *b'*, the valve 19 will be seated and the orifices 6' opened. Thus the tube 25 functions in the nature of a time-delay, affording the valve B full opportunity to close prior to even a portion of the pressure-wave reaching the exhaust-chamber *b'*.

As an additional protection to the patient, any flame entering the mask C will be intercepted by the screen 35, and propagation thereof into the respiratory tract of the patient will thereby be positively and certainly prevented. I may add that the screen 35 being permanently attached to the face-ring 33, full protection is afforded the patient even if the hood 5 should be removed.

After an explosion has dissipated its force and the flame, if any, has been extinguished, the apparatus may again be restored to initial operative position by manually causing the piston 16 to move downwardly to again rest in supported position upon the supports 29, the piston 16 in such movement rocking the link 41 and the spring 44 past "dead center" and thereby restoring the valve B to initial position.

Under some circumstances, an electro-magnet 45 may be substituted for the described toggle-mechanism, the magnet coil or winding 46 being connected in series with a manual switch *s*, a source of current 47, and a conventional tilting mercury switch 48 rockably supported at one end by means of a bracket 49 upon the cylinder 6 and at its other end operatively connected by means of a depending link 50 to the upper face of the piston 16. As the piston 16 is forced upwardly, the mercury switch 48 will be tilted, closing the circuit to the coil 46 and energizing the electro-magnet 45, thereby holding the piston 16 through an associated armature 51 in upwardly supported position. After the explosion has dissipated its force and any flame has been extinguished, the switch *s* may be manually opened, deenergizing the coil 46 and causing the electro-magnet 45 to release the armature 51, whereupon the piston 16 will return to initial position.

It will thus be evident that, by my invention, I have provided an anesthetic-administering apparatus which is entirely safe, positively eliminating the hazards of explosion and fire and preventing injury or damage to the respiratory organs of the patient in the event of accidental explosion.

It will further be evident that the anesthetic-administering apparatus of my present invention is simple in operation and durable in construction, being free of any parts which may readily become worn or broken and cause failure of operation during use, and it will also be understood that other changes and modifications in the form, construction, arrangement, and combination of the several parts of the apparatus may be made and substituted for those herein shown and described without departing from the nature and principle of my invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. Anesthetic-administering apparatus including a safety valve comprising a shell divided by longitudinally spaced transverse walls into an intake chamber, an intermediate chamber, and a discharge chamber, the wall between the intermediate and discharge chambers being provided with an outlet-port and said intake chamber being connected by an elongated conduit with the intermediate chamber, and means comprising a stem within the shell and a valve-member on the piston-stem for closure-wise co-operation with the outlet-port, said means being responsive to sudden increases of pressure for actuating the valve-member for closing the outlet-port.

2. Anesthetic-administering apparatus including a safety valve comprising a cylindrical shell divided by longitudinally spaced transverse walls into an intake chamber, an intermediate chamber, and a discharge chamber, the wall between the intermediate and discharge chambers being provided with an outlet-port and said intake chamber being connected by an elongated conduit with the intermediate chamber, and means comprising a piston-stem shiftably mounted in the intake chamber and a valve-member connected on the stem for closure-wise co-operation with the outlet-port, said intake chamber being provided with a plurality of relief ports adapted to be closed when the outlet-port is open and open when the outlet-port is closed, said means being responsive to sudden increases of pressure for actuating the valve-member for closing the outlet-port.

3. An anesthetic-administering apparatus comprising an applying-member, in combination with a supply-line and means incorporated in the line for feeding an anesthetic-gas to the applying-member under pressures corresponding to normal flow, said means including a tubular shell having an intake chamber, an outlet chamber, and an intermediate chamber, said intake chamber having a fluid inlet, the shell having an annular series of orifices in the wall of its intake chamber, the intake and intermediate chambers having conduit-communication, and there being a normally open valve-aperture between the intermediate and outlet chambers, and valve-means for normally closing said orifices, said valve-means being automatically actuable by the gas for closing said aperture and opening said orifices for interrupting feed of the gas through the shell to the applying-member and venting the same from the shell when the rate of increase of pressure exceeds a predetermined amount.

4. An anesthetic-administering apparatus comprising an applying-member, in combination with a supply-line and means incorporated in the line for feeding an anesthetic gas to the applying-member under pressures corresponding to normal flow, said means including a tubular shell, a diaphragm within the shell dividing the chamber thereof into an intake compartment and a second compartment, the shell having an annular series of orifices in the wall of its intake compartment, a ring-shaped wall within the shell spaced from the diaphragm for dividing the second shell-compartment into outlet and intermediate compartments, said intake compartment having a fluid inlet and the intake and intermediate compartments having conduit-communication, a valve-seat on said wall, a piston having a bearing for reciprocation in the diaphragm and projecting through the wall-aperture, a flanged head on the piston normally closing said orifices, and a valve-disk on the piston disposed within the shell outlet compartment in spaced relation normally to said valve-seat, the piston being automatically actuable by the gas for seating the valve for closing said aperture and opening said orifices for interrupting feed of the gas through the shell to the applying-member and venting the same from the shell when the rate of increase of pressure exceeds a predetermined amount.

5. An anesthetic-administering apparatus comprising an applying-member, in combination with a supply-line, means incorporated in the line for feeding an anesthetic-gas to the applying-member under pressures corresponding to normal flow, said means including a chambered shell and a valve-member automatically motivated in the shell by the gas for interrupting feed thereof to the applying-member when the rate of increase of pressure exceeds a predetermined amount, and means for releasably retaining the valve-member in gas-flow interrupting position.

6. An anesthetic-administering apparatus comprising an applying-member, in combination with a supply-line, means incorporated in the line for feeding an anesthetic-gas to the applying-member under pressures corresponding to normal flow, said means including a chambered shell and a valve-member automatically motivated in the shell by the gas for interrupting feed thereof to the applying-member when the rate of increase of pressure exceeds a predetermined amount, and manually releasable mechanical toggle-means for retaining the valve-member in gas-flow interrupting position.

7. An anesthetic-administering apparatus comprising an applying-member, in combination with a supply-line, means incorporated in the line for feeding an anesthetic-gas to the applying member under pressures corresponding to normal flow, said means including a chambered shell and a valve-member automatically motivated in the shell by the gas for interrupting feed thereof to the applying-member when the rate of increase of pressure exceeds a predetermined amount, and electro-magnetic means for releasably retaining the valve-member in gas-flow interrupting position.

8. Anesthetic administering apparatus comprising an applying-member, a supply line connected with said applying-member, a source of fluid supply connected to the other end of said supply line, valve means in said supply line intermediate the source of fluid supply and the applying-member, additional means on the fluid supply side of said valve means and cooperating with said valve means actuatable by explosive increases of pressure on the fluid supply side of said valve means for closing said valve means against the flow of fluid therethrough toward the outlet end and the applying-member, and means creating a lag in the fluid course between said

additional means and the opening closed by said valve.

9. Anesthetic administering apparatus comprising comprising an applying-member, a supply line connected at one end with said applying-member, a source of fluid supply to the other end of said supply line, valve means in said supply line intermediate the source of fluid supply and the applying-member, additional means on the fluid supply side of said valve means cooperating with said valve means and actuatable by explosive increases of pressure on the fluid supply side of said valve means for closing said valve means against the flow of fluid therethrough in a direction toward the outlet end and the applying-member, said valve means including normally closed escape ports uncovered by such actuation of the valve closing means under increased explosive force providing escape passages for the explosive force, and means creating a lag in the fluid course between said additional valve closing means and the opening closed by said valve.

10. Anesthetic administering apparatus comprising an applying-member, a source of fluid supply, a supply line leading from the source of the fluid supply to said applying-member, a valve casing connected in said supply line, valve means in said casing actuatable to close the opening therefrom establishing communication with the part of the supply line leading to the applying-member, valve closing means in said casing additional to and cooperating with said valve means actuatable by and responsive to explosive increases of pressure on the fluid supply side of said valve for actuating the valve means and closing the supply line connection leading to the applying-member, and an elongated conduit extending between portions of said casing and creating a lag in the fluid course between said additional means and the opening closed by said valve.

11. Anesthetic administering apparatus comprising an applying-member, a supply line connected with said applying-member, a source of fluid supply to said supply line, valve means in said supply line intermediate the source of fluid supply and the applying-member, means actuatable by explosive increases of pressure on the fluid supply side of said valve means for closing said valve means against the flow of fluid therethrough toward the outlet end and the applying-member, and means actuated by the closing of said valve under such explosive pressure retaining said valve in closed position until manually reopened.

12. Anesthetic administering apparatus comprising an applying-member, a source of anesthetic fluid supply, a supply line connected with and leading from the source of fluid supply to said applying-member, valve means in said supply line intermediate the source of fluid supply and the applying-member, means actuatable by explosive increases of pressure on the fluid supply side of said valve means for closing said valve means against the flow of fluid therethrough, said valve means having a casing provided with a plurality of chambers one of which is in communication with the supply side of said line and the other chamber being in communication with the side leading to the applying-member and having the valve means closing the discharge opening therefrom to the applying-member, and an elongated conduit connecting said chambers.

13. An anesthetic administering apparatus comprising an applying-member, a source of anesthetic fluid supply, a supply line connected between said source of fluid supply and said applying member, a valve casing in said supply line intermediate the source of fluid supply and the applying-member having therein non-communicating chambers connected respectively with the intake and discharge portions of said supply line, a valve seat interposed in the chamber leading to the discharge side, a valve in said chamber movable into opened and closed positions, valve operating means in the inlet chamber operable by explosive increases of pressure on the supply side of said valve casing to close said valve, and an elongated fluid conducting conduit from said intake chamber to said discharge chamber delaying travel of fluid under explosive pressures from said inlet chamber to said outlet chamber until said valve is closed.

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