J. A. HEIDBRINK.

ANESTHETIC APPARATUS.

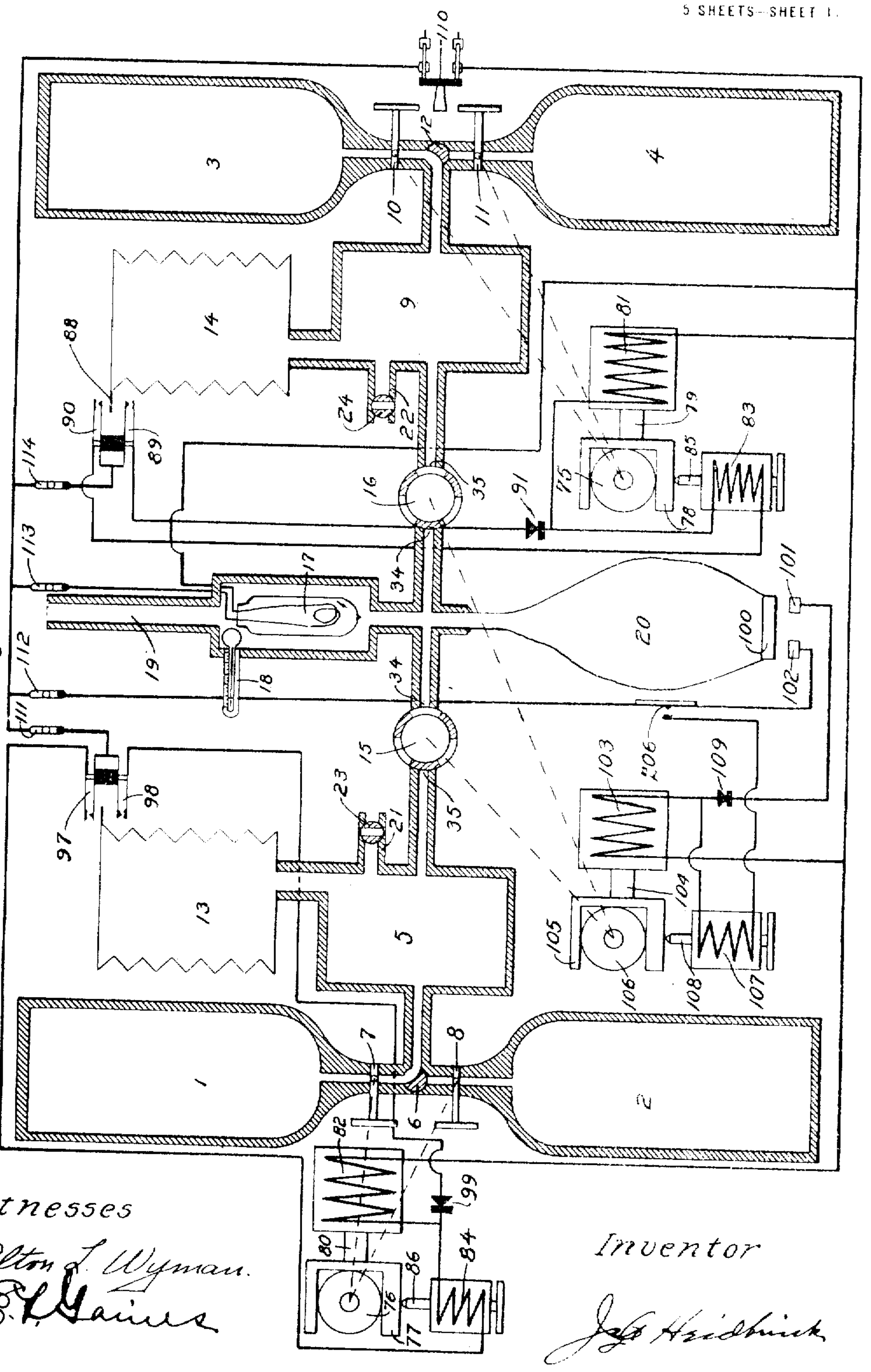
APPLICATION FILED NOV. 23, 1911.

1,309,686.

Patented July 15, 1919.

5 SHEETS—SHEET 1.

Fig. 1



Witnesses

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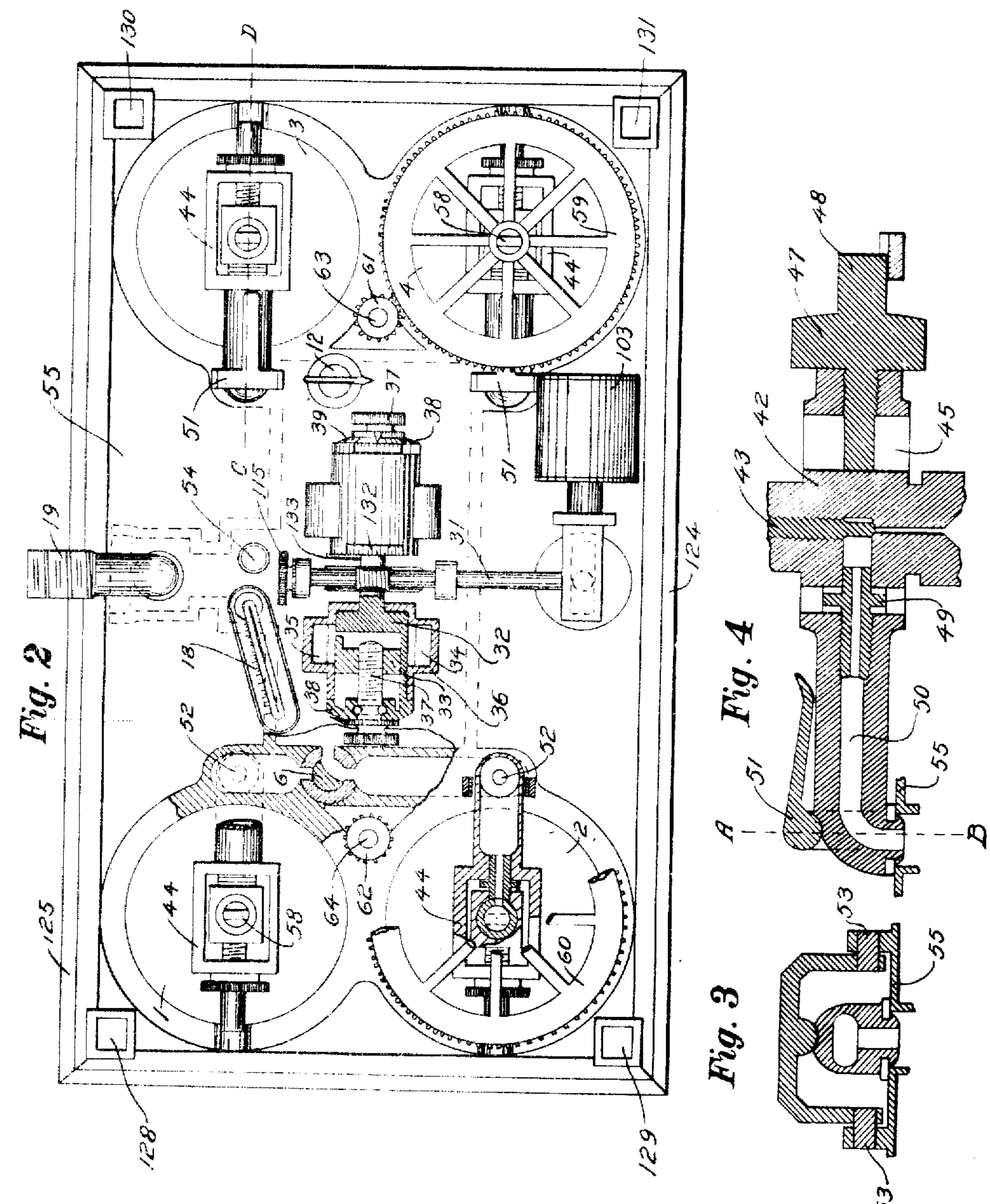

Fig. 2

Fig. 3

Fig. 4

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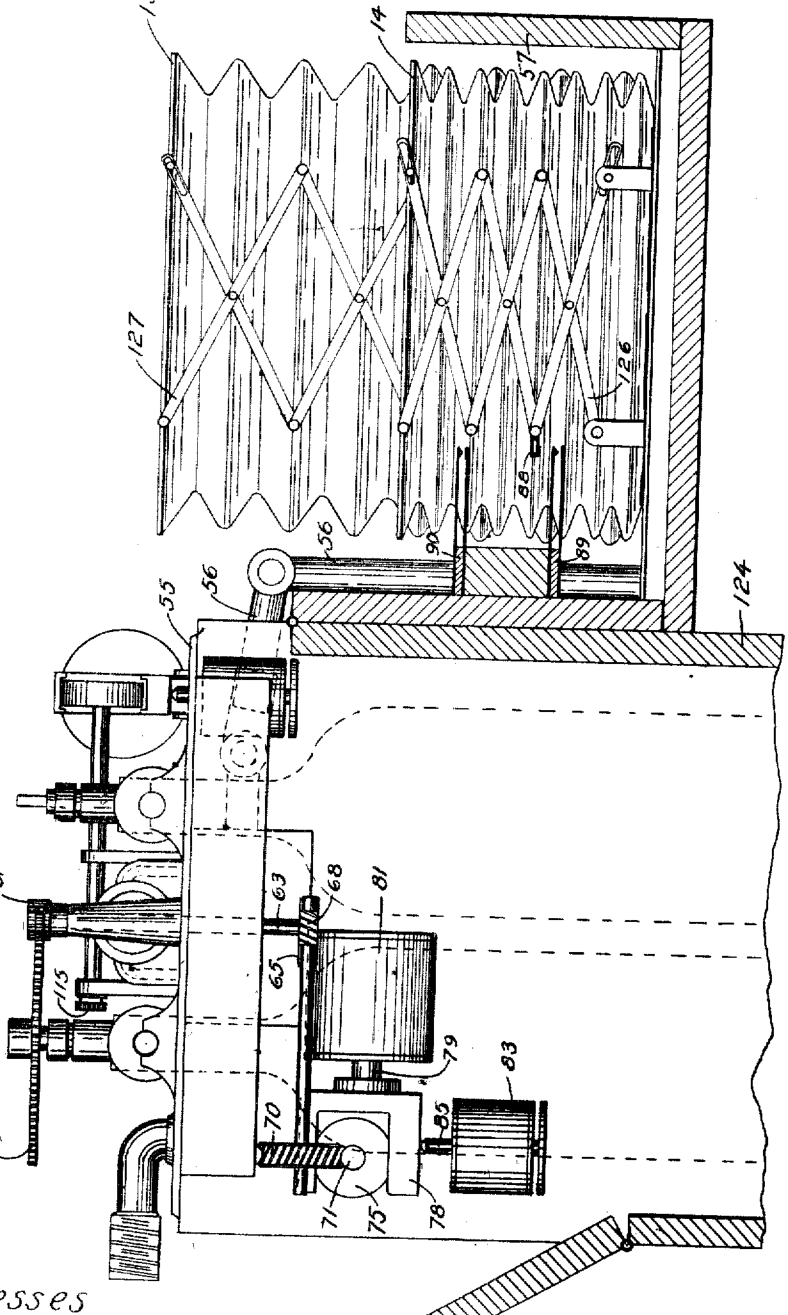
Fig. 5



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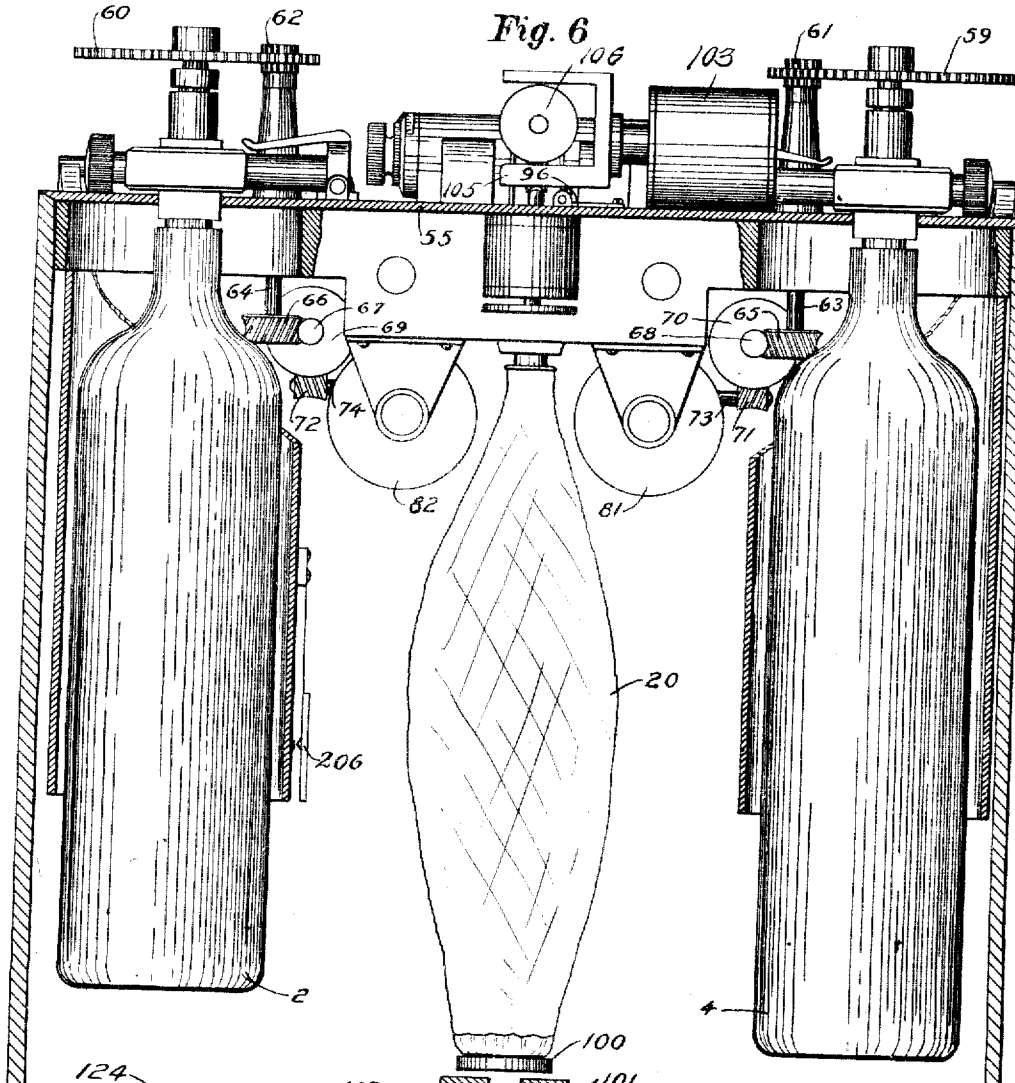
5 SHEETS—SHEET 4.

Fig. 6



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5 SHEETS—SHEET 5.

Fig. 7

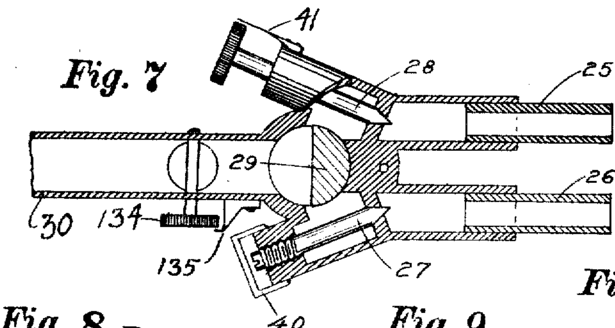


Fig. 8

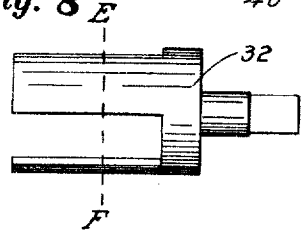


Fig. 9

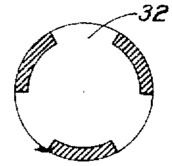


Fig. 10

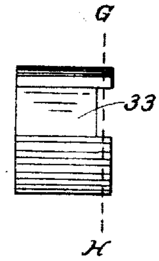


Fig. 11

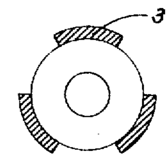


Fig. 12

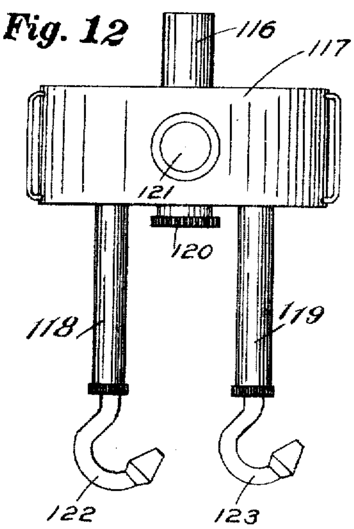
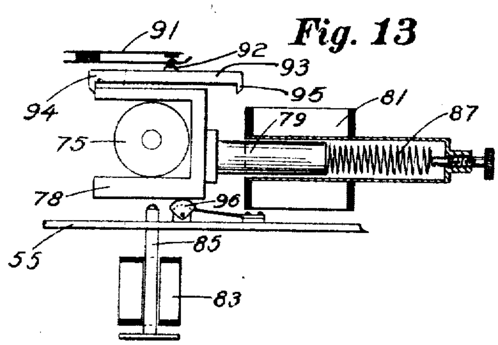


Fig. 13



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UNITED STATES PATENT OFFICE.

JAY A. HEIDBRINK, OF MINNEAPOLIS, MINNESOTA.

ANESTHETIC APPARATUS.

1,309,686. Specification of Letters Patent. Patented July 15, 1919.

Application filed November 23, 1911. Serial No. 662,066.

To all whom it may concern:

Be it known that I, JAY A. HEIDBRINK, a citizen of the United States, and a resident of Minneapolis, in the county of Hennepin and State of Minnesota, have invented certain new and useful Improvements in Anesthetic Apparatus, of which the following is a specification.

My invention relates to apparatus for producing a state of anesthesia by the inhalation of a mixture of nitrous-oxid (N_2O) and oxygen (O). With the proper mixture of these two gases anesthesia may be produced and maintained for a length of time sufficient to perform the most delicate and difficult surgical or dental operation with a minimum of nausea or other bad effects resulting and with no danger to the life of the subject.

The vital point in this method is to secure the proper quantitative relation of the gases in the mixture administered, it being the general opinion that the oxygen should constitute from six to ten per cent. of the total mixture. This per cent. may vary with different subjects but with any subject it is always of the utmost importance to know at all times the exact mixture being administered.

It is the object of this invention to provide a reliable apparatus whereby it will be possible to deliver a mixture of a predetermined volume and in which mixture the gases will bear an exact predetermined relation to each other. It is also the object of this invention to provide means for indicating at all times the exact quantitative relation of the gases in the mixture delivered and means for changing that relation to another predetermined relation at will. Another object is to provide means for indicating the total volume of the mixture delivered and for regulating the total volume delivered without changing the proportion of gases in the mixture. Other objects of this invention are to provide means for automatic constant pressure control of the gases before mixing, means for electrically warming the gases, means for indicating the temperature of the mixture delivered and various details of construction as will be explained farther on.

To enable those skilled in the art to which my invention relates to more fully understand the construction, operation and advantages thereof, a particular embodiment is more fully set forth in the following specification and illustrated in the accompanying drawings in which like figures of reference indicate similar parts throughout the several views.

In the drawing—

Figure 1. is a diagrammatic view of my apparatus showing the pipes, wiring, etc.

Fig. 2. is a top plan view of my apparatus with the cover removed, parts being broken away and parts in horizontal section.

Fig. 3. is an enlarged vertical section on the line A—B, Fig. 4.

Fig. 4. is an enlarged vertical section on one of the clamping attachments and a part of one of the gas cylinder valves taken on the line C—D Fig. 2.

Fig. 5. is a partly broken away, partly sectional end view showing the door on the front of the case partly open and the case cover open containing the bellows partly inflated, parts also being shown in dotted lines for the sake of clearness.

Fig. 6. is a side elevation partly in section and partly broken away.

Fig. 7. is a partly sectional and partly broken away view of the mouth inhaler.

Fig. 8. is an enlarged elevation of a part of one of the total flow or mixing valves and will be explained further on.

Fig. 9. is a section on the line E—F in Fig. 8.

Fig. 10. is an enlarged elevation of another part of one of the total flow valves.

Fig. 11. is a section on the line G—H in Fig. 10.

Fig. 12. is an elevation of a nasal inhaler.

Fig. 13. is a diagrammatic view of one of the electrical valve operating mechanisms.

As will be seen in **Fig. 1.**, two gas cylinders 1, 2, containing compressed nitrous-oxid are connected to the expanding chamber 5. In the neck of each cylinder 1, 2, is interposed a small regulating valve 7, 8, to control the flow of gas therefrom.

At the opposite side of the apparatus are cylinders 3, 4, containing pure oxygen, which are connected to their expanding chamber 9, through the valves 10, 11, in their necks, and the three-way valve 12, in the same manner the nitrous-oxid cylinders 1, 2, are connected to their expansion chamber 5, through their valves 7, 8 and the three-way valve 6. A small pointer on each three-way valve indicates the cylinder being used.

Each of the expansion chambers 5, 9, is directly connected to an individual gas holder in the form of a bellows 13, 14. These bellows are identical in construction and are designed to maintain equal pressure in the expansion chambers 5, 9. From these expansion chambers 5, 9, and the bellows 13, 14, the gases pass through the total flow or quantitative proportion valves 15, 16, and around the warming lamp 17, and thermometer 18, to the main discharge pipe 19. From this main discharge pipe a hose not shown conducts the mixture to the inhaler attached to the subject.

A gas bag 20, is provided to hold a sufficient quantity of the mixture to enable the subject to breathe regularly and easily at all times and also to relieve any excessive pressure that might pass the total flow valves 15, 16, it being desirable to have the mixture at such a slight pressure that it will only flow through the discharge pipe 19, when the subject being anesthetized inhales.

Two pipes 21, 22, together with their cut-off valves 23, 24, connect with the expansion chambers 5, 9. Tubes, not shown, connecting with these pipes 21, 22, pass to the mouth inhaler shown in Fig. 7, where they connect with the two pipes 25, 26, leading through the regulating valves 27, 28, and the cut-off valve 29, to the mouth discharge pipe 30, one end of which is placed in the open mouth of the subject. This mouth inhaler is especially designed for operations in the mouth and head when it is necessary to keep the subject's mouth open during the operation as in dental work. The subject may be anesthetized with a nasal inhaler even though the mouth be open, the subject's self control causing nasal breathing even in a prolonged state of analgesia; however when a complete state of anesthesia has been produced the subject is liable to breathe through the mouth and provision is thus made to keep the mouth filled at all times with the proper mixture of anesthetizing gases in order to prevent the subject's breathing a sufficient amount of air to counteract the anesthetic.

The regulating valves 27, 28, in the mouth inhaler serve to regulate the quantitative mixture of the gases since they are taken from the expansion chambers 5, 9, and do not pass through the main mixing valves 15, 16. In this instance the gases are taken directly from the expansion chambers in order to get a sufficient pressure to cause them to flow into and fill the mouth of the subject at all times.

If one of the cylinders 1, 2, containing nitrous-oxid should become exhausted during an operation the three-way valve 6, may be turned to instantly place the other cylinder in operation. The three-way valve 12, may be used to change the oxygen cylinders in the same manner.

The two total flow valves 15, 16, which are also the main mixing valves, are controlled by a common shaft 31, (Fig. 2.) and operate together as one valve. Each of these valves 15, 16, is made up of two main parts 32, 33, which are cylindrical in shape each having three equal slots and three extensions. Each of the three extensions around the periphery of the two parts 32, 33, fit snugly into the slots in the other part and when put together form a closed hollow cylindrical valve which entirely closes both of the ports 34, 35 in the valve chamber 36 (Fig. 2.). A regulating screw 37, passing through the valve chamber head 38, engages with its threaded portion the threaded center opening of the part 33 of the valve which is thereby longitudinally movable in the chamber 36. It will thus be seen that when the screw 37, is turned the valve part 33, will be withdrawn slightly from the valve part 32, leaving three open ports around the periphery of the valve as shown best in Fig. 1. Each of these ports will extend around one-sixth of the circumference of the valve, or sixty degrees. The width of these ports depends upon the amount the screw 37, is turned, its pitch, etc. By turning the shaft 31, together with the valve parts two of these openings will be brought opposite the two ports 34, 35 in the valve case thus permitting the gas to flow through the valve.

The quantitative proportion of the gases in the mixture is governed by the distance the valve parts 32, 33 are apart while the total flow is governed by the distance the valve is turned in the port openings 34, 35, and indicated on the scale 132, by the pointer 133 attached to the common shaft 31. Both valves 15, 16, are turned by the common shaft 31. If it is desired to deliver a mixture of ten parts of nitrous-oxid to one part of oxygen the opening between the valve parts 32, 33 of the nitrous-oxid valve 15, is made ten times as large as the opening between the valve parts of the oxygen valve 16.

The valve chamber head 38, is integrally connected to the valve part 32, and shaft 31, and revolves therewith. A small indicator point on the screw 37, shows at all times by means of a scale 39 on the valve chamber head 38, the proportionate amounts of opening of the ports of the valves, and since the two gases are at the same pressure this will give the exact mixture delivered.

Although two of these adjusting screws 37, are shown (one for each valve 15, 16,) only one will in practice need to be used. The nitrous-oxid valve will be fixed at a certain opening (*i. e.* a certain distance between the valve parts), the scale and indicator point of the oxygen valve indicating the percentage of oxygen in the total mixture delivered.

In order to determine the quantitative mixture of the gases delivered by the mouth inhaler the short screw valve 27, is opened a certain amount and a cap 40, placed over it to prevent its being tampered with. The percentage of oxygen in the mixture is then regulated by the hand valve 28, and indicated by the pointer 41. A butterfly valve 134, in the mouth pipe 30, serves to regulate the amount of mixture delivered, the amount being indicated by a pointer 135.

Nitrous-oxid and oxygen may be purchased on the open market compressed in cylinders 1, 2, 3, 4, as shown. These cylinders have a standard square neck 42, (Fig. 4.) and are provided with a needle valve 43, which may be operated by a small hand or gear wheel. As it is of the utmost importance to keep a constant supply of both nitrous-oxid and oxygen during a prolonged operation it is advisable to have several extra cylinders on hand to replace any that may be emptied. As my apparatus is provided with means for holding two of each of the cylinders, when one of either kind is discharged totally the other may be turned on and used while the discharged cylinder is being replaced by a full one.

It is of extreme importance that all such changing must take but little of the operator's time and therefore clamping attachments 44, 44 (Fig. 2.) are provided for each of the cylinders in use in the apparatus and extra ones provided for all extra cylinders on hand.

This clamping attachment comprises a frame or yoke 45, (Fig. 4.) which goes around the square neck 42, of the cylinder; a clamping screw 47, with an extension 48, at its outer end to support a part of the weight of the cylinder when in use; a nipple 49, extending into the opening in the square neck 42 of the cylinder and a curved hollow neck 50, extending outward from the nipple 49, and adapted to be quickly clamped in place on the apparatus by means of a clamp 51, one of which is located over one of each of the discharge openings 52, 52, in the machine proper. Gaskets of rubber or some similar material are provided to make tight joints around the nipple 49, and the outer end of the curved neck 50. Thus the clamp 51, may be quickly raised, the drum and clamping attachment lifted out, and another drum or cylinder and clamping attachment clamped in position, in a very short time. The clamp 51, is swiveled on its bearings 53, 53, as shown in Fig. 3.

The gases on expanding produce a very low temperature and in case of a long period of anesthesia would irritate the subject's air passages if means were not provided for warming the mixture before it passes the inhaler. For this purpose an incandescent electric light 17, is placed in such a position that the mixture must pass over and around it and in so doing absorb sufficient heat from the light bulb to warm the gases to a normal temperature. A small opening 54, (Fig. 2.) is made in the top covering plate 55, of the apparatus directly over a portion of the light bulb and provided with a glass closure to enable the operator to know at all times that the light is burning.

A small thermometer 18, with its bulb interposed in the warming chamber is always in plain view of the operator showing at all times the exact temperature of the mixture as it passes to the inhaler.

It is very evident that in order to obtain a mixture of a predetermined quantitative value by means of the relative sizes of openings in the main valves 15, 16, the pressure of the nitrous-oxid in the expansion chamber 5, must always be exactly equal to the pressure of the oxygen in the expansion chamber 9. In order to maintain equal pressure in these two chambers 5, 9, the two pair of bellows are provided and are always connected directly to the expansion chambers by hinged telescoping pipes, one of which 56, is shown in Fig. 5. partly in dotted lines. The only object of the hinges and telescoping arrangement is to provide means for carrying the gases into the hinged lid where the bellows are located.

In order to maintain a normal amount of the gases in the bellows at all times an automatic control is arranged to govern the flow of the gases through the valves 7, 8, 10, 11, in the necks of the cylinders. The valves 43, (shown more plainly in Fig. 4) have a large stem extending upward. These stems 58, 58, (Fig. 2) are adapted to be engaged by hand or gear wheels 59, 60, which in turn are engaged by small pinions 61, 62 integrally mounted on the upper ends of small shafts 63, 64. These pinions are so arranged as to engage the wheels 59, 60, when placed in position to operate either one of the two cylinders at each end of the apparatus. Thus, if the three-way valve 6, were turned to discharge from the cylinder 1, the wheel 60, would then be placed on the valve stem 58, of the same cylinder 1. On the lower ends of the pinion shafts 63, 64, (Fig. 6) are worm wheels 65, 66 which are engaged by worm wheels 67, 68, mounted integrally to rotate with other worm wheels 69, 70. These worm wheels 69, 70, are engaged by worm gears 71, 72, which are integrally mounted on shafts 73, 74, on the opposite ends of which are mounted friction wheels 75, 76, one of which 75, mounted on the shaft 73, with the worm gear 71, is shown in Fig. 5.

These friction wheels 75, 76, are operated by the yokes, 77, 78, and the armatures 79, 80, 85, 86, as is shown more plainly in Fig. 13. The coil spring 87, pushing against the armature 79, keeps it normally at its outer limit of travel as shown in the drawing. When the bellows 14, is partially exhausted the stop 88, (Figs. 1 and 5) comes in contact with the upper contact spring of the switch 89, pressing it against the lower contact spring and closing the electrical circuit through the solenoid 81, thus drawing in the armature 79, and yoke 78.

The weight of the heavy yoke 78 resting upon the upper part of the friction wheel 75, causes it to revolve a part of a revolution and thus operating the train of worm wheels and gears to turn the pinion 61, and thus open one of the valves 10, 11, in the cylinder necks according to which cylinder is in use.

Another switch 91, located near the yoke 78, is interposed in circuit with the solenoid 81, and operated by a small projection 92, on the slide 93. This slide 93, is operated by the yoke 78, striking upon small projections 94, 95, at either end of the slide 93.

As the armature is drawn in to its inner limit of travel the yoke 78, striking the projection 95, on the slide 93, moves it to the right. The projection 92, on the slide 93, being thus withdrawn from contact with the lower spring of the switch 91, the springs of this switch are permitted to come apart and open the solenoid circuit. The armature 79 is thus released and the coiled spring 87, which has been compressed by the indrawn armature now pushes the armature out again to its normal position. As the armature 79, is pushed out by the spring 87, the outer end of the yoke 78, striking against the projection 94, moves the slide 93, back to its normal position causing the contacts of the switch 91, to again close the circuit operating the solenoid 81, and thus to repeat the cycle of operations until the oxygen liberated by the opening of one of the valves 10, 11, in the cylinder necks raises the bellows 14, with its stop 88, high enough to release the upper spring of the switch 89, and open the solenoid circuit and stop the action of the armature 79. It should be noted in the operation of the armature 79, and yoke 78, that as the spring 87 pushes the armature to its outward position, the small cam 96, operating by friction due to the weight of the yoke turns from the position shown in Fig. 13 to that shown in Fig. 6 thus raising the yoke high enough that its upper arm does not rest upon the friction wheel 75, yet not so high that its lower arm comes in contact with the under side of the wheel 75. In this way no impulse is given the wheel on the outward stroke of the armature. The cam 96 is assisted by a leaf spring engageable beneath a portion thereof in its lifting movement, said spring being compressed by the turning of the eccentric through friction of the arm 78 upon the same when said arm is moved under the influence of solenoid 81.

When the bellows 14, is nearly filled with oxygen the stop 88, coming in contact with the lower spring of the switch 90, causes it to come in contact with the upper contact spring and thus close the double solenoid circuit as is plainly shown in Fig. 1, operating the lower solenoid 83. at the same time the upper solenoid 81, is operated. The armature 85, of the lower solenoid 83, carries a small roller at its upper end which is pressed against the under side of the yoke 78, when both solenoids are operated and raising the yoke until its lower arm presses against the under side of the friction wheel 75, thus causes the friction wheel to be turned in an opposite direction to that in which it turns when only the upper solenoid 81, is operated.

The two solenoids operate together in this manner until the oxygen is turned off enough to permit the bellows 14 to lower and release the switch contacts 90, which, coming apart, open the circuit and thus stop the action.

The bellows 13, regulates the flow of nitrous-oxid from the cylinders 1, 2, in the same manner by means of its solenoids 82, 84, armatures 80, 86, yoke 77, friction wheel 76, and worm gear train to the valves 7, 8, and the switches 97, 98, 99, corresponding to the switches 89, 90, 91, of the oxygen side.

After the gases have passed the mixing valves 15, 16, they are at liberty to fully expand by flowing freely into the light suspended bag 20, and thus practically all pressure is relieved, the bag 20, also acting as a reservoir to supply the intermittent breathing of the subject. To the lower part of this supply bag 20, is attached a light metal plate 100, which, when the bag is almost empty, rests upon the two switch contacts 101, 102, and bridging across between them closes the circuit through the solenoid 103, which operates its armature 104, and yoke 105, and friction wheel 106, together with a suitable worm gear train to open the total flow or main mixing valves 15, 16, in the same manner that the solenoids 81, 82, open the nitrous-oxid and oxygen valves 7, 8, 10, 11.

The switch thus closed by the plate 100, corresponds in its action in its circuit to the switches 89, and 98, in their respective circuits already described. When the bag 20, is filled it presses lightly against the switch 206, shown plainly in Fig. 6 and closing it, causes the solenoids 103, 107, to be operated together in the manner already described in the operation of the oxygen regulating solenoids 81, 83, and thus slowly close the mixing valves 15, 16, until the bag 20, becoming partly exhausted releases the switch 206. The switch 109, in its functions corresponds to the switches 91 and 99 in their functions.

Thus the regulation of the valves governing the pressure and the flow of the mixture is made entirely automatic and does not require any of the operator's attention. The electrical current may be derived from any convenient source and is admitted to the apparatus by a double pole switch 110, and may be entirely disconnected by opening the switch 110. The solenoid set circuits and also the lamp circuits are controlled by individual single pole switches 111, 112, 113, 114, by means of which any solenoid set or the lamp may be turned off at will.

The cylinder valves 7, 8, 10, 11, may be operated by hand by raising the gear wheels 59, 60, out of engagement with the small pinions 61, 62. In the same manner the main valves 15, 16, may be operated by means of the thumb nut 115, (Fig. 5) mounted on the same shaft with the friction wheel 106. Any desired form of inhaler may be used, a nasal inhaler being shown in Fig. 12. This inhaler is attached to the subject's forehead and a hose from the main discharge pipe 19, on the machine proper to the intake pipe 116, on the inhaler. The mixture passing through the intake pipe 116, enters the chamber 117, which is provided with two flexible outlet pipes 118, 119, an air valve 120, and an exhaust valve 121. These flexible outlet pipes 118, 119, are provided with curved nostril pieces 122, 123, which are swivel connected to the flexible outlet pipes in such a manner as to be fitted snugly to the subject's nostrils.

The entire apparatus is inclosed in a carrying case 124, provided with a deep hinged cover 57, in which are located the bellows 13, 14, in such a manner that they may be folded into the cover when it is closed. These bellows are guided in their movements by light lazy-tongs devices 126, 127, and may carry weights to give variations of pressure to the contents if desired.

Four telescoping legs 128, 129, 130, 131, (Fig. 2) are provided at the corners of the case 124, which slide up into the case when not in use. A door 125, on the front of the case 124, may be opened when the apparatus is in operation so that all operating parts will always be in full view of the operator.

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

1. An anesthetic administering apparatus comprising means including delivery valves for producing a mixture of gases of a predetermined proportion, an expansible member for receiving the mixture as the same is delivered from the valves, and a system of solenoids controlled by movement of said expansible member for controlling the valves.

2. A gas administering machine comprising a plurality of sources of fluid supply under pressure, means for producing a mixture of such gases in predetermined proportions, means for delivering such mixture as the same is produced, and means for controlling and varying at will the rate of production and deliverance of said mixture while the relative amounts of gases in the mixture are kept constant.

3. A gas administering machine comprising a plurality of sources of fluid supply under pressure, means for producing a mixture of such gases in predetermined proportions, means for delivering such mixture as the same is produced, and means for controlling and varying at will the rate of production and deliverance of said mixture while the relative amounts of gases in the mixture are kept constant, said controlling means being provided with an indicating device showing the quantity of mixture being produced.

4. A machine for mixing and administering anesthetics comprising a plurality of gas supplies each separately connected to a supply line, an expansion chamber in each of said connections, valves in said line, a flexible chamber in said line capable of inflation, and means operative therefrom for operating said valves while maintaining a constant proportion of said gases in different volumes.

5. A machine for mixing and administering anesthetics comprising a plurality of fluid retainers, valves for said retainers, expansion chambers having connection with said valves, and means operative from the expansion of said chambers for operating said valves to provide and deliver a variable flow of anesthetic at a constant proportion and means for indicating the flow and the proportion.

6. In a device of the class described, a series of fluid and gas retainers, valves and flexible expansion chambers having connection with said retainers, means operative from the expansion of said chambers for operating said valves to provide a mixture of varying proportion, and an indicator for indicating the proportion.

7. In anesthetic apparatus arranged to be equipped with a compressed gas cylinder, a

regulating valve in communication with the gas supply from such cylinder, an expansible elastic gas bag constituting a variable-pressure reservoir for a relatively large volume of gas at a relatively low pressure in free communication with the gas-administering passages of the apparatus, and means governed by the inflation of such bag for controlling said regulating valve.

In testimony that I claim the foregoing as my own, I have hereunto affixed my signature in the presence of two subscribing witnesses.

JAY A. HEIDBRINK.

Witnesses:
CARL H. JOHNSON,
EARL J. GAINES.