July 17, 1956 H. M. KIRSCHBAUM 2,754,819

APPARATUS FOR AUTOMATICALLY ADMINISTERING ANESTHETICS

Filed June 29, 1953 2 Sheets-Sheet 1

FIG.1.

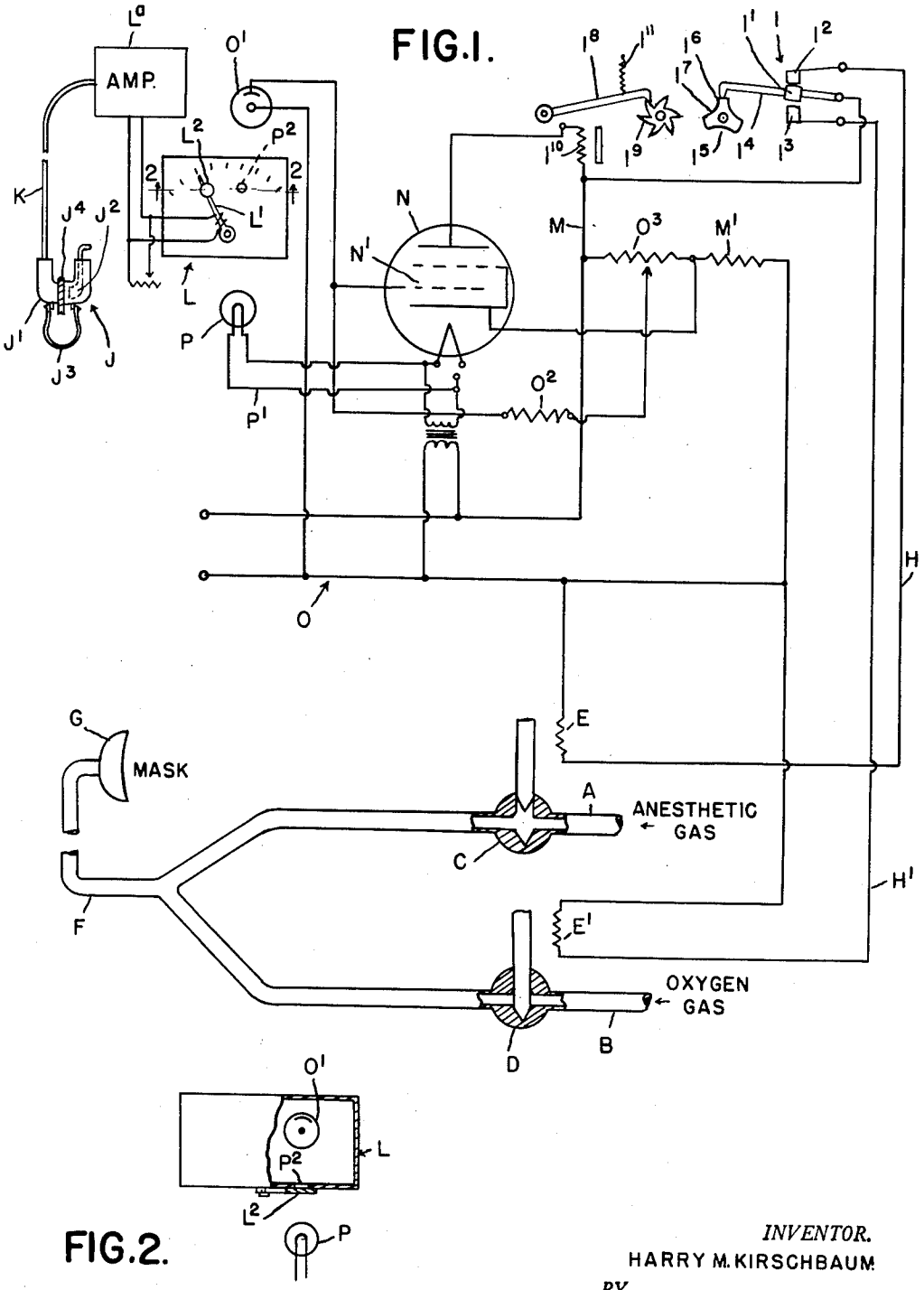





FIG.2.

INVENTOR.
HARRY M. KIRSCHBAUM
BY
Whittemore Hulbert & Belknap
ATTORNEYS

July 17, 1956 H. M. KIRSCHBAUM 2,754,819

APPARATUS FOR AUTOMATICALLY ADMINISTERING ANESTHETICS

Filed June 29, 1953 2 Sheets-Sheet 2

FIG.3.

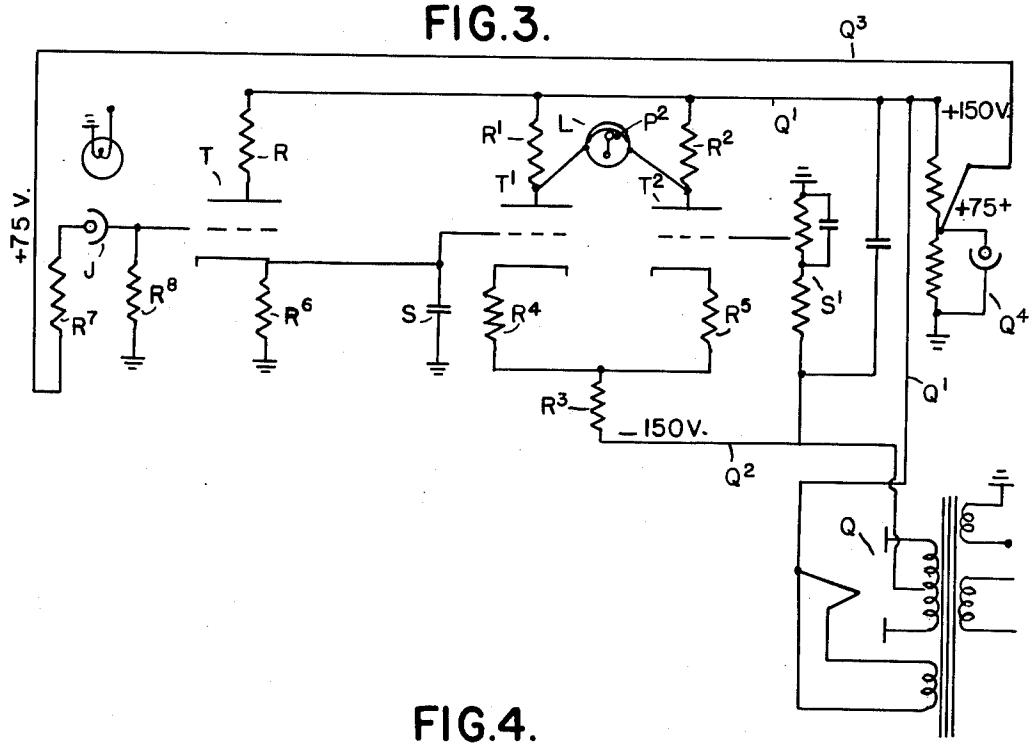
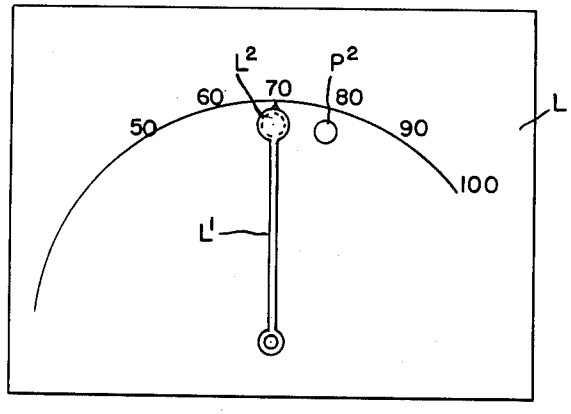



FIG.4.




*INVENTOR.*

HARRY M. KIRSCHBAUM

*BY*

Whittemore Hulbert & Belknap

ATTORNEYS

United States Patent Office 2,754,819 Patented July 17, 1956



2,754,819

# APPARATUS FOR AUTOMATICALLY ADMINISTERING ANESTHETICS

Harry M. Kirschbaum, Detroit, Mich.

Application June 29, 1953, Serial No. 364,980

4 Claims. (Cl. 128—188)

In general anesthesia produced by the administration of gaseous anesthetics, the oxygen content of the blood of the patient is diminished and if carried beyond a certain point is dangerous, if not fatal. Correction of this condition can be made by administering oxygen gas, but it is essential that this should be performed without delay.

My invention relates to automatic means for administering a gaseous anesthetic, and it is the primary object of the invention to accomplish this without danger of diminishing the oxygen content in the blood of the patient beyond a predetermined point. This application forms a continuation-in-part of my pending application, Serial No. 171,869, filed July 3, 1950, and now abandoned.

It is a further object to obtain a construction which alternatively administers oxygen gas, and in which the change from one gas to the other is automatically effected by means responsive to the condition of the patient.

The invention therefore consists in the construction as hereinafter set forth.

In the drawings:

Fig. 1 is a diagram of the apparatus;

Fig. 2 is a cross section through the control means on line 2—2, Fig. 1;

Fig. 3 is a diagram for the amplifying means for the current directly responsive to the condition of the patient; and

Fig. 4 is an enlarged view of the calibrated meter and index forming the trip mechanism.

Generally described the apparatus comprises a supply of anesthetic gas, a supply of oxygen gas, a hood or other means for administering gas to the patient, a connection between each of said supplies and said hood, valve means reversable in successive operation thereof for simultaneously opening one of said connections and closing the other, and vice versa, closing the first and opening the other, and means automatically responsive to the condition of the patient with respect to oxygen content of the blood for timing said successive reversal of said valve means.

*Gas supply and controlling valve mechanism*

As shown in Fig. 1, A is a conduit leading from a container (not shown) for the anesthetic gas and B is a conduit from an oxygen supply. C and D are valves, respectively, in the conduits A and B, which valves are biased to automatically close but are opened by electromagnetic means such as solenoids E and E'. F is a conduit connected with the conduits A and B beyond the valves and leading to a mask, or other device, G for administering the gas to the patient. The solenoid E of the valve C is included in an electric circuit H and solenoid E' of the valve D is included in electric circuit H'. Both circuits are controlled by a step-relay I so constructed that when one circuit is closed the other will be open and vice versa. As diagrammatically illustrated the step-relay I has a movable contact I' and a pair of contacts $I^2$ and $I^3$ on opposite sides thereof. The contact I' is mounted on a lever $I^4$, the free end of which is in contact with a rotary cam $I^5$ having



alternating raised and depressed portions $I^6$ and $I^7$. $I^8$ is a pawl lever engaging a ratchet wheel $I^9$ coupled by any suitable means (not shown) to turn the cam step by step, each actuation advancing it a distance equal to that between the adjacent raised and depressed portions. An electromagnet $I^{10}$ actuates the pawl lever to turn the ratchet wheel $I^9$ one notch and a spring $I^{11}$ returns it to engage another notch of the ratchet wheel. The arrangement is such that, when the lever $I^4$ rests upon a projection $I^6$ of the cam, the contact I' will engage the contact $I^2$ to close the electric circuit H, thereby energizing the solenoid E to open the valve C. On the other hand, when the lever $I^4$ engages a depression $I^7$ of the cam, the contact I' will engage the contact $I^3$ to close the electric circuit H' energizing solenoid E' and opening the valve D. This movement simultaneously deenergizing the solenoid E to close the valve C and thus, when one valve is open, the other is always closed.

*Control means responsive to condition of patient*

The control means J, which is applied to the patient, is similar to that forming the subject matter of my former Patent No. 2,414,747. It consists of a photoelectric cell J' and an electric lamp $J^2$ for placing on opposite sides of a portion of the animal tissue through which blood is circulating, such as the lobe $J^4$ of an ear. A spring $J^3$ clamps the member J in position so that the beam from the lamp passes through the tissue and the blood circulating therein. Oxygenized blood is more transparent to the beam than blood deficient in oxygen so that electric current generated in the photoelectric cell will vary in volume in correspondence to oxygen content. The cell current passes through conductors K to an amplifier $L^a$ and meter L in which latter an index hand L' is moved in opposite directions corresponding respectively to increase and decrease in the amplified current volume.

*Control circuit for the relay I*

An electric circuit M from a source of A. C. current includes a resistor M', an electromagnet $I^{10}$ for the relay I, and also a thyatron tube N having a grid N'. A branch electric circuit O including a photoelectric tube O', a resistor $O^2$ and a potentiometer $O^3$ is connected to the grid N' and is so adjusted that when a light beam impinges on the tube O' the grid N' will be maintained a potential which is negative with respect to the cathode of said tube, thereby preventing flow of current through the circuit M. A lamp P in a branch electric circuit P' is used for forming the beam impinging on the photoelectric tube O', and these elements are arranged in connection with the meter L on opposite sides of the plane of movement of the index hand L'. Preferably the photoelectric tube is placed within the casing of said meter and the lamp P outside the same, the light passing through an aperture in the casing. Also, the positioning is such that a shield $L^2$ on the index hand L' will momentarily intercept the beam of light at a selected point $P^2$ in the travel of the index hand in either direction. Thus, when the shield intercepts the beam, flow of current through the tube O' is cut off and the negative potential of the grid N' will change to the potential of the cathode of said tube. This immediately starts flow of current through the circuit M and operates the step-relay I to close one of the circuits H, H' and open the other. The continuing movement of the index hand removes the shield reestablishing the light beam and again placing a negative potential on the grid N', thereby stopping flow of current through the tube N. The valves C and D are each biased to close and this will occur when their respective circuits H and H' are opened. It will thus be apparent that the interception of the light beam by

the shield $L^2$ forms an instantaneous trip mechanism for reversing the valves C and D.

As the modification in the oxygen content of the blood takes place in the lungs of the patient and, as a time interval is required for the modified blood to reach the instrument J, there will be a lag in the operation of the valves. However, by properly setting the instrument, the valves will be reversed before the oxygen content is dangerously low to cut off the anesthetic gas and supply oxygen. After such reversal the index L' and shield $L^2$ will continue to move in the same direction for a brief interval, which will again expose the tube O' to the light beam thereby cutting off current in the electromagnet $I^{10}$ and permitting the spring $I^{11}$ to return the pawl lever for engaging another notch in the ratchet wheel $I^9$. Upon the return movement of the index L' (to the right in Fig. 1) the shield $L^2$ will once more cut off the light beam and as a result the magnet $I^{10}$ will be energized to actuate the pawl lever $I^8$ and move the ratchet wheel $I^9$ and cam $I^5$. In brief the overrunning of the index and shield merely returns the pawl lever to engage another notch, and it is only the return movement of said index and shield which produces another actuation of the cam. It will thus be understood that any fluttering action of the valves is avoided and each successive actuation is spaced by a timed interval from a preceding actuation.

The amplifier for the variable current from the cell J' may be of any suitable construction but, as specifically shown in Fig. 3, is as follows: Q is a transformer and rectifier from which extend positive and negative leads Q' and $Q^2$, each preferably of a potential of 150 volts. A third lead $Q^3$ from a voltage regulator $Q^4$ has a positive potential of 75 volts. T, T' and $T^2$ are triode tubes, the plates of which are connected through suitable resistors R, R' and $R^2$ with the lead Q'. The cathodes of the tubes T' and $T^2$ are connected to the negative lead $Q^2$ through resistors $R^3$, $R^4$ and $R^5$. The plate of the tube T is connected through a resistor R with the lead Q' and the cathode of said tube is connected to the grid of the tube T' and being also connected to a grounded resistor $R^6$ and a capacitor S. The photo-cell J has connected thereto through a resistor $R^7$ the lead $Q^3$ and also connects to the grid of the tube T, which latter has a ground leak resistor $R^8$. A potentiometer S' connected to the lead $Q^2$ forms a means for varying the voltage on the grid of the tube $T^2$ so as to balance this up with the tube T. The meter L is in a bridge connection between the plates of the tubes T' and $T^2$.

With the hook-up just described, adjustment may be made prior to the administration of the anesthetic to compensate for variables, such as individual variation in light transmission through the ear of the patient to the photo-electric cell J. The meter L is calibrated from 50 to 100 indicating progressive decrease in oxygen content of the blood. An aperture in the wall of the meter casing located at the point $P^2$ which is near to eighty of the calibrations permits light from the lamp P to impinge on the photo-electric tube O', but as before explained, the light beam will be momentarily cut off when the shield $L^2$ of the index L' registers with said aperture. This forms the trip means timing the reversals from one gas to the other.



What I claim as my invention is:

1. Apparatus for administering anesthetics comprising a gas administering mask for the patient having connections thereto, respectively for an anesthetic gas and for oxygen, valve means controlling said connections adapted to open one and close the other and alternately to open the latter and close the former, means for operating said valve means to reverse the same in each successive operation thereof, and means automatically responsive to the condition of the patient as to oxygen content of his blood for timing said successive operations.

2. The construction as in claim 1 in which said means responsive to the condition of the patient varies an electrical current, a meter for said current including an index hand, means for directing a beam of light across the path of said hand located at a predetermined point in the range of movement thereof, a photo-electric tube in the path of said beam controlling said operating means, and a shield on said index hand for momentarily interrupting said light beam, thereby actuating said valve operating means.

3. The construction as in claim 2 in which said meter has an enclosing casing also enclosing said photo-electric tube with an aperture in said casing for the passage of said light beam therethrough from an outside source, said shield momentarily registering with said aperture in the movement of said index hand.

4. The construction as in claim 2 provided with amplifying means for the variable current in advance of said meter.

**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 2,185,067 | Sholes | Dec. 26, 1939 |
| 2,414,747 | Kirschbaum | Jan. 21, 1947 |
| 2,442,462 | Kirschbaum | June 1, 1948 |