Dec. 1, 1931. P. DRINKER ET AL 1,834,580

RESPIRATION APPARATUS

Filed July 23, 1929 2 Sheets-Sheet 1

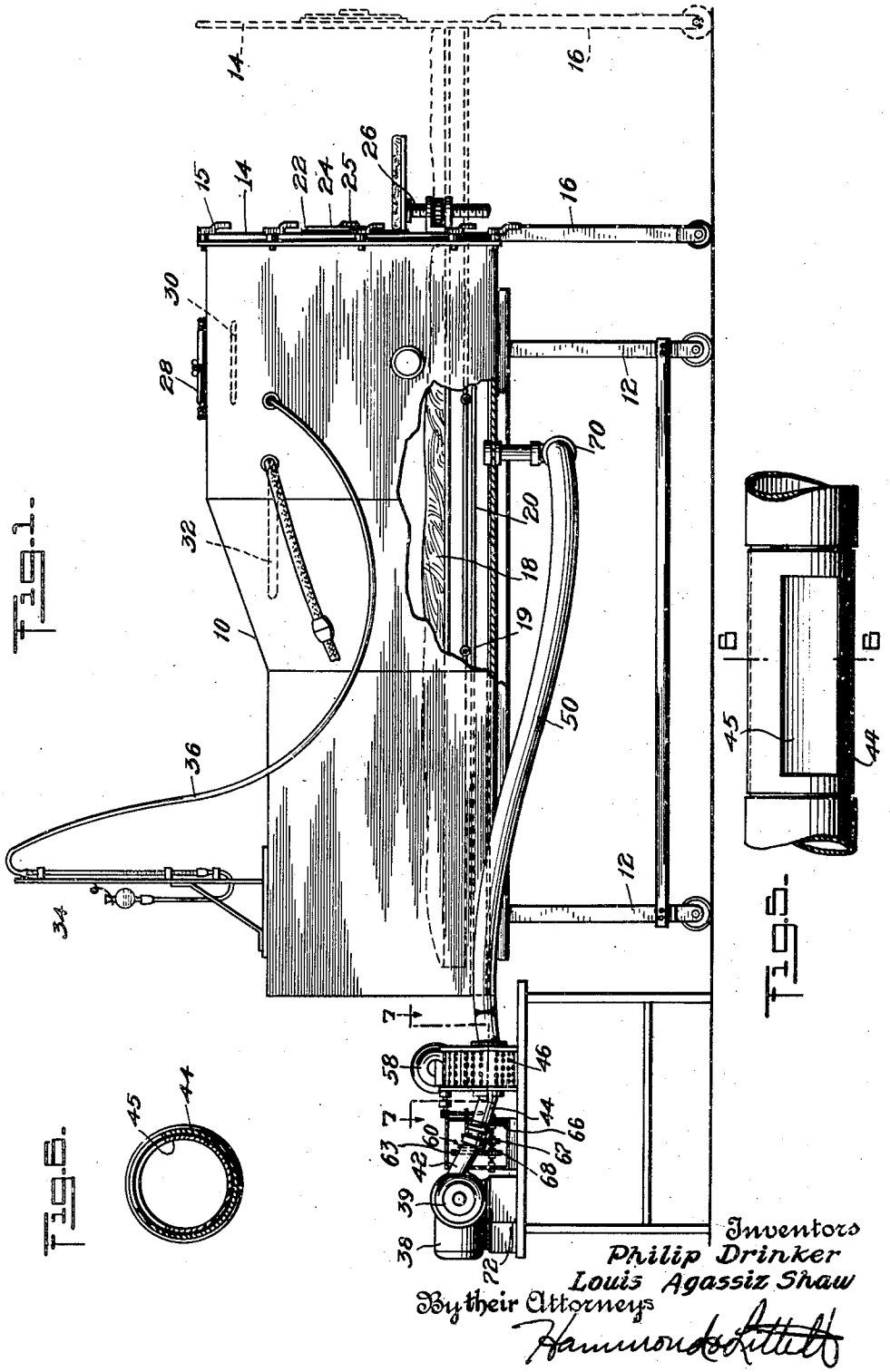

Fig. 1.

Fig. 5.

Fig. 6.

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RESPIRATION APPARATUS

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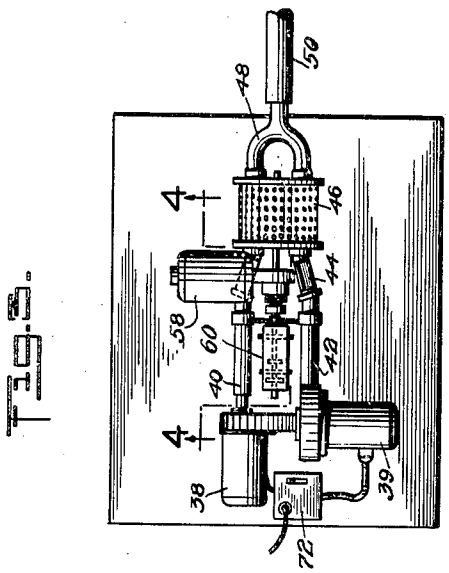


Fig. 3.

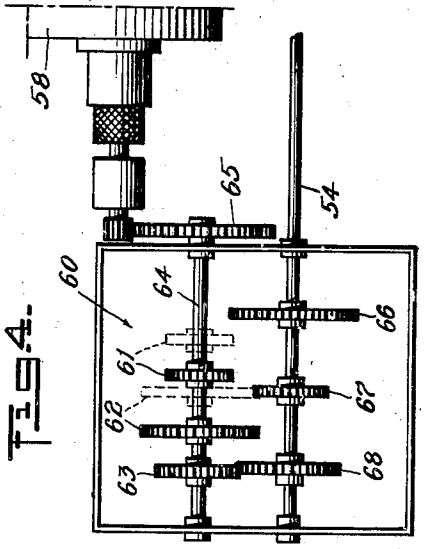


Fig. 4.

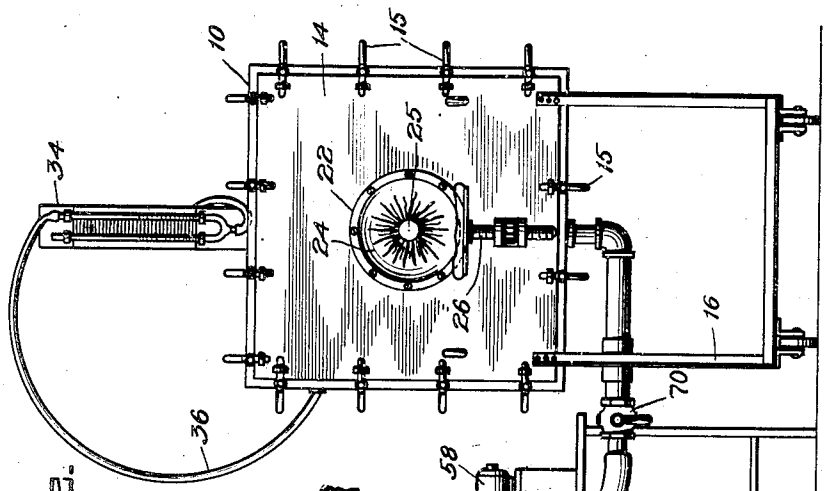


Fig. 2.

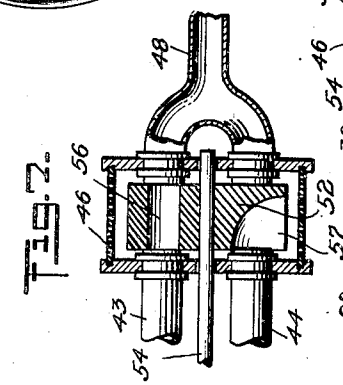
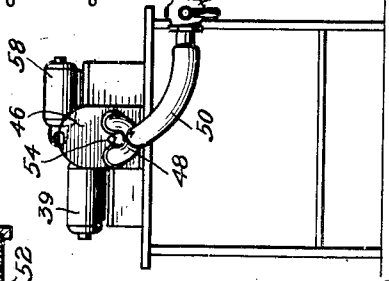


Fig. 7.



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UNITED STATES PATENT OFFICE

PHILIP DRINKER AND LOUIS AGASSIZ SHAW, OF BOSTON, MASSACHUSETTS, ASSIGNORS TO THE CONSOLIDATED GAS COMPANY OF NEW YORK, OF NEW YORK, N. Y.

RESPIRATION APPARATUS

Application filed July 23, 1929. Serial No. 380,271. REISSUED

This invention relates to an apparatus for providing artificial respiration for human beings.

It is a primary object of the invention to provide an apparatus which will simulate natural breathing in the patient, both as to the periods of exhalation and inhalation and as to the quantity of air drawn into the lungs of the patient, thus resulting in artificial breathing which will be regular and rythmic.

It is a further object of the invention to provide an apparatus of this character in which the patient will be at his ease during the treatment and in which he can breathe naturally, if so inclined, or in which he may be assisted to any desired extent by the apparatus.

It is a further object to provide an apparatus of this character in which the patient can talk, eat and sleep without discomfort and without discontinuing the treatments.

These and other objects will appear more fully from the following description when considered in connection with the drawings, in which:

Fig. 1 is a side elevational view of one form which our apparatus may assume.

Fig. 2 is a front elevational view thereof.

Fig. 3 is a slightly enlarged plan view of the pressure producing apparatus and alternator.

Fig. 4 is a detailed view of the reduction gears employed for varying the period of the pressure changes.

Fig. 5 is a detailed view of one of the exhaust valves.

Fig. 6 is a sectional view on the line 6—6 of Fig. 5.

Fig. 7 is a detailed view of the valve mechanism of the alternator.

Referring to the details of the drawings, there is provided a relatively strong, air-tight casing 10 of any preferred shape which is constructed of sufficient length, height and breadth to accommodate the body of a large man or woman. The casing 10 is supported upon any suitable standard, as indicated for example at 12, whereby the casing is placed at a convenient height for use. One wall of the casing, preferably the front wall 14, is removable to provide access to the interior thereof. As at present constructed, the front wall 14 has an additional support 16 facilitating the movement of the wall 14 toward or away from the casing 10.

A body support 18, shown as a mattress and its supporting frame, is mounted for movement into or out of the casing 10. Rollers 19 and a cooperating track 20 on the floor of the casing serve to support the body rest 18 within the casing and to permit the withdrawal of the body support from the casing when desired. The body support 18 is rigidly attached to the end wall 14 whereby it may be partially supported by the supports 16 for the end wall 14.

The end wall 14 is provided with an opening 22 which receives a flexible sealing member 24 formed of relatively strong, flexible rubber. The sealing member 24 has a central opening 25 adapted to fit snugly around the neck of the patient. The head of the patient may be passed through the opening 22 due to the resiliency of the material of the sealing member 24. The member 24 is removably attached within the opening 22 and is sealed at its outside edge against the admission of outside air by means of the securing bolts shown. Several different sizes of collars or sealing members 24 may be provided and the one best suited to the size of the patient selected.

The head of the patient is allowed to rest upon a support 26 positioned just outside of the opening 22 and adjustable vertically to accommodate the particular patient being treated. Any suitable adjustment means may be used for the support 26.

The casing 10 is provided with various accessories to modify the condition within the same and to indicate such conditions. To this end, the casing is provided with one or more openings 28 closed by means of transparent closures so that the interior of the casing may be inspected. The closure for the opening 28 is preferably of thin aluminum or glass composition, so that X-ray or ordinary pictures may be taken of the patient without removing the body from the casing. A ther-

mometer 30 indicates at all times the temperature within the casing. This temperature is normally maintained at substantially room temperature by the air-flow to and from the casing as described below. The temperature may be raised at any time by means of an electric light 32 mounted in the casing, or lowered by passing the air through a suitable cooling medium.

The degree of pressure or partial vacuum within the casing is indicated at all times by means of an open manometer 34 one leg of which is connected to the casing 10 by means of a tubular conductor 36, the other leg being exposed to the outside air. The manometer is provided with a suitable chart to indicate the degree of suction or pressure then present. The manometer 34 thus serves as an indicator of the pressure conditions within the casing. The manometer also serves as a pressure or suction relief valve in that any excessive pressure or suction blows or draws the fluid out of the open manometer and thus relieves the excessive pressure or suction condition within the casing.

The mechanism for providing alternate suction and pressure conditions within the casing 10 may be constructed in various manners. In the present embodiment, we have shown a preferred construction wherein a plurality of centrifugal air compressors 38 and 39 are connected in series relation to the suction tube 40 and pressure tube 42. This construction is preferred in that it provides a substantial air flow and sufficient pressure for the proper operation of the apparatus at all times. The tubes 40 and 42 are formed with vents 43 and 44 which are normally closed, but which permit either the suction or pressure portion of the apparatus to be rendered ineffective. The rotary closures 45 may be readily adjusted to open or close the tubes 40 or 42 with respect to the outside air. The tubes 40 and 42 pass through the valve mechanism or alternator 46 and may thence pass to a Y-joint 48, the latter being connected by a relatively large tube 50 with the interior of the casing.

The alternator 46 includes a rotary valve member 52 mounted for rotation with a shaft 54 and formed with a transverse opening 56 and a cut-away portion 57. The openings 56 and 57 are constructed to be placed alternately in the path of the tubes 40 and 42 so as to cause one of these tubes to communicate with the tubular member 50 and the other member to be exposed to the outside air through the cut-away portion 57. On rotation of the valve member 52 about a half circle the other tube (42 or 40) will then be placed in communication with the tubular member 52 and the opposed member (40 or 42) placed in communication with the outside air.

Rotation of the valve shaft 54 is accomplished by means of a timing motor 58 and a set of reduction gearing indicated generally at 60. This gearing includes three stages or sets of gears which have been found sufficient for our purposes. The gears 61, 62, and 63 are mounted rigidly on a shiftable shaft 64 having a squared portion to cause the same to be rotated with the gear 65 driven from the motor 58. The driven shaft 54 carries three cooperating gears 66, 67 and 68 which may be enmeshed with any of the shiftable gears 61, 62 or 63 respectively. When the gears 61 and 66 are in mesh, the shaft 54 is driven at a relatively slow speed. This provides the minimum number of alternations of pressure conditions, for example 12 to 16 changes per minute. This is the adjustment normally used for adults. When the gears 63 and 68 are enmeshed the shaft 54 is driven at an intermediate speed and provides approximately 20 to 24 alternations of the pressure condition per minute. This is the adjustment employed for small children up to six or eight years of age. When the gears 62 and 67 are enmeshed the shaft 54 is rotated more rapidly providing alternations in the pressure changes at a relatively higher rate of from 45 to 60 pressure changes per minute. This adjustment is used for the treatment of very small children, for example, premature and still-born babies.

While the pressure and suction pumps 38 and 39 provide greater degrees of pressure and partial vacuum than required for the normal use of the apparatus, their effect may be varied to any extent by means of the adjustment valve 70. This valve is manually adjustable to permit only a sufficient amount of air to pass the same to increase or decrease the pressure within the casing to the extent desired. It will be evident that if the valve 70 is adjusted to provide a relatively small opening permitting the passage of air therethrough, the pressure or partial vacuum condition within the casing 10 will reach a much lower extent than where the valve 70 is wide open and the entire force of the compressors is directly admitted into the interior of the casing. The usual degree of vacuum or pressure required for producing artificial breathing in the average patient is about 5 to 15 centimeters of water, although 30 centimeters of water or more may be required to cause the subject to fall into rhythm with the pump.

Suitable switches indicated generally at 72 supply electric current to the timing motor 58 and to the motors of the compressors 38 and 39.

In the operation of the above apparatus, the clamps 15 are unfastened and the end wall 14 and body support 18 are moved outwardly from the casing 10 into position to receive the body of the patient. The head of the patient is passed through the opening 22, the

flexible sealing member of which is enlarged to permit the passage of the head of the patient therethrough. The flexible member then contracts into engagement with the neck of the patient and provides a seal at this point against the outside air. The adjustable head rest 26 adjusted to suit the patient and the end wall 14 is then moved inwardly toward the casing and the clamps 15 tightened to seal the wall 14 against the casing 10. The body of the patient is thus entirely within and subjected to the pressure conditions within the casing, yet the head of the patient is exposed for observation or treatment and the patient is entirely at ease. The shaft 64 is shifted to cause the proper gears to enmesh as described above for the patient then being treated. The switch 72 is then actuated to start the timing motor and compressors. The valve 70 is adjusted while observing the manometer 34 to provide the proper extent of the pressure variations within the casing. Thereafter the patient is observed and if a higher temperature is necessary within the casing, the light 32 is lighted and the temperature correspondingly increased. The body of the patient may be observed within the casing through the opening 28. The patient may be given food or medcine, and can sleep or talk without interrupting the treatment.

If at any time it appears that the patient is breathing normally and of his own power the valve 70 may be entirely closed and the apparatus used as a plethysmograph. Any natural breathing of the patient may thus be observed in the manometer without disturbing the patient or the apparatus in any other manner. If it appears that the patient is not breathing naturally, the valve 70 may be opened again and the artificial respiration resumed.

It will be evident that many variations may be made in the apparatus within the principles of the invention as stated above, the shape and size of the casing may be varied and any desired mechanism used to effect the pressure changes therein without departing from the spirit of our invention or the scope of the accompanying claims.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. In an apparatus for producing artificial respiration, a casing constructed to receive the major portion of the body of a patient, a bed which is slidable into and out of said casing, said casing having a removable wall section connected to said bed and including an opening through which the head of the patient may be passed, a sealing member positioned in said opening and formed with a restricted opening adapted to fit snugly around the neck of the patient, means for forming a seal between said movable wall and the casing and means for producing alternate variations of pressure within said casing.

2. In an apparatus for producing artificial respiration, a portable hollow casing having an open end, a portable carriage adapted to receive the body of a patient and to slide in and out of said casing, a closure for the open end of said casing having an opening through which the patient's head projects, means to provide a seal between the neck of the patient and said opening, means to seal said closure to the open end of said casing, and means to induce periodic variations of pressure within said casing.

3. In an apparatus for producing artificial respiration, a hollow casing having an open end, a portable carriage adapted to receive the body of a patient and to slide within said casing, a closure for the open end of said casing connected to said carriage and movable therewith, means to seal said casing with the head of the patient external of said casing, and means to periodically vary the pressure within said casing from a negative pressure to atmospheric pressure and to regulate the rate of said variations to correspond to the normal rate of breathing.

4. In an apparatus for producing artificial respiration a hollow casing having a removable wall section with an opening for the head of the patient, a portable carriage to receive the body of a patient, means to slide said carriage into and out of said casing, means to seal said casing with the head of said patient projecting through said opening in the removable wall section, a pump, a distributor valve between said control device and said casing to periodically vary the pressure within said casing and means to control the maximum and minimum amounts of said pressure variation.

5. An apparatus for producing artificial respiration comprising a hollow casing having a removable wall section with an opening for the head of the patient, a portable carriage to receive the body of a patient, means to slide said carriage into and out of said casing, means to seal said casing with the head of said patient projecting through the opening in the removable wall section, a pressure control device, a distributor valve between said control device and said casing to periodically vary the pressure within said casing, means to control the maximum and minimum amounts of said pressure variation, a manometer connected to said casing to indicate the variations of pressure within said casing, and an inspection plate whereby the patient may be observed during the pressure variations.

6. A respirator apparatus for artificially producing respiration comprising a hollow casing having an open end, a patient receiving carriage slidable into and out of said cas-

ing, a closure connected to said carriage and adapted to seal said casing, said closure having a central aperture through which the patient's head may be projected and a collar to closely encompass the neck of the patient, said carriage adapted to receive a patient and to be slid into said casing with the head of said patient extending outside of said casing, said collar acting as a pressure seal whereby the body of said patient within said casing may be at a pressure different from the atmospheric pressure around the head of said patient, and means to periodically vary the pressure within said casing from a negative pressure to atmospheric pressure or above.

7. A respirator apparatus for artificially producing respiration comprising a hollow casing having an open end, a patient receiving carriage, and a closure connected to said carriage and adapted to seal said casing, said closure having a central aperture through which the patient's head may be projected and a rubber collar to closely encompass the neck of the patient. said carriage adapted to support the body of the patient and to be slid into said casing with the head of said patient extending outside of said casing, said collar acting as a pressure seal whereby the body of said patient within said casing may be at a pressure different from the pressure upon the head of said patient, means to periodically vary the pressure within said casing from a below atmospheric pressure to atmospheric pressure or above, means to control the temperature within said casing including a warming means, cooling means and a ventilating means, said housing having gauges whereby said internal conditions may be known.

8. In an apparatus for producing artificial respiration, a hollow casing for receiving the body of a patient, a body support slidable to and from the interior of said casing, said casing having a removable wall section through which the head of the patient is adapted to project, means for forming an airtight seal around the neck of the patient and means for forming an airtight seal between the section and the body of the casing, and means for producing alternate variations of pressure within said casing.

9. In an apparatus for producing artificial respiration, a hollow casing for receiving the body of a patient, a body support slidable to and from the interior of said casing, said casing having a removable wall section comprising a flexible rubber sheet with an opening through which the patient's head may be inserted, said sheet being arranged to form an airtight seal around the neck of the patient, an adjustable head rest cooperating with said flexible sheet to permit adjusting of the head of the patient and means for producing alternate variations of pressure within said casing.

10. In an apparatus for producing artificial respiration, a hollow casing for receiving the body of a patient, a body support in said casing, said casing having a removable wall section comprising a flexible rubber sheet with an opening for the patient's neck, said sheet being arranged to form an airtight seal around the neck of the patient while permitting movement of the head and neck, means for clamping the outer edges of said rubber sheet to form an airtight seal with the wall of the casing, a head rest outside of said casing and means for producing alternate variations of pressure within said casing.

11. In an apparatus for producing artificial respiration a hollow casing for receiving the body of a patient, a body support in said casing, said casing having a removable wall section comprising a flexible elastic rubber sheet with an opening for the patient's neck, said sheet being sufficiently elastic to permit insertion of the head through the opening and being adapted in contracted condition to form an airtight seal around the patient's neck, means for clamping the outer edges of said rubber sheet to form an airtight seal with the wall of the casing, a head rest outside of the casing and means for producing alternate variations of pressure within said casing.

In testimony whereof we have affixed our signatures to this specification.

PHILIP DRINKER.
LOUIS AGASSIZ SHAW.

CERTIFICATE OF CORRECTION.

Patent No. 1,834,580. December 1, 1931.

PHILIP DRINKER, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, lines 103-104, claim 4, for "control device" read pump; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 21st day of November, A. D. 1933.

F. M. Hopkins

(Seal) Acting Commissioner of Patents.