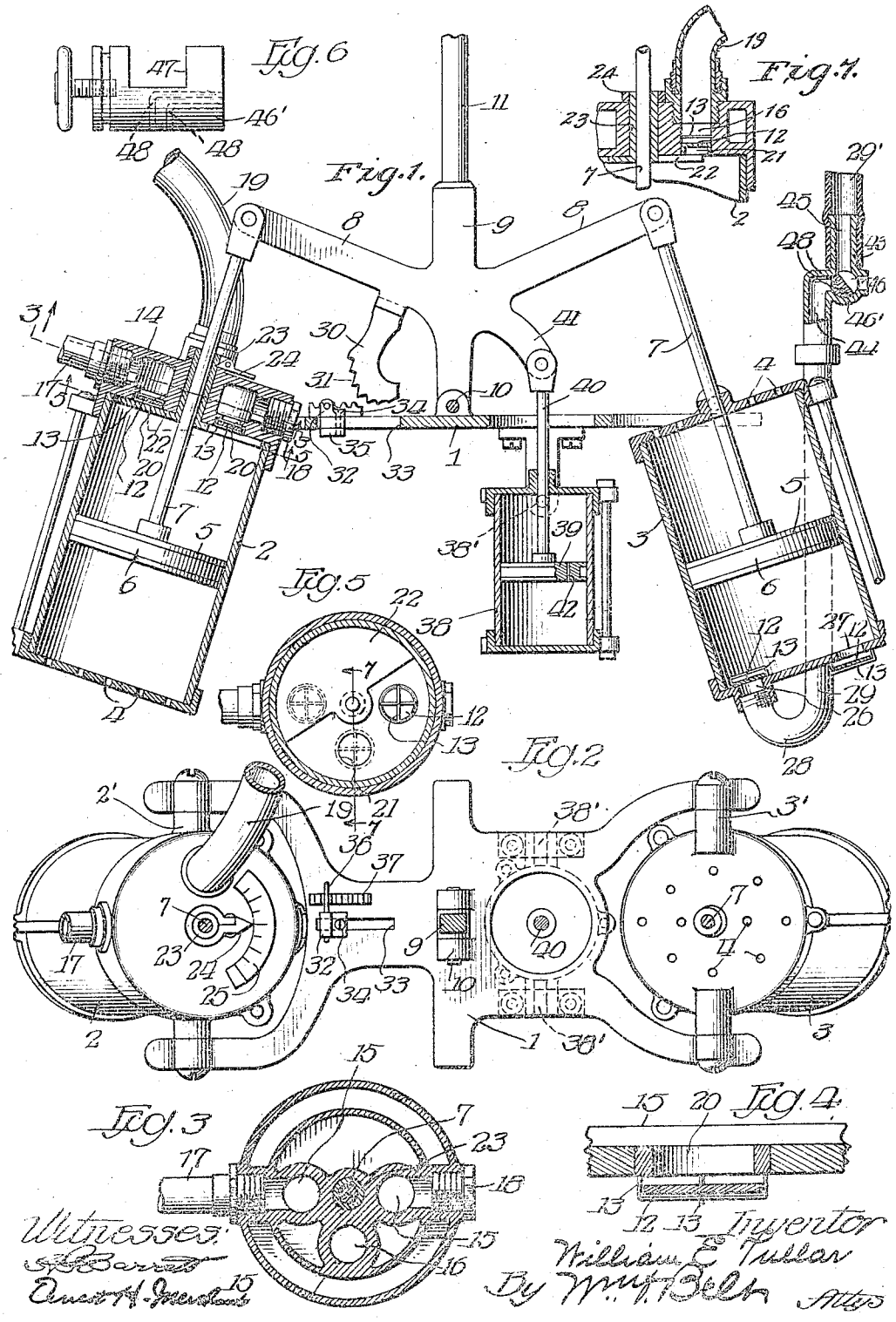
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APPARATUS FOR PRODUCING ARTIFICIAL RESPIRATION.

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1,241,056. Patented Sept. 25, 1917.



UNITED STATES PATENT OFFICE.

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APPARATUS FOR PRODUCING ARTIFICIAL RESPIRATION.

1,241,056. Specification of Letters Patent. Patented Sept. 25, 1917.

Application filed July 19, 1915. Serial No. 40,559.

To all whom it may concern:

Be it known that I, WILLIAM E. TULLAR, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Apparatus for Producing Artificial Respiration, of which the following is a specification.

This invention relates to an apparatus for producing artificial respiration, whereby air or oxygen or mixtures thereof may be forced into and carbon-dioxid or other waste products withdrawn from the lungs of a patient alternately, the purpose being to simulate and thereby stimulate spontaneous breathing where respiration has ceased owing to asphyxiation or other causes.

In the use of apparatus of this character it is essential that as soon as the patient revives sufficiently to breath spontaneously he should be given an opportunity to do so without delay. The principal defect of apparatus heretofore suggested for the purpose is that in order to allow spontaneous breathing the straps, which are customarily used to hold the mouth and nose piece in position, must be removed, the character of the apparatus being such that the patient is unable to breath therethrough. This consumes an appreciable amount of time and frequently the patient, who has shown ability to breathe spontaneously, collapses before the mouth and nose piece can be removed. The reviving operation must then be repeated but is often unsuccessful. It requires expert judgment in operating such an apparatus to determine exactly when the mouth and nose piece should be removed and inasmuch as the apparatus is of necessity frequently used by inexperienced persons it will be apparent that an apparatus which allows spontaneous breathing without removal of the mouth and nose piece attains a desirable but hitherto impossible result.

It is the object of my invention to provide an apparatus for producing artificial respiration whereby the patient is allowed to breathe spontaneously at any instant without removing any of the parts and in which the operation of artificially supplying oxygen-containing gas to and withdrawing waste products may be instantly resumed should the patient fail to breathe spontaneously as expected.

A further object of my invention is the provision of means whereby the speed of operation of the apparatus is regulated and controlled so that injury to the patient is prevented.

Other objects and advantages of my invention are the provision of novel means for measuring the quantity of oxygen-containing gas supplied, and, where oxygen is used in addition to air, for proportioning the relative quantities of oxygen and air supplied to the patient, as well as the provision of means whereby the patient may be allowed to exhale directly to the atmosphere while the apparatus is in operation to alternately supply oxygen-containing gas to the lungs.

Further objects and advantages of my invention will be apparent as it is better understood by reference to the following specification when read in connection with the accompanying drawing in which—

Figure 1 is a vertical section through an apparatus according to my invention;

Fig. 2 is a plan view partially in section of the apparatus;

Fig. 3 is a section on the line 3—3 of Fig. 1;

Fig. 4 is an enlarged detail in section of one of the valves which are utilized in the apparatus to close the various inlets and outlets for the gases;

Fig. 5 is a section on the line 5—5 of Fig. 1.

Fig. 6 is an enlarged detail in elevation of the valve plug, whereby the patient is allowed to exhale directly to the atmosphere.

Fig. 7 is a fragmentary detail in section on the line 7—7 of Fig. 5.

Referring to the drawing, 1 indicates a suitable frame on which at either end the cylinders 2 and 3 are pivotally mounted by means of trunnions 2′ and 3′, the cylinder 2 constituting means for supplying oxygen-containing gas to the lungs of a patient and the cylinder 3 constituting means for withdrawing waste and other products from the lungs of a patient. Within the cylinders 2 and 3, each of which is freely open to the atmosphere at one end, as indicated at 4, the plungers 5 are disposed and provided

with packing rings 6, preferably of metal to insure a tight joint between the pistons 5 and the walls of the cylinders 2 and 3. The pistons 5 are connected by rods 7 to the oppositely directed arms 8 of the member 9 pivoted at 10 to the frame 1 and provided with an operating handle 11, so that as the member 9 is moved about its pivot the plungers 5 are reciprocated in the cylinders 2 and 3.

Each of the cylinders 2 and 3 is provided with valved inlets and outlets and in order that the objects and mode of operation of the apparatus may be entirely clear I will first describe the valves employed, which, as shown in Fig. 4, comprise a disk 12 of relatively light material, preferably mica, although other material such as aluminum, for example, may be employed. The disk 12 is held in proper relation with the respective inlet or outlet by a pair of crossed wires 13, the ends of which are suitably secured adjacent the inlet or outlet, the disk 12 being so held that it will alternately close and open the inlet or outlet to allow or prevent the passage of gases therethrough. I employ the particular form of valve disclosed in order that a patient may breathe spontaneously through the apparatus, the valves being extremely light and sensitive and, therefore, operable by the lungs of a patient even when in exhausted condition.

The upper end of the cylinder 2 comprises a head 14 chambered to provide three ducts or passages 15, 15′ and 16, the ducts 15 and 15′ being respectively adapted to receive a supply of oxygen from a suitable source through the tube 17 and to receive air through the inlet 18, the duct 16 being adapted to deliver oxygen-containing gas through the tube 19 to a mouth and nose piece of usual construction. The oxygen and air-receiving ducts 15 and 15′ deliver the gases through the inlets 20 to the cylinder 2 and are, therefore, provided with valves comprising the disks 12 held in position by the wires 13, so arranged that the valves are open as the plunger 5 moves downwardly in the cylinder 2. The duct 16 adapted to deliver oxygen-containing gas to the tube 19 receives the gas through the outlet 21, which is provided with a similar valve but oppositely disposed, so that it opens as the plunger 5 moves upwardly in the cylinder 2, the valves in the inlets 20 being closed at this period of the operation. In order that oxygen and air may be mixed in any desirable proportion I provide a rotatable valve 22 secured to a sleeve 23 surrounding the rod 7 and coöperating with the inlets 20 to the cylinder 2, so that as the valve 22 is rotated the inlets 20 are proportionately opened or closed. An operating member 24 is secured to the upper end of the sleeve 23 and an indicator 25 is provided with which the operating member coöperates to indicate the position of the rotatable valve 22. It will be understood from the foregoing description that I am enabled to allow oxygen or air alone or mixtures thereof in any proportion to enter the cylinder 2 and that this mixture will be forced from the cylinder 2 through the tube 19 to the mouth and nose piece during the operation of the apparatus.

The lower end of the cylinder 3 is provided with valves similar to those already described and adapted to alternately close and open the inlet 26 and the outlet 27. The inlet 26 is connected by means of an elbow 28 to a pipe 29 leading to a flexible tube 29′ connected with the mouth and nose piece (not shown). A valve is disposed between the pipe 29 and the tube 29′ whereby the patient is allowed to exhale directly to the atmosphere and comprises a casing 43 provided with three ducts, 44 leading to the pipe 29, 45 leading to the tube 29′ and 46 leading to the atmosphere. A valve plug 46′ is disposed in the casing 43 and is slotted at 47 so that by turning the plug 46′ the duct 45 may be connected also with either duct 46 or duct 44 at will, thus providing for exhalation by the patient through the machine or directly to the atmosphere as desired. The plug 46′ is provided with a pair of ducts 48 which, when the plug 46′ is disposed as in Fig. 1 to allow exhalation direct to the atmosphere, provide an air inlet to the cylinder 3, thus preventing the formation of a partial vacuum therein which would retard the speed of operation. The outlet 27 communicates with the atmosphere. It will be understood that as the plunger 5 rises in the cylinder 3, provided the valve plug 46′ is set to allow communication between ducts 45 and 44, waste and other products will be withdrawn from the lungs of the patient through the tube 29 and as the plunger 5 descends the waste products will be exhausted through the outlet 27.

The lungs of persons of different sizes vary in capacity and it is desirable that the quantity of air or oxygen supplied be carefully measured and remain constant throughout the operation of the apparatus. This is accomplished by the provision of a sector 30 secured to one of the arms 8 of the member 9 and provided with a plurality of teeth 31 disposed eccentrically with respect to the pivotal point 10 of the member 9. A member 32 is slidably mounted in a slot 33 in the frame 1 and may be adjusted longitudinally of the frame by means of a screw 34, which engages the member 32, and a cross member 35, disposed beneath the frame 1, and holds the members in firm engagement with the frame. As will be apparent from an inspection of Fig. 1 of the drawings, the position of the member 32

determines the length of the stroke of the plungers 5, since the member 32 will be engaged by one or the other of the teeth 31, depending upon its position in the slot 33. A spring pin 36 is secured in the member 32 and adapted to resiliently engage a rack member 37 secured to the frame 1, so that the member 32, when adjusted, will assume one of a plurality of definite positions which register properly with one of the teeth 31 as the sector 30 swings about the pivot 10. The number of positions may be varied, as desired, the form of the sector 30 shown in the drawings being that which I have found the most desirable in practice.

To limit the speed of operation of the apparatus so that the patient can not be injured I provide a cylinder 38 pivotally secured to the frame 1 by means of trunnions 38′ and adapted to contain a fluid, such for example as castor oil, which has the advantage of not varying in viscosity to any extent at usual temperatures. A plunger 39 is disposed within the cylinder 38 and connected by a rod 40 to an arm 41 of the member 9, so that as the member 9 moves about its pivot 10 the plunger 39 is reciprocated within the cylinder 38. The plunger 39 is provided with a restricted opening 42 which allows the fluid to pass from one side to the other of the plunger 39 as it reciprocates. The fluid being incompressible it will be apparent that the speed of operation of the plunger 39 and hence of the member 9 depends on the rate of flow of the fluid through the restricted opening 42. The size of the opening 42 is designed to allow flow of fluid with sufficient rapidity to permit the apparatus to be operated at a speed sufficient to supply oxygen-containing gas to and withdraw waste products from the lungs of a patient at the normal rate of breathing.

It will be understood from the foregoing that I have perfected an apparatus which not only overcomes an inherent defect in the various types of apparatus which have heretofore been suggested but which provides additional and advantageous features which have not previously been suggested. The use of disks of light material to control the inlets 2 and the outlets from the cylinders allows the patient to breathe directly through the apparatus since the valves are so sensitive that they may be operated without effort by the lungs of an exhausted patient. This in itself is an advance in the art which is of the greatest importance, since the apparatus meets a requirement which can not be met by any apparatus heretofore known. Furthermore, by the provision of means for limiting the speed of operation of the apparatus I prevent injury to the patient by careless use of the apparatus by inexperienced persons. The means allowing spontaneous exhalation while the apparatus is in use is desirable in many cases and I have found, also, that the particular means employed by me for measuring the quantity of oxygen or air supplied to the lungs as well as the means for mixing air and oxygen in any desired proportion is peculiarly adapted to accomplish the desired result with the greatest simplicity and precision.

It is obvious that various changes may be made in the form, construction and arrangement of the parts without departing from the spirit and scope of the invention or sacrificing any of its material advantages, the form hereinbefore described being merely a preferred embodiment thereof.

I claim:

1. In an apparatus for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, the combination of a plurality of cylinders, plungers therein, means for actuating said plungers, an inlet to and an outlet from each of said cylinders, valves in said inlets and outlets, and means for preventing the operation of said plunger actuating means beyond a predetermined rate of speed.

2. In an apparatus for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, the combination of a pair of cylinders, plungers therein, means for actuating said plungers, an inlet to and an outlet from each of said cylinders, valves in said inlets and outlets, means for adjustably varying the stroke of said plungers, and means for preventing the operation of said plunger actuating means beyond a predetermined rate of speed.

3. In an apparatus for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, the combination of a pair of cylinders, plungers therein, pivoted means connected to and adapted to actuate said plungers, an inlet to and an outlet from each of said cylinders, valves in said inlets and outlets, and means for preventing the operation of said plunger actuating means beyond a predetermined rate of speed.

4. In an apparatus for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, the combination of a pair of cylinders, plungers therein, means for actuating said plungers, an inlet to and an outlet from each of said cylinders, valves in said inlets and outlets, a third cylinder, and means operating therein and connected to said plunger-operating means to prevent the operation thereof beyond a predetermined rate of speed.

5. In an apparatus for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, the combination of a pair of cylinders,

plungers therein, pivoted means connected to and adapted to actuate said plungers, an inlet to and an outlet from each of said cylinders, valves in said inlets and outlets, means disposed in the path of said pivoted means to adjustably vary the stroke of said plungers, a third cylinder, and means operating therein and connected to said plunger-actuating means to prevent operation thereof beyond a predetermined rate of speed.

6. In an apparatus for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, the combination of a pair of cylinders, plungers therein, means for actuating said plungers, an inlet and an outlet to each of said cylinders, valves in said inlets and outlets, a third cylinder adapted to contain a fluid, and a plunger disposed in said third cylinder, connected to said plunger-actuating means and provided with a restricted opening through which said fluid passes, whereby operation of said plunger actuating means beyond a predetermined rate of speed is prevented.

7. In an apparatus for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, the combination of a pair of cylinders, plungers therein, means for actuating said plungers, an inlet to and an outlet from each of said cylinders, valves in said inlets and outlets, a third cylinder adapted to contain fluid, a plunger disposed in said third cylinder, connected to said plunger-actuating means and provided with a restricted opening through which said fluid passes, whereby the operation of said plunger actuating means beyond a predetermined rate of speed is prevented, and means for adjustably varying the stroke of said plungers.

8. In an apparatus for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, the combination of a pair of cylinders, plungers therein, an inlet to and an outlet from each of said cylinders, valves in said inlets and outlets, said valves comprising disks of relatively light material loosely maintained in bodily movable relation to said inlets and outlets, pivoted means for actuating said plungers, means for varying the stroke of said plungers and means for preventing operation of said plungers beyond a predetermined rate of speed.

9. In an apparatus of the character described, the combination of a supporting frame, means for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, an inlet to and an outlet from each of said means, valves in said outlets and inlets, means for actuating said first-mentioned means, and means for limiting the movement of said actuating means, comprising a toothed sector, and a member mounted on said frame and adjustable into different positions relative to said teeth of said sector and adapted for engagement thereby.

10. In an apparatus for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, the combination of a supporting frame, a pair of cylinders, plungers therein, an inlet to and an outlet from each of said cylinders, valves in said inlets and outlets, means for actuating said plungers, and means for varying the stroke of said plungers, comprising a sector connected to said plunger-actuating means and having eccentrically disposed teeth, and a member slidably mounted on said frame and adustable into different positions relative to the teeth of said sector and adapted for engagement thereby.

11. In an apparatus for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, the combination of a frame, a pair of cylinders, plungers therein, means for actuating said plungers, an inlet to and an outlet from each of said cylinders, valves in said inlets and outlets, a third cylinder adapted to contain a fluid, a plunger disposed in said third cylinder connected to said plunger-actuating means and provided with a restricted opening through which said fluid passes, whereby the speed of operation of said plunger-actuating means is limited, and means for varying the stroke of said plungers, comprising a sector connected to said plunger-actuating means and having eccentrically disposed teeth, and a member slidably mounted on said frame and adjustable into different positions relative to the teeth of said sector and adapted for engagement thereby.

12. In an apparatus for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, the combination of a pair of cylinders, plungers thereon, means for actuating said plungers, an inlet to and an outlet from each of said cylinders, valves in said inlets and outlets, means for admitting air and oxygen to the inlet of one of said cylinders, means for proportioning the relative quantities of air and oxygen admitted and means for preventing operation of said plungers beyond a predetermined rate of speed.

13. In an apparatus for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, the combination of a pair of cylinders, plungers therein, means for actuating said plungers, an inlet to and an outlet from each of said cylinders, valves in said inlets and outlets, means for admitting air and oxygen to the inlet of one of said cylinders, a rotatable valve disposed adjacent said inlet and air and oxygen-admitting means for proportion-

ing the relative quantities of air and oxygen admitted and means for preventing operation of said plungers beyond a predetermined rate of speed.

14. In an apparatus for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, the combination of a plurality of cylinders, plungers therein, means for actuating said plungers, an inlet to and an outlet from each of said cylinders, a disk of relatively light material closely maintained in bodily movable relation to each of said inlets and outlets and adapted to alternately close and open said inlets and outlets, the weight of said disks being such that they are readily operable by the lungs of the patient to permit spontaneous breathing through said apparatus, and means for preventing operation of said plungers beyond a predetermined rate of speed.

15. In an apparatus for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, the combination of a pair of cylinders, plungers therein, means for actuating said plungers, an inlet to and an outlet from each of said cylinders, a disk of relatively light material loosely maintained in bodily movable relation to each of said inlets and outlets and adapted to alternately close and open said inlets and outlets, the weight of said disks being such that they are readily operable by the lungs of the patient to permit spontaneous breathing through said apparatus, means for adjustably varying the stroke of said plungers, and means for preventing operation of said plungers beyond a predetermined rate of speed.

16. In an apparatus for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, the combination of a pair of cylinders, plungers therein, pivoted means connected to and adapted to actuate said plungers, an inlet to and an outlet from each of said cylinders, a disk of relatively light material loosely maintained in bodily movable relation to each of said inlets and outlets and adapted to alternately close and open said inlets and outlets, the weight of said disks being such that they are readily operable by the lungs of the patient to permit spontaneous breathing through said apparatus, and means for preventing operation of said plungers beyond a predetermined rate of speed.

17. In an apparatus for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, the combination of a pair of cylinders, plungers therein, means for actuating said plungers, an inlet to and an outlet from each of said cylinders, a disk of relatively light material loosely maintained in bodily movable relation to each of said inlets and outlets and adapted to alternately close and open said inlets and outlets, the weight of said disks being such that they are readily operable by the lungs of the patient to permit spontaneous breathing through said apparatus, a third cylinder, and means operating therein and connected to said plunger-operating means to prevent operation of said plungers beyond a predetermined rate of speed.

18. In an apparatus for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, the combination of a pair of cylinders, plungers therein, pivoted means connected to and adapted to actuate said plungers, an inlet to and an outlet from each of said cylinders, a disk of relatively light material loosely maintained in bodily movable relation to each of said inlets and outlets and adapted to alternately close and open said inlets and outlets, the weight of said disks being such that they are readily operable by the lungs of the patient to permit spontaneous breathing through said apparatus, means disposed in the path of said pivoted means to adjustably vary the stroke of said plungers, a third cylinder, and means operating therein and connected to said plunger-actuating means for preventing operation of said plungers beyond a predetermined rate of speed.

19. In an apparatus for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, the combination of a pair of cylinders, plungers therein, an inlet to and an outlet from each of said cylinders, a disk of relatively light material loosely maintained in bodily movable relation to each of said inlets and outlets and adapted to alternately close and open said inlets and outlets, the weight of said disks being such that they are readily operable by the lungs of the patient to permit spontaneous breathing through said apparatus, pivoted means for actuating said plungers, means for limiting the stroke of said plungers and means for preventing operation of said plungers beyond a predetermined rate of speed.

20. In an apparatus of the character described, the combination of a supporting frame, means for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, an inlet to and an outlet from each of said means, a disk of relatively light material disposed adjacent each of said inlets and outlets and adapted to alternately close and open said inlets and outlets, the weight of said disks being such that they are readily operable by the lungs of a patient to permit spontaneous breathing through said apparatus, means for actuating said first-men-

tioned means, and means for limiting the movement of said actuating means, comprising a toothed sector, and a member mounted on said frame and adjustable into different positions relative to said teeth of said sector and adapted for engagement thereby.

21. In an apparatus for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, the combination of a supporting frame, a pair of cylinders, plungers therein, an inlet to and an outlet from each of said cylinders, a disk of relatively light material disposed adjacent each of said inlets and outlets and adapted to alternately close and open said inlets and outlets, the weight of said disks being such that they are readily operable by the lungs of the patient to permit spontaneous breathing through said apparatus, means for actuating said plungers, and means for varying the stroke of said plungers, comprising a sector connected to said plunger-actuating means and having eccentrically disposed teeth, and a member slidably mounted on said frame and adjustable into different positions relative to the teeth of said sector and adapted for engagement thereby.

22. In an apparatus for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, the combination of a pair of cylinders, plungers thereon, means for actuating said plungers, an inlet to and an outlet from each of said cylinders, a disk of relatively light material loosely maintained in bodily movable relation to each of said inlets and outlets and adapted to alternately close and open said inlets and outlets, the weight of said disks being such that they are readily operable by the lungs of the patient to permit spontaneous breathing through said apparatus, means for admitting air and oxygen to the inlet of one of said cylinders, means for proportioning the relative quantities of air and oxygen admitted and means for preventing operation of said plungers beyond a predetermined rate of speed.

23. In an apparatus for supplying oxygen-containing gas to and withdrawing waste and other products from the lungs of a patient, the combination of a pair of cylinders, plungers therein, means for actuating said plungers, an inlet to and an outlet from each of said cylinders, a disk of relatively light material loosely maintained in bodily movable relation to each of said inlets and outlets and adapted to alternately close and open said inlets and outlets, the weight of said disks being such that they are readily operable by the lungs of the patient to permit spontaneous breathing through said apparatus, means for admitting air and oxygen to the inlet of one of said cylinders, a rotatable valve disposed adjacent said inlet and air and oxygen-admitting means for proportioning the relative quantities of air and oxygen admitted and means for preventing operation of said plungers beyond a predetermined rate of speed.

24. In an apparatus of the character described, the combination of means for supplying oxygen-containing gas to and withdrawing waste products from the lungs of a patient, an outlet from and an inlet to each of said means, valves in said outlets and inlets, and means comprising a casing provided with a plurality of ducts and means for selectively connecting said ducts whereby said waste-product-withdrawing means may be made inoperative while said oxygen-containing gas-supplying means continues in operation.

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Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."