W. E. GARFORTH.

RESPIRATION APPARATUS FOR USE IN COAL MINES AND OTHER PLACES.

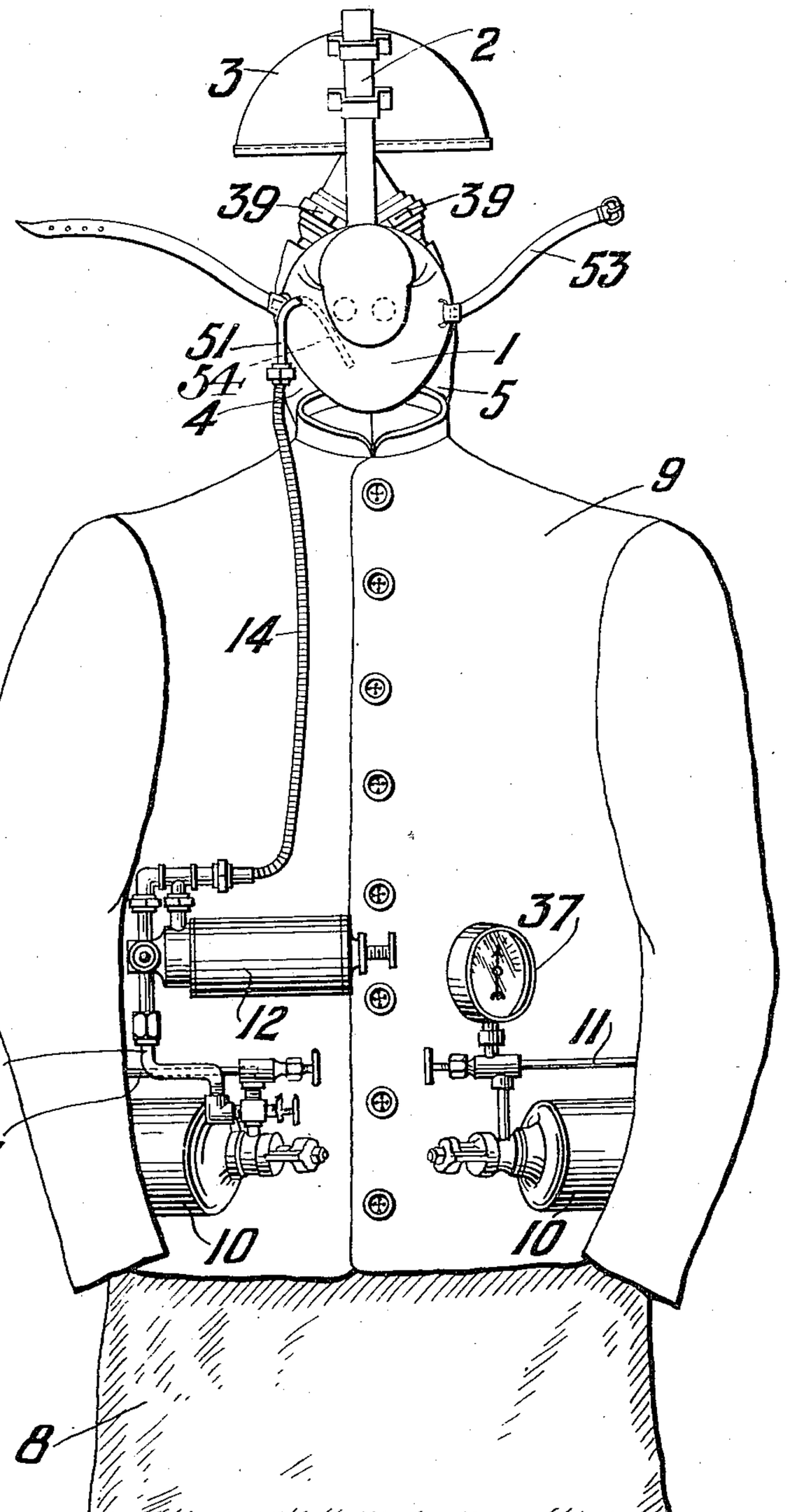
APPLICATION FILED APR. 10, 1908.

953,462.

Patented Mar. 29, 1910.

3 SHEETS—SHEET 1.

FIG. 1.



Witnesses.

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3 SHEETS—SHEET 2.

FIG. 2.

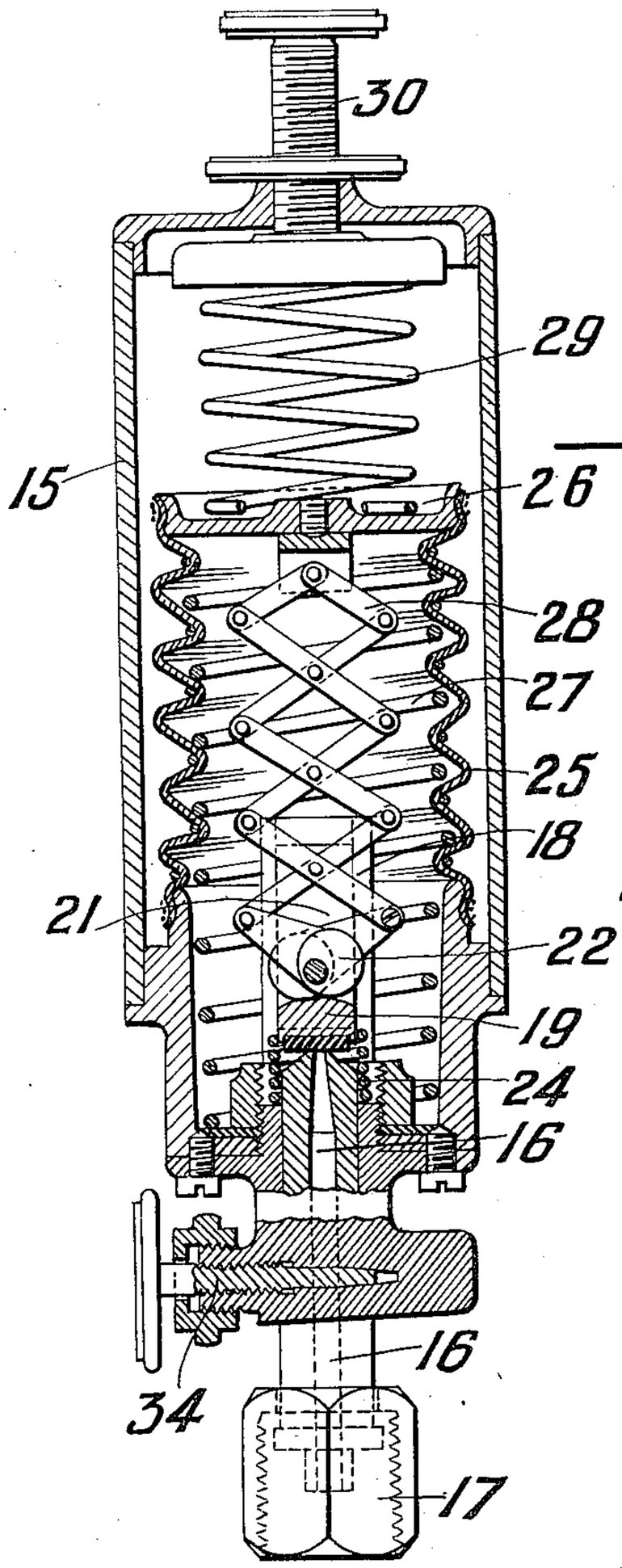
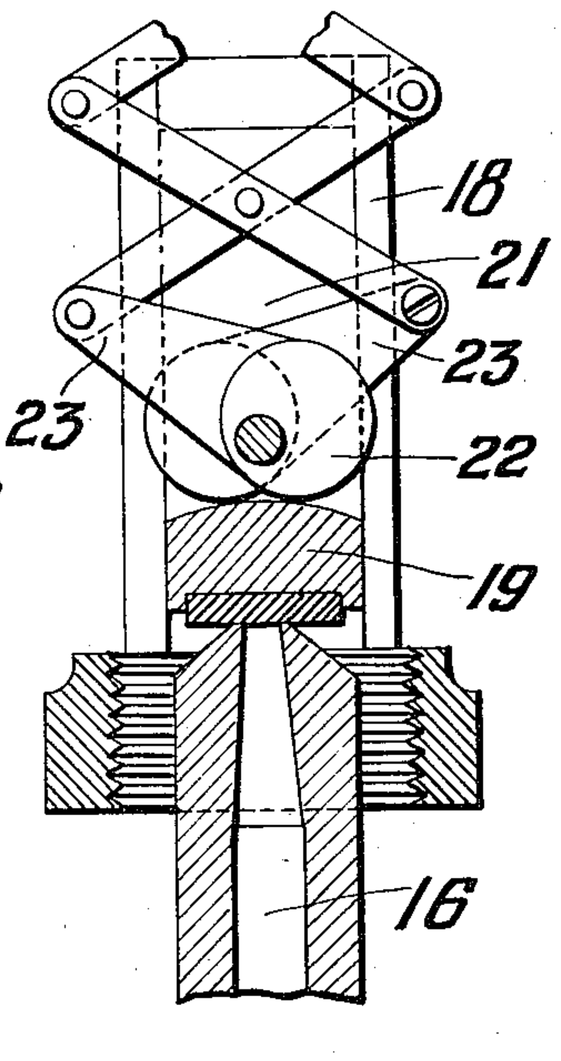


FIG. 3.



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3 SHEETS—SHEET 3.

FIG. 4

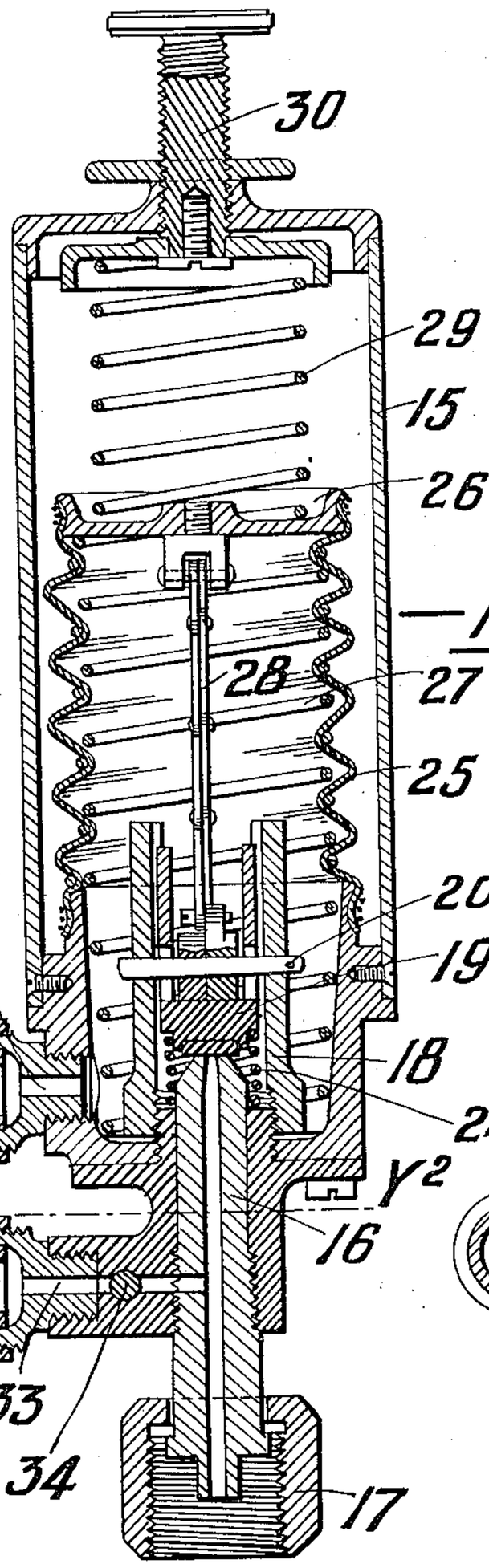


FIG. 5.

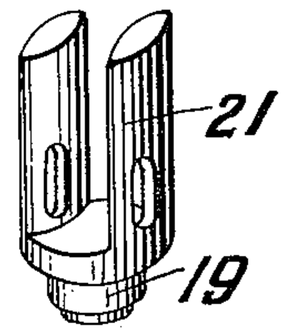


FIG. 6.

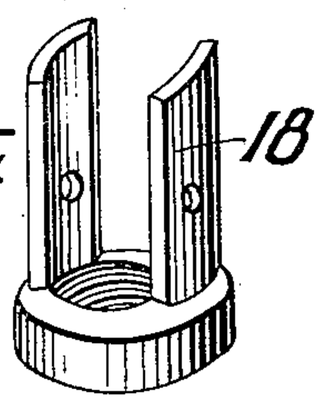
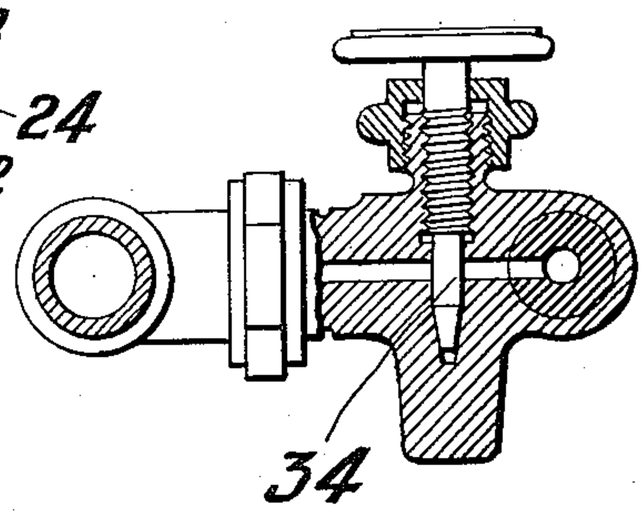


FIG. 7.



Witnesses
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UNITED STATES PATENT OFFICE.

WILLIAM EDWARD GARFORTH, OF NORMANTON, ENGLAND.

RESPIRATION APPARATUS FOR USE IN COAL-MINES AND OTHER PLACES.

953,462. Specification of Letters Patent. Patented Mar. 29, 1910.

Application filed April 10, 1908. Serial No. 426,188.

To all whom it may concern:

Be it known that I, WILLIAM EDWARD GARFORTH, a subject of the King of Great Britain, residing at Normanton, Yorkshire, England, have invented a certain new and useful Improved Respiration Apparatus for Use in Coal-Mines and other Places, and of which the following is a specification.

This invention refers to improvements in respiration apparatus for the use of persons entering places filled with or containing irrespirable gases, and the apparatus is particularly intended for the use of trained explorers, to enable them to rescue life and relieve suffering brought about by explosions or other accidents in coal mines.

Now the object of the present invention is to so arrange and construct such apparatus, that the volume of oxygen admitted to the face-piece from the pressure cylinder, shall be governed automatically by the action of the lungs of the user and thus regulated in accordance with his varying requirements, and this end I attain by employing a very sensitive reducing valve between the oxygen cylinder and the face-piece in conjunction with a face-piece of limited capacity.

According to this invention, the face-piece is of such limited capacity that the force of the lungs can expel all the vitiated air contained in it, the air expired by the lungs thus producing sufficient pressure within the face-piece to open a sensitive outlet valve therein and pass away to a regenerator, while the inspiration of the explorer reduces the pressure within the face-piece, so that there is then drawn in through a sensitive inlet valve in said face-piece, a volume of purified nitrogen and also a variable volume of oxygen through the reducing valve aforesaid, according to the requirements of the explorer, and not depending upon the pressure of the storage oxygen acting through an injector as is common.

The valve for admitting oxygen I preferably adopt for use in carrying out my present invention, is of that type which has already been suggested for use in gas regulators or governors, in which the opening and closing of the valve is regulated by eccentrics operated through a lazy-tongs arrangement of levers connected with a rising and falling diaphragm. I have, however, made certain alterations or additions hereafter described, to such a valve with the object of increasing its sensitiveness and its certainty of action, which features are specially important in view of the serious and fatal results which would happen to the wearer through either failure of action, or the valve not being sufficiently sensitive to respond with ease to the efforts of the lungs of the explorer.

The present invention will now be described with reference to the accompanying drawings, where is illustrated an example of application of a valve apparatus actuated by the breathing of the wearer and which forms the subject of the present invention, the said invention being illustrated in conjunction with a construction of helmet and face-piece forming the subject of Letters Patent No. 908,239, granted to me December 29, 1908, for an improvement in respiration apparatus.

Figure 1 is a front view of the apparatus. Fig. 2 is a vertical section of the reducing valve for the oxygen. Fig. 3 shows a vertical section of a portion of the valve drawn to a larger scale. Fig. 4 is a vertical section of the same valve corresponding to Fig. 2, the section being taken at right angles to that shown in the latter figure. Fig. 5 shows detached and in perspective, the vertically movable valve forming a part of the apparatus shown at Fig. 4. Fig. 6 shows detached and in perspective, the vertical guides for the valve as shown at Fig. 5. Fig. 7 is a horizontal section on the line X^2, Y^2 of Fig. 4 showing a valve which closes an emergency by-pass from the oxygen cylinders to the face-piece.

In order to enable the apparatus, according to my invention, to be properly understood, I will first broadly describe the general arrangement of the parts with reference to Fig. 1.

The face-piece 1, which is secured by straps 53 to the head of the wearer or otherwise attached, is fitted on the interior with an inlet and an outlet valve hereafter described, respectively communicating with a double tube 2 passing over the helmet 3, the tube 2 being bifurcated at its rear end, and to these two tubular ends two flexible pipes

4, 5 are connected by screw-threaded nozzles 39, the pipe 4 being in communication with the exit valve in the face-piece and communicating with the regenerating case 6, while flexible pipes 7 connect the regenerating case 6 with the storage bag 8 for nitrogen, constructed of india-rubber or other suitable material and located in the rear part of a coat 9 worn by the explorer. The pipe 5, which is in communication at one end through the double tube 2 with the inlet valve to the face-piece, at its other end communicates with the storage bag 8.

The storage cylinders 10 containing oxygen, one upon each side of the person of the wearer, are connected by a pipe 11, and 12 (Fig. 1) is the valve which communicates by a pipe 13 with a branch of the pipe 11 connected with the oxygen cylinders, and the oxygen passed by the valve 12, passes by a flexible pipe 14 directly to the interior of the face-piece 1.

Such being the general arrangement of the apparatus, I will now describe the construction of the valve with reference to Figs. 2 to 7, inclusive. This valve is designed to act in such manner that with a normal pressure within the face-piece 1, the oxygen will not enter therein, but upon the pressure within the face-piece being disturbed and lessened by the indrawing of the breath of the user, the valve is opened and a supply of oxygen admitted to the face-piece; the valve is therefore so constructed and so delicately balanced, that the volume of oxygen admitted varies with the energy of the inspiration of the user. To this end the valve is composed of a closed cylinder 15 (Figs. 2 and 4) with a nozzle 16 at its base, the nozzle 16 being connected by a union nut 17, to the oxygen supply tube 11 from the cylinders 10.

Within the cylinder 15 upon the base thereof, there are vertical guides 18 shown detached at Fig. 6, which guides support a vertically movable valve 19 shown detached at Fig. 5 for controlling the orifice of the nozzle 16; the vertical guides 18 carry a transverse pin 20, Fig. 4, which passes through slots in wings 21 formed on the valve 19, and upon the pin 20 aforesaid there are loosely mounted eccentrics 22, Fig. 3, each connected with an angularly extending arm 23. By these means, when the arms 23 of the eccentrics 22 are given angular motion, the eccentrics will bear upon the upper face of the valve 19 and force it to its seat on the end of the nozzle 16, or on the other hand, when given a reverse angular movement, the valve 19 will be free to lift. Beneath the said valve I provide a helical spring 24 (Fig. 4) tending to raise the valve 19 and always hold it against the eccentrics.

To an annular flange within the cylinder I fix one end of a flexible tube 25, crimped or otherwise constructed so that it can be compressed in the direction of its axis like a camera bellows, and the upper end of this flexible tube is fixed to a disk 26, and within this tubular bellows there is a helical spring 27 tending to hold it in extension. The disk 26 at the upper end of the tubular bellows, is connected by links 28 (Fig. 2) jointed together lazy-tongs fashion with the two arms 23 of the eccentrics 22, and above the disk 26 there is a helical spring 29 acting between the said disk, and an adjustment screw 30 passing through the top cover of the cylinder. By the use of the adjustment screw 30 and the spring 29, the balance of the bellows can be adjusted with the greatest nicety, the outer spring 29 being made to balance the spring 27, and the movement of the bellows 25 regulates the position of the valve 19 and consequently the admission of the oxygen to the face-piece. The oxygen when admitted by the valve, passes from the tubular bellows through a tubular nozzle 31 (Fig. 4) connected by a branch pipe 32 with the flexible pipe 14 leading directly to the face-piece 1. The pipe 14 is shown at Fig. 1, and it is connected to a tube 51, which passes through the walls of the face-piece and freely opens into a chamber within the face-piece. Within this chamber the tube 51 terminates in a short flexible open pipe 54 shown by dotted lines in Fig. 1 which the user may seize between his lips upon emergency and inhale pure oxygen.

With this apparatus, properly adjusted, the tubular bellows 25 will operate and become contracted in proportion to the energy of inspiration of the explorer, and consequently a proportion of oxygen will be admitted to the face-piece in accordance with his requirements.

The branch pipe 32 by which the oxygen is delivered from the valve, has a by-pass 33 (Fig. 4) communicating directly with the passage 16, in the nozzle leading from the oxygen cylinders, and this is normally closed by means of a screw valve 34 (Figs. 4 and 7) but is capable, upon emergency, of being opened.

The oxygen cylinders 10 connected by the pipe 11 as before described, can be fitted with a gage 37, in such a position relatively to the face of the user, that he can conveniently ascertain by observation the pressure of oxygen in the cylinders.

From the description and drawings of the apparatus according to this invention which has now been given, it will be thoroughly understood that the regulation and variation of the supply of oxygen does not call for the use of the hands of the explorer, and therefore leaves his hands free for more useful purposes, such as for assisting suffer-

ers in mining disasters and doing useful and necessary work.

The air expired by the lungs of the explorer produces of itself sufficient pressure within the face-piece to open the sensitive outlet valve 44 and so pass to the regenerator, while the inspiration of the user reduces the pressure within the face-piece, closes the outlet valve 44 and opens the inlet valve 45, and there is then drawn in through the inlet valve 45 a quantity of purified nitrogen from the storage bag, and at the same time a supply of oxygen through the pipe 51 communicating directly between the chamber 41 of the face-piece and the valve controlling the oxygen supply, the valve admitting the oxygen being acted upon by the indrawing or inspiration of the user, in such manner as to deliver the requisite quantity of the said oxygen. If the user takes what is termed a long breath, it therefore follows that he will draw in not only a greater volume of the purified nitrogen, but also a greater volume of oxygen, and therefore this apparatus does not depend for its operation upon the pressure of the storage oxygen acting through an injector to mechanically draw in the nitrogen, nor does it call for the constant manipulation of the explorer.

What I claim as my invention and desire to secure by patent is:—

1. In a respiration apparatus, a valve structure comprising a casing, an expansible bellows within the said casing, an inlet connection terminating within the bellows chamber, an outlet connection leading from the bellows chamber, a valve controlling the orifice of the said inlet connection, guides extending into said bellows from the said casing within which guides the said valve is adapted to move, a spring beneath the said valve tending to open the same, a spindle extending transversely above the said valve and having bearings in the said guides, two eccentrics loose on the said spindle, an arm fixed to each eccentric and extending therefrom, pivoted links forming lazy-tongs extending from the said arms to the free end of the said bellows and means for balancing the said bellows.

2. In a respiration apparatus, a valve structure comprising a casing, an expansible bellows within the said casing, an inlet connection terminating within the bellows chamber, an outlet connection leading from the bellows chamber, a valve governing the orifice of the said inlet connection, guides extending into the bellows chamber from the said casing and within which the said valve is adapted to move; a spring beneath the said valve tending to open the same, a spindle extending transversely above the said valve and journaled within the said guides, two eccentrics loose on the said spindle, an arm fixed to each eccentric and extending therefrom, pivoted links forming lazy-tongs extending from said arms to the free end of said bellows, a helical spring within the said bellows acting between the said casing and the free end of the bellows, a helical spring within the casing acting between the end of the same and the exterior of the free end of the bellows, and means for adjusting the tension of the last aforesaid spring for balancing the said bellows.

3. In a respiration apparatus, a valve structure comprising a cylindrical valve casing, a cylindrical bellows expansible in the direction of its axis and located within the valve casing and having one end connected to the said valve casing, a disk carried by and closing the other or free end of the said bellows, an inlet connection terminating within the bellows chamber, an outlet connection leading from the bellows chamber, a valve controlling the orifice of the said inlet connection, guides extending from the said casing into the bellows chamber and within which the said valve is adapted to move, a spring acting between the said valve and the valve casing tending to open the said valve, means for permitting the said valve to open upon the said bellows becoming contracted and for closing the said valve upon the said bellows becoming expanded, a helical spring within the said bellows tending to expand the same, a screw-threaded spindle passing through the end of the said valve casing adjacent to the free end of the said bellows, a cup-formed disk carried by the said spindle within the said casing and a helical spring located between the said cup disk and the top of the said bellows.

4. In a respiration apparatus, a valve structure comprising a cylindrical valve casing, a cylindrical bellows expansible in the direction of its axis and located within the valve casing and having one end connected to the said valve casing, a disk carried by and closing the other free end of the said bellows, an inlet connection terminating within the bellows chamber, an outlet connection leading from the bellows chamber, a valve controlling the orifice of the said inlet connection, guides extending from the said casing into the bellows chamber and within which the said valve is adapted to move, a spring acting between the said valve and the valve casing tending to open the said valve, a spindle extending transversely above the said valve and being journaled in the said guides, two eccentrics loose on the said spindle, an arm fixed to each eccentric and extending therefrom, pivoted links forming lazy-tongs extending

from said arms to the free end of the said bellows, a helical spring within the said bellows tending to expand the same, a screw-threaded spindle passing through the end of the said valve casing adjacent to the free end of the said bellows, a cup-formed disk carried by the said spindle within the said casing and a helical spring located between the said cup disk and the top of the said bellows.

In witness whereof I have hereunto set my hand in the presence of two witnesses.

WILLIAM EDWARD GARFORTH.

Witnesses:

GRIFFITH BREWER,

JOHN JOWETT.