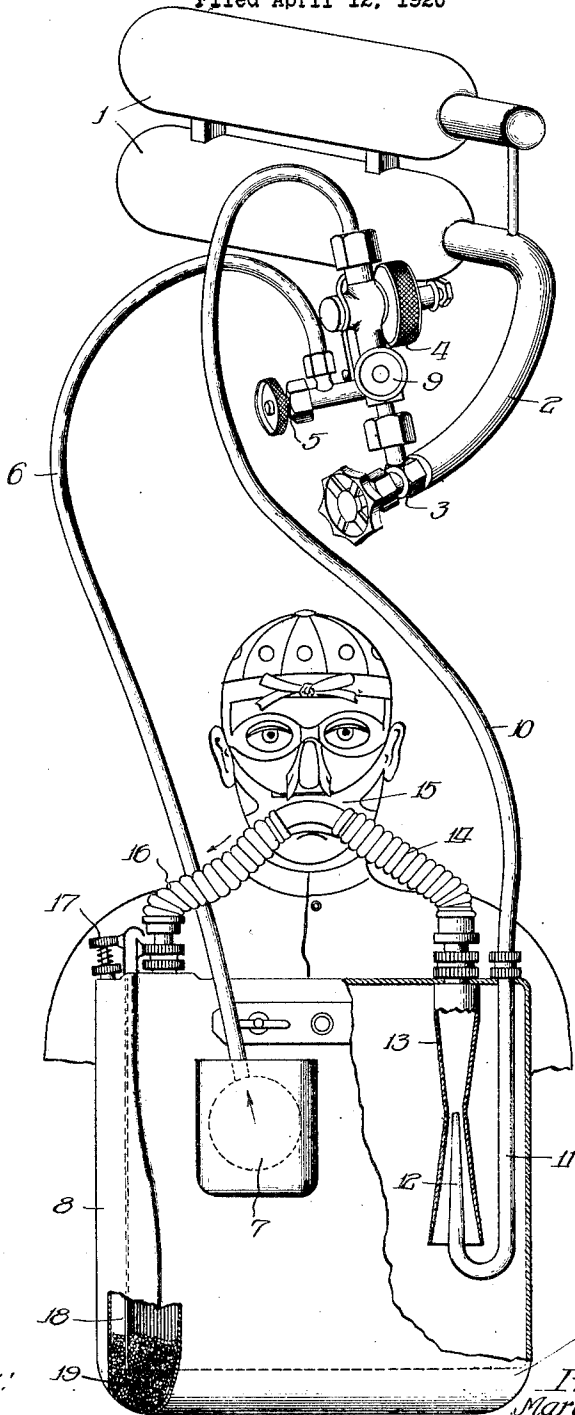


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LIFE SAVING APPARATUS
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UNITED STATES PATENT OFFICE.

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LIFE-SAVING APPARATUS.

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My invention relates to life-saving apparatus, such as is used in mines and other places where gas is prevalent, whereby the wearer of the apparatus may safely enter places where otherwise he would be subjected to danger of injury, if not death. More particularly the invention relates to apparatus including a supply of oxygen and means connecting the oxygen supply with the respiratory organs of the wearer in such manner that the wearer may have a sufficient supply of oxygen at all times regardless of the amount consumed. The apparatus is provided with means for exhalation as well as inhalation, the usual type of apparatus including a bag preferably suspended in front of the wearer and connected by suitable means to the mouth and nose of the wearer, means within the bag for absorbing the carbon-dioxide exhaled by the wearer, and means for preventing its admission to the inhalation portion of the apparatus.

It is a well-recognized fact that the inhalation and exhalation of a human being varies according to the exertion of that person. The amount of oxygen inhaled and exhaled when a person is exercising or working hard is greater than under normal conditions.

I am aware that various kinds of apparatus have been devised for supplying oxygen to a person, but such do not function satisfactorily under all conditions. At the present time there are two types of apparatus used. In one form a constant flow of oxygen is supplied to the wearer, which supply is more than sufficient to supply the oxygen consumed when the wearer is not exerting himself, but which is below the amount required when the wearer is exerting himself violently. In such apparatus it is necessary to provide means for throwing off the excess amount of oxygen supplied, which results in a material waste of oxygen. To take care of the increased supply demanded when the wearer is exerting himself, a manually controlled valve is provided in the apparatus. The other type of apparatus is what is known as a variable flow apparatus and is so constructed that the rate of flow of the oxygen varies with the consumption. This regulation is accomplished by the opening and closing of an auxiliary valve which is operated by a bellows. The chief objection to this type of apparatus is that the openings in the auxiliary valve must necessarily be

very small, the result being that these small openings become clogged very easily, thus impairing the efficiency of the apparatus and endangering the life of the wearer by cutting off the flow of oxygen when the same is needed.

My invention finds particular application in that type of apparatus wherein the supply of oxygen is responsive to the consumption.

An object of my invention is the provision of a life-saving apparatus of the class described which is of simple construction and in which the oxygen supply is made responsive to the variations in breathing of the wearer so as to supply the requisite amount of oxygen at all times.

Another object is to provide an apparatus of the class described which will furnish oxygen in proportion to the consumption thereof.

A further object is to provide an apparatus which will be as simple in mechanical construction as is practicable, and one in which there are no outside moving parts and in which there are no small apertures through which the oxygen must pass, thereby removing the possibility of clogging and the endangering of the life of the wearer.

These and other objects are accomplished by means of the arrangement disclosed on the accompanying sheet of drawings, which shows in somewhat diagrammatic form a life-saving apparatus in which are incorporated the features of my invention.

Oxygen cylinders 1 are arranged to be carried preferably on the back of the wearer in any desirable manner. In these cylinders the oxygen is contained at high pressure. A tube 2 in communication with the oxygen cylinders 1 has the supply of oxygen there-through controlled by means of a main valve 3 and in part by a reducing valve 4. Interposed between the valves 3 and 4 is a pressure gauge valve 5 which is connected by means of a pressure gauge tube 6 to a pressure gauge 7 carried on the bag 8. Around the reducing valve 4 is a by-pass valve 9 which on being opened permits oxygen to pass to the discharge side of the pressure-reducing valve 4. The by-pass as arranged in my construction is used only in the case of an extreme emergency when the Venturi and reducing valve have entirely failed to function. From the reducing valve 4 the oxygen is led into the breathing bag 8 by

means of a supply tube 10. In my arrangement the portion 11 of the oxygen supply pipe preferably is inside the breathing bag 8 and projects downwardly a considerable distance therein and has an upturned end 12 which enters a Venturi tube 13 and has its discharge end terminating within the Venturi tube 13 at the point of greatest restriction of the latter. The Venturi tube 13 is connected by a flexible tubing 14 to the mouth-piece 15, which is secured to the head of the wearer in any suitable manner. From the mouth-piece an exhalation tube 16 extends to the breathing bag 8. This breathing bag 8 is provided with a flexible partition 18 which extends from the top of the bag to almost the bottom thereof, so that for all intents and purposes the bag may be considered as being divided into two portions by means of the partition 18. The inhalation tube 14 is connected to the breathing bag 8 on one side of the partition and the exhalation tube 16 on the other side thereof. In the bottom of the bag a quantity of caustic soda 19 or other carbonic acid absorbent is placed in such quantity as to extend above the bottom of the partition 18 and thus prevent the flow of gas from either side of the partition without necessarily having to pass through the absorbent. An exhaling relief valve 17 is provided which may be adjusted by the wearer as occasion demands.

The operation of the apparatus without the Venturi tube 13 may be described briefly as follows:

In such a case the reducing valve 4 would become a constant flow valve and be set to permit the flow of approximately two litres of oxygen per minute. The main valve 3 being opened, oxygen from the cylinders 1 would pass therethrough, then to the valve 4 and through oxygen supply pipe 10 to the breathing bag 8. The supply of oxygen necessarily distends the bag 8 and if there were no consumption of oxygen this supply would have to be relieved by means of the valve 17. It will be understood that the inhalation tube 14 is in communication with one of the portions formed by the partition 18, while the exhalation tube 16 is in communication with the other portion, which is standard in all bags of this general type. When the wearer is breathing, the oxygen supplied to the bag is inhaled through the tube 14 and exhaled through the tube 16, the carbonic acid passing through the absorbent 19 and being absorbed thereby, the volume within the bag being augmented by the constant flow of oxygen delivered thereto. In case of violent exertion, the two litres of oxygen are insufficient to supply the requisite amount of oxygen, and accordingly the wearer manipulates the by-pass valve 9 to admit an excess supply of oxygen to the bag from time to time to make up for the de-

ficiency caused by the constant flow of two litres.

However, as stated before, in the apparatus of my invention, the extension 11 of the oxygen supply pipe 10 projects into the bag with the delivery end 12 thereof projecting into the Venturi tube and terminating at the point of greatest restriction. With this arrangement the reducing valve 4 serves as a variable flow valve set to discharge at a constant pressure; that is to say, if the pressure in the oxygen supply pipe 10 is increased or decreased, the flow through the valve 4 will be correspondingly increased or decreased. This reducing valve is the regular standard type of reducing valve used for many purposes in the use of steam, air and other fluids. There is nothing peculiar about the construction of said valve in this case. The reducing valve is set to discharge oxygen at a constant pressure, said pressure being sufficient to distend the bag to its working pressure; namely, five centimeters of water gauge, whereupon the flow through the reducing valve stops and no further oxygen flows therethrough until a reduction in pressure takes place in the tube 10. Accordingly, as the inhalation of the wearer increases or diminishes a corresponding increase or decrease of suction through the Venturi tube is caused, this suction necessarily acting to control the supply of oxygen through the pipe 10. If the pressure at the end of the pipe 12 is decreased the flow of oxygen thereto would necessarily be increased as the pressure of oxygen delivered through the valve 4 is constant. The suction through the Venturi tube is a function also of the velocity of the flow therethrough, the result being that increased inhalation causes a corresponding increase of the supply of oxygen, which supply is responsive absolutely to the variations in the breathing of the wearer. It is apparent, therefore, that air drawn through the Venturi tube 13 will greatly increase in speed at the point of greatest restriction, causing a suction in the oxygen supply extension 12 and causing the reducing valve to open for supplying oxygen with an amplifying action.

I might state that in the constant flow type of apparatus, an injector principle is made use of in which the pressure of oxygen from the cylinders is reduced by a reducing valve to a somewhat lower pressure and then passed through a minute nozzle or orifice introduced into an injector which causes the air and carbonic acid to circulate independently of the breathing of the operator. In short, in the injector type of apparatus the flow of oxygen causes a circulation of respiratory gases. In my apparatus, using the Venturi and the constant pressure reducing valve combination, the flow of respiratory gases through the breathing bag

in response to the demands of the wearer's lungs, causes an increase or decrease in the flow of oxygen.

My invention has eliminated moving parts which easily become disorganized and cause inefficient functioning of the apparatus and constant danger to the life of the wearer. Furthermore, I have secured a variable oxygen supply with the elimination of the small apertures and by-pass valves, and there is nothing in my arrangement which will become easily disorganized or put out of order by rough usage or constant demands on the system.

While I have described more or less precisely the details of construction of my invention, I do not wish to be understood as limiting myself thereto, as I contemplate changes in form, the proportion of parts and substitution of equivalents as circumstances may suggest or render expedient, without departing from the spirit of my invention.

I claim:

1. In a device of the class described, a

source of oxygen supply, a valve operatively associated with said source, a Venturi tube, and a connection between said source and said Venturi tube including said valve, said connection terminating in a relatively large opening at the point of greatest restriction of said Venturi tube for controlling said valve and the supply of oxygen from said source.

2. In a device of the class described, a source of oxygen supply, a Venturi tube directly connected by piping to the mouth of the wearer, pressure reducing valve connected to the source of oxygen supply, and piping leading from said valve and terminating in an opening of relatively large size within the restricted portion of the Venturi tube, whereby the valve is responsive to suction created in said portion of the tube by the wearer.

Signed at Chicago, Illinois, this 29th day of March, 1920.

MARCUS C. STEESE.