

Aug. 14, 1928.

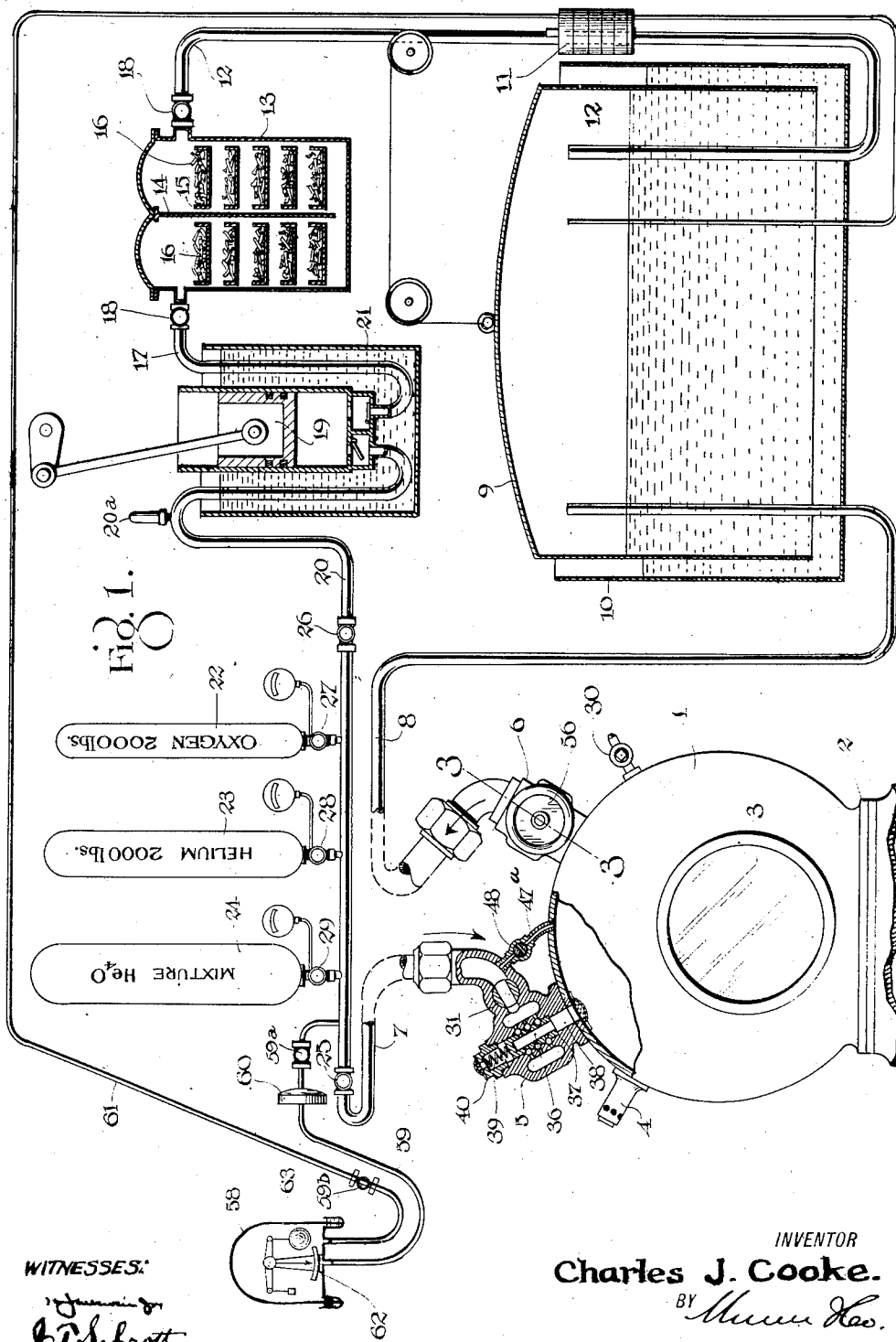
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DIVING APPARATUS

Filed Oct. 23, 1920

2 Sheets-Sheet 1



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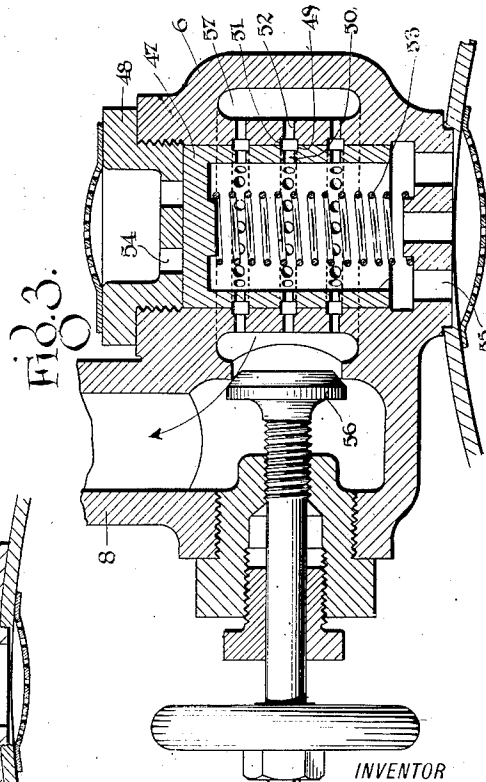
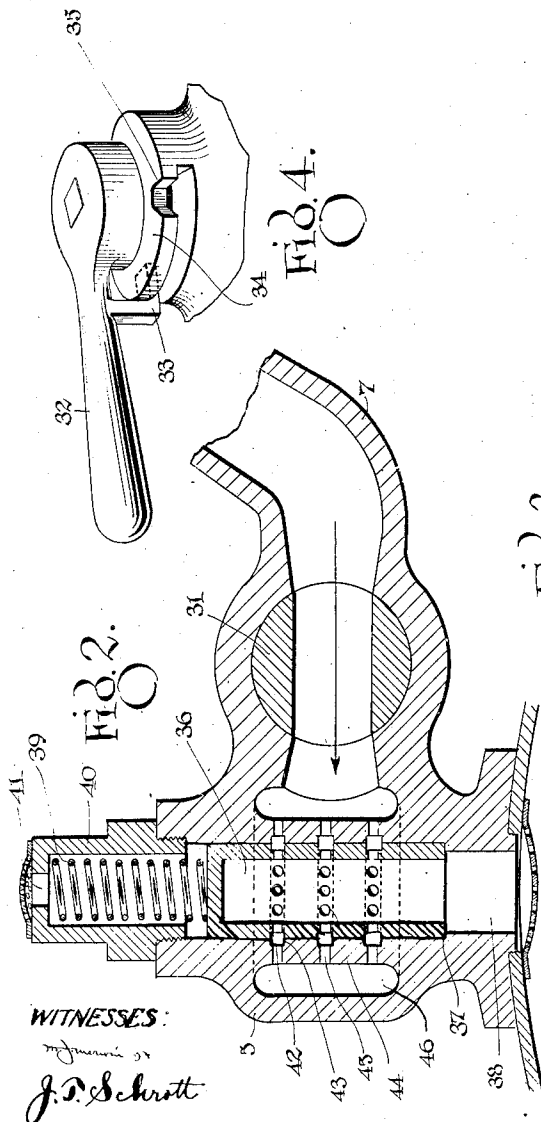
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2 Sheets-Sheet 2



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1,681,029

UNITED STATES PATENT OFFICE.

CHARLES J. COOKE, OF WASHINGTON, DISTRICT OF COLUMBIA.

DIVING APPARATUS.

Original application filed August 15, 1919, Serial No. 317,838. Divided and this application filed October 23, 1920. Serial No. 419,149.

My invention relates to improvements in diving apparatus, and it consists in the constructions, combinations, and mode of operation herein described and claimed.

5 One of the foremost objects of the invention is to provide a combination of apparatus with a diving dress of any type whatever, for supplying a breathing compound of any one of a number of particular formulas.

10 A further object of the invention is to include in said combination of apparatus, means for purifying or rejuvenating the vitiated air from the diving dress so that it may be used again and again.

15 A further object of the invention is to supply a pressure atmosphere to the diving dress, there being means included in the system for increasing the pressure on the inside as the depth increases.

20 Other objects and advantages will appear in the following specification, reference being had to the accompanying drawings, in which

25 Figure 1 is a diagram illustrating the general layout and combination of the improved diving apparatus.

Figure 2 is a detail section of the reducing valve shown at the left of the diving helmet in Figure 1,

30 Figure 3 is a cross section of the outlet valve taken on the line 3-3 of Figure 1,

Figure 4 is a detail perspective view of the handle for controlling the inlet cock associated with the valve in Figure 2, which handle can be removed only when the inlet cock is in the full open position.

35 This is a division of my co-pending application for Letters Patent on apparatus and atmospheric compound for divers' use, filed August 15, 1919, Serial No. 317,838, now matured into Patent #1,473,337 of December 6, 1923. By way of introduction of the purposes of the diving apparatus in Figure 1, it will doubtless be of interest to read excerpts from the patent named above, which give a general survey of the difficulties and dangers of deep sea diving according to present methods.

40 "Nitrogen, as is commonly known, comprises about four-fifths of the atmosphere by volume. When used alone, that is to say, out of combination with the proper proportion of oxygen, it is incapable of supporting life.

55 "When breathed under pressure, as in cir-

cumstances where it is supplied to a diver under water in admixture with oxygen as common air, a peculiar and harmful effect is produced. The nitrogen is absorbed by the blood and tissues of the body of the diver. 60 While under high pressure the absorption of nitrogen by the blood and tissues is fairly great.

"Upon ascending from deep water, by which act the pressure is relieved, the blood 65 and tissue are no longer able to retain this dissolved nitrogen in solution and thus there is set up an escape of gas which forms into numbers of small bubbles. These, entering the blood vessels, impair the circulation of 70 the blood and other body functions, thus causing the gravest symptoms to take place which often terminate in death.

"According to present methods the diver is decompressed slowly, that is to say, he is 75 slowly pulled to the top so that the normal equilibrium is gradually reached and the dangers due to the escape of nitrogen as explained above, greatly minimized. This decompression takes an abnormally long time 80 when compared with the short time the diver is enabled to remain at work on the bottom.

"Obviously it becomes a matter of great importance to provide a breathing fluid 85 which has none of the insipiently dangerous properties of ordinary air. By providing such fluid, the diver can remain on the bottom much longer, because it now becomes unnecessary to pull him up within a comparatively short time after lowering him, in order to allow ample time for decompression. With an improved breathing compound, the time allowance for decompression may be greatly reduced."

95 This leads to a consideration of the improved breathing compound, of which the foregoing application discloses several modifications. Pure oxygen cannot be breathed and so it is necessary to provide a suitable diluent. In ordinary air we have nitrogen as the diluent for the oxygen. According to the foregoing invention, helium is selected as the foremost of a number of most suitable diluents for the oxygen gas. The reason for 105 its selection is this:

Helium is quite chemically inert and has a very low co-efficient of absorption. This co-efficient is about half that of nitrogen and would thus enable a diver to work at greater 110

depths with the same decompression difficulties, or if working at about a normal depth, to stay down much longer. A second formula for the improved breathing compound shall consist of 1 part oxygen and 4 parts argon; a third formula consists of 1 part oxygen and 4 parts hydrogen.

So far as the practical utilization of this improved breathing compound is concerned, it would of course be a simple matter to use any one of the formulas in place of air and in connection with the present well known diving equipment which consists generally of a pump, air pipe, helmet, and escape valve.

Such use, however, at once gives rise to the serious disadvantage of the considerable expense of the artificially made air. When working at great depths as proposed above, it becomes necessary to keep the partial pressure of the carbon-dioxide (CO_2) below a certain low value, and hence enormous volumes of air have to be supplied to the diver.

It is proposed to provide instrumentalities eliminating the CO_2 as soon as formed, or substantially so, thereby making it necessary to supply only sufficient air to satisfy the diver's demand for oxygen, his air supply remaining constant regardless of depth. There are two principal ways of doing this; on the surface as in Fig. 1, or locally in the diving dress as in Figures 5 and 6, etc. Consider first the apparatus in Figure 1. The helmet 1 is constructed of tinned sheet copper as is common practice, and is provided with the usual internally threaded collar or flange 2 by means of which the helmet is screwed on the breast plate. Suitably constructed windows 3 permit the diver to look out. The usual safety valve 4 is embodied but only functions in case of emergency.

There are two main valves on the helmet; the reducing inlet valve 5 and the outlet valve 6, these being located at what is herein generally regarded the inlet and outlet of the diving dress. The first controls the influx of fresh air in the pipe 7 from the surface, the latter controls the passage of air in the pipe 8 which also goes to the surface. The pipe 8 discharges into the bell 9 of the gasometer 10, in which bell the pressure stands at a little below one atmosphere. The bell is counterbalanced by weights 11.

Leading from the bell 9 is an exhaust pipe 12 which runs to one side of the CO_2 (carbon dioxide) absorber 13. This absorber is composed of a plurality of compartments, so formed by a partition 14, in which are located pans 15 containing pieces of caustic potash 16. This chemical substance purifies the exhaust air by neutralizing the CO_2 , so that fresh or rejuvenated air leaves the absorber at the pipe 17. Both pipes 12 and 17 are equipped with valves 18.

As the piston 19 of the pump is recipro-

cated, air is drawn in from the pipe 17 and discharged into the branch 20 of the main inlet pipe 7. A conventional method of cooling the pump is designated by the tank 21 filled with water, in which the major portion of the pump cylinder is suitably supported. The pressure in the branch 20 is approximately 150 pounds while diving operations are being performed.

This is under the supposition that the depth to which the diver is to descend is about 250 feet. More or less pressure is employed with an increase or decrease of depth.

Three reservoirs, respectively of appropriate sizes, are in fluid connection with the branch 20; the first 22 contains oxygen at 2000 pounds pressure; the second 23 contains helium at 2000 pounds pressure; and the third 24 contains the mixture of both gases at approximately 150 pounds, the same as in branch 20. This mixture constitutes a respirable composition (see the patent mentioned) and inasmuch as it is intended to be used with any of the forms of the invention disclosed is regarded as the definition of "air" as herein used.

In the beginning, the mixture or air in the reservoir 24 is produced in this manner: The ordinary air in reservoir 24 and in the entire closed system is flushed out and replaced by helium at about atmospheric pressure; the branch 20 is provided with two main valves 25, 26, both of which are closed. It also has a relief valve 20^a. The connections between the various reservoirs and the branch are provided with valves 27, 28 and 29. Close the valve 27, open the valve 29 and also open the valve 28 from the helium reservoir 23 until the gauge of the mixture reservoir 24 reads 120 pounds, then close the valve 28. Now open the valve 27, letting oxygen flow into the reservoir 24 until the gauge of the latter reads 150 pounds. There will now be a mixture of 4 parts helium and 1 part oxygen in the mixture reservoir 24, and this proportion is in accordance with the formula laid down in my Patent 1,473,337 above referred to. Reservoir valves 27 and 28 should now be closed and the valve 26 in the branch 20 may be opened. After the diver gets into the dress and before screwing on the face plate 3, valves 25 and 29, as well as cock 31, are opened, thus establishing a flow of breathing compound. The face plate is now screwed on and the pumps started. Simultaneously with this, the blow-through cock 30 is opened for a few seconds and the ordinary air in the dress flushed out by the helium oxygen mixture. The cock 30 is now closed and the handles of cocks 31 and 30 are removed. The diver is now ready to descend. Consider now the function of the inlet valve 5, which is shown in detail in Figure 2. It includes the inlet

cock 31 which has that type of handle which can be removed only when the cock is open.

The valve handle is shown in detail in Figure 4. It has an L-arm 33 extending beneath the flange 34 on the valve casing. The presence of the handle on the stem of the cock 31 indicates to the attendant that the cock 31 is closed and must be opened before the diver can be let down. Therefore, the handle must be turned until the arm 33 comes into registration with the notch 35, whereupon, and only then, the handle is taken off, leaving the cock 31 in the full open position.

The valve cylinder 36 is normally pressed inwardly into engagement with the shoulder 37 surrounding the inlet port 38, by the spring 39. The spring is contained by the housing 40, and the housing is screwed into the bore of the valve cylinder. It also has a screened opening 41 by which sea water enters to press against the head of the cylinder in the automatic controlling of the air supply.

There are annular channels 42 and 43 respectively in the cylinder 36 and valve 5, the former having ports 44 leading to the inside of the cylinder, the latter having ports 45 leading into the annular air space 46. The port 38 is protected by a screen on the inside of the helmet as shown.

Imagine the diver having entered the water and descended perhaps fifty feet. The attendant must gradually open the valve 29 wider to supply an increasing quantity of air for the pressure inside the dress must exceed the pressure of sea water on the outside if the driver is to be prevented from being subjected to a "squeeze".

Assume that the attendant, out of a desire to supply the diver with a sufficient quantity of air and to keep the dress properly inflated, lets in a volume of air at a pressure greatly in excess of the surrounding pressure. There is now danger of bursting the dress; but the valve 5 will automatically function to prevent this. The excessive pressure on the inside moves the cylinder 36 outwardly against the tension of the spring 39, partially or wholly closing the now aligning channels and ports.

The diver continues his descent and when the outside pressure exceeds the pressure now present in the dress, such pressure will move the cylinder 36 inwardly until the channels and ports are again in registration, placing the diver in air-communication with the main inlet pipe 7 as before. Thus, an equilibrium is always established.

A by-pass 47^a has a valve 48 which is to be opened by the diver only in an emergency. The cylinder 36 is of such design that it will probably never stick in its bore, but should it stick from some unforeseen cause and in such a position as to close the air supply,

the diver may reach up, open the valve 48 and supply himself with sufficient air from the main pipe 7 to prevent suffocation. Under such circumstances, he should return to the surface as rapidly as possible. Consider now the outlet valve 6. It will be apparent at once that this valve is very much like the inlet valve 5 in that there is a valve cylinder 47 retained by a cap 48, provided with annular channels 49 and ports 50 corresponding with similar channels and ports 51, 52 in the valve casing, but pressed outwardly against sea water pressure by the spring 53, instead of inwardly as in Figure 2. The cap 48 is screened and has openings 54 which admit the sea water. Ports 55 let the vitiated air out of the helmet.

A valve 56 operates over the opening of the annular exhaust air space 57. This valve is controlled by the diver and by opening or closing it more or less fully, he can increase or decrease the amount of mixture received and for that purpose it has an exposed handle. The strength of the spring 53 places the preponderance of weight on the inside of the cylinder 47 so that the various channels and ports are normally held in registration. It is only when the pressure on the inside of the dress approaches or falls below the outside pressure, that the spring 53 is overcome and an inward movement of the cylinder 47 follows.

The result is that the various channels are closed in proportion to a fall of pressure on the inside of the dress, thereby automatically reducing the rate of exhaust and retaining more air in the dress, thus preventing the collapse which might otherwise occur.

The mixture gauge 58 is a valuable adjunct for determining the condition of the air supplied to the diver. This gauge serves to indicate the condition of the air supplied to the diver, that is to say, it indicates the relative proportions of helium and oxygen. A small pipe 59 leads from the branch 20 to the bottom of the gauge; by means of the reducing valve 60 the pressure of say 150 pounds in the branch 20 is reduced to perhaps 15 pounds in the pipe 59. This pipe also has valves 59^a and 59^b. An off-take pipe 61 leads from the gauge to the space inside the gasometer bell 9. The valves 59^a and 59^b are opened a very little so as to produce a slow flow of the breathing compound through the gauge 58.

Proper proportions of helium and oxygen, i. e. 4 to 1, keeps the pointer 62 in the center of the scale. Should the oxygen content become greater, the float 63 will rise; should the helium content become greater, it will fall. A deviation of the pointer either to the right or left will indicate to the attendant that one or the other of the valves 28, 27 must be opened to restore the air to its proper condition. The bell 58 is of glass or

other transparent material to enable observation of the gauge pointer.

I claim:—

1. Diving apparatus comprising a diving
5 dress, a closed air circuit having an inlet
and an outlet at the dress, means in communication with the circuit for introducing
air to the inlet to the dress, and a valve situated
10 between the inlet of said circuit and
said dress operable by external fluid pressure
to hold the valve in a normally open
position.

2. Diving apparatus comprising a diving
dress, a closed air circuit having an inlet and
15 an outlet at the dress, means in communication
with the circuit for introducing air into
the inlet to the dress, a valve situated between
the dress and said inlet operable by
external fluid pressure to control the flow
20 of air to the inside of the dress, a valve situated
between the dress and said outlet also
operable by external fluid pressure to control
the escape of air from the dress to said

outlet, and separate valves associated with
each of the aforesaid valves permitting
25 manual control of the inflow and escape of
air respectively in conjunction with the automatic
functioning of the aforesaid valves.

3. The combination in diving apparatus
comprising a diving dress, a closed air circuit
30 having an inlet and an outlet at the
dress, means in communication with the circuit
for introducing air into the inlet to the
dress, a valve situated between the dress and
said inlet operable by external fluid pressure
35 to control the flow of air to the inside
of the dress, a valve situated between the
dress and said outlet also operable by external
fluid pressure to control the escape of
air from the dress to said outlet, and a cock
40 associated with the inlet valve arranged to
remain fixed in the open position when the
apparatus is in use, and a valve associated
with the outlet valve arranged for manual
operation while the apparatus is in use.

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