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 SUBAQUEOUS TORCH AND METHOD OF IGNITING.
 APPLICATION FILED JULY 31, 1915.

1,298,880.

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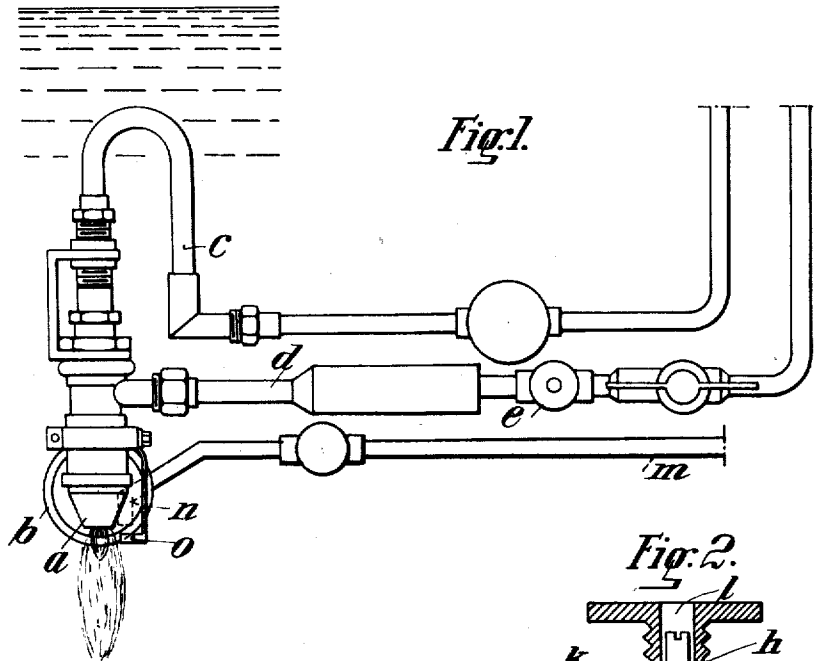


Fig. 1.

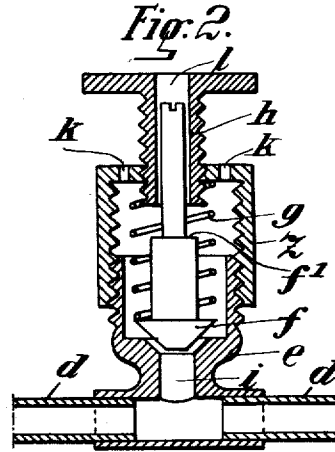


Fig. 2.

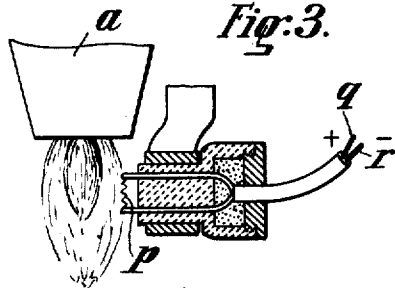


Fig. 3.

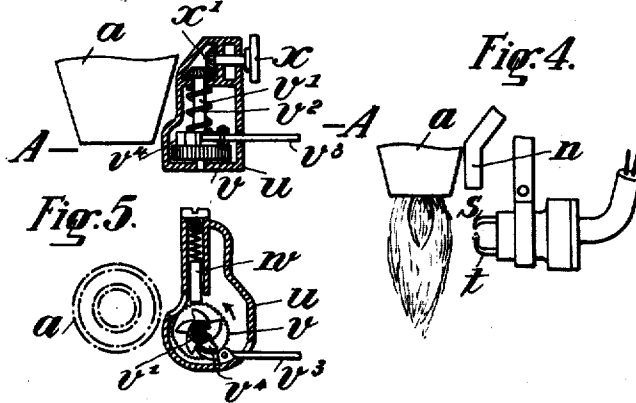


Fig. 4.

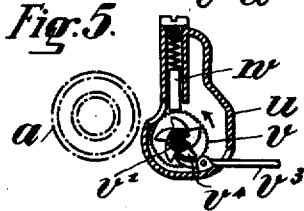


Fig. 5.

Fig. 6.

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UNITED STATES PATENT OFFICE.

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SUBAQUEOUS TORCH AND METHOD OF IGNITING.

1,298,880.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that we, FRIEDRICH WILHELM BRUSCH and WALTER FRANZ JOSEF BEYER, both citizens of the German Empire, residing at Dortmund, in the Kingdom of Prussia, German Empire, have invented new and useful Improvements in Subaqueous Torches and Methods of Igniting, of which the following is a specification.

Our invention relates to a method of lighting flames burning under water, in particular the flame of apparatus for autogenous cutting and welding under water, and to means for performing the said method.

When flames burning under water are employed it is desirable to be also able to light such flames under water. Otherwise the flame would have to be lighted above water and be, thus burning, introduced into the water, and if the flame should, for some reason or other, extinguish under water, it would be necessary to again fetch up the burner and relight the flame above water. This will prevent a rapid and smooth working. When, furthermore, the flame is to be employed at a greater depth under water, a further difficulty is encountered. At such greater depths of immersion it is necessary, owing to the greater pressure of the water, to increase the pressure of the gas and therewith also the velocity at which the gas escapes from the orifice of the burner. Experiments have shown that it is extremely difficult to light the gas above water, that is in the air, when it escapes from the burner at an increased pressure. In order to obviate this difficulty it would be necessary to let the gas escape first at the ordinary pressure, light it in the air, and then, while lowering the burning flame into the water, increase the pressure gradually with the increasing depth of immersion. This is very difficult and causes practically unsurmountable difficulties.

Our experience has shown that it is impossible to light sub-aqueous torches under water when using during the ignition period the pressure and the mutual proportion of the components of the gas mixture and the velocity of said gas mixture which are necessary for autogenous cutting or welding at the aforesaid depth of submergence. If an

attempt to light the torch be made under these conditions the flame will be immediately extinguished by the resulting explosion.

Our process will avoid these difficulties, hereinbefore stated. For lighting the flame under water we reduce the rapidity of the combustion of the gas mixture relatively to the velocity of its escape, or, in other words, we provide that the difference between the said two velocities is increased in favor of the velocity of the escape. We thereby succeed in avoiding an explosion in lighting which could overcome the said difference. In consequence thereof a flame is instantly produced which burns calmly and evenly outside of the burner nozzle.

This increase of the difference between the said velocities we may obtain either by increasing the velocity of the escape of the burner gases, or also by reducing the speed of the combustion. For the latter purpose we reduce the percentage of oxygen contained in the gas mixture. Under certain conditions we may, for the time being, entirely stop the oxygen supply, so that the speed of the combustion is *nil* and the gas mixture will burn under water either not at all or with difficulty only. For obtaining a combustible mixture we there supply through a separate pipe air or oxygen outside of the burner nozzle, for example by means of a nozzle according to our application for invention Serial Number 29,909, filed May 22, 1915, in order to support the flame during the operation. This method has the advantage that the regulating of the operating flame proper under water might be avoided.

In the accompanying drawing a burner is exemplified which is adapted for performing the present method and for cutting and welding under water.

Figure 1 is an elevation of the burner.

Fig. 2 is a section through the middle of a valve employed for controlling the relation between the two velocities.

Fig. 3 is an elevation partly in section illustrating an incandescible electrical lighting device.

Fig. 4 is an elevation of means employing an electric arc for lighting the burner.

Fig. 5 is an elevation and Fig. 6 a section on line A—A Fig. 5, of a lighting device employing cerium-iron.

a is a cutting burner of the known kind which is guided on the work (not shown) by means of the wheels *b*. For cutting and for welding different burners are used, which differ essentially in the arrangements for supplying the oxygen and the like. Although we have here shown only one type of oxygen burner, it is obvious that we do not mean to limit our invention to the employment of this special type of burner, but that, on the contrary, the said invention may be employed with all kinds of sub-aqueous burners. It is unnecessary to here describe the use of all kinds of burners in connection with our invention as the statements which we make herein will enable anyone skilled in the art to apply our invention in the proper manner. *c* is the tube through which the heating gas, for example hydrogen is supplied and *d* is the tube for the supply of the oxygen. In these tubes stop valves or the like are provided in known manner. For carrying out the method according to the present invention we might, for example, provide in tube *d* a valve as shown in detail in Fig. 2. This valve has a valve cone *f*, which is under action of a spring *g*. The pressure of this spring *g* may be varied by turning the cap *z*. In the said cap *z* is provided a screw *h*. This screw is usually screwed down onto the shoulder *f'* of the valve cone *f*, so that the valve is tightly closed. When the flame is to be lighted, the screw *h* is unscrewed, so that the valve is only under action of the spring *g*. The valve may be now opened by the pressure of the oxygen flowing through *d*, so that oxygen can pass from *d* through the branch pipe *i* and the orifices *k* and *l* to a more or less great degree and escapes into the surrounding water. As a rule we tighten the spring *g* by means of cap *z* so far that after the screw *h* has been unscrewed the valve will open at half the normal pressure. As already stated the valve operates by unscrewing the screw *h* and for starting purposes only.

If, however, instead of employing the valve arrangement *e*, which reduces the oxygen supply, we carry out the method in such a manner that we completely cut off the oxygen supply during the lighting period, we provide, for example, a pipe *m*, as indicated in Fig. 1, which pipe we employ, according to our application for Patent Ser. No. 29,909 to produce by aid of a nozzle *n* a jet of compressed gas in close proximity to the flame of the burner *a* and thereby support the flame under water. Through this pipe we supply air or oxygen during the lighting period, so that it is possible to light the gases emerging from the burner *a*. With the

known types of burners (not shown), having two different oxygen supply pipes, of which the one leads into the mixing chamber, and provides the oxygen required for heating-up, whereas the other supplies the oxygen for the subsequent cutting directly to the burner, we dispose the valve, according to Fig. 2, in the first mentioned pipe, or completely close this pipe, and in the hereinbefore described manner, we let a sufficient volume of oxygen emerge from the second pipe for effecting the lighting of the flame, as this has been described hereinbefore with reference to the pipe *m*.

For the lighting itself any known devices may be employed, which are adapted to produce the lighting heat by chemical, electrical or mechanical means. So, for example, we may provide in proximity of the burner *a* a fine tube *o*, Fig. 1, made of glass or some other substance, which contains sodium or potassium, which will be ignited on coming in contact with water. For effecting the ignition we open or break such fine tube *o*, so that the metal inclosed therein will be ignited and will light the jet of gas emerging from the burner. In place of the sodium or potassium we may also fill the tube *o* with platinum sponge, which will be heated on meeting with the hydrogen, and thereby effect the lighting of the gas. When we employ a nozzle *n* in the manner hereinbefore described, we preferably arrange the igniting device within the range of the air jet, so that the water is driven away from the platinum sponge. The igniting device may be so attached to the burner that it may, after use, be easily moved aside, and will not obstruct the further working of the tool.

Figs. 3 and 4 illustrate two other means for lighting the flame, which are electrically operated. In the arrangement according to Fig. 3 a small wire coil *p* is provided within the range of the flame, the said wire coil being connected to the poles of an electric battery and receiving the current over insulated wires *q*, *r*. For effecting the lighting a current is sent through the coil *p*, so that it commences to glow and lights the flame. According to the arrangement shown in Fig. 4 an electric spark is produced between the metal parts *s* and *t* by any of the means known in automobile engineering, the said spark effecting the lighting after the water between *s* and *t* has been removed by a jet of air emerging from the nozzle *n*. Also the coil *p* according to Fig. 3 might be so arranged, that the water is blown away from it by aid of the nozzle *n*.

In the arrangement shown in Fig. 5 a small steel wheel *v* provided with sharp teeth is mounted on a shaft *v'* within a small casing *u*. Against this wheel *v* a pin *w* of cerium-iron is pressed by aid of

a spring. The wheel v and its shaft v' may be turned by means of a handle w or a gear w' , whereby the spring v^2 is tightened. The wheel is turned in the sense of the hands of a clock. A pawl v^3 engaging in a ratchet wheel v^4 prevents an unintended turning of the wheel. When the burner is to be lighted, the difference between the hereinbefore stated velocities is increased, according to our invention, the pawl v^3 is lifted from the ratchet wheel v^4 and the spring v^2 will turn the wheel v very rapidly in the direction of the arrow, so that a stream of sparks is produced in the known manner, and will pass in front of the burner a , there igniting the gas emerging therefrom. The water between the burner a and the igniting device just described may be again removed by aid of a nozzle n as shown in Fig. 1.

The ignition may also be effected by means of small charges of powder exploded or the like, not shown in the drawing. These means would be employed in a manner similar to that hereinbefore described with reference to the electrical and chemical igniting devices, and either with or without a nozzle n . As, however, our invention does not consist in the special arrangement of such igniting devices, it is superfluous to here go into further details thereof.

Now we wish it to be well understood that when in the following claims we speak of using physical means alone, this has been done for the sake of avoiding alternativity in the claims. Therefore, we consider all available means either of chemical, electrical or mechanical nature as equivalents in our case, so that all the said means will be included in the single expression "physical means".

We claim:

1. The hereinbefore described method of controlling submerged sub-aqueous torches, in particular the flame of apparatus for autogenous cutting and welding under water by means of a mixture comprising a combustion gas and oxygen, which consists in first producing for the ignition a large difference between the rate of combustion of the gas mixture and the rate of issuance of said gas mixture from the burner directly into a body of water at the existing sub-aqueous pressure in favor of the rate of flow of said gas mixture, igniting the gas mixture, and during the working proper adequately decreasing the difference between the rate of combustion and the rate of issuance of the gas mixture while maintaining the water displaced at the burner solely by gas pressure.

2. The method of governing submerged sub-aqueous torches, in particular the flame of apparatus intended for autogenous cut-

ting and welding under water by means of a mixture composed of a combustion gas and of oxygen, which consists in adequately increasing during the ignition period the range between the rapidity of combustion of the gas mixture and the velocity of its escape from the nozzle in favor of the velocity of escape of said gas mixture at the existing sub-aqueous pressure in an unconfined body of water, and during the working period diminishing the range between the rapidity of combustion and the velocity of said gas mixture to such an extent as to render the rapidity of combustion almost equal to the velocity of escape at the depth of submergence while maintaining the water displaced at the burner solely by gas pressure.

3. The method of controlling submerged sub-aqueous torches intended in particular for autogenous cutting and welding, in which a combustion gas and oxygen supplied at pressure proportioned to the depth of submergence are used, which comprises initially increasing the difference between the rate of combustion of the gas mixture and the rate of issuance of said gas mixture from the burner directly into the water at the depth of submergence in favor of the rate of issuance of the gas mixture, igniting said gas mixture by physical means, and subsequently during the working proper, diminishing the difference between the rate of combustion of the gas mixture and its rate of issuance from the burner so far that the rate of combustion very nearly reaches the rate of issuance, though the latter still remains higher.

4. The method of governing submerged sub-aqueous torches intended in particular for autogenous cutting and welding, in which a combustion gas and oxygen are supplied directly into the water at the burner at a pressure of escape exceeding the water pressure at the depth the torch is used, which comprises reducing the normal rate of combustion of the gas mixture by lowering the supply of oxygen, igniting said gas mixture by physical means, and during the working period augmenting the supply of oxygen in such a proportion that the rate of combustion of the gas mixture becomes almost equal to the rate of issuance of said gas mixture, though the rate of combustion remains somewhat lower than the rate of issuance while maintaining the water displaced at the burner solely by the gases.

5. The method of governing submerged sub-aqueous torches intended for autogenous cutting and welding while submerged, in which a combustion gas and oxygen are supplied directly into the water at the burner at pressures proportioned to the depth of submergence, which consists in reducing initially the rate of combustion of the gas mixture by venting a part of the oxygen supply

into the surrounding water before reaching the point where the gas mixture and combustion are to take place, igniting said gas mixture by physical means, and during the working period augmenting the supply of oxygen in such a proportion that the rate of combustion of the gas mixture becomes almost equal to the rate of issuance of said gas mixture, though the rate of combustion remains somewhat lower than the rate of issuance while maintaining the water displaced at the burner solely by gas pressure.

6. The method of governing submerged sub-aqueous torches intended for autogenous cutting and welding while immersed, in which a combustion gas and oxygen are supplied directly into the water at the burner at pressures proportioned to the depth of submergence, which consists in temporarily reducing the oxygen supply to the nozzle of the torch sufficient to enable sub-aqueous ignition, removing the water in front of the nozzle so as to form a space suitable for ignition in the free mass of water in proximity to said nozzle, igniting the gases escaping from the nozzle, and after ignition, that is, during the sub-aqueous working period, increasing the supply of oxygen in such a proportion that the rate of combustion of the gas mixture becomes almost equal to the rate of issuance of said gas mixture, though the rate of combustion remains somewhat lower than the rate of issuance while maintaining the water displaced at the burner solely by gas pressure.

7. The method of igniting submerged sub-aqueous torches while submerged, which comprises increasing for ignition purposes the difference between the rate of combustion of the gas mixture and speed of issuance of the mixture from the torch directly into unconfined water while maintaining the latter in excess of the former at a pressure con-

formable to the water pressure at the depth of operation, igniting the mixture, and thereafter diminishing said difference until the rate of combustion nearly reaches the rate of issuance from the torch while maintaining the latter slightly in excess and conformable to the pressure existing at the submerged depth of operation while maintaining the unconfined water displaced from the burner solely by gas pressure.

8. In a burner for flames intended for autogenous cutting and welding of metals under water, the combination with supply pipes for the heating gases and for the oxygen, said supply pipes leading by a common outlet into the free mass of water surrounding the submerged torch and metallic work; of means for momentarily causing a reduction of the oxygen supply to the respective supply pipe while maintaining a pressure sufficient to keep the water displaced from the burner, means for leading a compressed gas into the free mass of water in proximity to the outlet of said supply pipes so as to form a dry space adapted for ignition of the gas mixture in proximity to said outlet of the supply pipes and adjacent to the work-piece, means for igniting the gases escaping from the outlet of said pipes, and means for increasing during the working period the supply of oxygen in such a proportion that the rate of combustion of the gas mixture becomes almost equal to the rate of issuance of said gas mixture, though the rate of combustion remains somewhat lower than the rate of issuance.

In witness whereof we have hereunto set our hands in presence of two witnesses.

FRIEDRICH WILHELM BRUSCH.

WALTER FRANZ JOSEF BEYER.

Witnesses:

J. D. ZIESECKE,

ANTON GOTTFRIED KÖFFE.