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SUBMARINE AND METHOD OF OPERATING THE SAME.

APPLICATION FILED FEB. 25, 1916.

Patented July 15, 1919.

1,310,253.

FIG. 1.

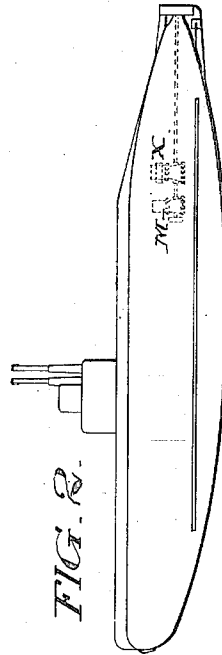
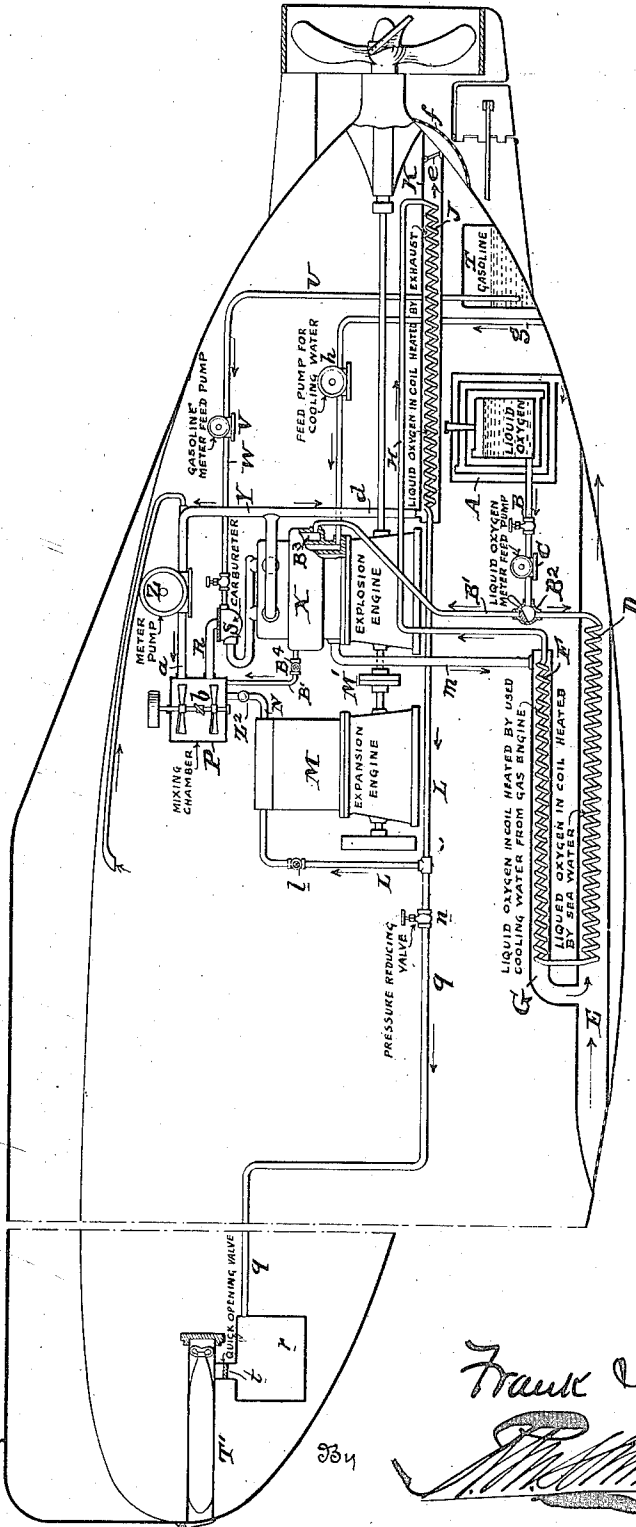


FIG. 2.

Witness

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SUBMARINE AND METHOD OF OPERATING THE SAME.

1,310,253.

Specification of Letters Patent.

Patented July 15, 1919.

Application filed February 25, 1916. Serial No. 80,477.

To all whom it may concern:

Be it known that I, FRANK SHUMAN, a citizen of the United States, and resident of Philadelphia, county of Philadelphia, and State of Pennsylvania, have invented an Improvement in Submarines and Methods of Operating the Same, of which the following is a specification.

Heretofore in submarine practice, it has been customary to employ both explosive engines and electric motors as the propelling means, the former for use at the surface and the latter when submerged. Storage batteries as the source of energy for the electric motors, aside from their great weight, involve liability of accident and loss of life by suffocation or explosion due to the generation of gases. Aside from this, the storage batteries occupy a great deal of space which would be better utilized if suitable means other than electric motors could be employed for propulsion while submerged.

It is the object of my invention to provide a motive power which is both suited for operation of submarines at the surface as well as when submerged, and which shall eliminate the employment of storage batteries and electric motors, and in the most preferred form of my improvements, I may employ at one time both an expansion engine and an internal combustion engine, and in such manner that the motive gases operating the expansion engine may then be employed in the explosive engine and the products so produced may be liberated from the vessel in a manner in which no "wake" due to bubbles may be formed at the time the vessel is running submerged. By my improvements, all storage batteries, auxiliary electric motors for propulsion, and the carrying of extra reservoirs of compressed air for discharging the torpedoes, are eliminated.

By my improvements, I arrange the submarine with provision for carrying large quantities of liquefied oxygen or liquid air (preferably the former), and which is capable of being employed first by vaporization, then utilization as a motive means both in the expansion engine and in the explosive engine, as well as for discharging torpedoes, supplying fresh oxygen to the impure atmosphere which may exist in the submarine, and for operating any of the auxiliary motors for whatever requirement may be necessary. By the employment of liquefied oxy-

gen or liquid air, a period of submergence would be greatly increased over what is at present possible, thus giving time for repairs and otherwise providing available motive power, which could not be done or maintained under conditions heretofore existing. Even should repairs be impossible, the fact that the time of submergence may be maintained as long as several months, enormously increases the opportunity of rescue of the occupants of the submarine. Furthermore, the interior of the submarine may be kept comfortably cool and the atmosphere normal, thus promoting the general welfare of the crew. The simplicity of the machinery employed over that heretofore in use will also render maneuvering much easier of accomplishment.

When explosive engines are relied upon as the means of propulsion at a time when the submarine is submerged, the method heretofore of supplying air from compressed air in tanks, has caused the escaping of the exhaust products from the engine to form a very pronounced "wake" by the rising bubbles, the presence of which enables the submarine to be tracked by fast moving destroyers or motor boats; but when pure oxygen is substituted for the compressed air the production of the aforesaid "wake" is avoided. When air is burned with the hydrocarbon in an explosive engine, the products are essentially carbonic acid, nitrogen and water, and of these the nitrogen cannot be readily dissolved in the sea water, and is in such quantity that it produces a very decided "wake"; on the other hand, when oxygen is employed as a substitute for the air, the presence of nitrogen is avoided and consequently the objectionable "wake" is avoided.

Furthermore, by use of my improvements, whatever the source of oxygen may be, (I employ the oxygen whether pure or in the composition of air), it is in liquefied form, either in liquefied oxygen or liquefied air, and in which form it may be readily carried in ordinary vessels of suitable construction which would not be subjected to enormous pressures such as results in the employment of compressed air or compressed oxygen unliquefied; and moreover by employing liquefied sources of oxygen it is manifest that a very large quantity of oxygen (in the form in which it would be used in the engine) may

be stored in a comparatively small space, and hence provide capacity for wide range of submarine cruising, or as before stated, a long period of submergence in case of accident.

With the above and other objects in view, the nature of which will be more fully understood from the description hereinafter, the invention consists in the novel construction of submarine and method of operating the same as hereinafter more fully described and defined in the claims.

In Figure 1 of the drawing, I have shown diagrammatically the more essential elements of the apparatus which would enter into the commercial use of my invention as applied to a submarine.

Fig. 2 is a side elevation of the submarine. Assuming that the submarine would be equipped with the usual essentials to a vessel of that character other than thus specifically required by my invention, I will now refer to the diagram in respect to the particular features therein illustrated.

As liquefied oxygen, or liquefied air, when turned into gas under high pressure, will give very efficient returns in power, this power obtained without any additional expense, is first utilized by my improved method in operating the engine M by expansion and subsequently in operation of the explosive engine X.

The liquefied oxygen, or liquefied air, is pumped from the container A through pipe B by means of a feed pump C, and is forced through three successive coils D, F and J and pipes H and L, to expansion engine M. In coil D the liquefied oxygen is turned into gaseous oxygen, under a very high pressure, by means of the heat contained in the large quantities of ordinary sea water, running through pipe E around coil D. This means that all of the latent heat, which was taken out of the oxygen, or liquefied air, while being liquefied, is put back into it again by the sea water rushing around the coil B. This addition of heat furnishes the main power which will be produced in the expansion engine M. The liquefied oxygen, after having passed through the coil D, goes through the coil F submerged in the pipe G. Through this pipe G rushes all of the cooling water, which has been used in the jacket of the gasoline, or the oil, engine and has by this use become heated, thus superheating the gaseous oxygen or air. After having passed through the coil F, the oxygen goes through the pipe H and the coil J, which is submerged in the greater portion of the hot exhaust gases from the gasoline or oil engine. This further superheats (relatively considered) the gaseous oxygen or the air, if employed, to a high point, and it then passes, while under pressure, into the expansion engine M, where whatever power there is in it

will be utilized by expanding it to a pressure equal to that which is necessary to force it into the gasoline or oil engine. The pressure of the gaseous oxygen as it is fed to the engine may be 3000 pounds per square inch, or any other pressure found most available and efficient.

Before passing into the gasoline or oil engine, the oxygen goes into the mixing tank P where by means of any practical mixing device, it is mixed with a sufficient quantity of the hot exhaust gases from the gasoline, or oil engine, to dilute it to such a point that it will be sufficiently toned down to provide normal explosions and cause no danger in or to the engine.

The portion of the exhaust gases from the gasoline, or oil engine, which is necessary to effect this result, is drawn through the pipe Y by the meter pump Z and forced through the pipe "a" into the mixing tank P.

The gasoline or oil from tank T is drawn through the pipe U, and by means of the gasoline feed pump V, delivered through the pipe W into the carbureter S, and thence, with the oxygen supplemented by the products of combustion, from the mixer P, is supplied to the explosive engine X. The carbureter may be of any suitable construction so long as it produces a suitable mixture of the hydrocarbon with the oxygen or other gaseous materials to be supplied to the engine to support combustion or reduce its violence. In case oil is employed in place of gasoline, it would be vaporized before being delivered to the carbureter, as is customary in explosive (oil) engines.

Should liquefied air be used instead of liquefied oxygen, for those purposes where the visible "wake" will not be an objection, then the waste gases from the engines may be exhausted into the surrounding water, through any ordinary pipe supplied with a check valve to prevent inflow of water. Should, however, an invisible "wake" be desired, then liquefied oxygen must be used, and the water products or exhaust gases will be forced out into the surrounding water through a hood f which is provided with a large number of small perforations, so that the carbonic acid may be finely sub-divided, whereby it will be more or less absorbed by the sea water, which absorption will be aided by the propeller throwing the water backward, and stirring up the exhaust gases with large volumes of water.

In the diagram drawing, the actual positions of the various elements involved are not definitely shown, but said diagram is intended simply for the purpose of showing the cycle of the steps in the method and the apparatus elements required with reasonable clearness. The practical submarine constructor will put each element of the apparatus wherever he considers it should be located.

cated to accomplish its function properly; and it is not intended in this description to show dimensions, pressures, or any one of the numerous details which may enter into various parts of the apparatus which may enter into the complete equipment of a submarine vessel as these are matters of commercial engineering rather than of invention so far as the present improvements are concerned.

If small cruising radius and quick action are only required rather than economy, then several of the steps shown can be eliminated. For instance, to go to extremes, the expansion engine and the three coils D, F and J may be all cut out, and the liquefied oxygen forced, by pipe B', directly into the mixing chamber P, and there mixed with the proper amount of hot exhaust gases. To accomplish this, a three-way valve B² may be employed. If the expansion engine M is not to be employed, it may be uncoupled by the coupler M'.

The complete cycle, as shown, is that which is necessary to secure the most economical running. Instead of going to the extreme of eliminating all three of the coils, a less number of them might be used without affecting the actual working of the cycle.

In the case of the employment of liquefied air, the mixing chamber P can be omitted if the products of combustion are not to be mixed with it, because then there is simply the ordinary atmospheric air forced or delivered into the carbureter; and if the liquefied air is used directly in the carbureter in said manner, the meter pump Z, as well as the mixing tank P, may be eliminated.

It will be understood that the general construction of the various elements of the apparatus hereinbefore referred to is secondary to my invention, and may be greatly varied without departing therefrom, and I do not in any manner wish to be restricted or limited in this respect, as any or all of the parts may be changed or modified so long as they are adapted to the proper performance required by the nature of this invention.

I have not described any method or means for liquefying oxygen or air, as liquefied air and liquefied oxygen are both available products in the commercial field at the present time, and any of the known processes therefor may be employed in providing these substances for use in connection with my invention. The expansion engine may be of any suitable construction of simple form or compound type as desired, and likewise the explosive engine may be of any of the types heretofore constructed and which may be found best adapted to the particular use of submarine propulsion; and while water is shown as a cooling medium

for the jacket of the engine, it will be understood that the vapor from the liquefied air or oxygen may be employed (in place of or in addition to the water) as the cooling medium by simply forming the jacket, B³, as a part of the vapor conduit or pipe B', and turning the three-way valve B², as will be readily understood by anyone skilled in the art.

While gasolene engines, as at present constructed, might not be sufficiently strong to stand the greater energy resulting from the employment of pure oxygen gas with hydrocarbon, and for which reason I have indicated the dilution of the oxygen gas with a portion of the waste products from the engine as a means of reducing the energy of the oxygen and giving a larger bulk of the explosive medium, nevertheless it is quite possible to construct specially designed explosive engines which may be suitable for the employment of the oxygen in undiluted condition except so far as it may be considered as diluted by the hydrocarbon, and in this case the mixer may be omitted and the oxygen may go directly into the carbureter S, the latter being suitably constructed to adapt itself for the handling of this more energetic gas.

The three-way valve B² may be such that the oxygen may be directed into the coil D as shown, or it may be directed into the pipe B', or it may be caused to flow into both of these parts merely by the adjustment. If the oxygen is to be supplied solely through the jacket B³ of the explosive engine, and without the use of the expansion engine M, the valve Z² in pipe N may be shut off so that the oxygen gas will not escape backward into the engine M. When the expansion engine is being used and the oxygen is not being employed as a cooling means for the explosive engine, then the valve Z² is open and the by-pass valve B² is closed to the pipe B', but this may be supplemented by the use of an additional valve between the explosive engine and the mixing chamber, as at B⁴.

In the most desirable form of my invention, liquid oxygen is employed, more particularly because a greater bulk of the necessary oxygen can be carried and because no appreciable "wake" will be formed, but considering the invention generally I use the expressions, more particularly in the claims, "liquefied gas in which oxygen is present", and "means for supplying oxygen in gaseous condition", as including any liquefied gas from which oxygen may be liberated, whether the same be pure oxygen or not, such as would be the case by employment of liquefied air; but it is manifest that whatever the source may be, the oxygen should be capable of separating as a gas whereby it may oxidize the hydrocarbon va-

pors from which the main motive power is to be derived.

It will also be understood that some control must be had of the escape of the liquefied oxygen or oxygen containing liquid, so as to reasonably control the amount of oxygen gas to be supplied to the engines and obviate the tendency to produce too high a pressure, and this is best done by a measuring or meter fed pump, as indicated at C. though it is manifest that the supply could be controlled or measured by the use of a valve, but this would require constant attention. By employing a meter pump, the stopping of the operation of the engines might also be so arranged as to stop the pump whereby the oxygen would only be fed for creating a motive power when the requirement for engine purposes would be necessary.

It will now be apparent that I have devised a novel and useful construction which embodies the features of advantage enumerated as desirable, and while I have in the present instance shown and described the preferred embodiment thereof which will be found in practice to give satisfactory and reliable results, it is to be understood that I do not restrict myself to the details, as the same are susceptible of modification in various particulars without departing from the spirit or scope of the invention.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:—

1. The combination of an explosive engine, a source of liquefied gas adapted to liberate oxygen, means to supply a hydrocarbon to the explosive engine, measuring means for supplying measured quantities of oxygen gas and exhaust products from the engine associated with the hydrocarbon to the engine, and means for permitting the escape of the surplus of the exhaust products.

2. The combination of an explosive engine, a carbureter for supplying a hydrocarbon thereto, a source of liquefied gas adapted to liberate oxygen, a mixer separate from the engine cylinders for receiving measured quantities of the oxygen gas, means for delivering a measured portion of the products of combustion from the engine to the mixer whereby it is mixed with the oxygen gas in the proper proportions, and means for delivering the mixed oxygen gas and products of combustion to the carbureter whereby they are mixed with the hydrocarbon and subsequently delivered to the engine.

3. The combination of an explosive engine, a source of liquefied gas adapted to liberate oxygen, means to supply a hydrocarbon to the explosive engine, means for supplying oxygen gas in measured quantities

and a portion of the exhaust products from the engine also in measured quantities associated with the hydrocarbon to the engine, and means for permitting the escape of the surplus of the exhaust products.

4. The combination of an explosive engine, means for delivering a hydrocarbon to the engine, a source of liquefied gas adapted for giving off oxygen, means for raising the temperature of the oxygen and increasing its pressure, means for bringing the oxygen after having its temperature raised into association with the hydrocarbon before being exploded in the engine and means to thereafter admit the explosive mixture of oxygen, products of combustion and hydrocarbon to the engine wherein it is exploded.

5. The combination of an explosive engine, means for delivering a hydrocarbon to the engine, a source of liquefied gas adapted for giving off oxygen, means for delivering oxygen in measured quantities to the engine, means for raising the temperature of the oxygen and increasing its pressure, means for delivering measured quantities of the products of combustion from the engine to the measured quantities of oxygen before being delivered to the engine, means for mixing oxygen and products of combustion before being delivered to the engine, and means for bringing the oxygen into association with the hydrocarbon before being exploded in the engine.

6. The combination of an explosive engine, a source of liquefied gas in which oxygen is present, means for supplying oxygen in gaseous condition to the explosive engine, means for supplying a hydrocarbon to the oxygen gas to provide an explosive mixture for operating the engine, means for independently measuring the amount of oxygen and the amount of hydrocarbon which are to be simultaneously delivered to the engine, and means for heating the oxygen before it is delivered to the explosive engine, said means comprising a passage through which the oxygen is caused to pass and over which a current of water is caused to circulate for heating the oxygen.

7. The combination of an explosive engine, a source of liquefied gas in which oxygen is present, means for supplying oxygen in gaseous condition to the explosive engine, means for supplying a hydrocarbon to the oxygen gas to provide an explosive mixture for operating the engine, and means for heating the oxygen before it is delivered to the explosive engine, said means consisting of a plurality of separate coils through which the oxygen gas passes in succession and by which it is gradually heated, the first of said coils being cooled by water of normal temperature, the second by the cooling water of the explosive engine and the third by the exhaust products from the ex-

plusive engine whereby the oxygen gas is superheated.

8. The combination of an explosive engine, a source of liquefied gas in which oxygen is present, means for supplying oxygen in gaseous condition to the explosive engine, means for supplying a hydrocarbon to the oxygen gas to provide an explosive mixture for operating the engine, means for heating the oxygen before it is delivered to the explosive engine, said means consisting of a plurality of coils through which the oxygen gas is passed said coils being subjected to heating mediums having different degrees of temperature, the higher temperature being imparted to the coils nearest the delivery to the explosive engine, and means for mixing a portion of the heated products of combustion from the explosive engine with the heated oxygen before being fed to the explosive engine.

9. The combination of an engine, a source of liquefied gas in which oxygen is present, a pipe for supplying oxygen from the source to the engine for operating it, measuring means for regulating the supply of oxygen so fed, and means for heating the oxygen to expand the same before it is delivered to the engine said means comprising a plurality of coils whereby the oxygen is first heated by the heat of the water surrounding a portion of the coils and superheated by the heat of the exhaust of the engine passing over another portion of the coils.

10. The combination of an expansion engine and an explosive engine, with a source of liquefied gas in which oxygen is present, means for supplying the oxygen to the expansion engine in controlled quantities, means for heating the oxygen before being delivered to the expansion engine, means for delivering the expanded oxygen from the expansion engine to the explosive engine, and means for supplying a hydrocarbon to the oxygen to form an explosive mixture for operating the explosive engine.

11. The combination of an expansion engine and an explosive engine, with a source of liquefied gas in which oxygen is present, means for supplying the oxygen to the expansion engine in controlled quantities, means for heating the oxygen before being delivered to the expansion engine said heat being derived from the waste heat of the explosive engine, means for delivering the expanded oxygen from the expansion engine to the explosive engine, and means for supplying a hydrocarbon to the oxygen to form an explosive mixture for operating the explosive engine.

12. The combination of an expansion engine and an explosive engine, with a source of liquefied gas in which oxygen is present, means for supplying the oxygen to the expansion engine in controlled quantities,

means for heating the oxygen before being delivered to the expansion engine part of said heat being derived from the waste gases of the explosive engine and the remaining heat from water, means for delivering the expanded oxygen from the expansion engine to the explosive engine, and means for supplying a hydrocarbon to the oxygen to form an explosive mixture for operating the explosive engine.

13. The combination of an expansion engine and an explosive engine, with a source of liquefied gas in which oxygen is present, means for supplying the oxygen to the expansion engine in controlled quantities, means for heating the oxygen before being delivered to the expansion engine, means for delivering the expanded oxygen from the expansion engine to the explosive engine, means for mixing a portion of the waste gases from the explosive engine with the oxygen received from the expansion engine to dilute the explosive mixture utilized in the explosive engine, and means for supplying a hydrocarbon to the oxygen to form an explosive mixture for operating the explosive engine.

14. The combination of an expansion engine and an explosive engine, with a source of liquefied gas in which oxygen is present, means for supplying the oxygen to the expansion engine in controlled quantities, means for heating the oxygen before being delivered to the expansion engine, means for delivering the expanded oxygen from the expansion engine to the explosive engine, means for mixing a portion of the waste gases from the explosive engine with the oxygen received from the expansion engine to dilute the explosive mixture utilized in the explosive engine, means for measuring the amount of waste gases to be thus mixed, a mixing device for thoroughly mixing the waste gases with the expanded oxygen, and means for supplying a hydrocarbon to the oxygen to form an explosive mixture for operating the explosive engine.

15. The combination of a vessel floating in water provided with means for propelling it, an engine for operating the propelling means, a source of liquefied gas in which oxygen is present arranged within the vessel, means for supplying oxygen from the source to the engine, means for controlling the amount of said supply of oxygen, and means subjected to the water in which the vessel floats for heating the oxygen before it is delivered to the engine, said means comprising a coil through which the oxygen is caused to pass and a surrounding conduit arranged lengthwise of the vessel through which the water flows as the vessel is propelled and thereby brought into contact with the coil to heat the oxygen therein, and further comprising a second coil through

which the oxygen passes, a conduit surrounding the second coil, and pumping devices for circulating the water in which the vessel floats through the conduit of said second coil.

16. The combination of a vessel floating in water provided with means for propelling it, an engine for operating the propelling means, a source of liquefied gas in which oxygen is present arranged within the vessel, means for supplying oxygen from the source to the engine, means for controlling the amount of said supply of oxygen, a heating device through which the oxygen passes on its way to the engine, a conduit forming a part of the vessel and inclosing the heating device for the oxygen, and means on the vessel for circulating the water in which the vessel floats through the conduit for transferring the heat of said water to the oxygen.

17. The method of operating a submarine vessel without an appreciable wake, which consists in supplying a hydrocarbon vapor and oxygen gas to an internal combustion engine to propel the submarine, and subdividing the waste products from said engine into a multitude of small streams into the surrounding water so that they are diffused and mixed with sufficiently large quantities of water to become substantially absorbed.

18. The method of operating a submarine vessel without an appreciable wake, which consists in supplying a hydrocarbon vapor and oxygen gas to an internal combustion engine to propel the submarine, subdividing the waste products from said engine into a multitude of small streams into the surrounding water so that they are diffused and mixed with sufficiently large quantities

of water to become substantially absorbed, and assisting the said absorption by a violent disturbance of the water adjacent to the escaping products for more thoroughly intermingling them with the water.

19. A submarine vessel having means for propelling it, combined with an internal combustion engine, a source of liquefied oxygen on the vessel, means for supplying an oxygen gas from said source to the engine, means for supplying a hydrocarbon to the engine and exploding it associated with the oxygen gas, means for permitting the escape of the products of combustion from the vessel, and means through which the products escape for subdividing them whereby they are dissipated in the surrounding water.

20. A submarine vessel having means for propelling it, combined with an internal combustion engine, a source of liquefied oxygen on the vessel, means for supplying an oxygen gas from said source to the engine, means for supplying a hydrocarbon to the engine and exploding it associated with the oxygen gas, means for permitting the escape of the products of combustion from the vessel, and means through which the products escape for subdividing them whereby they are dissipated in the surrounding water, the said subdividing means arranged adjacent to the propelling means of the submarine.

In testimony of which invention, I hereunto set my hand.

FRANK SHUMAN.

Witnesses:

PATSEY VENANGO,

ADELAIDE B. WATSON.