



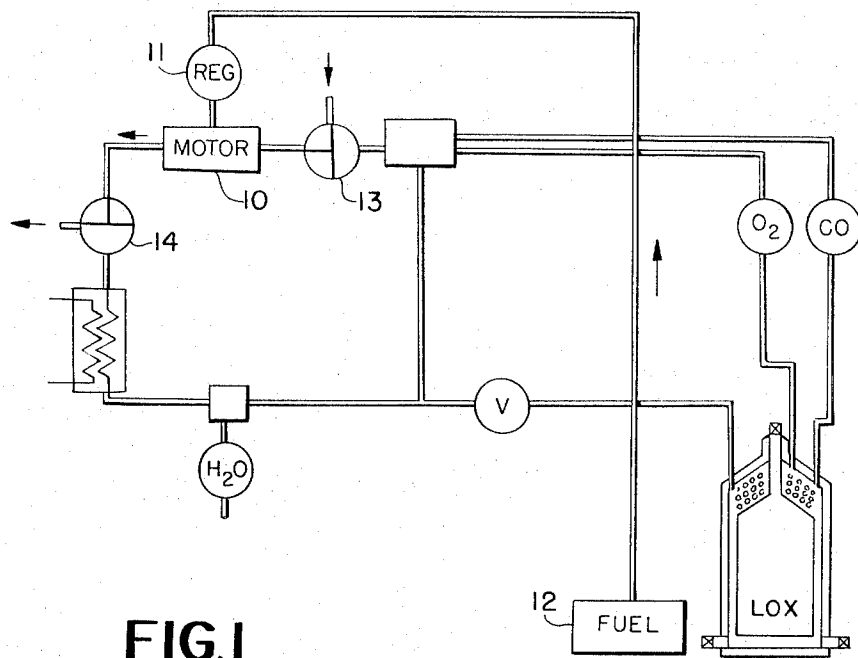


FIG. 1

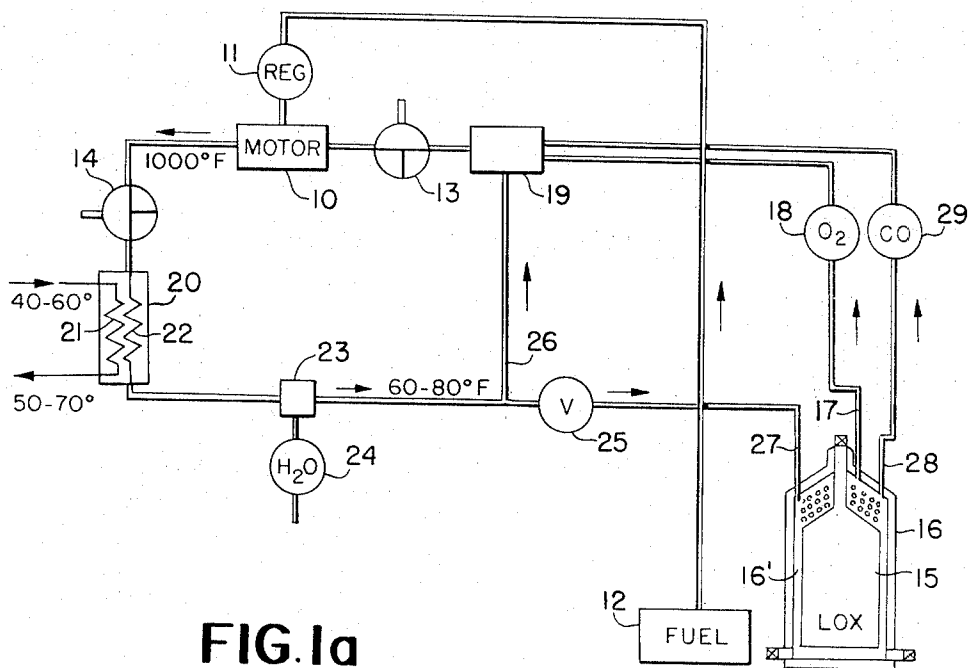


FIG. 1a

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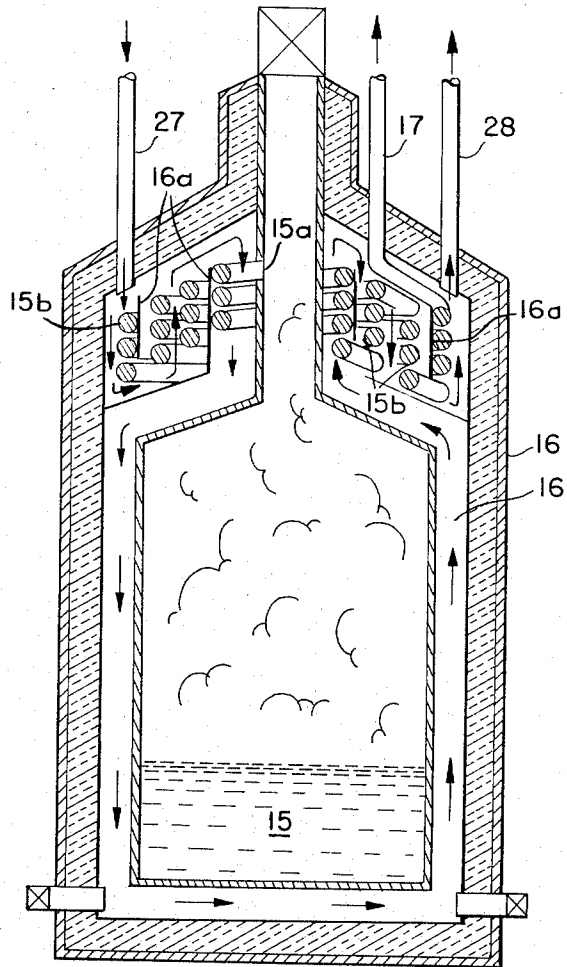


FIG. 2

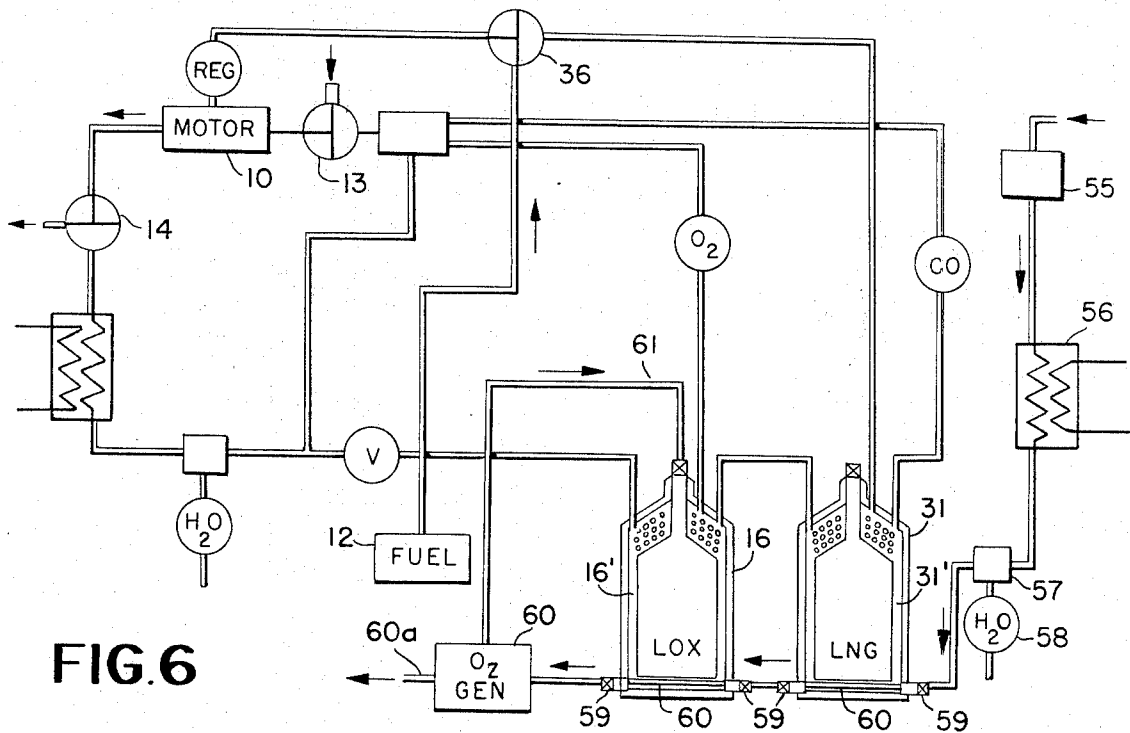


FIG. 6

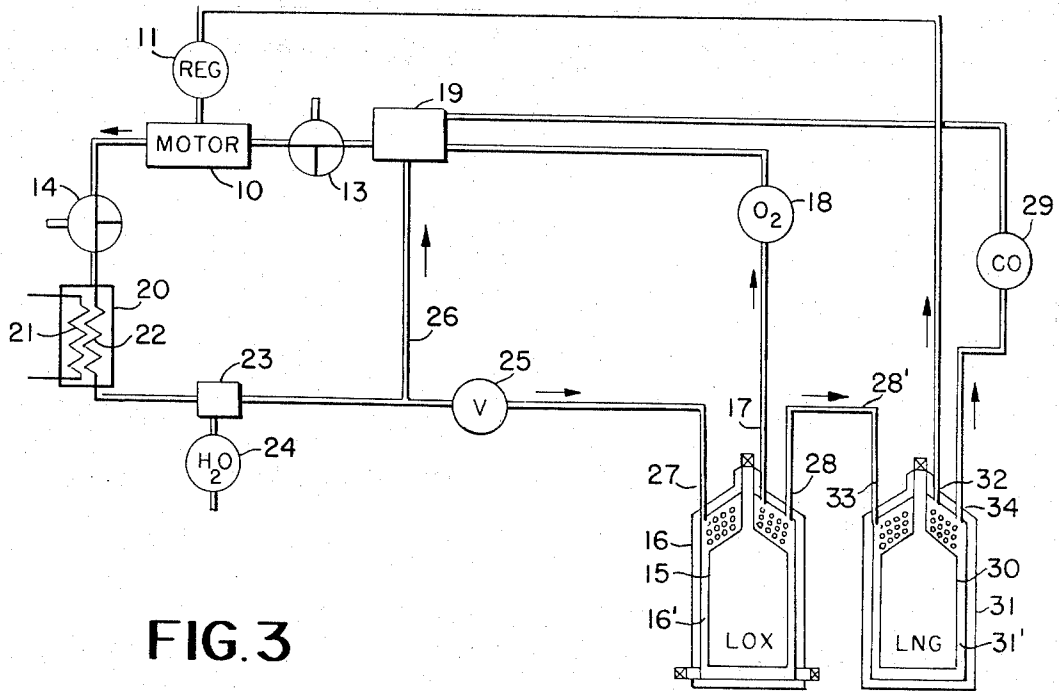


FIG. 3

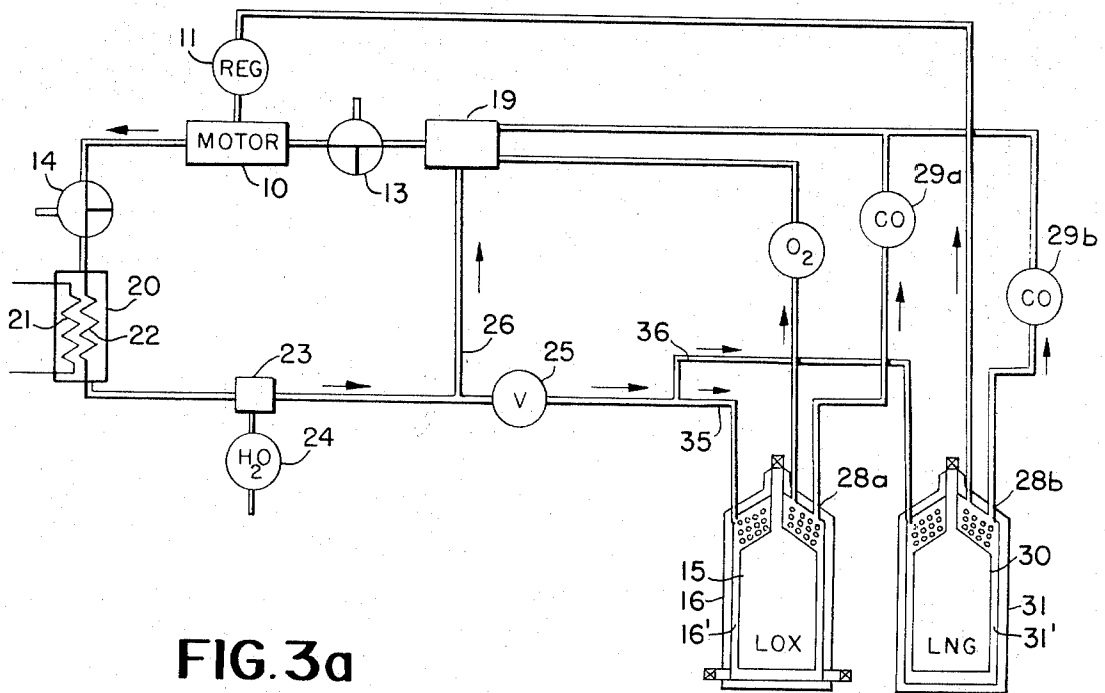
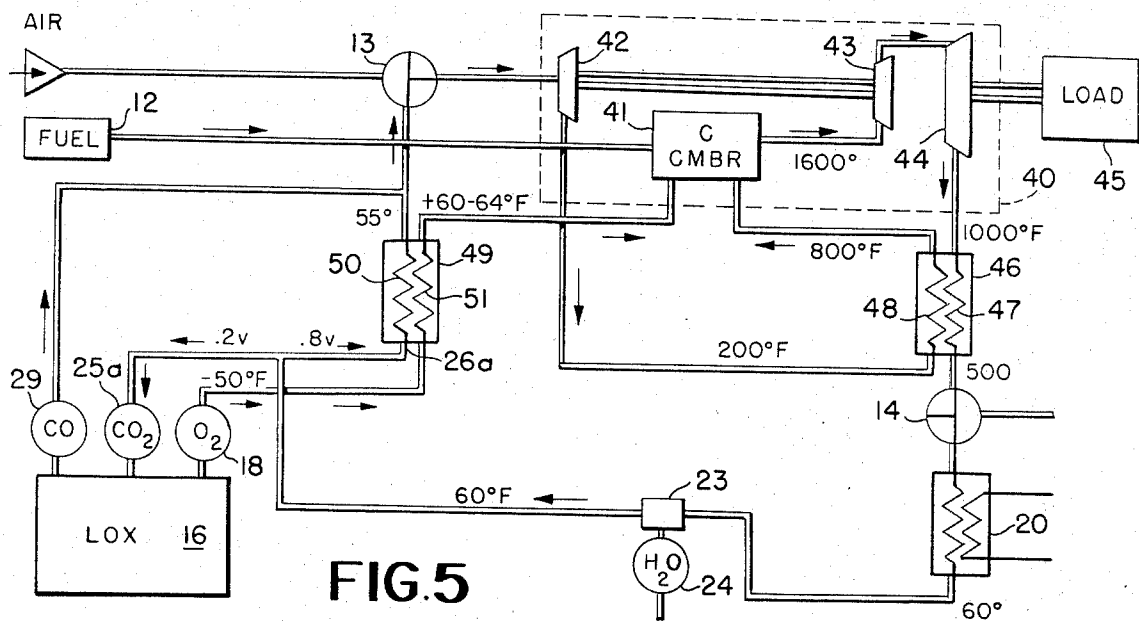
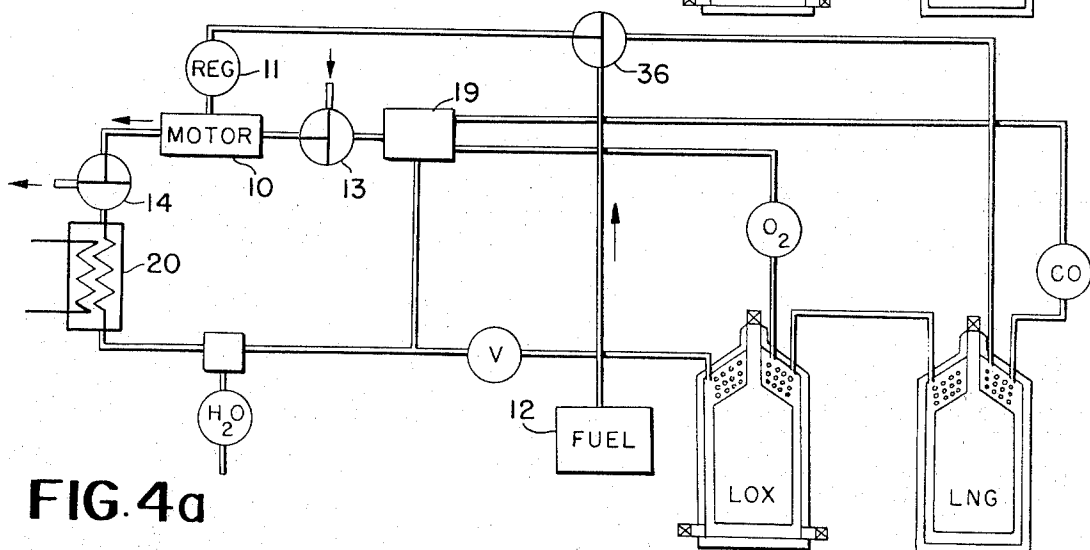
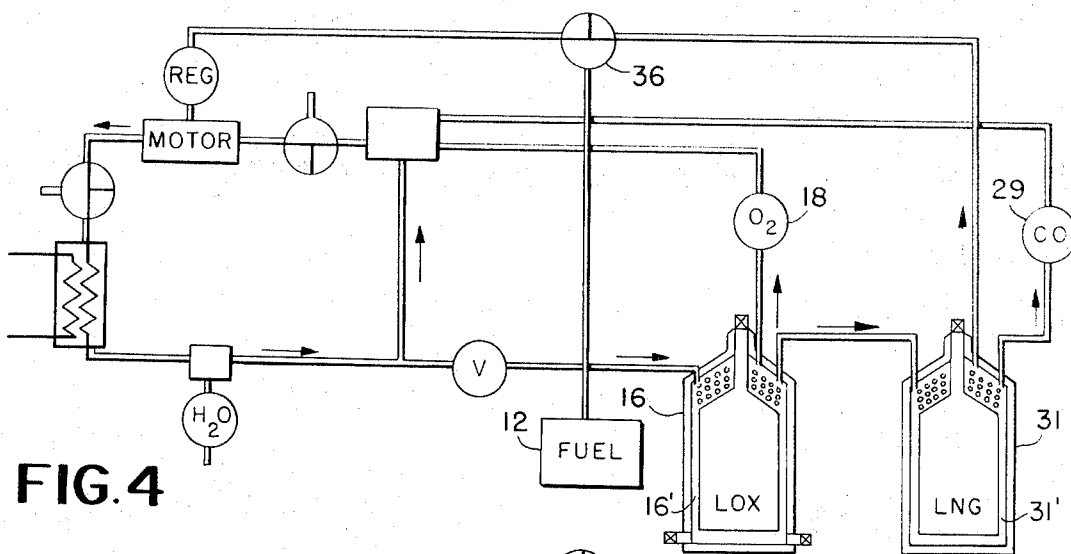


FIG. 3a



# LOX HEAT SINK SYSTEM FOR UNDERWATER THERMAL PROPULSION SYSTEM

## STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

## CROSS REFERENCE TO A RELATED APPLICATION

There is disclosed and claimed herein an unobvious improvement over "The Supercritical Thermal Power System Using Combustion Gases for Working Fluid" by Horace E. Karig, U. S. Patent Office Ser. No. 151,331.

## BACKGROUND OF THE INVENTION

A number of closed or semi-closed power plants, such as the Rankine, the Walter, Sterling, Feher and Supercritical Combustion Gas systems, have been the subject of wide investigation to determine their practicability in undersea applications. Although these systems have varying degrees of efficiency, some of which preclude their practical application, high pressures usually are attendant. The problems associated with this hazard cannot totally be eliminated by providing heavy-duty, costly piping and valving arrangement. For most undersea applications, high pressure systems are to be avoided since the ever present possibility of rupturing of the high pressure lines would mean total system failure and disaster. In addition, most of the contemporary systems do not provide for on-board storage of the by-products of combustion, chiefly carbon dioxide and water. As a consequence, as more and more fuel and oxygen are consumed, a submersible changes its buoyancy and buoyancy compensation and trimming become a constant, reoccurring task. While some systems provide for condensing the water vapor carried in the exhaust gases and either storing it or venting it overboard, there have been no attempts to sublimate the gaseous carbon dioxide to the solid state using the source of liquid oxygen and storing it for buoyancy equilization purposes or for use in a subsequent oxygen generation process.

## SUMMARY OF THE INVENTION

The invention is directed to providing a closed power system including a source of fuel and a source of liquid oxygen feeding fuel and oxygen to an internal combustion engine or a turbine. After burning, the exhaust gases are fed through a condenser for expelling condensed water from the system and a pressure-tight container housing the source of liquid oxygen receives the exhaust gases. Since the interior of the pressure-tight container is cooled by the liquid oxygen below the temperature of sublimation of carbon dioxide, the gaseous carbon dioxide in the exhaust gases is sublimated to the solid state and is stored in the bottom of the container. The heat exchange between the carbon dioxide as it solidifies causes the liquid oxygen to boil off as gaseous oxygen to ensure the continued operation of the system.

It is a prime object of the invention to provide a closed system ensuring continuous reliable operation.

Another object is to provide a closed power system minimizing the generation of atmospheric pollutants.

A further object of the invention is to provide a closed power system providing for the storage of by-products of combustion.

Yet another object of the invention is to provide a closed power system having internal pressures at a near atmospheric level.

Still another object of the invention is to provide a closed power system employing an internal combustion engine.

Still another object of the invention is to provide a closed power system employing a gas turbine.

Still another object of the invention is to provide a closed power system having the capability for recycling the noncondensed portion of the exhaust gases back to the energy conversion means.

Another object is to provide a power system having the dual capability of being operated as a closed mode or an open mode.

Another object is to provide a power system having the capability for generating its own liquid oxygen for ensuring its continuous reliable operation.

Still another object is to provide a power system fueled by liquid oxygen and liquid natural gas suitably connected to ensure the sublimation of substantially all gaseous carbon dioxide generated in the system.

These and other objects of the invention will become more readily apparent from the ensuing description when taken with the drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of one embodiment of the invention operating as an open system.

FIG. 1a depicts the embodiment of FIG. 1 operated as a closed system.

FIG. 2 is a cross-sectional schematic representation of a pressure-tight container for liquid oxygen.

FIG. 3 is another embodiment of the invention employing a source of liquid natural gas as a serially-connected coolant for the exhaust gases.

FIG. 3a shows the embodiment of FIG. 3 employing a source of liquid natural gas connected in parallel with the source of liquid oxygen.

FIG. 4 shows yet another variation of the invention operated in the closed-system mode.

FIG. 4a depicts the embodiment of FIG. 4 in the open-system mode of operation.

FIG. 5 is yet another embodiment of the invention employing a gas turbine.

FIG. 6 sets forth a variation including a liquid oxygen generator to ensure prolonged closed-system operation.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1 of the drawings, a power system is shown which, because it is capable of prolonged operation and introducing no weight change by storing nearly all of its by-products of combustion, is adaptable for use as a submersible's power plant. A motor 10, a conventional internal-combustion engine, is fitted with a suitable regulator-carburetor 11 for mixing and spraying a proper mixture of hydrocarbon fuel from a fuel tank 12 to the motor's intake manifold.

To simplify a thorough understanding of the power system, its open-circuit mode of operation, being less complicated, is described first. A cut-out valve 13 is rotated to allow ambient air to be drawn into the motor

and another cut-out valve 14 is adjusted to vent exhaust gases permitting the motor's functioning in the same manner as any other internal combustion engine. Selective actuation of both these valves for operation as a conventional motor is desirable whenever the system is free to draw upon air from the atmosphere or when other considerations allow surface operation of a submersible. However, when subsurface operation is called for or when communication with the atmosphere is not possible, both cut-out valves are rotated to close the system as shown in FIG. 1a.

Being so connected for closed-circuit operation, the power system draws upon a source of liquid oxygen (LOX) 15, having an over-pressure release valve in its neck, carried in a pressure-tight container 16. Gaseous oxygen ( $O_2$ ) is boiled from the LOX source, as explained below, and is fed to a fitting-feeder line 17 and to an  $O_2$  regulator valve 18 adjusted a 0.5 PSIG bypass pressure for ensuring that the proper amount of  $O_2$  for combustion reaches motor 10.

A mixing chamber 19 receives the  $O_2$  and other gases as will be explained to provide a volume within which a mixing of all the gases occurs. In addition, since the motor is an internal combustion type, it is advisable to substantially size the chamber for smoother operation. That is to say, with a chamber enclosing a sufficiently sized dead-space volume, the on-off sequence of impulses created during the operating cycle of an internal combustion engine is blocked or damped from the other elements located "upstream" in the system.

After combustion of the gaseous  $O_2$  and fuel has occurred in the motor 10, the exhaust gases are expelled through valve 14 into a water-cooled water condenser 20. The condenser is of conventional design schematically represented as a pair of coils 21 and 22 for exacting a bilateral heat transfer while condensing water vapor from the exhaust gases. Ambient seawater or fresh water, as the case may be, is pumped through a jacket coil 21 and an adjacent coil 22 routes the exhaust gases through the condenser to cool the gases. The exhaust gases have a temperature of approximately 1,000° F. as they leave the motor and enter the water condenser, while the circulated cooling water has a temperature of between 40° and 60° F. By pumping a sufficient volume of water through the condenser, the temperature of the exhaust gases is brought down to the 60°–80° F. range and nearly complete condensation of all the water vapor occurs.

This condensed water vapor runs through coil 22 and is collected in a water trap 23. The water trap, in one form, is a sintered metal filter having a porosity permitting the flow of exhaust gases yet trapping condensed water as it attempts to pass through the trap. A water valve 24 is provided to drain the condensed water from the system or to vent it to storage tanks for buoyancy stabilization or reuse in life-support systems.

The cooled exhaust gases reach a back-pressure control valve 25 which maintains a back pressure of approximately 0.5 PSIG. This back pressure stabilizes system pressure by forcing a portion of the cooled exhaust gases to mixing chamber 19 via a feedback line 26. Were it not for feeding back a portion of the exhaust gases, consisting mostly of  $CO_2$ , carbon monoxide (CO), unburned  $O_2$ , and trace amounts of other gases, the high temperatures created as pure oxygen and hydrocarbon fuel are burned in the motor would scorch and damage the motor. The cooling effect and the buff-

ering action of fed-back exhaust gases markedly contribute to system reliability and safety. On the downstream side of back-pressure control valve 25, the remainder of the cooled exhaust gases, approximately 25 percent of the exhaust gases vented from the motor, are fed to an exhaust gas inlet fitting 27 penetrating the wall surrounding the pressure-tight container 16.

Leaving FIG. 1a for the moment and turning to FIG. 2, the heat exchange process is shown more clearly as it occurs in pressure-tight container 16. The container's outer walls are stainless steel or a similar low temperature resistant material capable of containing pressures and are lined with an insulation layer for maintaining the temperature of container interior 16' at the very low level necessary to prevent excessive  $O_2$  boil-off from a LOX source 15. The flask-shaped LOX source boils off gaseous  $O_2$  through a duct 15a provided in its neck and the gaseous  $O_2$  is fed to a concentrically oriented helical coil arrangement 15b. As the gaseous oxygen warms, as disclosed below, it is forced through the helical coil arrangement and is vented through a fitting-and-feeder line 17.

The initial temperature of parts of the surface of the coil arrangement is nearly the same temperature as LOX, namely -280° F. The essence of the invention partially resides in the fact that this -280° F. temperature sink is advantageously employed to condense and settle out, sublimate, the  $CO_2$  in the exhaust gases since gaseous  $CO_2$  has a freezing temperature causing it to sublimate to the solid state at a mere -110° F.

Thus, by providing a series of baffle plates 16a, exhaust gases entering interior 16' of pressure-tight container 16 through exhaust gas inlet fitting 27 are channeled to impinge onto the super-chilled helical coil arrangement 15b and be cooled. The exhaust gases are cooled further by their coming in contact with the outer surface of the flask-shaped LOX source 15. As the exhaust gases are cooled more and more, they are brought below their -110° F. temperature of sublimation and crystals of solidified  $CO_2$  or dry-ice, as they are called, collect on the coils and flask or fall to the bottom of the pressure-tight container.

While FIG. 2 shows the baffles as complete walls preventing the settling of the dry-ice crystals to the bottom of the container, it is understood that these solid structures are shown as such for purposes of example only. In an actual embodiment suitably disposed baffles are mounted which direct the flow of the exhaust gases through the interior of the pressure-tight container yet allow the settling of the  $CO_2$  crystals.

Since the water vapor has been condensed in water condenser 20 and vented from the system via water trap 23 and valve 24, there is little or an insignificant amount of residual moisture creating ice crystals in the pressure-tight container. As the exhaust gases continue through the labyrinth defined by the baffle plates and flask, substantially all of the  $CO_2$  is sublimated out of the exhaust gases leaving only CO, unburned  $O_2$  and small traces of inert gases which are bled from the pressure-tight container through a recycle fitting 28.

Returning once again to FIG. 1a, recycle fitting 28 is joined to a feeder line which passes the noncondensed remainder of the cooled exhaust gases to a check valve 29. This check valve prevents back flow of exhaust gases from chamber 19 into the interior 16' of the pressure-tight container and assures the flow of the noncondensed remainder to the chamber.

From the foregoing it is immediately apparent that the system is well suited for use in a submersible where weight and buoyancy must be maintained constant. As this system provides power for an electrical power generator or other machinery on board, the weight of the fuel and the LOX used in the combustion process is balanced by the weight of the condensed water and CO<sub>2</sub>. The efficiency of the system, approximately 30 percent may be as high as conventional atmospheric pressure systems operating in the open-circuit mode yet this system introduces none of the dangers of high-pressure closed systems since it operates at near atmospheric pressures plus or minus a few PSI.

In the embodiment of FIGS. 1 and 1a, a closed power system used hydrocarbon fuel, such as, gasoline, diesel fuel, pentane or butane. It has been discovered that a system relying upon a single pressure-tight LOX container will cause as little as a 75 percent cryogenic cooling capacity and all the CO<sub>2</sub> produced by combustion may not be sublimated.

Thus, in the embodiment of FIGS. 3 and 3a, a nearly complete cooling and sublimation of the CO<sub>2</sub> is ensured by substituting a source of liquid natural gas (LNG) 30, having an over pressure release valve at the top of its neck, in a pressure-tight enclosure 31. Since LNG has a temperature of approximately -250° F., interior 31' of pressure-tight enclosure 31 also is advantageously employed to further cool the CO<sub>2</sub> and effect its sublimation. This interior is modified to have baffles and a helical coil arrangement, similar in design to the interior of the pressure-tight LOX container to ensure further cooling of the CO<sub>2</sub> and, at which place, its nearly complete sublimation occurs.

Noting FIG. 3, rather than directly recycling the non-condensed remainder of the cooled exhaust gases from the pressure-tight LOX container 16 to mixing chamber 19, a feeder duct 28' passes any remainder of the exhaust gases to a second exhaust gas inlet-fitting 33 penetrating the wall of pressure-tight LNG enclosure 31. After the remainder of the exhaust gases have bypassed the baffles and piping in interior 31' of the LNG enclosure, the noncondensed remainder of the exhaust gases, consisting mainly of CO, unburned O<sub>2</sub>, and other noncondensable gases, are vented from LNG enclosure 31 via a second recycle fitting 34.

Other than providing for the serial feeding of the exhaust gases through the pressure-tight LOX container 16 to the pressure-tight LNG container 31, the rest of the system and its operation is substantially identical to that set forth with respect to the embodiment of FIGS. 1 and 1a. A further variation of the basic embodiment appears in FIG. 3a which concerns itself with providing for a parallel distribution of the exhaust gases.

A pair of branch feeder lines 35 and 36 pass cooled exhaust gases to pressure-tight LOX container 16 and pressure-tight LNG enclosure 31 respectively. The gases are further cooled, sublimation occurs and any remainder of the gases are vented through recycle fittings 28a and 28b to respective check valves 29a and 29b as disclosed before.

Both the embodiments set out of FIG. 3 and FIG. 3a have the capability for open-cycle operation when the system is so disposed by appropriately aligning valves 13 and 14 to draw in air and vent exhaust gases.

A further variation of the invention is schematically represented in FIG. 4 which provides for the inclusion of a source of hydrocarbon fuel 12 in addition to the

serially connected LOX container 16 and LNG enclosure 31. Relative to the cost of other hydrocarbon fuels, LNG is costly; therefore, it behooves designers to allow for the switching to hydrocarbon fuel whenever it is practical.

The power system of FIG. 4 provides for more efficient low-cost operation by including a bypass valve 36 selectively rotatable to switch the source of hydrocarbon fuel 12 in or out of the power system. When the power system is used in a submersible, and during submerged operations, bypass valve 36 switches the source of hydrocarbon fuel 12 out of the circuit to enable energy conversion substantially the same as disclosed above, it being fully understood that either serial or parallel interconnection between the LOX source and the LNG source is made as a mere matter of choice. After a prolonged period of closed-circuit operation, during which time substantially all of the CO<sub>2</sub> is sublimated within the interiors 16' and 31' of pressure-tight LOX container 16 and pressure-tight LNG enclosure 31, the system is switched for open-circuit operation by appropriately switching valves 13 and 14 to put the system in contact with the atmosphere and by turning bypass valve 36 to shut-out the LNG source from the system, see FIG. 4a. Low-cost hydrocarbon fuel is fed through bypass valve 36 to regulator 11 and into the motor for surface running. Upon resubmergence should it be desirable to conserve the supply of liquid natural gas, bypass valve 36 optionally is maintained in its switched position provided, of course, that valves 13 and 14 are rotated to once again create a closed system. Nearly complete sublimation of the exhaust gases is ensured during this mode of operation when there is enough cooling capacity in both the LOX container 16 and the LNG enclosure 31. As a matter of fact, when the supply of LNG is low, making a continued sublimation of all the CO<sub>2</sub> questionable, it is wise to switch to the source of hydrocarbon fuel 12 beforehand to ensure continued closed system operation.

Another embodiment of the inventive concept of applying the cryogenic effect of the LOX and, when available, LNG to sublimate CO<sub>2</sub> in the exhaust gases is shown in FIG. 5. This embodiment is substantially identical to the closed power system set forth before with the exception that another type of motor, a gas turbine, is substituted in place of the internal-combustion motor. Like-elements functioning in a like-manner with respect to the previously disclosed embodiments are identified by identical reference characters. Valves 13 and 14 are switched to a position to guarantee the closed-system operation and pressure-tight LOX container 16 yields O<sub>2</sub> for burning as does a source of hydrocarbon fuel 12 provide the fuel for combustion. Water condenser 20 cools exhaust gases and a following water trap 23 permits the collecting and purging of water from the system as disclosed before. More efficient operation is provided with respect to using an internal combustion engine by noting the precise manner in which a turbine 40 is included in the system.

To start operation as a closed system the fuel from source of fuel 12 is jetted into a combustion chamber 41 and a predetermined amount of O<sub>2</sub> is boiled-off from the LOX source and passes through O<sub>2</sub> regulator valve 18 to the combustion chamber. Upon ignition therein, hot exhaust gases drive a shaft-mounted compressor turbine stage 43, the opposite end of which terminates in and is secured to a compressor stage 42. Ex-

haust gases are vented from the compressor turbine stage and drive the power turbine stage 44 connected to a load. The hot exhaust gases having a temperature of approximately 1,000° F. are fed into a regenerator 46 schematically depicted as having a pair of longitudinal passageways 47 and 48. The passageways are in communication with each other to effect a bilateral heat transfer, that being cooling the exhaust gases vented from turbine stage 44 while warming the compressed gases as they travel from compressor stage 42 to the combustion chamber.

After the cooled exhaust gases have passed through longitudinal passageway 47, water is condensed in water condenser 20 and purged via trap 23 and valve 24 and CO<sub>2</sub> is fed back to pressure-tight LOX container 16 for sublimation of the CO<sub>2</sub>.

From inspection of FIG. 5, it is noted that a feedback line 26a recycles a portion of the exhaust gases to the combustion chamber in the turbine for the dual purpose of cooling the combustion of the O<sub>2</sub> and fuel in the combustion chamber and for warming and ensuring the complete converting of the O<sub>2</sub> to the gaseous state on its way to the combustion chamber. To elaborate, that portion of the recycled gas being fed through feedback line 26a is warmed while passing through a second regenerator 49 having a pair of longitudinal passageways 50 and 51. O<sub>2</sub> boiling off from the LOX source is fed through O<sub>2</sub> regulator valve 18 at a temperature of approximately -50° F. and is vented through regenerator 49 via longitudinal passageway 51 to the combustion chamber. As O<sub>2</sub> passes through the second regenerator, it is heated to a temperature of approximately +58° to +64° F. This warmer temperature increases the efficiency of the burning operation in the combustion chamber while that portion of the recycled exhaust gases traversing the length of longitudinal passageway 50 is cooled somewhat from a 60° F. temperature to a 55° F. temperature. Check valve 29 prevents CO<sub>2</sub> from backflowing into the interior of LOX container 16 and the slight vacuum created by compressor stage 42 as it draws in the recycled gases through valve 13 ensures that operation continues.

Compressed recycled gases are fed from compressor stage 42 to longitudinal passageway 48 in regenerator 46. The temperature of these gases has been measured to be approximately 200° F. at the input side and at 800° F. at the "downstream" side of longitudinal passageway 48.

The recycled gases, largely consisting of CO<sub>2</sub> heated to an 800° F. level, reach the combustion chamber and are mixed with O<sub>2</sub> at the 60° F. level and fuel. Because of the mixing and cooling, the O<sub>2</sub> and fuel mixture is diluted and ignition produces exhaust gases held down to an approximate 1,600° F. level, whereas, if there were only fuel and O<sub>2</sub> burning, a temperature of over 5,000° F. would have been created and heat damage to turbine stage 43 and power turbine stage 44 would be the inevitable result. Thus, by mixing a portion of the recycled exhaust gases containing CO<sub>2</sub> in the combustion chamber, the overall temperature of combustion is lowered and damage to following components is avoided.

Exhaust gases from power turbine stage 44 having a temperature of 800° F. to 1,000° F. heat the recycled gases in regenerator 46, as mentioned above and, in the meantime, the exhaust gases from the power turbine stage are lowered to a near 500° F. level. As the cooled gases enter water condenser 20, however, they are fur-

ther cooled to a 60° F. level at which temperature water vapor is condensed. The condensed water is collected at water trap 23 and purged from the system via water valve 24.

This system is designed with back-pressure control valve 25a to ensure that 0.8 of the volume of the system's exhaust gases are recycled, via feedback line 26a to the turbine and the remaining 0.2 volume of the exhaust gases are fed to pressure-tight LOX container 16 for sublimation and subsequent recycling of CO and other gases.

The embodiment depicted in FIG. 6 incorporates any one of the closed systems described above and lends itself toward continued closed-system operation by including an O<sub>2</sub> regeneration system. The regeneration system and its adaption with the embodiment and mode of operation described with respect to FIG. 4a shows a source of fuel 12 connected via bypass valve 36 to motor 10 with cut-out valves 13 and 14 suitably switched for open-circuit operation. In addition, surface air is drawn in through a suitably connected motor-pump unit 55 which impels it through a water condenser 56, roughly the parallel of water condenser 20. Water vapor is condensed and purged through a water trap 57 and a valve 58. Fitting 59 on LNG enclosure 31 and LOX container 16 direct the passage of the cooled, dehydrated air through appropriate channels 60 in contact with the condensed, solid CO<sub>2</sub>. By being so directed, the incoming air is cooled sufficiently for additional processing in a conventional O<sub>2</sub> generator 60. LOX is then pumped into flask-shaped source of LOX via line 61 while the unwanted gases are vented at vent 60a.

In all the described embodiments a closed system operating at near atmospheric pressure levels provides continuous power. Buoyancy and trimming problems are nearly nonexistent. Furthermore, there are vented no pollutants either inside or outside a submersible.

The compact noncomplicated design lends itself well for adaptation to small submersibles where power demands for prolonged periods cannot be met by battery powered electric systems. Relatively bulky, conventional diesel-electric power plans also are replaceable by the invention which uses only a single prime mover to effect energy conversion.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings, and, it is therefore understood that within the scope of the disclosed inventive concept, the invention may be practiced otherwise than specifically described.

What is claimed is:

1. A closed power system comprising:

- a motor for producing a thermal energy conversion having a fuel inlet, a gas inlet and an exhaust outlet;
- a source of fuel joined to pass fuel to said fuel inlet;
- a source of liquid oxygen coupled to a helical coil arrangement to boil-off and to vent gaseous oxygen to said gas inlet;
- means connected to said exhaust outlet for condensing water from exhaust gases;
- means coupled to the condensing means for receiving said exhaust gases and for expelling condensed water from said system;
- a pressure-tight container housing said source of liquid oxygen and said helical coil arrangement to ensure the cooling of its interior thereby below the

temperature of sublimation of carbon dioxide, said container is provided with a first fitting and a second fitting penetrating said container in communication with the interior;

means connecting the receiving and expelling means to said first fitting for passing said exhaust gases to the cooled interior to sublimate and store carbon dioxide in said container while heating said liquid oxygen to boil-off said gaseous oxygen; and means interconnecting said second fitting to said gas inlet for recycling the noncondensed remainder of the cooled exhaust gases back to said motor.

2. A power system according to claim 1 further including:

means interposed between said gas inlet and said source of liquid oxygen and said second fitting for mixing said oxygen and said noncondensed remainder of the cooled exhaust gases.

3. A power system according to claim 2 further including:

means coupling said receiving and expelling means to the mixing means for feeding back a portion of said exhaust gases to dilute the oxygen-fuel mixture in said energy conversion means and

means interposed between the feedback means and said first fitting creating a back pressure to ensure that said portion of said exhaust gases are fed back.

4. A power system according to claim 3 further including:

means for allowing the intake of ambient air while blocking the passage of oxygen being interposed between said motor and said mixing means and

means for venting said exhaust gases to the surroundings while blocking their passage to said condensing means being interposed between said motor and said condensing means, the allowing means and the venting means cooperating to give said power system an optional open-system capability.

5. A power system according to claim 1 in which the source of fuel is a chamber enclosing a vessel of liquid natural gas and having its interior cooled thereby below the temperature of sublimation of carbon dioxide, said chamber being provided with a first, a second, and a third coupling, the first coupling being connected to said vessel to pass gaseous liquid natural gas to said fuel inlet and the second coupling and the third coupling communicating with the fuel chamber interior, and the

interconnecting means includes,

a first duct connecting said second fitting to the second coupling for ducting the cooled exhaust gases to the fuel chamber for the further sublimation of carbon dioxide and

a second duct interconnecting the third coupling to said gas inlet for recycling the noncondensed remainder of the cooled exhaust gases back to said motor.

6. A power system according to claim 1 in which said motor is a gas turbine having a compression stage, a combustion chamber including said fuel inlet, said gas inlet, and an oxygen inlet, a compressor-driver stage, and a power stage and said system further includes:

an intake regenerator having a first passageway connecting said first fitting and said compression stage together for receiving a noncondensed remainder of said cooled exhaust gases and a second passageway connecting the source of liquid oxygen to said oxygen inlet for warming said gaseous oxygen and an exhaust regenerator having a first passageway coupled to said compression stage to receive a noncondensed remainder of said cooled exhaust gases from said compression stage and feeding them to said combustion chamber and a second passageway coupled to receive exhaust gases from said power stage for the cooling thereof and transfer to said condensing means.

7. A power system according to claim 5 further including:

means for generating oxygen coupled to receive air from the atmosphere, process it, and feed liquid oxygen back to said source of liquid oxygen.

8. A power system according to claim 7 in which the oxygen generation means includes a water condenser receiving the air for purging water therefrom, interconnecting ducting for feeding the dehydrated air through said pressure-tight chamber and said pressure-tight container for precooling the air, and a liquid oxygen producing device for producing liquid oxygen.

9. A power system according to claim 8 in which said interconnecting ducting is cooled by the sublimated carbon dioxide causing same to revert to the gaseous state evacuating said container and said chamber to ready them for continued cooling of said exhaust gases.

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