Nov. 21, 1944. J. A. BERTSCH 2,362,966

APPARATUS FOR FILLING GAS BALLOONS AND AIRSHIPS WITH LIGHT GASES

Filed June 12, 1941 2 Sheets-Sheet 1

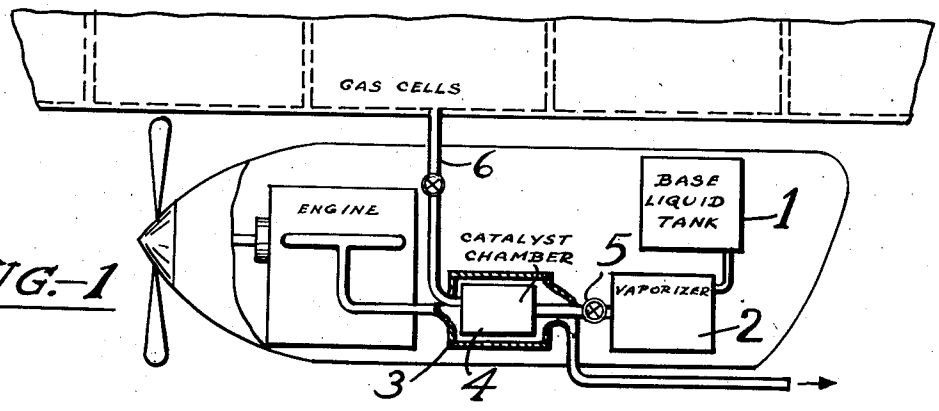


FIG.-1

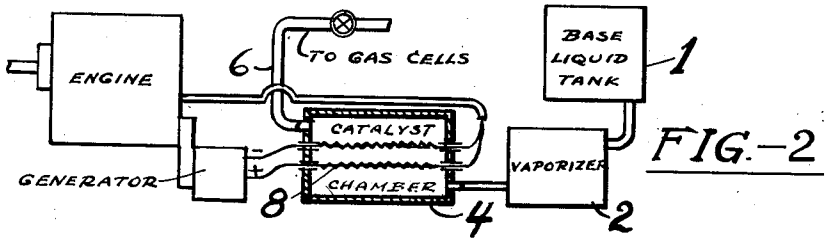


FIG.-2

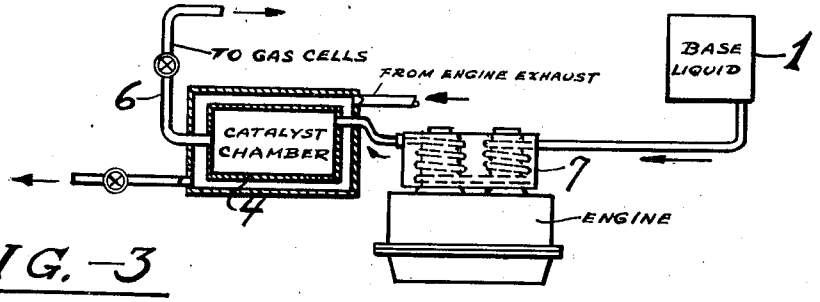


FIG.-3

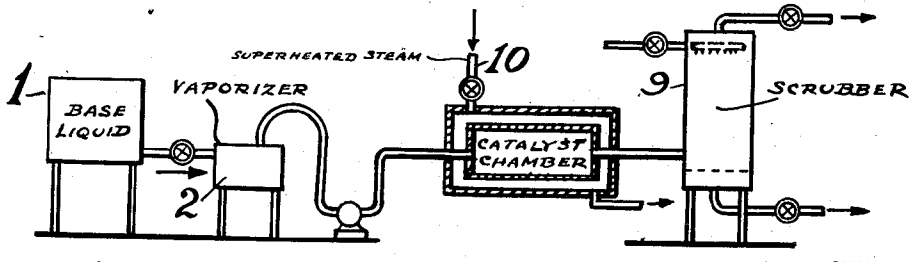


FIG.-4

INVENTOR.
JOHANN ADAM BERTSCH., DECEASED
THE MANUFACTURES' BANK AND TRUST CO. OF ST. LOUIS, EXECUTORS
BY J. Kifelli, Jr.
ATT'Y.

Nov. 21, 1944. J. A. BERTSCH 2,362,966

APPARATUS FOR FILLING GAS BALLOONS AND AIRSHIPS WITH LIGHT GASES

Filed June 12, 1941 2 Sheets-Sheet 2

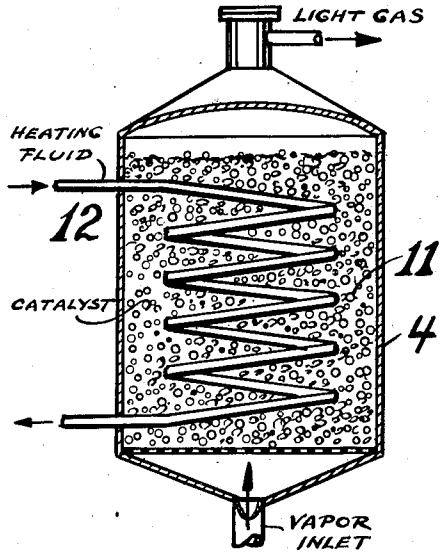


FIG.—5

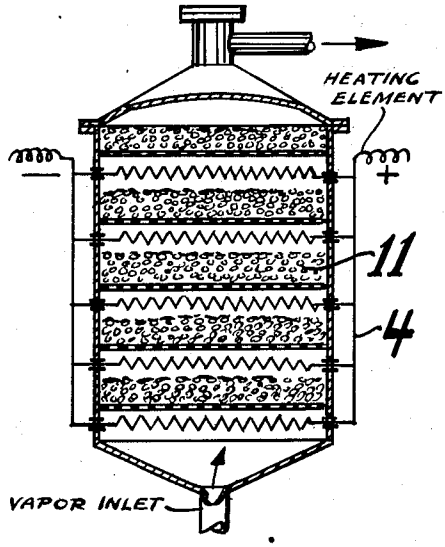


FIG.—6

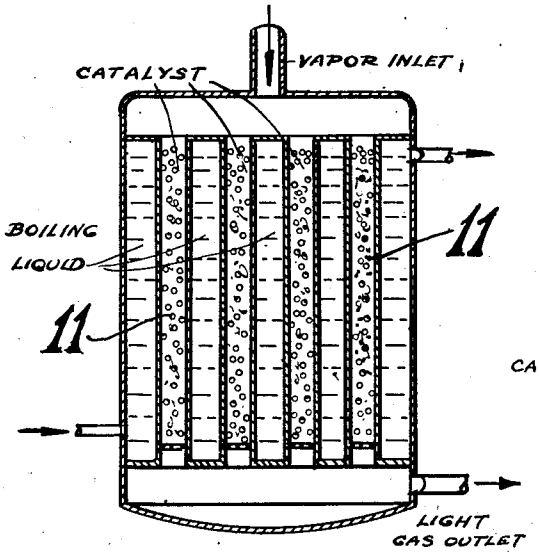


FIG.—7

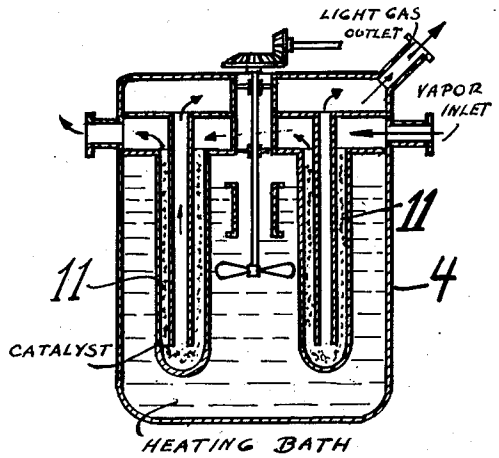


FIG.—8

INVENTOR.
JOHANN ADAM BERTSCH, DECEASED
THE MANUFACTURES' BANK AND TRUST CO. OF ST. LOUIS, EXECUTORS.
BY J. Kufelli, Jr.
ATT'Y.

Patented Nov. 21, 1944 2,362,966

UNITED STATES PATENT OFFICE

2,362,966

APPARATUS FOR FILLING GAS BALLOONS AND AIRSHIPS WITH LIGHT GASES

Johann Adam Bertsch, deceased, late of St. Louis, Mo., by the Manufacturers' Bank and Trust Company of St. Louis, executor, St. Louis, Mo.

Application June 12, 1941, Serial No. 397,727

4 Claims. (Cl. 244—98)

This invention relates to a method and apparatus for producing lifting mediums and for filling balloons and airships with same, and also to novel mixtures of gases for lift mediums for lighter-than-air aircraft.

The ordinary practice of filling balloons and dirigibles entails the use of a central-station ground plant in a fixed location. Such plants consist of various pieces of expensive apparatus of considerable size and complexity. Moreover, they are subject to criticism, militarily, by reason of their immobility and their susceptibility to attacks from the air. None of the gases heretofore used for the purpose, for example, helium, hydrogen, or producer gas, or the modern so-called "blue" gas, have been produced in the quantities required for filling large balloons except in plants of the kind just noted.

For permitting the filling of balloons at places other than such gas-producing plants, it has been proposed to utilize compressed gas, particularly hydrogen, shipped in containers such as are commonly employed for the storing and transportation of gases for welding. A great number of these cylinders have to be employed, making the cost of the method of procedure often prohibitive, and always expensive. In this connection, it is noted that the ratio of the weight of the cylinder, empty, to the weight of hydrogen contained therein is 100:1. Also, the handling of the compressed gases in the cylinders involves a risk of explosion which would undoubtedly cause great damage if it occurred while the balloon was being filled. For example, in commercial hydrogen there is always a certain percent of oxygen which becomes concentrated as the cylinder is emptied by reason of the fact that it has a lower orifice velocity than hydrogen. Extreme care should be exercised in using commercial hydrogen, in welding, for example, to prevent the formation of an explosive mixture.

The present invention provides a means for cheaply and quickly producing the lift-medium *in situ* on the airship itself, whereby instead of depending on the unsatisfactory ground-plants mentioned above, each airship can carry its own generating plant and produce a standard gas and be filled easily and quickly *in situ* wherever it may be.

It was discovered that the gaseous products formed by decomposing certain volatile oxygen-containing liquid organic compounds, such as methyl alcohol, by the action of heat, or by heat in the presence of a catalyst, form eminently suitable lift-mediums for lighter-than-air aircraft.

Accordingly, the present invention contemplates providing the airship with a supply of one or more volatile liquids; drawing out the desired quantity of the liquid when necessary; vaporizing it; dissociating or decomposing the vapor, *in situ* in the aircraft, into a gas lighter than air or a mixture of gases lighter-than-air; and conducting and controlling the flow of the products into the gas cells.

In order that the inventive concept may be better understood, several embodiments of the invention will now be described in conjunction with the accompanying drawings, but the inventive idea itself is limited in its embodiments only by the scope of the sub-joined claims. In these drawings,

Fig. 1 is a diagrammatic representation of a gas generating apparatus combined with one of the propulsion engines of a dirigible;

Fig. 2 shows a modified form thereof;

Fig. 3 shows another modification;

Fig. 4 is a diagrammatic representation of an apparatus suitable for use as a fixed or portable ground plant for carrying out the invention; and

Figs. 5–8 are diagrammatic illustrations of various forms of catalytic reaction chambers.

The substance known as methyl alcohol is plentiful and cheap, besides being a relatively light liquid and not of an explosive nature. It will, therefore, be taken as the preferred one of the various volatile organic compounds referred to hereinabove. It can be decomposed at 200°–450° C. either by the action of heat alone, or by the action of heat in the presence of a catalyst, into a gaseous mixture consisting of two volumes of hydrogen and one volume of carbon monoxide, in accordance with the following reaction formula:

$$CH_3OH \rightarrow 2H_2 + CO$$

It was found that the gaseous mixture resulting from this reaction is well-suited for use as the lift-medium of airships. This fact will become plainer upon considering that the weight of 1 liter of air under normal conditions is 1.2927 grams; that the weight of 1 liter of H_2 under normal conditions is .0898 grams, the weight of 1 liter of CO under normal conditions is 1.2501 grams, and that the weight of 1 liter of the above mixture of $CO+2H_2$, at the above ratio of 1 volume of CO to 2 volumes of H_2 is .4766 gram, so that it at once appears that

the lifting power of the dissociation products is therefore, .8161 gram per liter.

The methyl alcohol may be stored under pressure on board the airship in a reservoir 1 which can be located in the car, or in a gondola. From the reservoir, the methyl alcohol is allowed to flow by gravity, or is otherwise released, into a vaporizer 2, of any suitable type, wherein the liquid methyl alcohol is converted into methyl alcohol vapor. From the vaporizer, the methyl alcohol vapor is conducted by suitable piping to a suitable catalytic chamber 4, which is provided with jacket 3. In cases where the exhaust gases of the engine are used for heating the catalyst chamber, a particular advantage can be obtained by a subsequent total combustion of such engine gases by means of catalysts. The engine exhaust gases are rich in carbon-monoxide and the hot engine gases eventually, after addition of air, can be conducted over a catalyst such as Hopcalite or a more rigid catalyst, such as a Ceroxide mixture or fused Metaloxide, which catalysts cause total combustion, whereby additional heat may be produced.

By modifying the sensitiveness of the catalyst, it is possible to compensate within certain limits for any deficiencies in the heat of the exhaust gases, as for varying types of engines, so as to always have the optimum reaction temperature in the catalytic chamber 4. It is preferable to so control the flow and proportions of the methyl alcohol vapors entering into the catalytic chamber that no undecomposed methyl alcohol will leave the farther end of the chamber, and to this end, a suitable valve 5 may be provided in the pipe leading into the chamber.

The mixture of hydrogen and carbon monoxide, as it is produced and leaves the chamber 4, is suitably protected from contact with sparks or open flames, and is led thence either directly to the cells of the gas-bag, by means of the usual piping and valves 6; or, if desired, first over activated charcoal, or silica gel or through water, to remove water vapor and any trace of methyl alcohol vapor not dissociated in the chamber. This washing is, however, not obligatory but is advisable when the rate of flow and dissociation in the chamber cannot be properly controlled. In either case, however, it is not necessary to employ pressure-increasing means, such as a gas-pump or blower fan, as the dissociation of the substances of the present invention is accompanied in every instance by an increase of pressure, which is always sufficient to completely inflate the gas bag without the aid of auxiliary pressure-increasing means.

The separate vaporizer may, if desired, be dispensed with by running the methyl alcohol in place of water into the cooling system of the engine, whereby the liquid will not only be vaporized and the resulting vapors advantageously preheated, but the necessity for carrying a separate supply of engine-cooling medium, such as water, will be obviated. As shown in Figure 3, this may be accomplished by enclosing a conduit 7 within the water-jacket block of the engine, and coiling it around each cylinder, whereby the methyl alcohol is vaporized and the vapors preheated before entering the catalytic reaction chamber 4.

Various instrumentalities can be employed to heat the catalytic chamber. As already mentioned in connection with Fig. 1, the exhaust gases from the engine can be used directly for heating the catalytic chamber or chambers. The usual temperature of the exhaust gases is between 330 degrees C. and 380 degrees C. When used on the ground, the catalytic chamber may be surrounded by a suitable fluid bath. A very good temperature regulation is then secured by using a liquid of suitable boiling point, which point may be adjusted by regulating its vapor pressure, or by circulating the liquid by a force feed system connected to the engine. The liquid bath may also be replaced by a solid block of metal in which the catalytic chambers are embedded, such block serving as a heat reservoir. Heat may also be supplied electrically as indicated at 8 in Fig. 2, and in Fig. 6. If the catalytic material is an electrical conductor in itself, or is coated on an electrical conductor such as metals and alloys, the catalytic elements may be heated directly by electric current. The vapors may also be dissociated by the discharge through the chamber of silent electric sparks. Heat may also be produced by combustion, particularly surface combustion of a liquid or gaseous fuel. Thus methyl alcohol or gasoline vapors mixed with air may be passed over a suitable catalytic material, such as platinum asbestos or Ceriumoxide or Hopcalite catalyst whereby a flameless combustion is produced which furnishes a very uniform heat. The air as used for such combustions may be passed before entering the fire box over exhaust scrubbing material such as silica gel or charcoal, which is soaked with undecomposed liquid obtained from scrubbing the gases to be conducted into the balloon.

Any suitable catalyst may be employed in carrying out the invention, and the invention is not limited to any particular catalyst or type of catalyst. When using methyl alcohol, it is preferred to use a type of catalyst which, in a reaction converse to that of the present invention, will produce methyl alcohol or the like from the oxides of carbon in the presence of gases containing hydrogen. For example, the catalyst may be an oxide, or a mixture of oxides, suboxides, silicates, borates, fluosilicates, halides, alloys, or metallides, of zinc, copper, silver, chromium, vanadium, uranium, manganese, gold or lead, or all of them, or any combination of them. The invention is not limited to any of these materials however.

The catalytic chamber can be constructed in any well known manner which secures a uniform distribution of heat through the catalytic mass. The catalyst may be carried as a single layer (Fig. 5) or a plurality (Fig. 6) of flat layers and the supporting plates or grids may be heated from outside by electricity (Fig. 6) or pipe coils wherein a gaseous or liquid heating medium circulates (Fig. 5). Heating elements may also be embedded in the catalyst layer (Figs. 5–6). The catalyst tubes may be immersed in a liquid or gaseous heating bath. These types of catalytic chambers are merely representative and it is to be understood that any other suitable arrangement of the catalytic chamber may be used without deviating from the present concept. However, the chamber is contemplated as always being made of copper or stainless steel, or alloys or other substances which do not form Ironcarbonyl with carbonmonoxide, since such is harmful to the catalyst. Vice versa, the catalyst may be located outside the tubes and the inside of the tubes may be traversed by heating gas or liquid. The tubes containing the catalyst may be closed on one end and have a center tube extending partly through the closed-end tube for conducting inlet or outlet gases and such tubes may be embedded in the heating medium (Fig. 8). Vice versa, the heating

fluid or gas may be circulated in these double tubes and the catalyst may be located outside the tubes. Flat layers of catalyst may be combined in succession with layers arranged between, or inside of open or closed-end tubes.

The catalytic apparatus illustrated in the various figures may be combined in series or in parallel, and one type may be combined in series or in parallel with any other type. Heat-exchange elements for preheating the incoming gases and cooling the outgoing gases may be connected with the single converters, or may be placed between a plurality of converters connected in series. Heat exchangers may also be located inside the catalytic chambers.

The manner of bringing the catalyst into the reaction is also of considerable flexibility, as the catalyst may be brought into the reaction either by being coated on the carrier or the carrier may be impregnated with catalyst, or the carrier may itself be either catalytic or inert. When the carrier is to be impregnated with the catalyst, the carrier preferably consists either of silicic acid or a silicate such as zeolite. It may also consist of a base-exchanging body having a highly ramified, cellular inner surface, in which the silica may be substituted by other groups, such as stannates, plumbates, aluminates, etc. Instead of employing a separate carrier, the walls themselves of the chamber may be coated with the catalyst. In this case, the catalyst is reduced before use at about 250°–300° C. by hydrogen-containing gases or methyl alcohol vapors.

By means of the present invention, therefore, both the lifting medium for the gas-cells and fuel for the engines may be generated *in situ* in the airship. The use of those volatile liquids from which are produced only hydrogen and a heavier gas also gives the advantage that the heavier gas generated therefrom serves to automatically compensate for the loss in weight during flight caused by the consumption of fuel. Further, if the gas-bags are originally filled with pure hydrogen, and it is desired to reduce altitude during flight, replenishing the bags with the carbonmonoxide-hydrogen mixture of the present invention serves automatically to restore the craft to the desired weight. If it is desired to lower the lifting power still more, the carbonmonoxide-hydrogen mixture, or a part thereof, may be conducted through an additional catalytic chamber producing methane from the gases, or a part thereof, so that a gas mixture of a still further decreased lifting power is produced. Also—particularly when the invention is embodied in a central-station ground plant—one or more components of the mixture, such as suitably small amounts of carbon dioxide or of carbonmonoxide, may be removed by scrubbing with any suitable absorbent, to vary the hydrogen content of the dissociation product and, therefore, the lift power of the craft, to any desired degree.

By the use of one of the sources of hydrogen contemplated by the present invention from which also other useful by-products can be produced, the present invention makes it possible to not only generate a standard, high quality lift-gas *in situ* on short notice wherever the airship may be and in any quantities, but also obviates the necessity of depending upon the unreliable local products along its course, as when on an extended voyage, and thus widens considerably the field of usefulness of lighter-than-air craft.

If desired, the gas producing plant of the present invention can be erected on the ground at an airport, as shown in Fig. 4, the size of the various components being increased sufficiently to supply the airships berthed there, instead of being designed in combinations with the motive plant of a single airship. Various other modifications of like nature may be made without going beyond the scope of the present invention.

It is claimed:

1. In a lighter-than-air flying machine having a buoyant gas cell, a propeller, and an internal combustion engine for driving the same, means for chemically generating buoyant permanent gas for filling said gas cell, consisting of the combination of a reservoir of liquid methanol, means for vaporizing the methanol stored therein, said means being operated by the heat of said engine, catalytic means for converting the vaporized methanol into a mixture of permanent gases, and means for introducing said permanent gases into said gas cell.

2. In a lighter-than-air flying machine having a buoyant gas bag, a propeller, and an internal combustion engine for driving the same, means for generating buoyant gas for filling said gas cell, comprising the combination of a supply of liquid methanol, means for vaporizing said methanol, catalytic means for converting the vaporized methonal into a mixture of hydrogen and carbon monoxide, and means operated by said engine for heating said vaporizing means and said catalytic means.

3. In a lighter-than-air flying machine having a buoyant gas cell, a propeller, and an internal combustion engine for driving the same, means for generating buoyant gas for filling said gas cell, comprising the combination of a reservoir of liquid methanol, means for vaporizing the methanol stored therein, a catalytic combustion chamber for converting the vaporized methanol into a mixture of gases lighter-than-air, a plurality of electrically conducting catalysts in said catalytic combustion chamber, an electric generator motivated by said engine, and electrical conductors between said generator and said electrically conducting catalysts for passing an electric current through said electrically conducting catalysts to cause decomposition of said vaporized methanol.

4. In a lighter-than-air flying machine having a buoyant gas cell, a propeller, and an internal combustion engine for driving the same, means for generating buoyant gas for filling said gas cell, consisting of the combination of a reservoir of liquid methanol, means operated by the heat of said engine for vaporizing said methanol, catalytic means for converting the vaporized methanol into a mixture of hydrogen and carbon monoxide, and means for heating said catalytic means including a catalytic combustion chamber adapted to burn the exhaust gases from said engine and heat exchange means between said catalytic combustion chamber and said catalytic means.

THE MANUFACTURERS' BANK &
TRUST COMPANY OF ST. LOUIS,
Executor of the Estate of Johann Adam Bertsch, Deceased,
By HUGH B. ROSE,
Trust Officer.