Patented Oct. 15, 1929 1,731,840

# UNITED STATES PATENT OFFICE

JEGOR ISRAEL BRONN, OF BERLIN-CHARLOTTENBURG, GERMANY

## AIRSHIP

No Drawing. Application filed March 6, 1928, Serial No. 259,615, and in Germany March 14, 1927.

Nearly all known airships comprise a cell frame for receiving cells or bags which contain the light or buoyancy gas, and gondolas or cars for the engines with stores, as well as cabins for the crew and passengers.

Pure hydrogen and also occasionally helium, are mainly used as the light or buoyancy gas.

The engines of airships are at present worked almost exclusively with liquid fuels, such as benzene or petrol, benzol, gasoline and other liquid fuels usually employed for explosion engines. In view of the long distances which the airship have to travel as a rule, the stock of petrol and the like to be carried is very considerable, since the consumption of the same amounts as a rule to more than 200 grammes per horse power per hour. A ship which is propelled by only 1500 H. P. consumes therefore hourly 300 kg. petrol. In the case of a four-day journey, this amounts to $300 \times 24 \times 4 = 28800$ kg., that is to say, including the corresponding tanks, to more than 30 tons petrol. Accordingly, the cells for the buoyancy gas, as well as the quantity of light gas to be carried, must be so dimensioned as to lift these 30 tons petrol also.

It has been recently proposed to work the engines of airships not with liquid, but with gaseous fuel, in which case the driving gas is also accommodated in cells or bags.

Such airships have therefore two kinds of cells and gas filling: cells with hydrogen or helium, and cells with gas of high heating value for the working of the engines, which will be hereinafter referred to as the motor gas.

As generally the motor gas is not heavier than the air, practically no buoyancy or light gas is required in order to carry even large quantities of motor gas on the airship. This results in a very considerable economy of the said buoyancy gas, as well as of the cell space intended for the same. When a motor gas of the same specific gravity as the air is used, the result is that during the whole journey, the proportion between the weight of the ship contents proper and the volume of the buoyancy gas, remains practically without a change, for only motor gas of approximately the same specific gravity as the air, is consumed.

It is however somewhat difficult to obtain a gas which complies simultaneously with the following conditions: this gas must have approximately the same specific gravity as the air, that is to say, it must weigh 1290 grammes per cubic meter, it must have the highest possible heating value so as to store the greatest possible amount of energy in the same cell volume, the gas must be thoroughly suitable for use in explosion or internal combustion engines, it must not separate any liquid or solid ingredients even in very cold weather, it must be physiologically harmless, it must be as cheap as possible, it must be obtained in large quantities, and finally it must be easy to transport from the place of its manufacture to the filling place for the airships.

A motor gas which fulfills all the conditions here enumerated, is however very rare. Ethane was proposed for the purpose, but it can hardly be obtained in large quantities and is accordingly very expensive.

Methane has turned out to be an excellent motor gas, and it has been found that when using methane in an explosion engine, a considerably greater useful effect or efficiency can be obtained from one calorie than for instance from a calorie supplied by petrol. This is due to the fact that the mixture of air and methane can be much more heavily compressed in explosion engines, without a premature ignition or misfiring taking place. Since the introduction of the decomposition of coke oven gases by the process of the inventor, by intensive cooling, methane which forms 25% of the coke oven gases, is available in unlimited quantities in all countries rich in coal. The specific gravity of methane is however considerably smaller than that of the air (716 grammes per cubic meter as compared to 1290 grammes for the air). Consequently the density of methane is only 0.56. In filling the corresponding cells of the airship with methane, this gas will partly act as the buoy-

ancy gas and during the journey the buoyancy conditions of the airship will constantly change.

It is however possible, in decomposing coke oven gases by intensive cooling according to the process of the inventor, to obtain in place of a pure methane, a mixture of all the gaseous hydrocarbons contained in the coke oven gases, in which case a gas mixture of about 11000 heat units per cubic meter is obtained with a density of about 0.66 compared to the air. In order, when using as motor gas these gaseous hydrocarbons obtainable from coke oven gases, to obtain less variable buoyancy conditions of the airships, it is proposed to balance the difference between the weight of the stock of motor gas carried, and the weight of the air displaced thereby, by carrying a corresponding quantity of liquid fuel, for instance petrol.

The airship engines are then worked with the motor gas which passes through a tank with petrol, and as the stock of motor gas and therefore also the buoyancy of the latter decreases, the weight of liquid fuels is also changed, so that the conditions of buoyancy of the airship remain approximately the same.

In order to ensure that the motor gas, or its mixture with air, will always be saturated to the same extent with the vapors of the liquid fuel, the latter may be constantly maintained at the same temperature by means of separate heating devices. By means of such a temperature regulation, the proportion between the motor gas and the fuel vapors may therefore be regulated.

As the airships generally have four, five or even more engines working, the proceeding may also be such that for instance three engines are worked with motor gas, and one engine with petrol.

The useful effect or efficiency of such a method of working is extraordinarily great, as will be shown by the following example:

From the coke oven gases may be separated, for instance by intensive cooling, a gas mixture of the following composition:

| | Heating value share in 1 cb. c. m. of the gas mixture | Weight in 1 cb. c. m. of the gas mixture |
|---|---|---|
| | *H. U.* | *gr.* |
| 80% methane with a heating value of about | 7600 | 560 |
| 10% ethane and propane | 1500 | 135 |
| 5% ethylene | 750 | 60 |
| 5% propylene and butylene | 850 | 95 |
| | 10700 | 850 |

A cubic meter of this gas mixture, of the weight of about 850 grammes, has a heating value of about 11,000 heat units, and a buoyancy of (1290—850) 440 grammes, that is to say each cubic meter of this gas can carry over 400 grammes of petrol or some other liquid fuel. The heating value of these driving media amounts as a rule to about 10,000 heat units per kilogram, so that (without taking into account the weight of the tanks) it may be calculated that each cubic meter of the above gas mixture carried, represents an energy of 11,000+4000=15000 heat units.

The use of the said gas mixtures obtained by intensive cooling is also advantageous in so far as they are practically free from easily condensable hydrocarbon such as butane and pentane which become liquid at temperatures occurring in the open air. Therefore there is no danger that in the cells or bags, which contain the motor gas, liquids could be deposited which could impair the impregnation of the walls of the cells.

Gas mixtures of a similar kind can also be obtained by destructive distillation of solid or by cracking of liquid fuel provided that only those fractions of the gaseous hydrocarbons produced thereby are used which have the lowest boiling points for instance −90° C. or still lower.

Also earth gas or natural gas leaving the subsoil at many places has a similar composition.

All these gas mixtures can be used for the purposes of this invention, may it be alone or in mixture with the above mentioned distillation gases. Care should however preferably be taken that the final mixture is either completely or nearly free from easily condensable hydrocarbons.

The advantages obtained by the measures described, are of various kinds, as owing to the considerably higher energy with the greatly reduced weight of the liquid fuels to be carried, the airships are given a much greater radius of action, and also the relation between the buoyancy and the weight of the airships remains practically invariable during the whole journey. As regards the cost for the driving media, the use of methane or of the gas mixtures above mentioned is an advantage, as the heat units can then be obtained cheaper and give a higher driving efficiency.

What I claim is:—

1. An airship of the type in which the heat energy for operating the engines is obtained by burning buoyant fuel gas and liquid fuel in such proportions that the buoyancy is substantially independent of the fuel consumption, characterized by the fact that said buoyant fuel gas consists of a mixture of hydrocarbons free from components liquefiable at atmospheric temperatures and comprises a major portion of methane and lesser quantities of hydrocarbons of higher boiling points.

2. The invention as set forth in claim 1, wherein the fuel gas includes substantially 80% methane, and the higher boiling point hydrocarbons include ethane, propane, ethyl-

ene, propylene and butylene in such relative proportions that the weight of the fuel gas is of the order of 850 grams per cubic meter, and the heat energy per cubic meter is of the order of not less than 10,000 heat units.

In testimony whereof, I affix my signature.

JEGOR ISRAEL BRONN.