

# UNITED STATES PATENT OFFICE

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## GASEOUS FUEL

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1 Claim. (Cl. 48—199)

This invention pertains to a gaseous fuel which is suitable for use in internal combustion engines, and has particular reference to a gaseous fuel for air craft lighter than air, such as dirigibles.

5 In the practical operation of lighter-than-air air craft, the use of liquid fuels has several disadvantages; the fuel load constitutes a considerable additional burden which must be compensated for by providing lifting capacity for the starting load.  
10 As liquid fuel is consumed, the total weight of the craft is gradually reduced and over a long cruising range this loss is large. It thus becomes necessary to compensate for this loss in weight by exhausting from the gas bag a portion of the lifting gas. In the case of the rarer non-inflammable gas, helium, this would constitute a serious loss, difficult of replacement and highly expensive. Even with the use of hydrogen as a lifting gas, the loss of gas is such as to greatly add to the expense of operation. The use of condensers on the exhaust of engines has been resorted to, to retain the water formed by combustion as ballast but the provision of such equipment reduces the efficiency of the ship.

25 In view of these difficulties, it is proposed to use a gaseous fuel mixture which has a density approximately the same as air. Fuel storage space may be provided in the form of partitioned gas storage spaces within the body of the dirigible so that as gaseous fuel is consumed air may be admitted to such spaces and the same relative buoyancy of the ship may be maintained.

30 Such fuel must have a relatively high B. t. u. value per cubic foot to warrant its use, and it is essential also that the fuel shall have a relatively low dew point or point of condensation, such as for example below  $-20^{\circ}$  F. As pointed out above, the density should be approximately equivalent to air.

40 In the preparation of a gaseous fuel in accordance with my invention, various mixtures may be employed. For example mixtures may be made up from individual gaseous hydrocarbons and hydrogen in the proportion to give the desired density equivalent to air, low dew point and high thermal value. Thus, for example, a mixture of 27.5% of hydrogen and 72.5% of propane will have a density about equal to air and will have a high fuel value of about 2,035 B. t. u. per cubic foot; also a mixture of 52.0% of hydrogen and 48.0% of butane gives a fuel equal to air in density and a high fuel value of about 1,845 B. t. u. per cubic foot.

55 However, since the individual hydrocarbons are not readily available in quantity it is quite desir-

able to use mixtures of hydrocarbons, such for example as those from natural gas or from gas derived from the cracking of hydrocarbon oils, and other similar sources. By selecting a fairly close out of the gaseous hydrocarbons, such as may be obtained by carefully controlled rectification under pressure, a mixture of hydrocarbons may be secured which when mixed with hydrogen in the proper proportions gives a fuel having the required fuel value, density and dew point to be acceptable for dirigible use.

60 It is highly desirable that the hydrocarbon fraction selected should be of fairly close boiling range and contain only limited amounts of hydrocarbons which are difficult to liquefy and which may therefore be shipped on a commercial scale in metal cylinders or pressure tank cars. I may, for example, take the residual gases derived from the rectification of raw natural gasoline. The composition of these gases will vary, depending upon the character of the natural gas from which the gasoline was derived and upon the character of rectification to which the raw gasoline was subjected. However, in a typical case, this residual gas consisted almost entirely of butane and propane with very small amounts of pentane, ethane and methane. In some instances it may only be necessary to compress and liquefy this residual gas to obtain as a condensate a suitable hydrocarbon mixture which may be shipped under compression in cylinders, to be mixed with hydrogen in the proper quantity at the point of use to obtain the proper gravity. If the residual gas contains substantial quantities of methane and ethane, it may be desirable to subject the condensate obtained on compression and cooling to a rectification under pressure to eliminate these difficultly liquefiable gases from the desired condensate. The practice is similar to that employed in the manufacture of natural gasoline from raw compression gasoline in which a portion of the butane and all of the lighter hydrocarbons are generally removed by rectification.

What I claim is:

A gaseous fuel for internal combustion engines of lighter-than-air craft consisting of about 52% hydrogen and about 48% butane.

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