

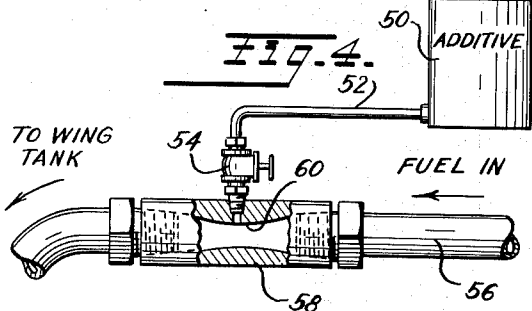
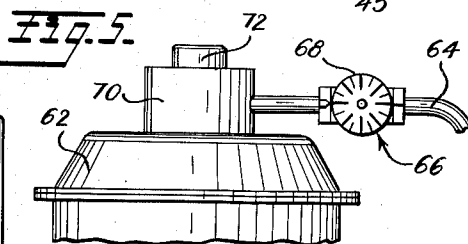
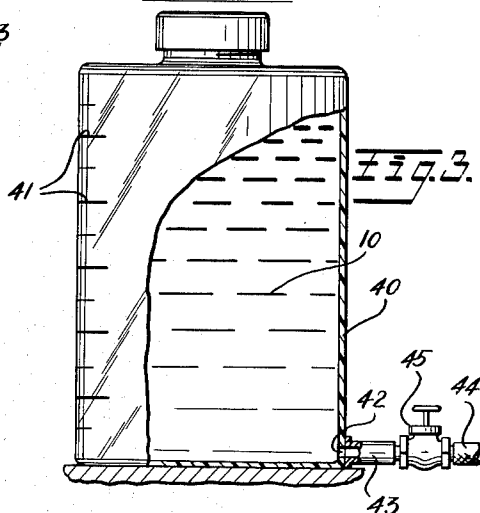
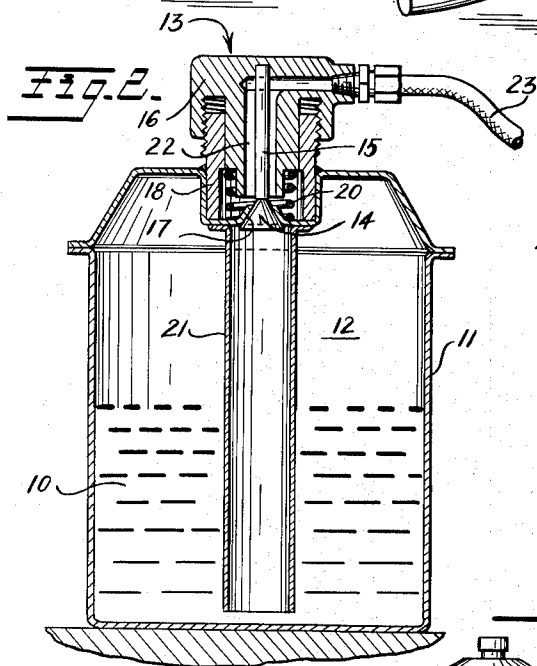
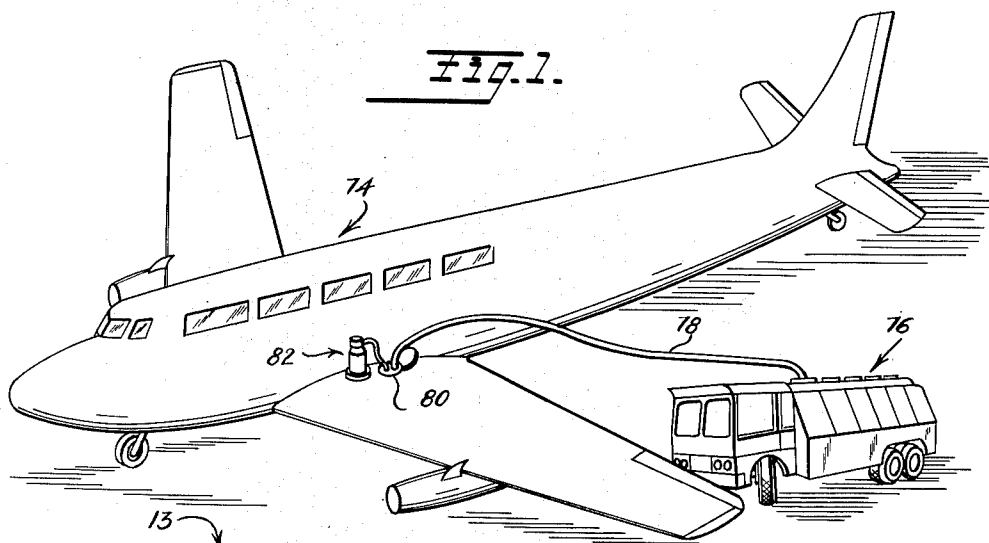
Jan. 4, 1966

J. C. MEEHAN

3,227,196

METHOD AND MEANS FOR BLENDING FUELS AND ADDITIVES

Filed April 8, 1964



INVENTOR

John C. Meehan

Bacon & Thomas

ATTORNEYS

1

3,227,196

METHOD AND MEANS FOR BLENDING FUELS AND ADDITIVES

John C. Meehan, La Grange Park, Ill., assignor to Hoffman-Taff, Inc., Springfield, Mo., a corporation of Missouri

Filed Apr. 8, 1964, Ser. No. 358,193

5 Claims. (Cl. 141-9)

The present invention relates to a method and means for introducing fuel additive to hydrocarbon fuel at the point of use.

As aircraft fly higher, for more prolonged periods, and under more diverse weather conditions, one of the principle problems of flight safety is the development of icing conditions in the fuel system. Hydrocarbon fuels and water are generally considered to be relatively immiscible fluids. However, hydrocarbon fuel specifications normally permit 70-120 parts of water per million parts of fuel. Such specifications recognize that small amounts of water are actually dissolved in the hydrocarbon fuel. The amount of dissolved water may actually go far higher than 120 parts per million which represents merely an amount permissible for aircraft.

In addition to the dissolved water in the hydrocarbon fuel, there is also present in varying quantities an amount of suspended water in fuel. The presence of the dissolved water and the suspended water is usually increased as the fuel is passed from container to container in its transit from the refinery to the point of use. Condensation and conditions of climate further affect the water content. When the temperature of water-saturated hydrocarbon fuel is lowered, the water tends to drop out of solution in small droplets, some of it actually finding its way to the bottom of a particular tank. When such fuel is subjected to extremely low temperatures, the water drops out as ice particles. These ice particles may cause trouble in the fuel system at any location from the fuel tank to the engine. For example, small valves may freeze, gas lines may be clogged, and the boost pump inlet screens or fuel strainers may be blocked. Oftentimes the icing occurs at some point in the fuel system causing a power malfunction or complete failure.

Two solutions to the icing problem have been attempted. The initial attempts, still being used today, provide for sources of heat at critical points in the fuel system to assure the dissolution of ice particles which might cause clogging of the fuel lines. This solution requires the bleeding off or drawing off of an amount of heat in some manner from the engine. Obviously, it provides relief only at the point where the heat is applied and points in the fuel line displaced from the heated portion are not affected. Furthermore, this approach is subject to the danger of mechanical failure.

The second approach is preventive in nature. It is concerned with the mixing of an additive to the hydrocarbon fuel, which additive is of such a nature as to prevent the ice from being formed. In other words, it prevents the dissolved and suspended water from becoming frozen at operating temperatures and pressures. Such an additive must not adversely affect the combustible properties of the fuel. It should have some degree of solubility with the hydrocarbon fuel. It should be readily soluble in water and should substantially lower the freezing point of the combined solution. Finally, the additive must have and reflect those properties which will make it compatible with the myriad of materials into which it may come in contact in the fuel systems of aircraft.

Such a fuel additive is shown and described in U.S. Patent No. 2,952,121 and U. S. Patent No. 3,032,971.

2

The present method, and the means for carrying out the method, is concerned with this second approach. The additive used is a development of Phillips Petroleum Company and is known in the trade as "PFA 55MB." This additive is the only one out of more than 200 tested that has received unqualified approval for all United States Air Force jet aircraft. It has now also been approved by the Federal Aviation Agency for all aircraft in this country. The rigid tests to which it was subjected took several years and resulted in unqualified success.

One of the problems with "PFA 55MB" additive is that it must be blended gradually into the hydrocarbon fuel so that the additive is substantially uniformly distributed throughout the entire contents of the particular storage tank or container. Heretofore this blending has been done at the refinery by utilizing expensive proportionating pumps which force a stream of the additive into a second stream of hydrocarbon fuel moving into a storage facility. In other words, the additive is accurately metered into a known rate of flow of the hydrocarbon fuel. This method is the most economical for hydrocarbon fuels for military and large commercial aircraft. However, refinery blending has its drawbacks because the water content of the fuel may change from the initial storage facility to subsequent storage facilities after which it is finally delivered to a particular air terminal or airport. Thus far, refinery blended hydrocarbon fuel has been limited to military usage where the fuel is used relatively quickly and in large quantities.

The best and most effective manner of utilizing the additive is to meter the additive into the hydrocarbon fuel at, or just before, the time the hydrocarbon fuel is to be used in the aircraft. The user will then be apprised with certainty that his fuel is provided with this protective additive. However, it was thought that this would require proportioning pumps at all terminals and airports which would necessitate expensive alterations in current equipment or the discarding of the current equipment altogether.

The present invention provides an effective method and means for introducing, continuously or intermittently, the fuel additive while utilizing current pumping equipment now in use at airports and air terminals.

The means for carrying out the method and process of the present invention is illustrated in the accompanying drawings, in which:

FIG. 1 is a perspective view illustrating the principles of the present invention; and

FIGS. 2, 3, 4 and 5, respectively, show example of types of portable equipment that may be used to practice the invention.

In the present invention, the additive or primary liquid 10 (FIG. 2) may be stored within a pressure-type portable container 11 which confines a pressure medium in its upper portion 12, the pressure medium being any one of the known types in common use in the aerosol industry today.

The container 11 is provided with a cap mechanism, generally designated 13, which includes a valve member 14 secured on a stem 15 which in turn is anchored in the upper adjustable cap portion 16. The valve member 14 is shaped to make sealing engagement in a conical seat 17 formed in the upper portion of the container 11.

Annular portion 18 of the cap member 13 cooperates with a part of the upper cap portion 16 to afford an annular chamber for confining a spring 20. The upper cap portion 16 is shown as threadably mounted on the annular portion 18.

A depending tube 21 extends downwardly from the upper portion of the container and terminates near the bottom thereof for the purpose of conducting the additive under pressure to a passageway 22 which is normally held

3

closed by the valve 14, and which leads to an external flexible discharge tube 23.

The upper cap portion may be threadably advanced or retracted upon the annular portion 18 so as to regulate the amount of separation between the valve member 14 and its seat 17 when the valve member is depressed against the action of the spring 20. The degree of depression of the valve member 14 regulates the size of the opening through which the additive may pass and thus the rate of flow of the additive out of the container 11. The top of the cap is preferably properly indexed to indicate the rate of flow of additive necessary for the particular rate of flow of fuel pump with which the container is to be used.

The illustration in FIG. 3 shows a portable container 40 which is preferably of transparent or translucent material so as to see the level of the additive 10 stored therein. Index marks 41 are provided on the container so that a user can visually see the amount of additive which has flowed out of the container. Passageway 42 leads out of the bottom portion of the container through a tube 43 and makes a secure connection with a flexible outlet tube 44. The tube 43 is provided with an adjustable valve 45 so that the rate of gravity flow through the flexible tube 44 may again be properly regulated in relation to the rate of flow of the fuel pump being used.

FIG. 4 shows a portable container 50 having a delivery tube 52 extending from the bottom portion thereof so that additive may flow from container 50 by gravity. The rate of flow through tube 50 is controlled and regulated by valve 54 which will be provided with suitable indicating means (not shown) so that a known valve opening can be preset. A fuel feed conduit 56 is provided with a fitting 58 defining a venturi throat 60 and the outlet port of valve 54 communicates with that throat, as shown. Thus the rate of flow of additive from container 50 into the fuel stream is not only dependent upon the setting of the valve 54, which determines the proportion, but also upon the rate of flow of fuel through conduit 56.

FIG. 5 shows a portable container 62 for additive and from which the additive is forced, by internal pressure, through discharge tube 64. Tube 64 is provided with a control valve 66 having calibrated dial means 68 by which the valve may be preset to a predetermined desired degree of opening. A second valve (not shown) in cap portion 70 is opened by a spring pressed push button 72 to permit free flow from the container 62 to valve 66 whenever desired.

While only four specific embodiments have been described it will be obvious that other structural forms may be employed. For example, the internal pressure for the forms of FIGS. 2 and 5 may be supplied from an external source such as a second pressurized container or a pump, if desired. Likewise, any other suitable form of metering valve may be used with any embodiment shown and other forms of aspirating means may be used in place of the specific venturi shown in FIG. 4. The primary requirement of each embodiment is that it comprise a portable supply of the additive and have means whereby the rate of flow of additive from the container into the fuel stream can be controlled and regulated within reasonably close limits.

FIG. 1 shows the manner of practicing the invention. The aircraft is designated 74 and a fuel truck 76 is shown delivering fuel, through hose 78, to an opening 80 leading to the aircraft's fuel tanks. A portable additive supply is shown generically at 82 and may be any one of the forms described or the other forms referred to. It will be obvious that the additive can be delivered to the fuel stream any time the plane is being refueled and without making any material modifications of the ordinary refueling equipment.

While the additive "PFA 55MB" has been available for a number of years, practically no personal aircraft, utility aircraft, executive aircraft, or commercial aircraft have been able to make use of its remarkable properties. The

4

heart of the present contribution is thus the recognition of a method and means by which the ordinary hydrocarbon fuels can be properly inoculated with this amazing additive precisely at the point of use; and furthermore, the recognition of a means by which this additive can be carried with the aircraft so that, at remote points of fueling, the safety features provided by this additive can still be utilized. The method also provides an inexpensive manner of injecting the additive into the fuel so that it can be used at any airport or terminal no matter how small.

One might initially inquire as to the reason for the discussion on precise metering of the additive. The chemical and physical characteristics of the additive prevent its proper utilization by simply being dumped into a fuel tank. However, the tolerances under which the additive may be blended into hydrocarbon fuel are such that the relatively simple and available devices set out and described in the drawings may be effectively utilized to intermix the additive with the fuel.

The "PFA 55MB" additive itself is a two component blend made up of a major component of ethylene glycol monomethyl ether and a minor component of glycerol. It has been shown under test to be completely compatible with the literally hundreds of materials with which it may come in contact in aircraft, fuel systems and ground equipment under varying extremes of operating conditions. The additive is completely soluble in water, and has a limited solubility in hydrocarbon fuels. Its solubility in hydrocarbons is much greater than the suggested concentrations for usage so that it does not drift out of solution even when excesses of the additive are added to hydrocarbon fuels. It does not have too great an affinity either for water or for hydrocarbons, so that the ratio of distribution of the additive when blended into solution is effective to reduce the freezing temperatures of the free water suspended in hydrocarbons fuel and also acts advantageously to lower the freezing point of the water which drops out of solution as the temperature of hydrocarbon fuels are lowered.

The recognition of the solubility properties of the additive led to the concept of the present method in which the incremental metering is approximate but is controlled within the limit of solubility of the additive or primary fluid in the hydrocarbon fuel or secondary fluid. The metering is precalculated to provide substantial maintenance of a predetermined ratio of additive and hydrocarbon fuel in a continuous manner so that the additive is substantially uniformly and proportionately distributed throughout the hydrocarbon fuel in the fuel tank.

In using the method of the present invention, the initial step is to ascertain the capacity of the fuel tank to be filled. Next, a container is selected having sufficient additive to accommodate the particular size of fuel tank. Then the rate of flow of the fuel pump to be used is ascertained. And finally, the control means associated with the container is regulated to provide a rate of flow of additive into a stream of fuel from the fuel pump in a predetermined ratio, subsequently to be explained, which ratio is within the limit of solubility of the fuel additive in the hydrocarbon fuel.

The additive material has certain properties which give it beneficial biocidal effects as well as anti-icing effects. Biocidal growths in the moisture content at the bottom of aircraft tanks deleteriously affect the lining of the tanks and have been a serious problem.

It has been found that the blending of hydrocarbon fuels with the additive at a rate of .02% additive to 99.98% hydrocarbon fuel is a desired blend to effect the desired anti-icing qualities of the fuel. It has also been found that a .05% blend of the additive with 99.95% fuel is a desirable mixture to impart the anti-icing qualities and the biocidal qualities to the fuel. Both of these ratios are well within the solubility limits of the additive in the hydrocarbon fuel so that there is no danger of a large excess of the additive being introduced into the

fuel mixture which can cause undesirable problems with the fuel mixture, which problems need not be discussed here.

Stating the desired ratio of blending in another way, to impart de-icing properties to the fuel, one part additive to 5000 parts hydrocarbon fuel is sufficient. To impart de-icing and biocidal properties to the hydrocarbon fuel, one part additive to 2000 parts hydrocarbon fuel is sufficient.

Thus it will be seen that the method of this invention is extremely useful in that it will enable the blending of this important additive to fuels for aircraft where such additive would otherwise not be available. The method can be carried out in a simple, effective and inexpensive manner. It will enable the additive to be properly and effectively used by all types of aircraft now in use no matter how far removed from the refinery or from large air terminals.

The method has recognized a convenient means for storing, for transporting and for using the additive. The containers are self-contained and may be thrown away after use. The containers and the means for dispensing the additive therein are so arranged by size and by rate of flow so that particular packages of the additive may be prepared for the fuel tanks of aircraft no matter how large or small. The container means also permits the additive to be carried in flight for use at any time so that the operator of the aircraft will always know that his fuel has been provided with this increased safety factor.

While this disclosure has been directed primarily to aircraft, it is also recognized that the method and the means for dispensing the additive has great potential use in cold climates with vehicles and with hydrocarbon fuels used for heating enclosures whether habitable or otherwise.

The foregoing detailed description is given for clearness of understanding only, and no unnecessary limitations should be understood therefrom since other modifications will be obvious to those skilled in the art.

I claim:

1. A method for alleviating fuel icing problems of aircraft using liquid hydrocarbon fuel, comprising feeding a stream of hydrocarbon fuel from a fueling source into an aircraft fuel tank without modification of the ordinary fueling equipment to introduce a predetermined volume of fuel into said tank, feeding a separate stream of liquid anti-icing additive of limited hydrocarbon solubility into said fuel tank from a body of said additive of predeter-

mined volume simultaneously with the feeding of said fuel stream, comingling said separate stream of additive with said stream of fuel within the fuel tank, the predetermined volume of additive being within the solubility limit of the additive in the predetermined volume of fuel, and the rate of addition of additive through said separate stream to the fuel stream being controlled so that the additive is incrementally distributed throughout said predetermined volume of fuel within the tank.

2. The method of claim 1 comprising the step of initially confining the body of additive under gas pressure capable of exerting sufficient pressure to exhaust the body of additive through said separate stream into the tank.

3. The method of claim 1 comprising incrementally introducing about 1 part by volume of additive into the tank for each 2000 to 5000 parts by volume of fuel introduced into the tank.

4. Apparatus for alleviating fuel icing problems of aircraft using liquid hydrocarbon fuel comprising, in combination, means for feeding a stream of hydrocarbon fuel from a fueling source into an aircraft tank, and means containing a predetermined quantity of anti-icing additive for hydrocarbon aircraft fuel and a body of pressurized gas, conduit means in communication with said quantity of additive and extending into said fuel tank for dispensing a separate stream of said additive into said tank for comingling with said stream of hydrocarbon fuel in the tank without modification of the ordinary fueling equipment, said body of pressurized gas being capable of exerting sufficient pressure upon said additive to exhaust same through said conduit, and said conduit means including means to control the rate of flow of said additive.

5. The apparatus of claim 4 wherein the means containing a predetermined quantity of anti-icing additive and a body of pressurized gas is a portable pressurized container.

References Cited by the Examiner

UNITED STATES PATENTS

2,057,226	10/1936	Bleecker	222—1
3,055,554	9/1962	Wight	222—145 X

LOUIS J. DEMBO, *Primary Examiner*.

ROBERT B. REEVES, *Examiner*.