Review of Aircraft Fuel System

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Abstract

This paper contain the content of basic review of an aircraft fuel system .This paper cover the various fuel system and fuel subsystem used in aircraft .Purpose of an aircraft fuel Sub system to monitors the fuel supply, its control, storage, drainage and also maintain stability of aircraft.. Basically the purpose of fuel system is to supply the fuel in all phase of including landing ,takeoff, Banking and sharp maneuvering fuel system should also supply the sufficient amount of neat and clean fuel at required pressure. Types of fuel system may vary in aircraft but all the aircraft keeps their own fuel system. The fuel system must be used keeping the centre of gravity to be stable in mind.

Keyword :- *aircraft fuelling system, stability margin, aerial refueling*

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1. Introduction

The fuel system is one of the most important systems in an aircraft and its purpose to stores, manages and supplies the fuel to the aircraft engine. The aircraft fuel system supplies a proper amount of clean fuel at all operating conditions to the engine.

Fuel system must be so designed such that it supplies a proper amount of fuel to the engine at various phases of flight such as changes in altitude, rapid maneuvering, sudden acceleration or deceleration.

The fuel system means a complete package of equipments which help from storage of fuel up to the delivery to the tank in a proper way i.e. fuel tanks, fuel pipe lines, valves, fuel indicators, fuel pressure pumps, warning signals etc. A fuel system should always be free from the tendency of vapor lock.

From the birth of the aircraft systems till now, there is much advancement made in the fuel systems. The fuel system design, construction and components selection vary from aircraft to aircraft and also depend on the number of engines employed. A light weight single engine aircraft will have simple or box type fuel system whereas a heavy aircraft with twin engine will have a complex fuel system such as integral type of fuel tanks.

2. Types of Fuel System

Generally, the fuel systems are classified into two broad categories on the basis of method to supply the fuel to engine . In small and light aircraft generally gravity feed fuel system is used while in large turbine engine aircraft pressure feed fuel system is used

2.1 Gravity feed system

This system makes use of the force of gravity to deliver the fuel in the power plants from storage tanks. It is most commonly used in high wing light aircrafts in which the engine is located below the main wing as a result below the fuel tank (as the fuel tanks are generally located on main wings). This is the simplest and cheapest mode of fuel feed system as no additional complex components are used and uses only the gravity force. The main disadvantage of this system is it is affected by vapor lock which stops the fuel to flow through the pipelines.

Vapor lock is caused by high altitude and high temperature operations; the solution to vaporization is to provide a positive pressure with the help of fuel pump. [1]

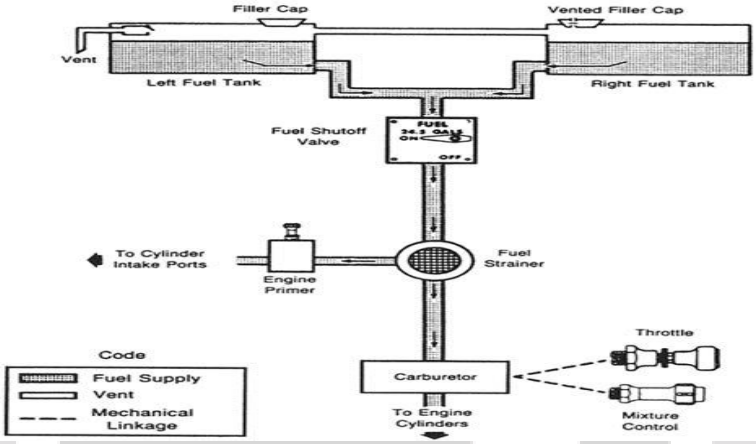

Fig 1: - Cessna 152 gravity fuel system

2.2 Pressure Feed System:

Most of the aircrafts are designed such that engine is mounting above the fuel tank for e.g. mid wing or low wing configured aircraft, or the engine is far away from the fuel tank, in this case the gravity fuel feed system cannot be used and therefore a need of positive pressure is developed to supply the fuel in adequate amount to the engines. It generally makes use of two electric pumps for the feeding of fuel into the engines. As stated above, the fuel system and its components vary from aircraft to aircraft the use of two electric pumps is the most basic method used. The complexity of fuel system increases with increase in aircraft size; a large transport aircraft or a maneuverable combat aircraft.

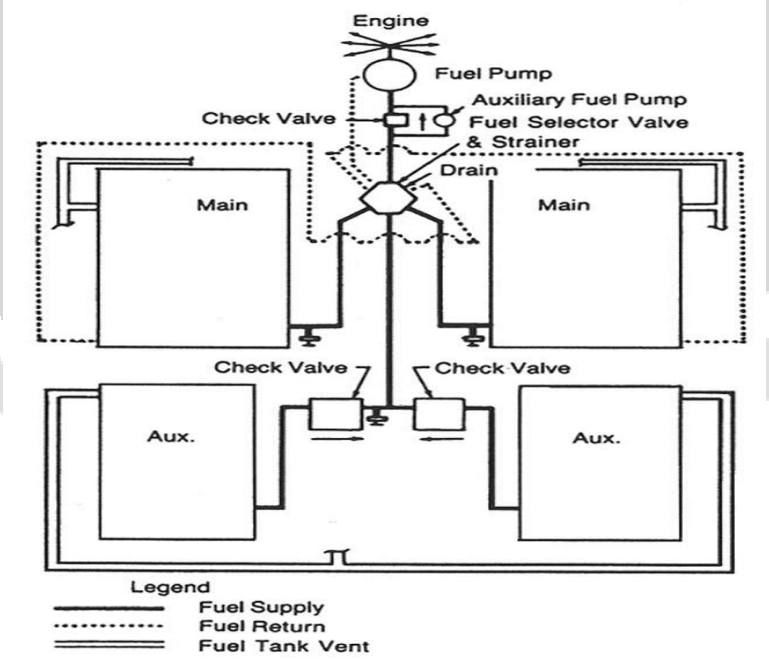

Fig 2:-Beech Bonanza K35 fuel system

3. Fuel System Components:-

The fuel system of an aircraft mainly consist of fuel tanks, fuel pumps, valves, filters and strainers, warning components, quantity indicators, heaters etc.

3.1 Fuel pump:-

Fuel pumps are used to supply fuel through the system. Their main another or from engine back to tanks. Basically 3 types of fuel pumps are used:

3.1.1 Vane type pump:-

It is a constant displacement type pump. Uses a rotor which turns the vanes in the cylinder and these vanes act to push fuel through the system.

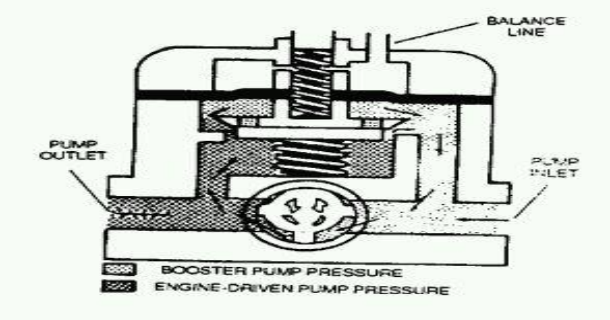

Fig 3:-Booster pump

3.1.2 Centrifugal boost pump

They are used to supply fuel from one tank to other or from tank to engine. Centrifugal pumps are electrically driven and can operate at different speeds as per requirement. Low speed is used to supply fuel while starting and high speeds are used to supply fuel from one tank to another.

3.1.3 Ejector pump

Ejector pumps are normally used to scavenge (eliminate) fuel from remote areas. It works on the venturi principle

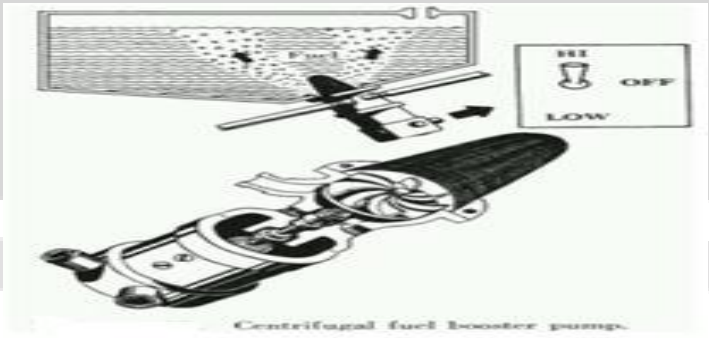

Fig 4:-Centrifugal Fuel Booster Pump

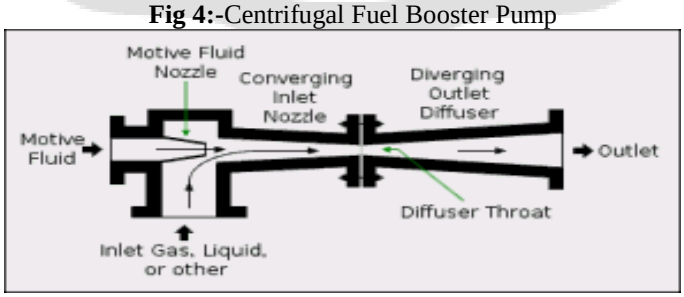

Fig 5:-Venturi Type Fuel Pump

3.2 Fuel Tanks-

Fuel tanks are used to store the fuel, they are made of such materials that it does not react with fuels. Different types of aircraft use various fuel tanks and depend on the location of tank and size of aircraft. The three basic types of fuel tanks in use are-Rigid Removable, Integral & Bladder Type.

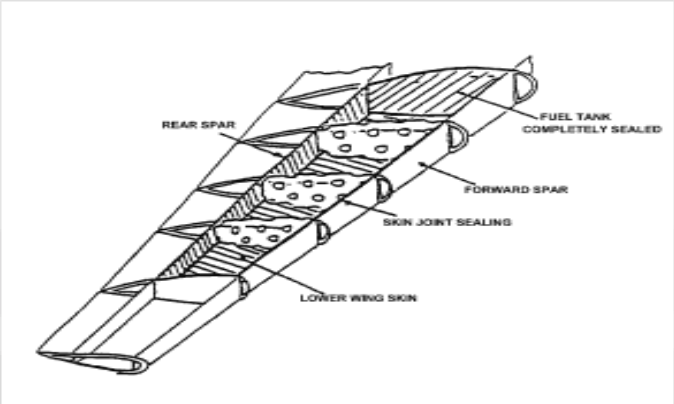

Fig 6:- Integral Type Fuel Tank

Figure shows an integral type fuel tank, these are inbuilt or integrally built into the structure of the aircraft either wing or fuselage. With the help of synthetic rubber and seams are sealed so as to produce an area to store the fuel inside the aircraft structure.Bladder type fuel tanks are generally made from neoprene or a similar material which is resistant to fuel. [3] It is simply a reinforced rubberized bag.Rigid removable fuel tanks are the oldest type of fuel tanks used and are now replaced by integral type and bladder type due to limitation of space and weight. [3]

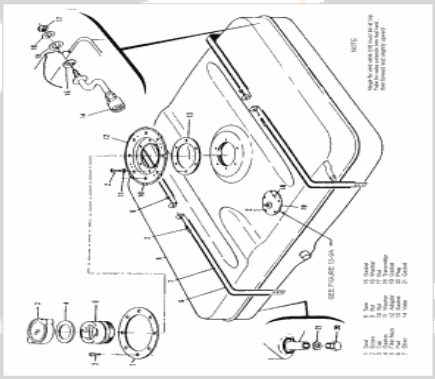

Fig 7:-Box Type Fuel Tank

3.3 Fuel Valves-

Selector valves are used in aircraft fuel system to shut-off fuel supply, cross feed and transfer fuel. They can be operated manually or electrically driven.

3.3.1 Hand operated valves:-

Hand operated valves are used on small aircraft and are either cone type or puppet type.

3.3.2 Motor operated valves:-

Motor operated valves are used in the fuel system of large aircraft. They are either electrically motor driven or solenoid driven.

Motor operated valve uses a motor driven sliding gate, when the gate is in open position the fuel is drawn in and vice versa. [3]

3.4 Filters and Strainers-

It is necessary that the fuel supplied to the engines must be clean i.e. free of contamination and due to this requirement; the aircraft fuel system is equipped with strainers and filters.

Generally, a micro filter is used made up of replaceable cellulose filter element. It is capable of removing foreign particles of size varying from 10-25 microns.

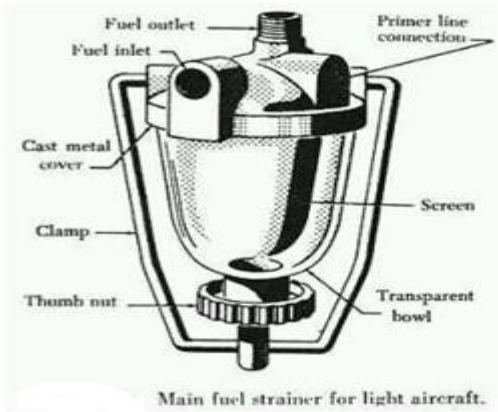

Fig 8:-Main Fuel Strainer

The strainer's function is to prevent foreign particles from entering the engine and also traps water (if present in the fuel or system).

Fig 9:-Fuel Strainer

3.5 Fuel Quantity Indicators-

It is necessary for every aircraft's fuel system to have fuel quantity indicators equipped in it, so that the amount of fuel present in the fuel tanks can be known for the purpose of safe flight. Some basic types of fuel indicators used are as follows:

3.5.1 Sight glass gauge-

It is the simplest type of fuel quantity indicator. It is generally a glass tube placed on same level as the fuel tank. It works on the principle that a liquid seeks its own level.

3.5.2 Mechanical type Indicator-

It is also known as direct reading gauge and is usually located on the fuel tank. It consists of a float attached to the indicator via. Mechanical means, as the level of fuel in tank changes it directly points it in the dial gauge.

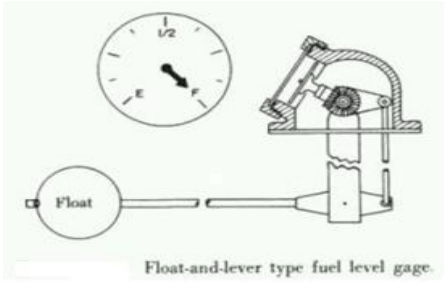

Fig 10:-Float and Lever Type Fuel Gauge

3.5.3 Electrical type Indicator-

This type of fuel indicator consists of a float type transmitter in the fuel tank and an indicator in the cockpit. The transmitter consists of a variable resistor at the outside of fuel tank, as the fuel level changes the transmitter sends a signal, which shows a changing level of fuel in the tank.

4. Electronic type Indicator-

Capacitance type electronic fuel does not have any moving parts in it; rather it uses only the dielectric value of air and fuel to show the quantity of fuel remaining in the tank.

Fuel Sub-Systems:-

Aircraft fuel sub-systems like: fuel jettison, fuel heating cross feeding are also required.

4.1 Fuel jettison System-

This system is generally used in large aircrafts to jettison (eject) or dump the fuel to lower the gross weight so that the aircraft attains minimum possible landing weight which enables the aircraft for safe landing. This system comprises a combination of pumps, valves and fuel lines to eject fuel on board during an in-flight emergency.
This enormously reduces the weight of the aircraft, so that it is of allowable landing weight. A jettison system dumps enough fuel in 10 minutes for general aviation aircraft and 15 minutes for a transport type aircraft. [3]The dump valves provided in the fuel tank allows the fuel to flow through the jettison valves in each wing tip.

Fig 11:-Fuel Jettison System

4.2 Fuel Heating-

As a large turbine engine aircraft operates at higher altitudes, and there is very low temperature due to which ice formation takes place. The same thing also happens in cold areas in normal altitude also and hence it is necessary to melt the ice particles for proper combustion and utilization of fuel. The ice particles otherwise will clog the filters.

The fuel is then passed through a heat exchanger which uses engine oil or compressor bleed air to bring the fuel to an acceptable temperature. [3]

4.3 Cross Feeding-

Cross feed mechanism system allows the fuel to be used from other tank. Cross feed mechanism is used on large aircraft. It is used because of the following reasons:

- Failure of engine;
- Problem with the fuel tank(s);
  (one or more)
- Redistribute fuel for weight and balance purpose (for stability margin).

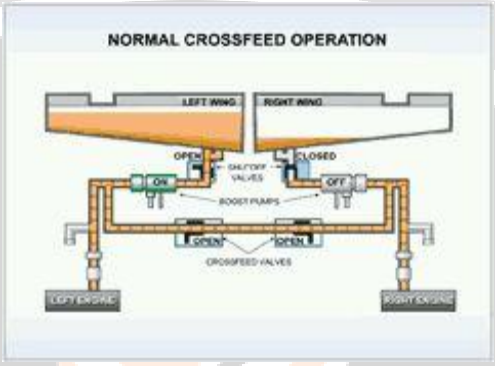

Fig 12:-cross feed mechanism

5. Conclusions

This paper concludes the discussion of aircraft fuel system used in modern aircraft with brief review of their component and sub system. Various type of fuel sub system used in aircraft such as cross feed mechanism, fuel jettison system .These system is very useful in aircraft.In emergency circumstances is helps to works in normal condition.

6. References

[1]. Sharma O.P.: "Aircraft Systems", Volume-IV

[2]. Mishap R., Kayla A.: "Study of Aircraft Fuelling System And Refueling Operation", Advances In Aerospace Science And Applications. ISSN 2277-3223 Volume 3, Number 3 (2013), Pp. 161-166

[3]. Goral Z., Zakrzewski P., "Aircraft Fuel Systems and Their Influence on Stability Margin", Transactions of the Institute of Aviation No. 183

[4]. Langton R., Clark C: "Aircraft Fuel Systems", Wiley Publications, ISBN 978-0-470-05708-7