

Importance of Auxiliary Power Unit in aircraft system.

¹Dr. Ritendra Rathore, ²Karthik Y B

¹Researcher, ²Student

National Forensic Science University Gandhinagar Gujarat India.

Abstract- Auxiliary Power Units (APU's) are the electrical power and heat source for mobile systems operating independently from the main engine responsible for propulsion. We are going to study the types of auxiliary power unit systems and its importance in the aircraft functioning system, we are also going to discuss how the auxiliary power unit supports the aircraft in emergency system and failure of the aircraft system, the role of APUs in hydraulic system, drag control, prevention of surge and stall of compressor, engine start up whether wet or dry engine start up.

We are going to study the evolution of auxiliary power units, various techniques and technologies used to subsided the auxiliary power units. The APUs also play a vital role in supplying of life support oxygen system in emergency situations.

INTRODUCTION

Various techniques are involved in the system of auxiliary power units (APUs). The primary use of APUs is on an aircraft. The aircraft is not dependent on Ground Support Equipment at an airfield. It can provide the necessary power for operation of the aircraft's electrical, hydraulic and pneumatic systems. The power unit selected to do this task is a GAS TURBINE ENGINE. The exact location of the APU is the tail end. The APU can use the same fuel system as the main engine so Reducing the need for additional systems. The type of engine layout normally used is that of the free turbine, turboshaft engine. The free turbine is usually designed to run at constant speed, which ensures that a generator run by the APU maintains a constant frequency without the need for an additional constant speed drive unit.

The independent APU from main engine which opens the potential separately the function of traction or propulsion and the supply of electricity which promises higher economy at reduced fuel consumption of the system at less noise and exhaust impacting the environment.

To maintain the mobility of fuel economy, development activities and substantial progress has been achieved and still an intensive activity is under the improved mobile system through less consumption of the fuel which is more environmentally friendly. The successful development of that APU is of higher importance for lot of applications and its influence considerably the architecture of system in the relevant industry.

The auxiliary power units is seen in the U.S as the most interesting products for the entrance market fuel cells and the most challenging project is the development of an aircraft APU with the higher requirements regarding the weight, volume and reliability.

Historical Perspective.

APUs were used in many ways especially in the transport aircraft whether the arms or weapons and soldiers from one place to another. When we take a look into the historical development of the APUs system we come to know that from ramayana and Mahabharata the APUs were used as applications.

Ramayana.

Pushpaka Vimana Of Ravana.

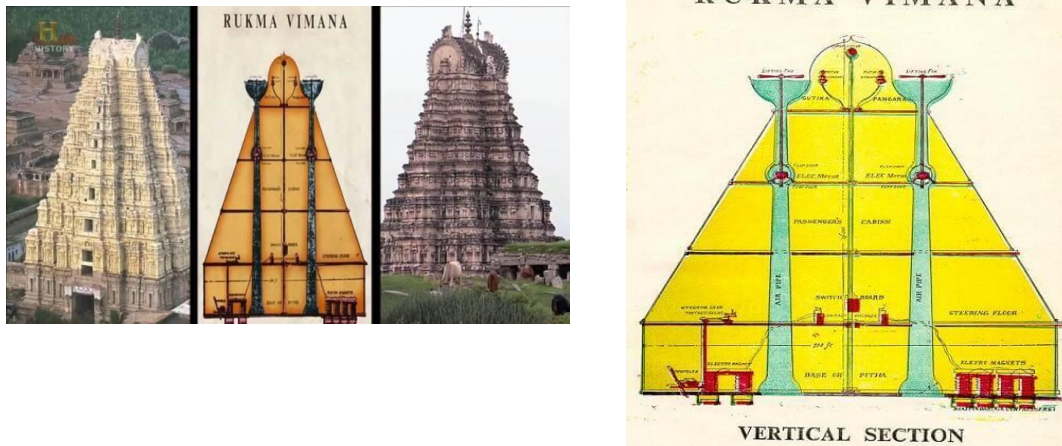
When we talk about epic Ramayana and Mahabharata, how can we forget to mention about pushpaka Vimana which was with Lankapati Ravana. That pushpaka Vimana was used by Ravana to kidnap Mata Sita from the forest. As per the epic story of ramayana , Ravana was using solar energy to fly pushpaka Vimana. When the pusphaka vimana was landed on the land, the functions of pushpaka Vimana continued, the source of the energy was solar energy and entire vimana was based on solar energy.

Mahabharata.

The vimana parva of Mahabharata was mentioned about that flying to the vimana and flying at the high altitude by locating from one place to another one.

There are various vimanas are being used during the Mahabharata and ancient India. These are as below.

- A) Rukma Vimana
- B) Shakuna Vimana
- C) Sundara Vimana
- D) Tripura Vimana.



Mahabharata epic story mentioned about Genius Yavanas as creator (Chief Designer) of a finite dimensioned Vimana with four solid wheels owned by Asura Maya.

Vimana parva, when the war of kurukshetra had ended along with the killing of duryodhana. But as per vimana purva, duryodhana approached the kingdoms which had vimana in the battle of Mahabharata

Epics of Indian history of vimana.

India is known to have given to the world most major concepts of mathematics set back as 1200 BC. Aryabhatta, Brahmagupta and Bhaskara were famous mathematicians in between 400 to 1200 AD.

THE CONCEPT OF ZERO DECIMAL SYSTEM, NEGATIVE NUMBERS, ARITHMETIC AND ALGEBRA WERE INDIAN CONTRIBUTION.

TRIGONOMETRY FUNCTIONS SINE AND COSINE ADDED BY ANCIENT INDIANS.

Shakuna Vimana was described in the ancient scriptures as the cross breed between a modern plant and rocket.

Sanskrit word vimana which means part that has been measured and set aside was first appeared in Vedas with the several meanings ranging from temple or palace to mythological flying machine. Flying machine were common in ancient Indian text, even describing their use in warfare and being able to fly within the atmosphere.

The demigods like sun and indra and several other vedic deities were transported by flying wheeled chariots pulled by animals, usually horses. Agnihotra Vimana with a two engine and the gaja vimana (elephant powered) were also familiar at that time.

Later history around 500 BC the self moving aerial care without animals.

As per Ramayana pusphaka (the flowery chariot) was originally created by vishwakarna for Brahma the Hindu god of creation. Brahma gifted to kubera (God of wealth), later it was stolen by Ravana. There were also mentioned that it was used by Lord Rama under the command of Raghira (Captain), chariot rose up into the higher atmosphere.

Jain Tirthankaras.

Various Tirthankaras flying different types of flying machines, 4th Tirthankaras travelling in Jayanta Vimana, to the very famous 24th Tirthankaras Mahavira emerging out of a great Vimana Pushpa Uttara.

Episodes Of Lord Krishna.

Lord Krishna and Rukamani as Groom and Bride in a celestial chariot driven by lord Ganesha.

When lord Krishna's another wife Satyabhama, on the day of Diwali, lord Krishna killed narakasura on chariot which was flown in sky at certain altitude. Entire vimana was flying on the basis of solar energy and also the internal potency of lord Krishna. The internal potency of lord Krishna would be considered as the Auxiliary Power Units which provide the start up and standing energy during that night when the sun light is not available.

Lord Vishnu's Vahana Garuda (Flying Bird) which lord Vishnu used it for transportation. Garuda was blessed by internal potency of lord Shree Hari regarding to potencies Garuda to fly here and there.

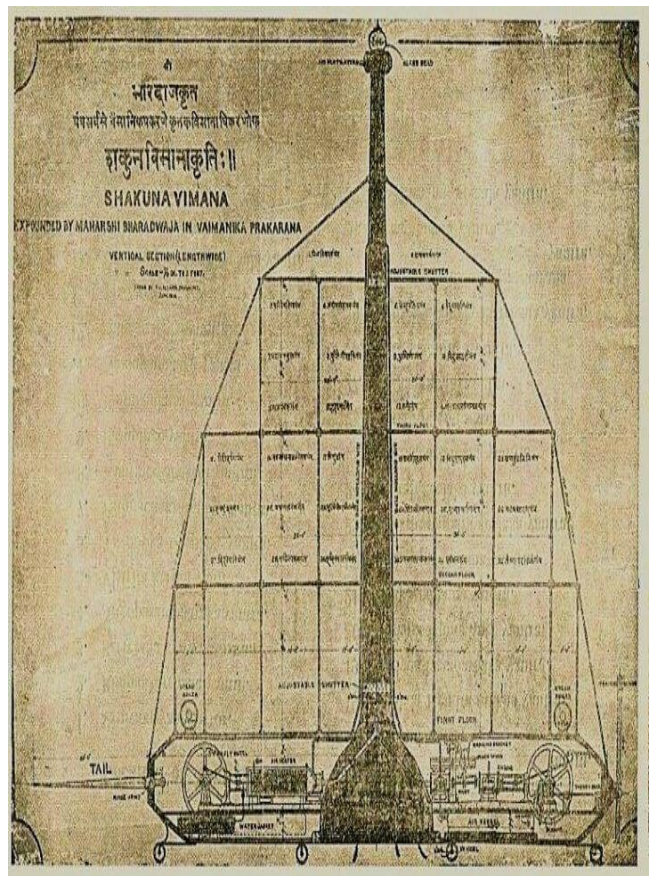
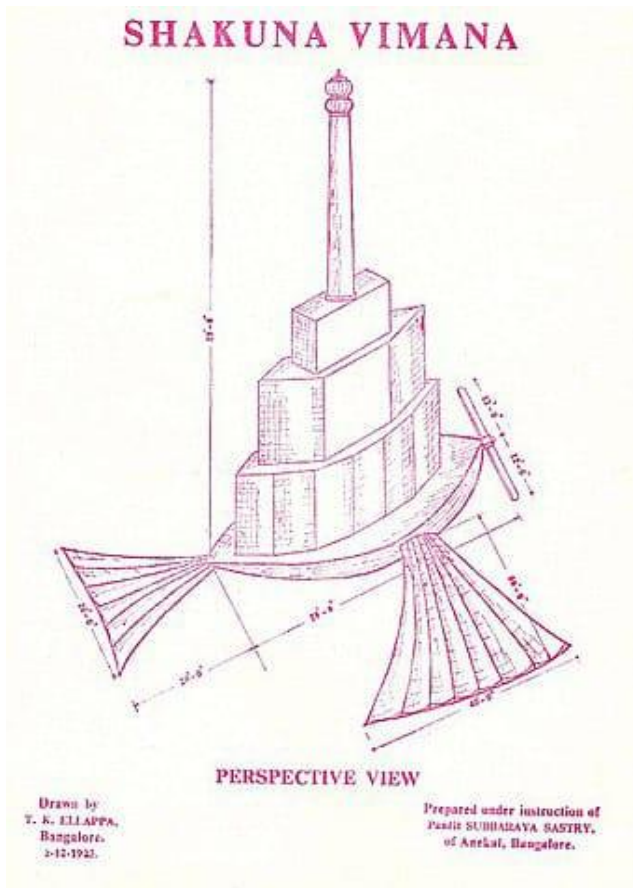


Recent Studies

The academy Sanskrit Research in Mysore, claimed that the academy had collected the manuscript which is compiled by ancient Rishi munis before 1000 years.

One of the manuscripts dealt with aeronautics, construction of the various kinds of aircraft for civil aviation and warfare. Following aircraft are mentioned in shastras.

- 1) Rukma Vimana. Dome shape version , having ng a landing gear for safe land. Something like temple design.
- 2) Shakuna Vimana:- trigonal shape , having a tower , which have a power supply units , having a flying wings etc.
- 3) Sundara Vimana :- Vertical Section , something like vertical building
- 4) Tripura Vimana:- 2 floors vertical shape design , having a tooth shaped wheels , folding link which connected second floor and first floor.



When we talked about ancient Vimanas and its power units then it would be powered by engine, vimanika shastra shown refers to the metals used in these crafts. There is mention of electricity and power sources, of pilots and their flying clothing about the food they eat.

Ramayana, does have a highly detailed story of a trip to the moon in a vimana, including details of a battle on the moon with an 'Asvin' (Atlantean Airship).

Why we should we need to study the evolution of vimanas or aircraft? When we study the vimana and architecture of the vimanas or aircraft we come to know about the exact power supply units which is directly related with the Auxiliary Power Units (APUs).

The Evolution Of The Auxiliary Power Units.

Several Fuel Types and fuel aspects.

- A) Polymer Electrolyte Fuel Cell (PEFC).
- B) Solid Oxide Fuel Cells

APUs application fields and relevant requirements.

- 1) APU for passenger cars
- 2) APUs for trucks and heavy mobile.
- 3) APUs for marine application
- 4) APUs for trains.
- 5) APUs for aircraft.
- 6) APUs for military application

APUs for aircraft.

APUs for gas turbine engine, APUs operate at 15% load cycle efficiency, contribute up to 20% of the aircraft ground-based emission and APUs / secondary account for 50% of the maintenance delays which presents 12% of the maintenance cost.

The main requirements to be fulfilled by such a fuel cell system are as follows...

- 1) High Reliability and safety
- 2) Long life time – greater than 20,000 operating hours
- 3) Light weight , high power density , low volume.
- 4) Suitable for kerosene or kerosene reformat
- 5) High tolerance against the fuel impurities
- 6) Relatively high power requirements.

APU could be operate in the air and providing the back up source of power to the systems in the event of an engine failure.

Design of the APU should be kept simple , rugged and reliable , able to start in flight at high altitudes and continue to operate under load et even higher altitudes.

APUs Control and operation.

Little way of indication does the pilot has when starting and running the APUs compared to the aircraft's main engine. The indications of the turbine temperature, compressor speed and system fault indicating lights which might be displayed. The extensive use is made of automatic sensors which will shut the APU down in the event of the APU fire , system malfunction or operating limits being exceed.

In terms of pilot flight deck controls for the APU.....

- a) A power on start switch (PWR ON).
- b) A Normal stop sswitch
- c) A manual emergency shut down and fire suppression control
- d) External APU control panel to facilitate the shutting down of the APU
- e) APUs turboshaft engine can easily be started by an electric starter motor powered from aircraft battery.
- f) APU is not able to power all the aircraft system but provide sufficient services that the aircraft can be operated safely

Ram Air Turbines.

APUs in some aircraft are fitted with a Ram Air Turbine (RAT) to provide power to aircraft system in emergency situations.

RAT consist of a turbine wheel which is driven by airflow due to Aircraft's forward speed (RAM AIR).

TURBINE is internally mounted in the aircraft and Ram air directed onto it via a control valve.

If the power lost in aircraft, then RAT will start to run automatically. The turbine which are driven by gearbox and fitted with a generator or a hydraulic pump.

Starter Motor.

The most common method of rotating the HP compressor on modern civil Aircraft are....

- A) The Air Starter Motor
- B) The Electric Starter Motor.

Any starter has a duty cycle the time limit that the starter is allowed to be energised and may have to be followed by a cooling down period before re-energizing.

The Air Starter Motor.

Most popular starting system presently in use which is light , simple to use and very economical utilising low pressure air. The Air Starter motor fastened to the accessory gearbox of the engine.

The sources of the air available for engine start , they are....

- A) The aircraft APU
- B) The Ground Power Unjt.

The wet start.

The failure to start , more commonly known as the wet start which is indicated that the EGT is not rising , this long period if the engine which fuel is being pumped means that the engine is becoming saturated with it that confirmed by the fuel flow meter indication , a very large jet of flame to issue from the exhaust system that is known as “ TORCHING”. In order to prevent this phenomena attempting a second attempt start , the motoring over or blown out” cycle must be carried out.

The Hot Start.

A Hot Start is happening by comparing it's indications to those of a normal start. Only chance of stopping the temperature limit being exceeded lies in having the ability to switch off that engine's fuel and ignition switch as quickly as possible. The reason behind the hot start lie almost entirely in having too much fuel and not enough air to cool the gases through the turbine.

The Role Of APUs When the compressor SURGE & STALL.

When the compressor surged which mentioned the violent air flow oscillating in the axial direction of a compressor. When the compressor got surged it's APU would supply the auxiliary power unit when when engine got choked so there is an important role of APUs in the compressor surge and stall condition which prevent the aircraft from the engine failure system.

Angle of attack and drag Vs APUs.

When the aircraft got dragged due to angle of attack and turbulence and failure of aircraft ssystem , it APUs which work like life supporting system to prevent the compressor from stall and surge.

Reverse thrust and APUs.

When the aircraft is landed on the ground , and in order to slow down the speed of aircraft the reversal of the thrust is required for safe landing. APUs is playing a vital role for the opening the wings shutter in order to generate the reversal of thrust for safe landing.

Author Review.

The APUs which is actually external power unit , which generate the power when the aircraft is on the ground and supply the power to all the system of the aircraft before start the engine and when the engine is unable to start in first attempt due to wet or hot them APU is playing vital role to start the engine in the second attempt.

When the aircraft is the emergency situation then the APU is playing a crucial life supporting role to aircraft which would prevent the aircraft from crash or accident.

Conclusion.

Many Techniques are being developed in the system of APUs , many modern technologies are being adopted in order to improvise the performance of the APU. APUs is external unit which laid at the tail of the aircraft and mainly used to start the engine or pushing the engine to start. This paper which lead to all us to understand the basic things about APU and also it's Evolution due course of the time. The historical perspective which is taken from ramayana and Mahabharata about the evolution of the aircraft and within the evolution of the aircraft system.

APU is the special and life support unit of the aircraft, APUs is mainly functional in the situation of the emergency likewise surge and stall of compressor, failure of the engine and also supply the power to the life support system like oxygen system and others.

REFERENCES:

1. Development of that auxiliary power unit by p. Lamp , j Tacbtket , o. Finkrtwith S Mukherjee and st. Shaffer
2. Auxiliary power units application by K A Friedrich and R Henne.
3. Vimana : The Ancient Indian space aerospace craft – time for indigenisation by Anil Chpara.