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Tubular Internal Combustion Engine (Tice) - a New Concept

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ABSTRACT

The two most common types of air breathing engines used for the propulsion of almost all powered flights are the reciprocating engine and the gas turbine engine. There are so many factors affecting the performance of reciprocating engine, In order to overcome the limitations of reciprocating engine and rotary engine, a new concept of internal combustion is proposed here, and it is named as Tubular internal combustion engine (TICE). The TICE having two stages (suction and compression) in first tube and having three stages (ignition, combustion and exhaust) in second tube. Two valves on each tubes and three ports are operated by cam for intake, transfer and exhaust operations. The design, maintenance, inspection and overhauling of TICE is less complicated when compared to the conventional reciprocating and rotary engines. The expected compression ratio is in range of 20:1 and it having dual fuel capability to run both in atomized liquid fuel and in gas. There is one rotor on each tubes which is connected to the shaft the engine; The propeller and reduction gear is connected to end of the shaft. Due to the light weight of the engine, it having more power ratio. The TICE may be air cooled or water cooled engine. Therefore the performance of the engine is much greater when compared to the conventional reciprocating, radial and rotary engines. The power can be augmented by adding more stages of the tubes in series.

KEYWORDS : Tubes, compression ratio, dual fuel capability, rotors, power to weight ratio.

1. INTRODUCTION TO TICE

Tubular Internal Combustion Engine (TICE) is a kind of rotary engine and its comes under the classification of internally combusted air- breathing engines. The main objective of this kind of engine is to overcome the limitation of conventional reciprocating and rotary engines. TICE offers high power to weight ratio when compared with most of the internal combustion engines.

2. LIMITATIONS OF RECIPROCATING ENGINE

The various factors affecting the performance of reciprocating engines are manifold pressure, Detonation and pre-ignition, brake specific fuel consumption, power to weight ratio, effects of altitude on performance, effects of fuel-air ratio and so on. Various researches are going on worldwide to overcome such kind of limitations. TICE is the better solution for aircraft power plants because it will offers high power density, power to weight ratio, good specific fuel consumption.

3. MAJOR COMPONENTS OF TICE

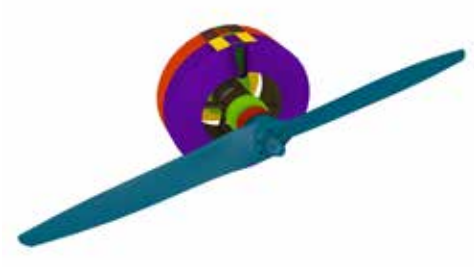

Fig.1 Model of TICE

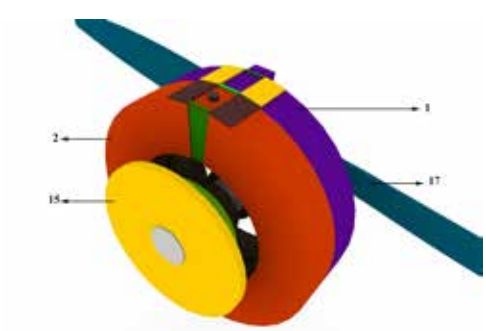

Fig.2 Rear view of TICE

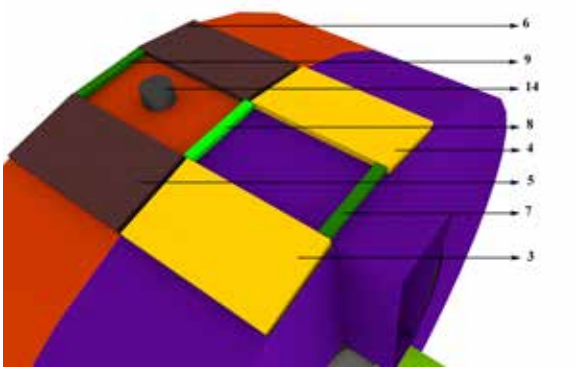

Fig.3 Closer view of TICE

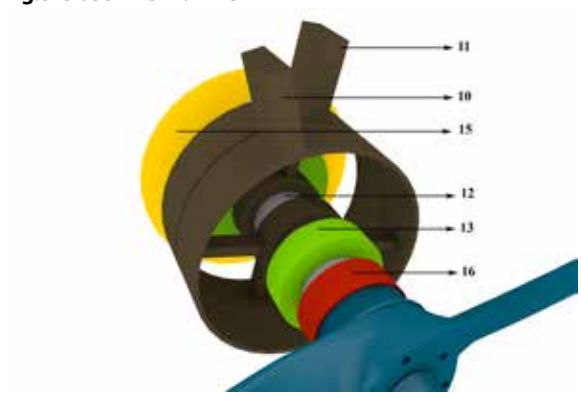

Fig.4 Rotor section

Various components of above figures are listed below:

(1) First tube
(2) Second tube
(3) Valve A
(4) Valve B
(5) Valve C
(6) Valve D
(7) Suction port
(8) Transfer port
(9) Exhaust port
(10) Rotor in first tube
(11) Rotor in second tube

(12) Shaft
(13) Bearing
(14) Igniter
(15) Flywheel
(16) Reduction gear
(17) Propeller

4. WORKING PRINCIPLE OF TICE

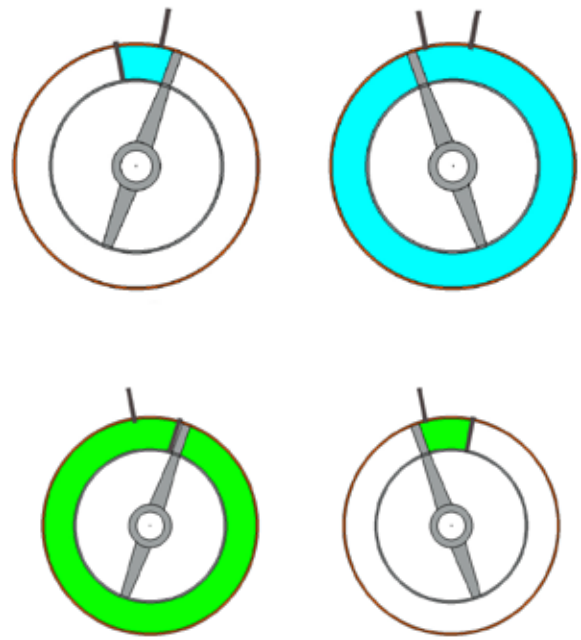

Fig.5 Stages in first tube

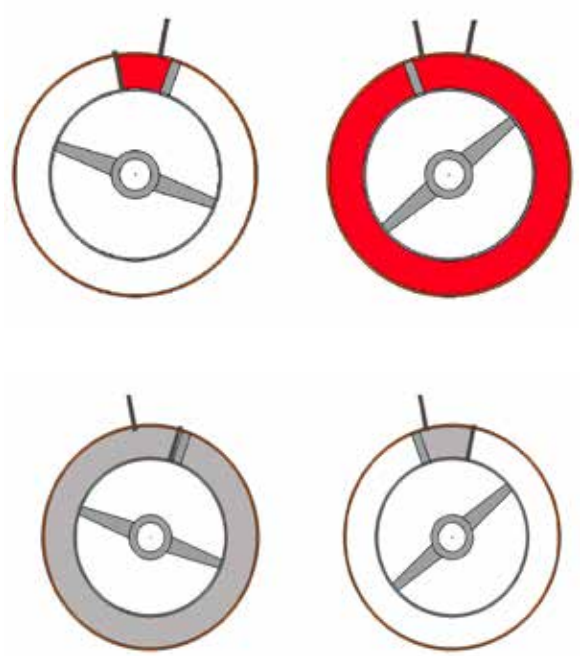

Fig.6 Stages in second tube

4.1 Suction Stage

The intake event occurs when the air-fuel mixture is introduced to the first tube through suction port by closing the valve A and opening the valve B. The movement of the rotor in clockwise direction creates a low pressure in the first tube. Ambient atmospheric pressure forces the air-fuel mixture through the open valve B into the first tube to fill the low pressure area created by the rotor movement. The valve A is opened when the rotor moves very nearer to it ,now both valves are opened and rotor crosses the opened valve B. When the rotor crosses the opened valve B, it get closed, as well as the suction port is also closed .Therefore the first tube continues to fill the air-fuel mixture till the closing of valve B and suction port.

4.2 Compression Stage

Once the suction port and valve B is closed, the first tube is sealed to form the charge because the compression process is initiated due to the continuous clockwise movement of rotor, So the trapped air-fuel mixture is compressed inside the first tube. The charge is the volume of compressed air-fuel mixture trapped inside the tube ready for ignition. Compressing the air-fuel mixture allows more energy to be released when the charge is ignited. The valve B, suction port and transfer port must be closed to ensure that the tube is sealed to provide compression. Compression is the process of reducing or squeezing a charge from a large volume to a smaller volume in the first tube. The flywheel helps to maintain the momentum necessary to compress the charge. When the rotor of an engine compresses the charge, an increase in compressive force supplied by work being done by the rotor causes heat to be generated. The compression and heating of the air-fuel vapor in the charge results in an increase in charge temperature and an increase in fuel vaporization. The increase in charge temperature occurs uniformly throughout the first tube to produce faster combustion (fuel oxidation) after ignition.

The increase in fuel vaporization occurs as small droplets of fuel become vaporized more completely from the heat generated. The increased droplet surface area exposed to the ignition flame allows more complete burning of the charge in the second tube. Only gasoline vapor ignites. An increase in droplet surface area allows gasoline to release more vapor rather than remaining a liquid. The more the charge vapor molecules are compressed, the more energy obtained from the combustion process. The energy needed to compress the charge is substantially less than the gain in force produced during the combustion process. For example, in a typical small engine, energy required to compress the charge is only one-fourth the amount of energy produced during combustion. The compression ratio of an engine is a comparison of the volume of the first tube with rotor after closing of valve B to the volume of the first tube with the rotor before the opened valve A. Gasoline engines commonly have a compression ratio ranging from 6:1 to 10:1. The higher the compression ratio, the more fuel-efficient the engine. A higher compression ratio normally provides a substantial gain in combustion pressure or force on the rotor of the second tube. However, higher compression ratios increase operator effort required to start the engine. Some small engines feature a system to relieve pressure during the compression stroke to reduce operator effort required when starting the engine. Therefore, the compression is achieved when the rotor moves toward the closed valve B and now the charge is ready to ignite.

4.3 Ignition stage

Once the compression is achieved, the transfer port which is in-between first and second tube immediately opened and the compressed charge is now entered into second tube, simultaneously valve C is closed and valve D is opened. When the charge entering into the second tube, the ignition (combustion) event occurs and the charge is ignited and rapidly oxidized through a chemical reaction to release heat energy. Combustion is the rapid, oxidizing chemical reaction in which a fuel chemically combines with oxygen in the atmosphere and releases energy in the form of heat. Transfer port get closed once the rotor crosses the valve B. Proper combustion involves a short but finite time to spread a flame throughout the second tube. The charge

comprises of atmospheric oxygen and fuel vapor are consumed by a progressing flame front. A flame front is the boundary wall that separates the charge from the combustion by-products. The flame front progresses across the second tube until the entire charge has burned.

4.4 Power Stage

The power stage is an engine operation Stroke in which hot expanding gases force the rotor away from the valve C. The power produced are transferred through the rotor to apply torque to the shaft. The torque applied initiates shaft rotation. The amount of torque produced is determined by the pressure on the rotor, the size of the rotor, and the throw of the engine. Due to high compression ratio of this engine, the flame front progresses to much higher angular distance. Now the valve C is also opened to give the way for the rotor to passes and simultaneously the valve D closes immediately after the rotor crosses it.

4.5 Exhaust Stage

The exhaust process occurs because the rotor in the second tube continues to rotate in clockwise direction after closing of valve D, because inertia of the flywheel push the rotor towards the closed valve D ,forcing the exhaust gases out through the open exhaust port, so that combusted gases are expelled from the second tube and released to the atmosphere. The exhaust process is the final stage and occurs when the valve C is open, valve D is closed and exhaust port is open. Rotor movement evacuates exhaust gases to the atmosphere. The valve C get closed immediately when the rotor crosses it and simultaneously valve D opens, therefore second tube is now ready for the next combustion and exhaust processes.

During suction process in the first tube there is a combustion process in second tube, and during compression process in first tube there is an exhaust process in second tube and the cycle continues. The engine become self sustaining at particular rpm range and it continues to operate until air-fuel mixture is stopped.

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