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STUDY ON BALL PISTON ENGINE: A REVIEW

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Abstract: This study contains the technical facts about the rotary piston engine and the description about the working principles and the benefits during practical application. Beside this its new concept which reduces the total engine friction. The basis of the design is ball pistons rolling on an eccentric track. The balls exert tangential force on the cylinder walls which turn the rotor. Useful power is available at the rotor output shaft.

Keywords—Ball piston; Wankle engine

1. INTRODUCTION

The ball piston engine is a new concept in high efficiency power machine. Although the basic geometry was invented by individuals, the concept has been subsequently studied and developed by scientists and professional engineers. The machine concept is attributes to simplicity. Having only a small number of moving parts, the design implements a modified version of the tried and proven thermodynamic otto cycle when use as a engine. Although the small parts count an important advantages, other than the ball piston engine will give future engineers new- found freedom in tailoring the combustion processes.

2. CONSTRUCTION OF MULTI ENERGY DOMAIN ENGINE(MULTISTROKE ROTARY BALL PISTON ENGINE MODLE)

A multi energy domain engine stimulation model was developed for efficiency studies. The model was based on the equation of motion (1).Approximate models working gas thermodynamics, coulomb friction and ball piston leakage were include. The multienergy (multi cylinder) domain engine consist of the number up to 8to12 in which the ball piston enclosed each cylinder.

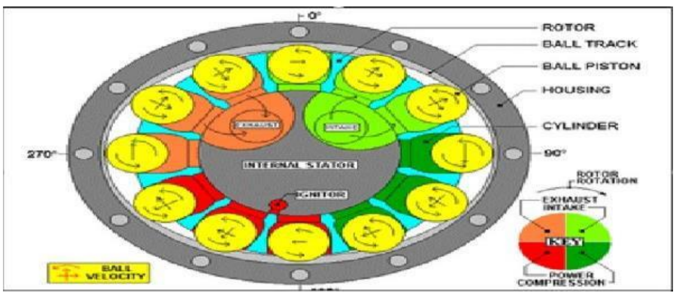

Fig:1 Ball piston engine [1]

WORKING OF MULTIENERGY DOMAIN BALL PISTON ENGINE

The basis of the design is ball pistons rolling on an eccentric track. The balls exert tangential force on the cylinder walls which turn the rotor. Useful power is available at the rotor output shaft. The combustion chambers are within the spinning rotor. Chamber porting for intake, compression, power, and exhaust strokes is achieved by passage of the chamber tops across an internal stator with appropriate feeds as the rotor spins.

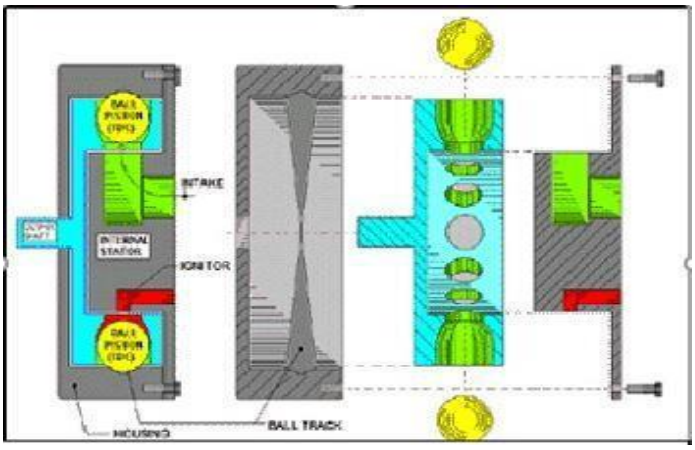

Fig:2 Cross-sectional view[1]

Beginning at top dead center (TDC) at 0 degrees rotation, the stator intake passage is open to the cylinder and a fuel/air charge is pulled into the cylinder as the ball piston moves radially outward for the first 90 degrees of rotation (intake stroke). Then the intake passage is closed off, and the ball reverses radial direction for the next 90 of degrees of rotation, during which time the new charge is compressed (compression stroke). Just past 180 degrees' rotation, the compressed charge is ignited as the cylinder port passes a small ignitor port. Combustion ensues, and the high combustion pressure pushes radially outward (on the ball piston for the next90 degrees of rotation. The ball in turn pushes tangentially on the cylinder wall because of the "slope" of the eccentric ball track, which is now allowing the ball to move radially outward. The tangential force produces useful torque on the rotor (power stroke).

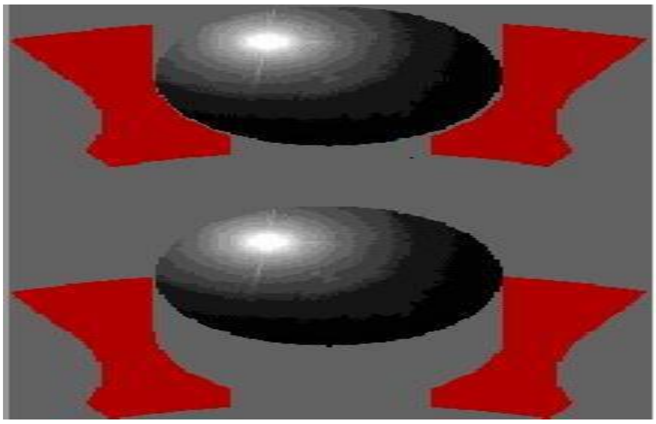

Fig:3 Compressions and Suction Stroke[1]

Compressions and Suction Stroke At 270 degrees of rotation, the spent combustion charge is allowed to escape through the exhaust passage as the cylinder port is uncovered. Exhaust is expelled as the ball moves radially inward for the next 90 degrees of rotation (exhaust stroke). Then the cycle repeats.

4. IMPORTANT DESIGN FUTURES

- The porting required for four stroke operation is achieved with numbers of additional part, and no valve train losses. The porting mechanism is achieved with simple port clocking within the rotor/internal stator bearing interface. Thus part count is low and hardware is simple in geometry, with only the rotor and ball piston as moving part.

- Sliding friction site are minimized by the use of a rolling ball piston. Sliding friction still exists at the ball/cylinder wall contact, but it minimized by special material selection and possibly local lubrication.

- The use of an eccentric ball track allows tailoring of the chamber volume vs time to optimize the cycle from a thermodynamic and chemical kinetics stand point. The only requirement is that the ball return to the starting radius at TDC before intake. For example expansion/exhaust stroke length can be made different than for intake/compression for more exhaust energy recovery, or the combustion can be held at constant volume for a certain period.

- Multicylinder rotor can be implemented. Instead of 4 stroke, 8,12 or more stroke can be transverse in a single revolution. This effectively multiplies the power out put proportionally if the stroke is maintain constant.

- The use of many ball pistons, which undergo the four strokes in clocked fashion, result in smooth power delivery and small net oscillatory forces, the total ball inertial forces are automatically balanced by symmetry if numbers of ball is even.

5. Construction of wankle two stroke rotaty ballpiston engine

The basic components of this engine are as

1 - rotary piston
2 - rotary cylinder
3 - housing
4 - spherical combustion chamber

6 - inlet
7 - exhaust
8 - air intake
9 - rotary cooling fins

10 - air outlet
12 - dividing wall

15 - piston ball bearing
16 - working chamber

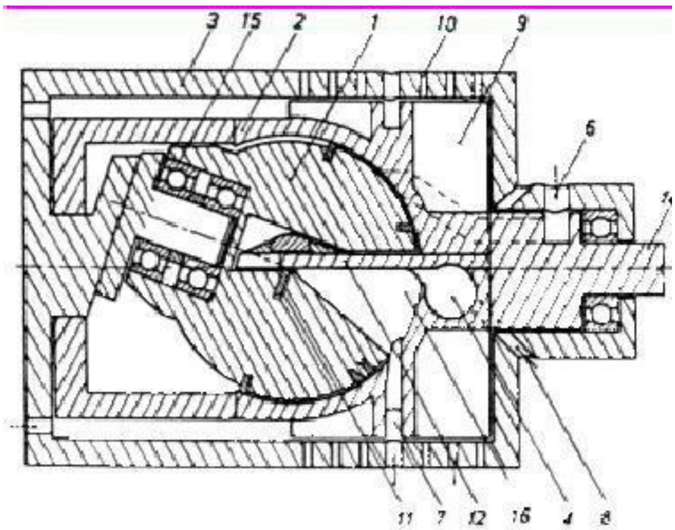

Fig:4 Drawing taken from German Patent Specification 2519911 and GDR-Patent 113788

The principle components of this engine are two rotors: (1), an inner piston rotor turning within (2), an external cylinder rotor, with both set at oblique axial angles to one another. The piston rotor is a sphere, from which a section resembling the shape of an orange wedge has been removed and which rotates around two ball bearings, (15). The cylinder rotor is a hollow sphere of proportionate size enclosing the piston rotor. Both rotors turn in concert at the same speed. Only their rotational axes are at an angle to one another. For the spherical piston to be able to swivel inside the hollow sphere/cylinder, both rotational axes must intersect exactly in the center of the sphere. (This must be duly observed when constructing such an engine, as otherwise reactive forces would be generated between the piston and the cylinder.) If no errors have been made, the piston and cylinder turn freely within one another without contact and without exerting unnecessary forces on one another (apart from utilizable torque). The cylinder rotor is seated at both ends in a stationary housing, (3) and possesses a shaft, (14). The cylinder rotor separates lengthwise into two halves, allowing it to be placed over the piston. Between these two halves, a dividing wall, (12) is also screwed in, turning the sphere into two hemispheres. The piston rotor has a corresponding cutout in the shape of an orange wedge, so that it can accommodate this wall. In between, two symmetrical working chambers,(16) are formed. (The whole unit resembles a joint for coupling two non-aligned shafts. The dividing wall connects the two rotors in a torque-proof fashion.)

6. WORKING OF WANKLE ENGINE

A spherical piston rotates in combination with a spherical housing, whereby the rotational axes alone incline towards each other slightly, not unlike a card an joint. In the process, “strokes” are created within the rotational system, which are employed to produce periodic volumetric change in working chambers. Two such symmetrical working chambers arise in diametrically opposing sides of the spherical piston, in sections cutout of the sphere like wedges removed from an orange, one on each side of a smooth dividing wall that extends into these areas and which is firmly anchored to the casing (external cylinder) that also rotates as part of the system.

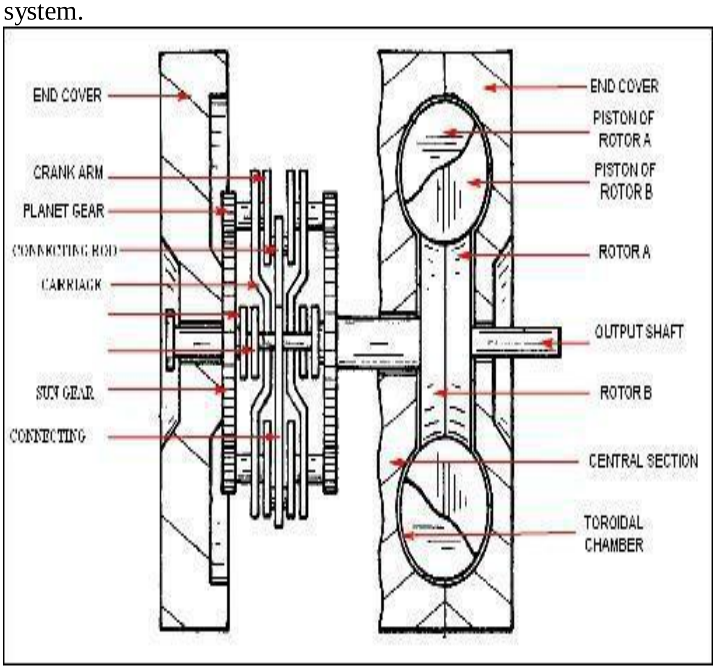

Fig:5 INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY ISSN: 0974 – 3154 Volume 6, Number 2 (2013)

In order to understand what goes on inside this device, we will have to take a look at the rotating system.

Try to imagine yourself rotating along with the cylinder rotor. You will observe a swiveling or tumbling motion of the sphere-shaped piston in the sphere-shaped cylinder. The piston moves back and forth at periodic intervals right up to the dividing wall, while simultaneously swiveling lengthwise to it. It carries out a tumbling motion that can be differentiated into two pivotal motions occurring vertically on top of one another. One of these creates the desired stroke motion in the rotating system, the other enables asymmetrical timing. This engine has the kinematics of a single-rotational engine with the centers of gravity of both rotating parts are at rest. In the coordinate system at rest there are, in the case of this engine, no to and fro motions.

The stroke motions exist only in the co-rotating, body-fixed coordinate system and generate no oscillating inertial forces. Consequently, this engine produces no vibrations resulting from oscillating inertial forces. (Consideration of the sealing components is for the time being left aside as this would go beyond the scope here of general descriptive purposes.)Two rotors turn, one nested in the other. Contact between the two occurs via the sealing components. The sliding speeds arising through the motion of both parts tumbling in opposing directions in the co-rotating system are in fact low. Accordingly, high revolutions per minute are possible (more than 20,000 rpm). Centrifugal and other inertial forces are however present and may affect particular sealing components at very high speeds.

Fig:5 This was the first model [3]

7. ADVANTAGES OF ROTARY BALL PISTON ENGINE

- The ball piston engine (multi energy domain engine) having small number of moving parts, the design implement a modified version of the tried and proven thermodynamic otto cycle when use as a engine.
- It will give the future engineers new found freedom in tailoring the combustion process.
- The stroke magnitude and rate can be different for different stroke in cycle (i.e. intake, compression, power and exhaust) so that it provides the possibility of converting more

energy to the shaft power by greater expansion during the power stroke.

- It has ability to complete any even numbers of strokes per revolution in single rotation of rotor. This effectively multiplies the power output proportionally if stroke is maintain constant.

- In this engine the frictional losses are low and independent of operating speed in contrast to conventional piston engine.

8. CONCLUSION

From analysis the design assumptions show that the ball piston engine has potential for achieving higher efficiency than piston internal combustion engine. Having only small moving parts and achieving higher efficiency. A new approach to kinematics design has devised to eliminate friction contribution from internal forces in the engine. On the other hand, conventional carburetion/induction and exhaust system are applicable to the new engine.

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