

# Design of A New Engine Transmission Mechanism Based on Gears and Racks

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**Keywords:** Gear and rack;Engine transmission mechanism;Bevel gear train

**Abstract.** A new type of engine transmission mechanism based on gears and racks is introduced,which is mainly composed of a pair of incomplete gears with overrun clutch, a composite rack and a bevel gear train.With the interval meshing of incomplete gears with composite rack, the reciprocating linear motion of piston is transmitted and eventually converted to continuous and rotational movement by the bevel gear train.Compared with traditional crank-connecting rod mechanism, the new drive mechanism performs with higher transmission efficiency, more stable power output and lower vibration noise.

## 1. Introduction

Engine also named internal combustion engine, is an energy output device to transform gas heat energy into mechanical kinetic energy, which is widely used on various kinds of machines and equipments that need power. At present, the engine widely used in the market is crank-connecting rod mechanism and its inherent structure attribute determines its many defects and shortcomings such as there being lateral pressure and friction loss between piston and cylinder block, dead point in connecting rod motion and grate impact force between piston and cylinder<sup>[1-2]</sup>.

This article introduces a new type of engine transmission mechanism based on gears and racks. With the interval meshing of incomplete gears assembled on overrun clutches with a composite rack with upper and lower racks installed in a staggered manner, the reciprocating linear motion is passed on and synthesized to be a continuous rotary motion,making power outputted with higher mechanical efficiency and more smoothly transmitted with no lateral pressure and so on<sup>[3-5]</sup>.

## 2. The Whole Plan of Engine Drive Mechanism

The overall design scheme of engine driving mechanism is shown in figure 1,which is mainly composed of pistons and cylinders as power input part, incomplete gears and composite rack as power transmission part and a bevel gear train as power output part.System is powered by alternate gas combustion in right and left cylinders.

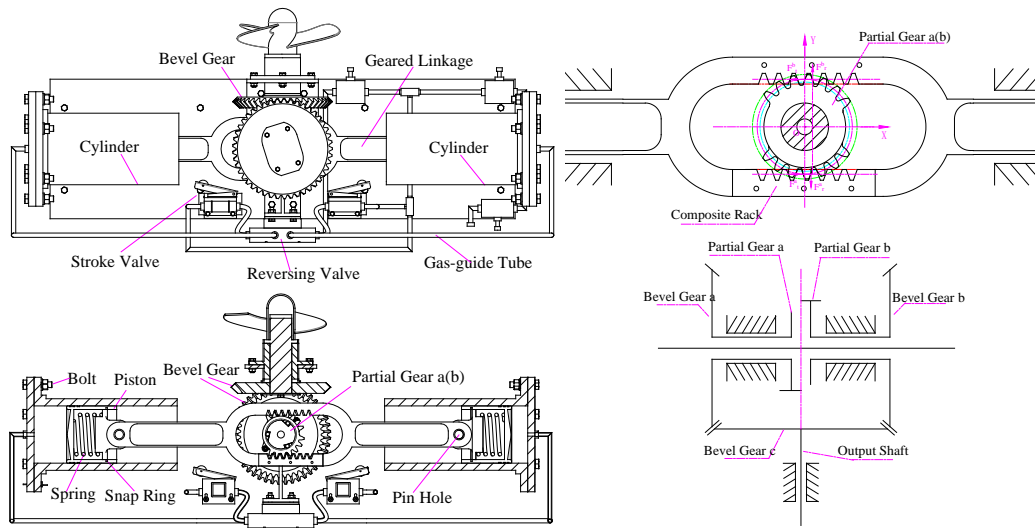


Figure 1 :The transmission mechanism diagram of engine

### 3. Core Transmission Mechanism

#### 3.1. The Piston and Cylinder Mechanism

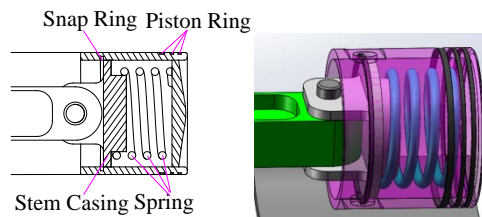


Figure 2 : The flexible structure diagram of piston

The power input portion is mainly consisted of standard carbon steel piston and cylinder, piston ring and sealing ring. Its structure is shown in figure 2.

Piston ring has sealing function, and each piston is equipped with three rings, which can significantly increase cylinder pressure tightness. In order to reduce the collision of rack with piston bar, in turn, to reduce meshing impact force of gears and racks, the piston and rack bar adopt flexible connection, namely rack bar and piston is connected by a spring with specific stiffness.

#### 3.2. The Incomplete Gear Rack Transmission Mechanism

The incomplete gears and racks transmission consists of a pair of incomplete gears and four racks with same teeth, modulus and pressure angle, and the power is transmitted to bevel gear system by their intermitted meshing motion, the 3D models are shown in figure 3 and figure 4.

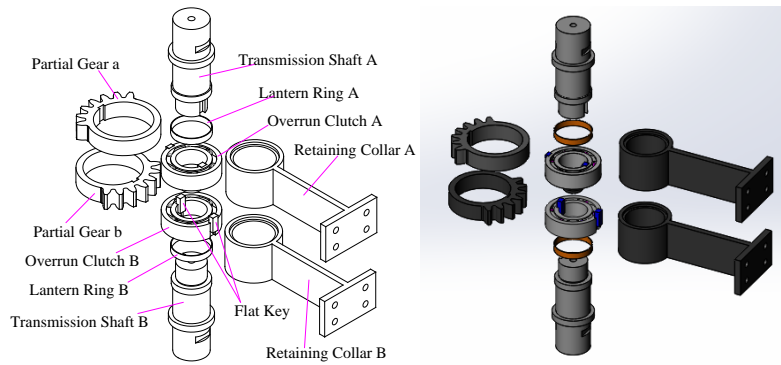


Figure 3 : The mechanism diagram of incomplete gear mechanism

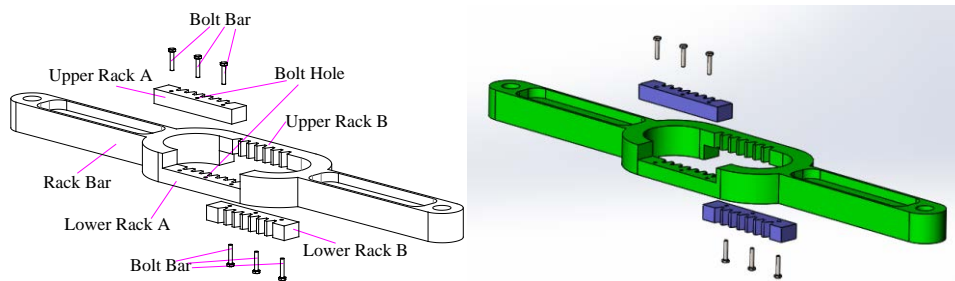


Figure 4 : The mechanism diagram of composite rack linkage

Composite rack is made up of double upper and lower racks installed in a staggered manner and adopts screw connection.

### 3.3. The Bevel Gear System Mechanism

The bevel gear system mechanism is composed of upper and lower bevels and side bevel with equal modulus and pressure angle. The 3D model of bevel gear train is shown in figure 5.

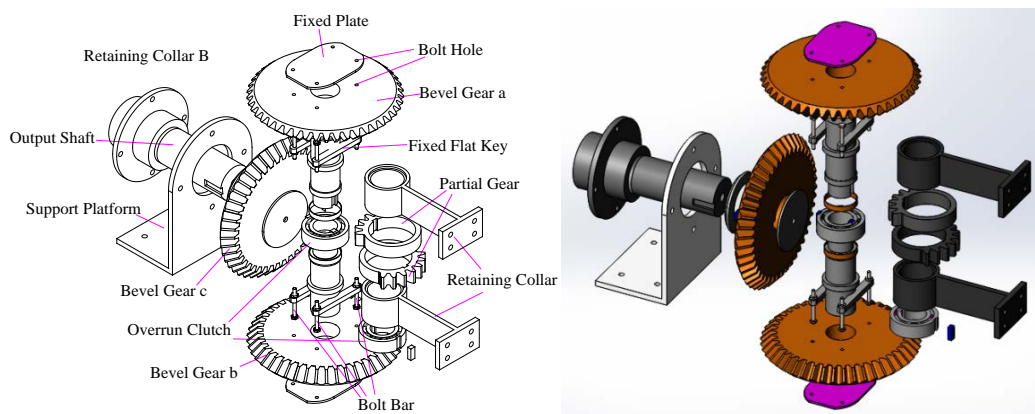


Figure 5: The mechanism diagram of bevel gears system

Incomplete gears and rack transfer movement through transmission shaft to upper and lower bevel gears, and then it is synthesized to be side bevel gear's continuous and homodromous movement.

#### 4. The Working Principle of Transmission Mechanism

New engines driving mechanism is mainly working through incomplete gear and composite rack's intermitted meshing to transmit power, and bevel gear system compounding movement to output power. The overall movement is divided into two stages as shown in figure 6.

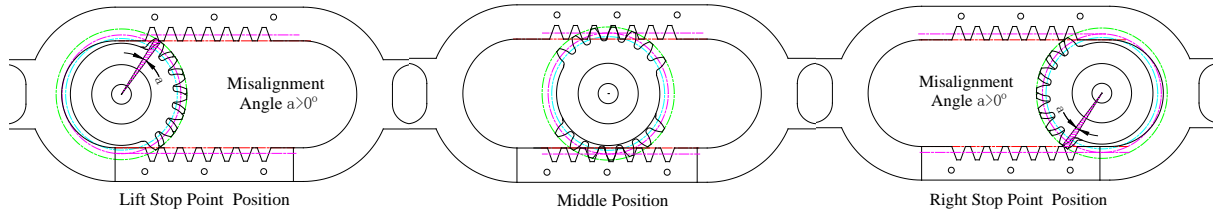


Figure 6: The motion diagram of incomplete gears

The first movement stages: when gas is combusted in left cylinder, the pressure drives gear linkage to the right and then make partial gear *a* mesh with the upper rack *A* and partial gear *b* mesh with the lower rack *B*, the right cylinder is exhausting gases. Then gas is combusted in right cylinder, partial gear *a* mesh with the upper rack *B* and partial gear *b* mesh with the lower rack *A*, the left cylinder is exhausting gases, the whole is a cycle motion.

The second movement stages: the upper bevel gear *a* and lower bevel gear *b* synthesize transmitted motion to be the side bevel gear *c*'s continuous and homodromous movement for power output.

#### 5. The Experiment Design of Engine Drive Mechanism

The design scheme of new engine driving mechanism is feasible in theory and also an experimental platform is needed to validate its authenticity. To simplify structure, the high pressure gas is used as power source to drive piston and a double pneumatic reversing valve with stroke valves to control gas movement, which is to simulate gas combustion and piston alternating movement. The schematic diagram is shown in figure 7.

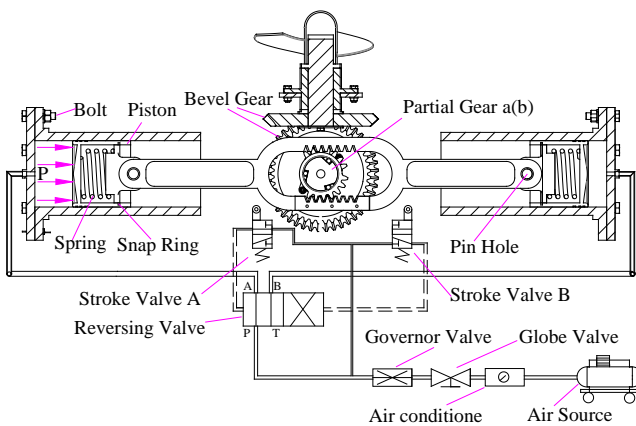


Figure 7: The schematic diagram of transmission mechanism

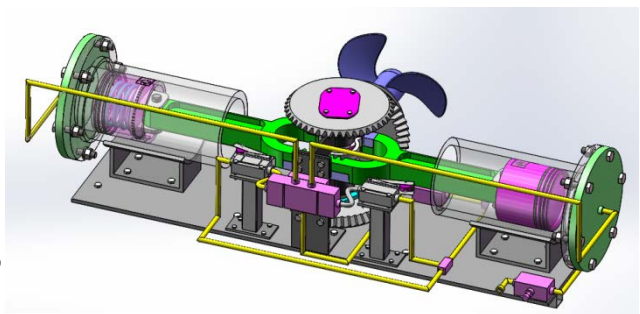


Figure 8: The virtual prototype of engine experiment

## 6. Conclusions

In view of the insufficiency of crank-connecting rod structure in traditional engine, a new kind of transmission mechanism as shown in figure 8 is described, which is based on gear and rack's interval meshing and bevel gear system's motion synthesis. The mechanism can transform the linear reciprocating motion of piston into continuous rotary motion to output power with characteristics of more smooth power output and higher efficiency as well as lower vibration noise, which provides a reference design scheme for development of new engine.

## Acknowledgements

The author sincerely acknowledges the teachers and classmates for their support and help as well as the parter's advice in the completion process of this paper.

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