UNIVERSITY OF PETROLEUM & ENERGY STUDIES
AUTOMOTIVE DESIGN ENGINEERING

"ROTARY DISC VALVE SYSTEM OF AN INTERNAL COMBUSTION ENGINE"

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For the Award of the Degree

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UNIVERSITY OF PETROLEUM & ENERGY STUDIES
AUTOMOTIVE DESIGN ENGINEERING

TO WHOMSOEVER IT MAY CONCERN

This is to certify that, Mr. **Kawaldeep Dang (r140206026), Mr. Saurabh Kumar (r140206053), & Mr. Vivek Kumar Sharma (r140206062)**, Bachelor students of Automotive Design Engineering, University of Petroleum and Energy Studies, have worked on '**ROTARY DISC VALVE SYSTEM OF AN INTERNAL COMBUSTION ENGINE**'. They have successfully completed the project for fourth year at University of Petroleum & Energy studies, Dehradun, Uttarakhand.

Their contribution in the project is significant and useful to us. I wish for their best future.

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B. Tech, DMES(Mechanical)

M.Tech (Machine Design)

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AUTOMOTIVE DESIGN ENGINEERING

DECLARATION

We, , Mr. **Kawaldeep Dang(r140206026), Mr. Saurabh Kumar(r140206053) & Mr. Vivek Kumar Sharma(r140206062),** Bachelor students of Automotive Design Engineering, University of Petroleum and Energy Studies, Dehradun hereby declare that the dissertation entitled **"ROTARY DISC VALVE SYSTEM OF AN INTERNAL COMBUSTION ENGINE"** embodies the report of project work carried out at 'University of Petroleum and Energy Studies, Dehradun for fourth year under guidance of **V.V.KONDAIAH,** B. Tech, DMES(Mechanical), M.Tech (Machine Design), **Assistant Professor.** This work has been submitted for the partial fulfillment of the requirement for the award of the honorable degree 'Bachelor of Technology in Automotive Design Engineering'.

Date: MAY 11,2010

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support and able guidance from numerous sources that helped to shape it and provided a

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Lastly, we offer our kind regards to our peers and friends and to all of those who have supported us in any respect to improve the quality of our work.

ABSTRACT

The disc value system comprises of at least one rotating disc valve and an intermediate real number. The stating disc is mounted between the cylinder head manifold which contains intake and exhaust port and our engine cylinder housing the piston and thus defining the combust non chamber. The disc comprised of sequencing parts to be brought into periodic communication with the exhaust and intake parts at cyclic intervals of the rotating movement, thus providing for the intake and exhaust parts to be brought into periodic communication with the combustion chamber.

The intermediate seal number mounting between the disc and the cylinder is used so as to seal this combustion chamber at a junction of the disc and the cylinder. This intermediate seal number comprises of a dynamic seal for contact with the disc and a stationary seal for sealing contact with the engine cylinder.

The rotating movement of the disc sequentially opens and closes each exhaust and intake parts synergistically with the translational movement of the piston.

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CHAPTER 1. INTRODUCTION TO INTERNAL COMBUSTION ENGINE

The device in which the combustion of fuel occurs with some amount of air or sometimes in the presence of an any oxidizer in the combustion chamber is known as the Internal Combustion Engine. The high pressure and temperature gases are produced due to the burning of fuel during the process of combustion. These then applies a direct force to the piston or the turbine blade. These are the components of the engine which are movable. The useful mechanical energy is generated by these movements.

CHAPTER 2. ROTARY DISC VALVE SYSTEM – AN INTRODUCTION

There is atleast an intermediate seal member and one roatating disc valve in the rotary disc valve combustion system.

The placing of the disc is in between the cylinder head manifold which in itself comprises of the exhaust and intake port and an engine cylinder which contains the reciprocating piston.

Normally in an Internal Combustion Engine, the exhaust and intake valve opens and closes with the help of tappets. But, In Rotary Disc Valve Internal Combustion Engine the the disc's rotating movement helps in the sequential opening and closing of each exhaust and intake ports with the reciprocating1 movement of the piston.

The disc is rotatively placed within the cylinder head of an Internal combustion engine which contains beveled gear teeth at the outer perimeter of the cylinder head and a number of equal distanced ports about the center of rotation of the disc which will meet with a couple of exhaust and intake ports.These exhaust and intake ports start from the combustion chamber and lead to the respective exhaust and intake manifolds.

The disc valve rotates systematically with the crankshaft taking the help of a chain which is mounted to the sprocket located on the crankshaft and also to the second sprocket which is in working mechanism with a pinions rear having bevel teeth.

Therefore, the disc valve allows the opening and closing of intake and exhaust port which helps in transfer of fuel and exhaust into and out of the combustion space.

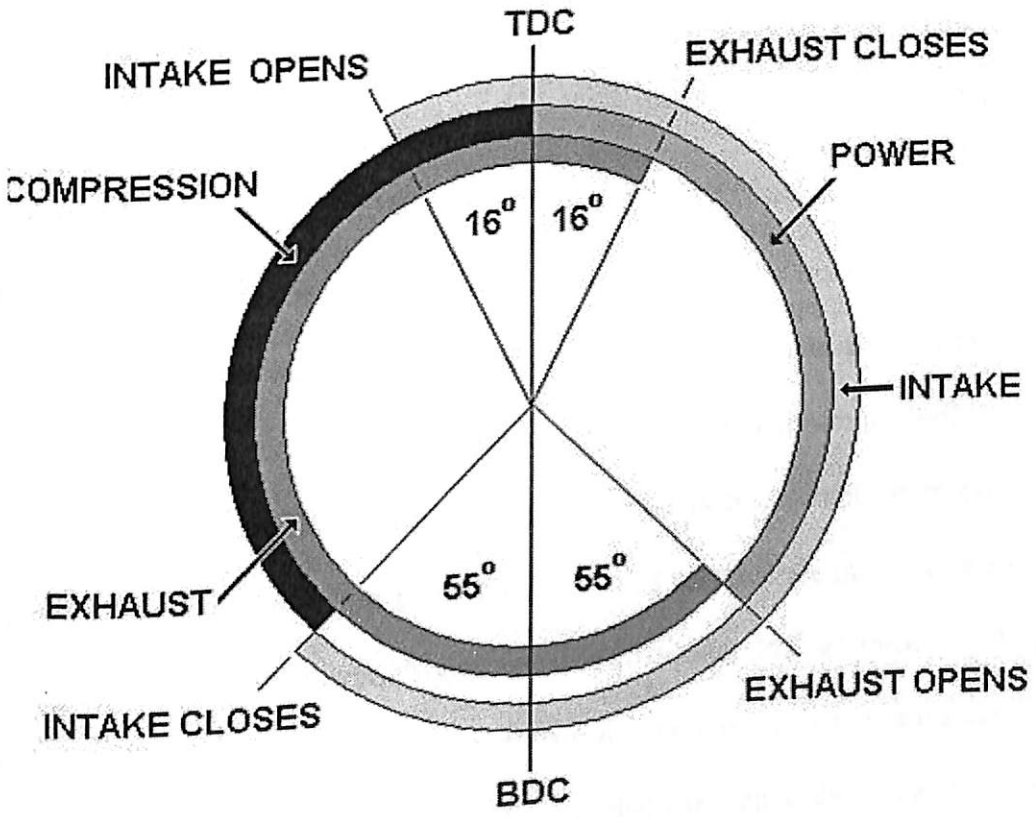

Figure 1. Valve timing diagrsm

The valve timing diagram for both rotating disc and tappet valve system remains same.

CHAPTER 3. CONSTRUCTION

The disc valve system comprises of a rotating disc for placing between the cylinder head manifold contains exhaust and intake parts and also there will be an engine cylinder which is guiding the piston and thus providing the combustion chamber.

There will be an intermediate seal material used for mounting between the rotating disc and the engine cylinder so as to seal the combustion chamber at the joining of the rotating disc and the intermediate seal member. The seal member includes a dynamic seal for contact with the rotating disc and a stationery seal for sealing contact with the engine cylinder. This will lead to the sequential opening and closing of the exhaust and intake ports due to this translational movement of the pistons because of rotating movement of the rotating disc.

CHAPTER 4. PROCESS OF DISC ROTATION

In the rotary disc valve system, the disc rotation is due to the transmission assembly which is placed between the crankshaft and the rotating disc in operating condition.

In the assembly, the transmission assembly is a gear assembly comprising of first and second gears, which are used in the form of sprockets. Sprockets are in working communications due to the movement transfer assembly which will be provided in the form of either a chain,belt or a wire. The first sprocket gear is in operating movement with the crankshaft, whereas the second sprocket gear is in engagement with the disc through a disc gear with the disc gear elements on the disc. Here, the disc gear elements are bevel teeth and the disc gear is a pinion gear which comprises of bevel teeth which are meshed together with the disc gear teeth. The first sprocket gear, that is mounted firmly to the crankshaft causes the rotation of the bearings by the engine piston acting though the connecting rod in the working similar to the 4-bar slider mechanism.

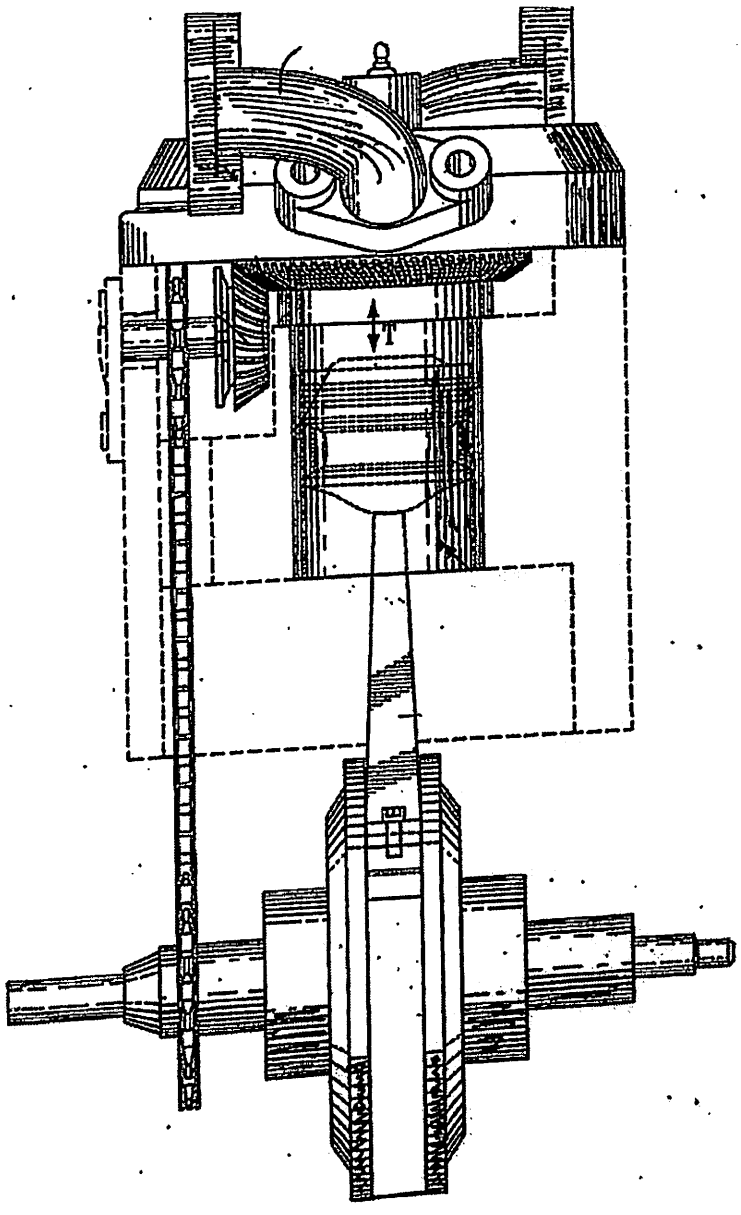

Figure 1.Front view of the Disc Valve System showing the cylinder box and cylinder in dotted line

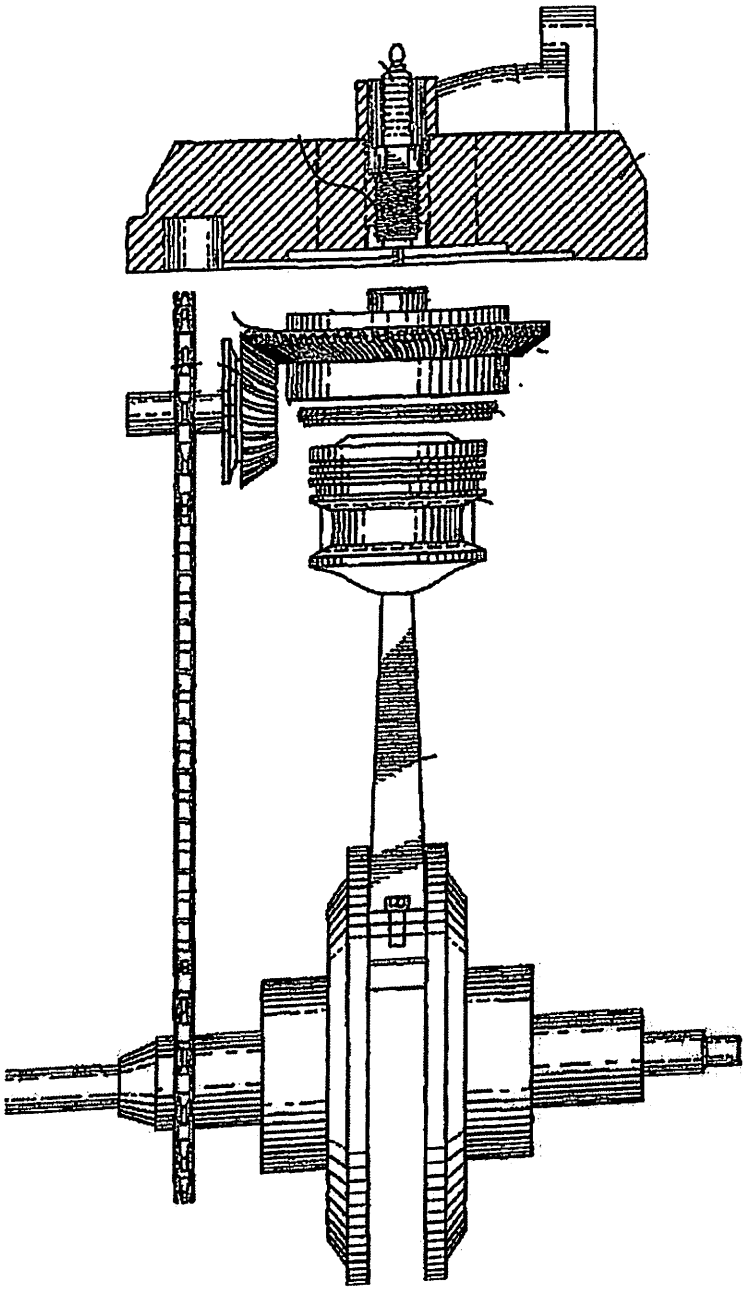

Figure 2. Front view of the Disc Valve System without the cylinder box and cylinder.

The rotation of the sprocket gear is transmitted to the second sprocket gear through the chain which is mounted to both the first and the second bevel teeth gears. The second gear includes an aperture used for receiving an extending member like a rod or shaft, which can be extended from the bevel gear.

As the rotary disc valve engine system can be used to operate on a variety of alternate fuels. Thus the need of the diversification of engine can be achieved by very slight modification. This is due to the fact that the intake and exhaust circuits are combined in a single disc, which operate in a single rotational motion relative to stationary cylinder head ports. Modification is easily accomplished by bringing out changes in the angular positioning and in dimensioning of the cylinder head port opening and the relative matching disc.

Combustion in the disc value engine is mechanically provided by the swirling motion which is generated in the combustion chamber due to the high speed rotation of the disc valve below the cylinder, that increases the turbulent mixing before to spark ignition. This swirling turbulence is highly increased by placing the small propelling black members that are located around the disc valve conical opening protruding from the disc located under the surface.

In diesel engine designs, auto ignition and combustion efficiencies are exhausted by injecting fuel into the conical volume found in the centre of the disc valve. The rotational velocity of the swirling motion changes the same at every axial location with in the conical section as the swirling motion is generated by the rotating movement of the disc. But air tangential or circular velocity decreases proportionally as the conical diameter decreases. This leads to increasing of the temperature at the point of fuel injunction. The atomization and combustion efficiency will increase with the increase in system temperature at the point of fuel infection and generated turbulent mixing.

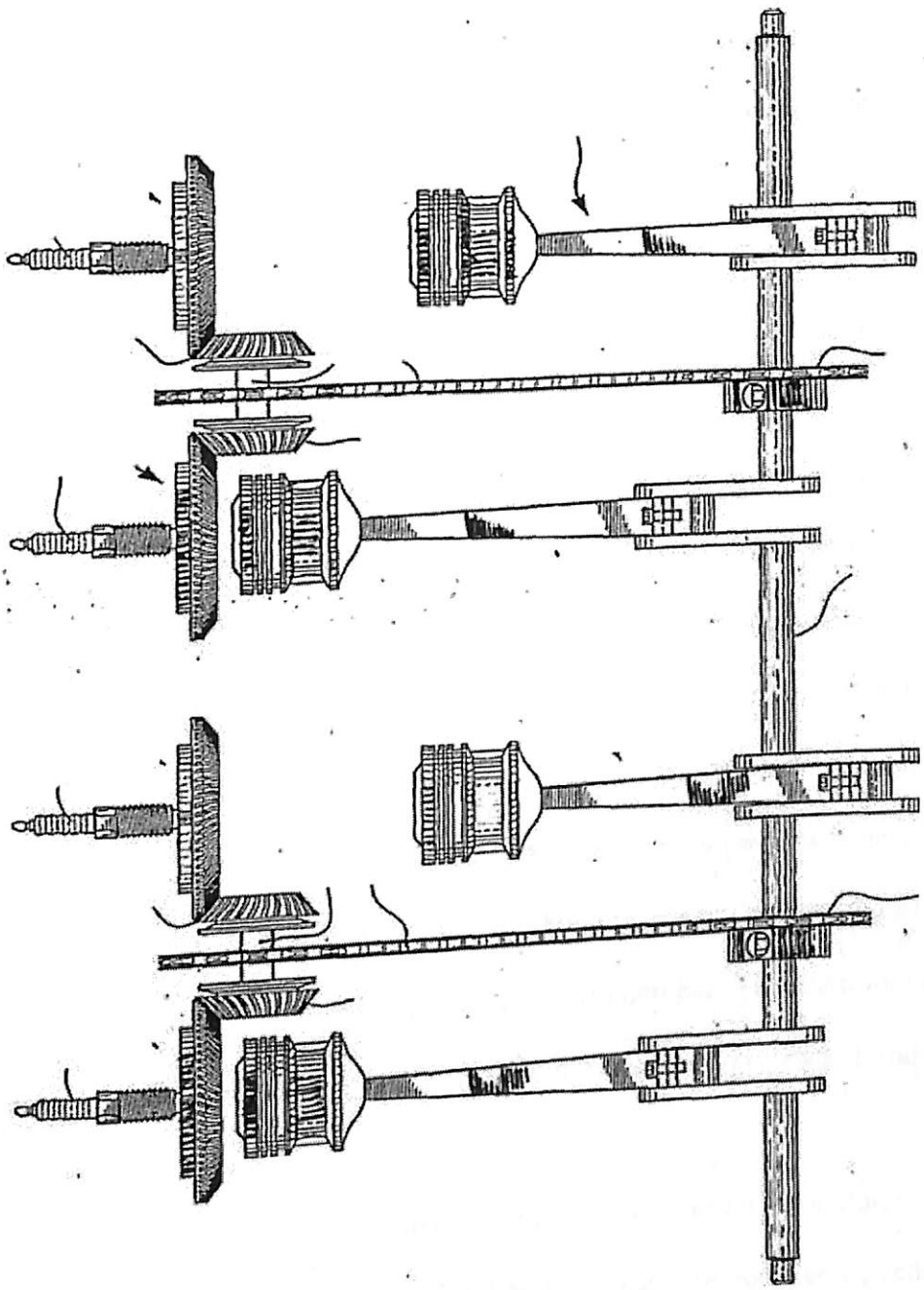

Figure 3. Front view of the Disc Valve System with multi-piston engine.

The major source of hydrocarbon is cylinder wall quenching, inefficient exhaust evacuation and incomplete combustion on assuming a complete homogeneous charge in the small high speed spark ignition rotary disc valve. These deficiencies are removed in the rotary disc valve engine system, which operates in a high pressure or temperature regime, which provides the fuel volatility and thus leads to subsequent mixing and is dynamically supplemented by mechanical movement disc rotation.

In the diesel rotary disc valve engine, constant volume Otto cycle is easily converted to the constant pressure diesel cycle. This can be done by the proper replacement of the engine ignition spark plug with the fuel injection unlike the homogeneous mixture of fuel and air on the constant volume combustion in gasoline engines, the constant pressure combustion of diesel engine is heterogeneous in nature, and it occurs as droplet surface burning phenomena. This produces a different mixture of emissions than those that were obtained in the gasoline engines. Auto ignition can occur at several locations in the combustion chamber of the diesel engine. The fuel may still be in the liquid phase in other portions of the chamber. The distribution of the fuel within the combustion chamber has a great effect on the combustion process and thus it also effects the emissions produced due to it.

The undesired emissions are unburnt hydrocarbons, carbon monoxides, aldehydes, nitrogen oxides and smoke particles. These harmful emissions can be reduced by redesigning the combustion chamber of the engine. This will result in efficient mixing which can be achieved during combustion process.

CHAPTER 5. DESIGN OF COMBUSTION CHAMBER

The most significant parameters in the designing of high performance low emission diesel engine are Atomization of fuel, good spray formation and Turbulence in the combustion chamber. This turbulence is created in conventional engines by applying a radial flow compression which is defined as squish.

In the disc value engine, Turbulence is generated as a radial swirl. This motion is carried upward in a spiral by conically designing the disc toward the point of fuel injection.

In the rotary disc value combustion chamber, the compression flow consists of a tangential as well as radial component. The radial flow is caused by the piston compression and the tangential swirl which is caused because of the spinning of the rotary disc valve. The two components of the radial and tangential flow results in a vectorial upward circular path which when compressed in the conical volume generate an upward climbing spiral which terminates at the injector opening.

As the piston has reached TDC, the upward mechanism of squishing action stops and fluid momentum reacts against the blades, thus producing an supplementary torque force in the same direction as the disc valve rotation which removes the frictional load.

The shapes, number, size and general configuration of the sequencing port could be varied for a number of intake and exhaust ports. Further the disc value can be configured and sized depending on the ill-positioning of the ports, depending upon the sequencing time for making the disc ports mating with the cylinder head ports, therefore modulating the outtake and exhaust time. All this depends upon the geometric shapes of the disc and the material from which it is made from.

The intermediate member comprises of a dynamic seal for contact with the rotating disc. Also, there will be a stationary seal for sealing contact with the engine cylinder.

The intermediate seal member consists of an upper face, a bottom face and an intermediate surface.

Ring seal effectively seals the combustion chamber defined by the engine cylinder by forming a dynamic sliding seal with the rotating disc and a stationery seal with the engine cylinder within the limiting axial distance of the combustion volume when the engine piston is at Top Dead Centre (TDC) at the end of the compression stroke.

The ring number includes the stationary seal at the intermediates surface. In this structure, the stationary seal is an O-ring extending beyond the surface and slidability held within a groove machined at the outer perimeter of surface.

The bottom face of ring seals are so designed so as to be fitted within the cylinder and mate with the inner top surface. Also, the bottom faces include a locking member in the form of a recess.

Ring seal includes either an inclined recess ring seal or a straight recess. Recess are so designed so as to accept complimentary locking numbers in the form of pin at the causes top perimeter surface of cylinder thus, performing the job of holding the intermediate ring seals in place and presenting their rotation.

As the top faces of both the ring seals are in a dynamic seal contact with any of the disc values. Thus, they provides for the disc values to rotate.

The stationary seal seals with the rim of the cylinder. The bottom face of each ring is in stationary seal within the cylinder. The top internal periphery is recessed and it forms a seating

arrangement that is complimentary to the bottom force so that the rings can be seated there on in sufficiently fit.

An important point of discussion of the rotary disc valve engine is the method of sealing the combustion chamber of the engine between the cylinder head and the engine cylinder. In the engine cylinder, intermediate ring seal provides a static seal with the engine cylinder by a seal operating with the seal groove machined into the outer surface of the intermediate ring seal. Thus, the intermediate ring seal comprises of both static and dynamic sealing characteristics as the sealing interface between the rotating surfaces of the engine cylinder.

In the system, the stationary seal mates with the external rim of the cylinder. Static and dynamic sealing between the rotating disc valve and stationary engine cylinder occurs within the limited axial length of the combustion chamber. To alleviate the restructure spatial requirement a skirt extension can be added to the disc valve, which extends the axial length of the sealing contact between the dynamic and stationary seals without changing the combustion volume, which will lead to the change in engine compression ratio and thus alters its performance.

Another view of the rotary disc valve engine is the extension of the axial distance between the dynamic seal and stationary sealing surface in such a way that they overlap the interfaces between the cylinder head and the engine cylinder. Thus facilitating the engine compound manufacture and installation of the cylinder head with improves sealing reliability.

The sealing of the combustor volume of the rotary disc valve engine is provided by the seals. The seals provide dynamic sealing against the sliding surfaces of the disc valve and also provide static seal with the engine cylinder. These seals are effective in the limiting axial length of the combustion volume measured as the distance between the engine piston head and the cylinder head surface configured within the surface of the disc valve.

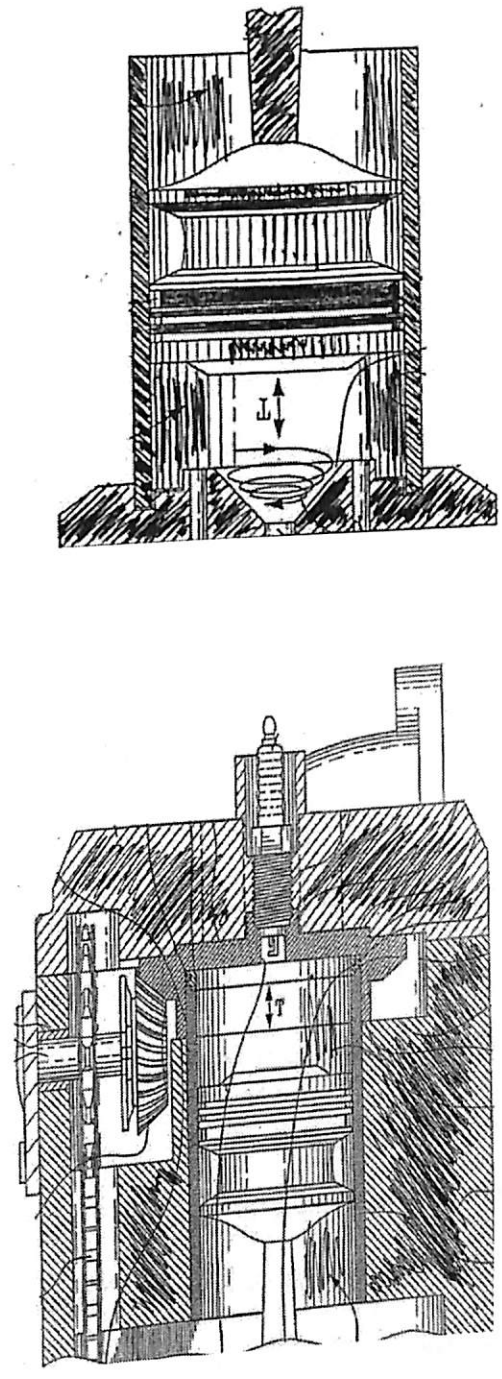

Figure 4. Sectional view of the Disc Valve System

To facilitate the sealing function, the intermediate ring seal is designed to overlap the distance between the engine cylinder head and engine cylinder. The main purpose of the intermediate ring seal is designed to confine the working fluids, being acted upon by the reciprocating motion of the engine piston, across the stationary interface of the engine cylinder and the rotation surface of the disc value of this engine. The present seals are dynamic in nature and hence during the translational movement of the piston, the side undergoes the minute tremble. The intermediate seal allows the combustion to take place.

There is also a second sprocket including a hub, which holds the resilient member as well as external teeth on which the chain is mounted. This sprocket gear functions as a timing gear has a hub which is assigned concentrically about the axis of rotation of gear. The hub holds the resilient number and it is corresponding by contoured in the hub. The timing gear is mounted on the timing shaft. The timing shaft comprises of the bevel gear, which is fixedly by a variety of natural or synthetic rubber.

This hub in combination with the resilient number serves as a flexible coupling between the gear and the shaft. This flexible coupling allows the shaft to work flexibly under heavy starting loads or to provide offset to a shaft misalignment.

The resilient member provides a mean for lowering big friction loads stationary stator and the surface of the rotating disc, which is operating with in the fluctuating pressure field of the combustion chamber of the engine. Rotation of the disc within the combustion chamber of the the engine periodically opens and closes plurality of exhaust and intake parts located in the stationary seal of the cylinder head of the engine through one or more dynamic pressure cycles. The rotation velocity of the disc during the highest peak pressure at the point of the igniters spike is slowed down due to the flexible coupling between the timing gear and the timing shafts. This

decrease in the rotational velocity of the disc reduces the sliding contact frictional energy between the disc and the stator surfaces, which is experimentally at its peak position during this brief period.

For the few milliseconds of the peak combustion pressure, ignition spike the resilient member between the hub of the timing gear and the timing shaft is slightly compressed causing the timing shaft to rotate slower the timing gear for a brief instant own a small millisecond increment of a rotation and thereby transmitting or slowing motion to the disc rotation. This slowing rotation is hardly measurable. The slowing impact across the interface is reduced exponentially as a function of the contact and velocity due to the molecular interface of the lubricating film between the surface and the sliding contact.

The wear between the two surfaces will be lessened due to absorption of peak torque load of the timing shaft by the resilient number at the time of peak combustions pressures when the sliding contact friction between the stator and the disc will be maximum.

The resilient number is an elastic material capable of fully responding over the engine operating frequency. The response can be stiffened by the formulation or rubber resilient numbers with an extender or catalyst accelerators, in a manner such that it permits complete recovery after each compression and also will not couple with the engine's natural frequency.

The major physical property which the material used to manufacture the resilient is that of sustained response of rapid compression loads with rapid recovery and good storage durability with long-term fatigue capability under heavy loads.

On those rotary disc valve systems, where chain is used, a tensioner system is used on it, which acts on the top and bottom sprocket gears. This tensioner system contains first and second tension element which are linked together by the means of dynamic members such as a rod, or a

spring, or an elliptical ring, or a solid rod. The tension element can also be mounted to the dynamic members by the means of flexible resilient numbers.

When the sprocket moves and the chain is in movement, it will act on tension element and this element will push the chain inward thus causing the dynamic member to push tension element in the same directions. This movement will cause the dynamic number or the biasing member, which is mounted to the tension element, due to an equal and opposite reaction to the upward movement of the chain causes the tension element to push side of the chain inwardly. Simultaneously, the dynamic number will tend to push the tension element inwardly. This reciprocating movement will tend to slow down the second gear or make it to rotate in a non-

constant speed. This slows down a given intake or outtake port on the disc from making its complementary outtake and intake aperture on the engine cylinder head. This meeting of the ports will be in such a way so as to cause non uniform sequencing by causing the periodic tension on the chain.As it is known that engine starts easier at high compression. For increased operating reliability, the disc value engine timing is designed for high compression starting at retarded intake and exhaust part openings. Dynamic flow losses and system resistances are alleviated by easily intake and exhaust part opening at high speed operation.

Thus, increasing the engine efficiency by advancing the effective period of the power cycle under load. Value timing improves the engine efficiency and reliability and also easier starting, higher operating equal and increased good capacity.

CHAPTER 6. CONSTRUCTION AND FABRICATION OF WORKING MODEL

For constructing the working model of Rotary Disc Valve System of an Internal Combustion Engine, we have used a cast iron rectangular Dimensions of the Cylinder Head -

- Length of the cylinder head = 139.6 mm
- Breadth of the cylinder head = 124.48 mm
- Thickness of the cylinder head = 6mm

Dimensions of Rotary Disc -

- Diameter of the Rotary Disc = 112.3mm
- Thickness of the Rotary Disc = 7.95

Diameter of the port –

- Diameter of the port = 21mm
- Inlet and exhaust centre to centre distance 47.79mm
- Inlet and spark plug centre to centre distance 82.82mm

CHAPTER 7. ADVANTAGES OF ROTARY DISC VALVE SYSTEM

- Low lubrication oil consumption
- Low vibration and noise during valve operations
- Easy in construction and simplicity in design
- Low material cost
- Small size and weight
- Low hydraulic resistance

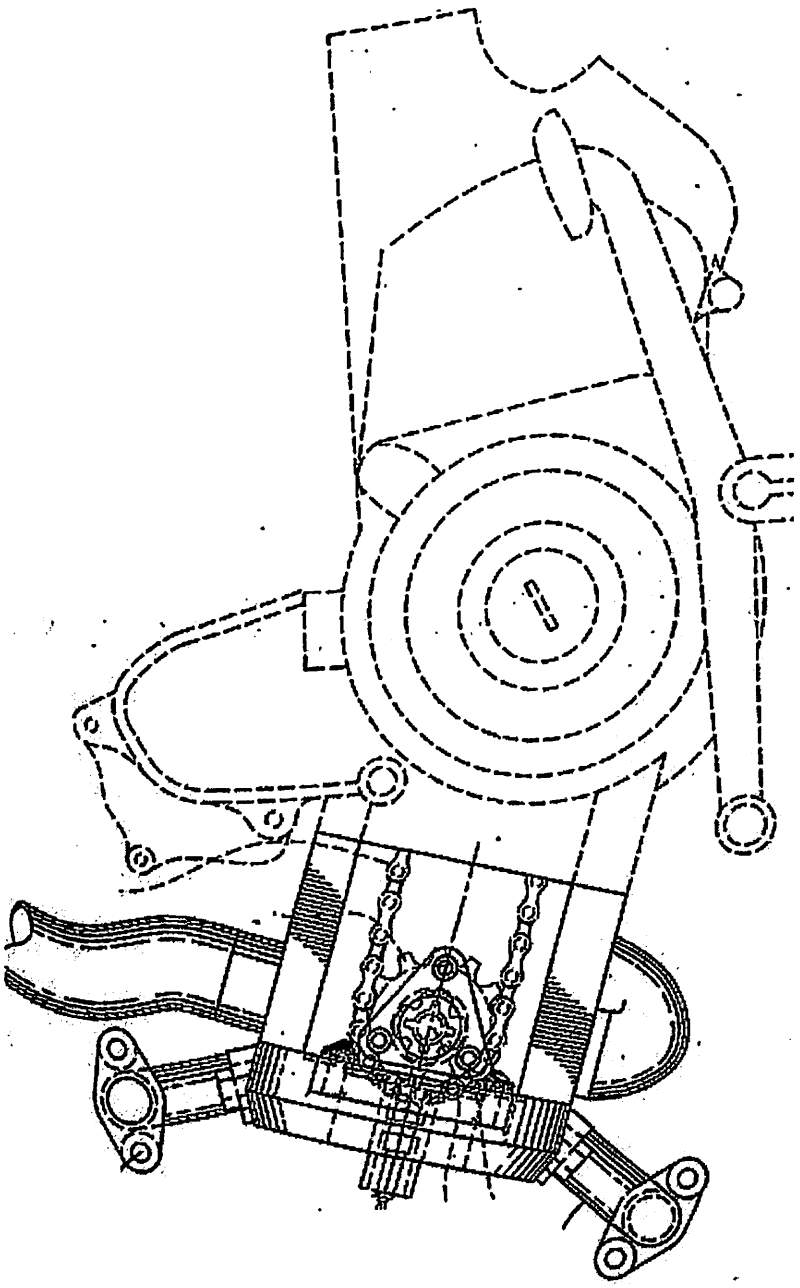

Figure 4. Lateral view of the Disc Valve System mounted onto an engine

CHAPTER 8. DISADVANTAGES OF ROTARY DISC VALVE SYSTEM

- Slightly low power output
- Loose chain may lead to lag in cycle.

CHAPTER 9. MATERIAL CHARACTERISTICS

- Cylinder head: Cast Iron
- Rotary Disc: Aluminum

Due to low coefficient of thermal expansion, Aluminum is used instead of Cast Iron in Rotary Disc.

CHAPTER 10. FACTORS AFFECTING THE COST

Material cost

Cost of the Aluminium disc

Gears: Bevel gears and Pinion gears

Sprocket

Timing chain

Seal : Stationary Seals and Dynamic Seals

Elimination of Cams ,camshafts and tappet

Manufacturing costs

Disc:

Turning ,Facing, Hobbing, Drilling and Heat Treatment process.

Labour costs

CHAPTER 11 COST ANALYSIS OF WORKING MODEL

Iron plate	**Rs.150**
Elbow	**Rs. 100**
Spring	**Rs 20**
Manufacturing cost	**Rs 1200**
(Facing surfacing turning and drilling)	
Welding cost	**Rs 500**

CHAPTER 12. APPLICATION

The disc value systems can be mounted to a variety of the present piston drives engines. The engine can be fitted any type of transport vehicle such as a car or a motorcycle. This system can also be fitted in gardening equipments and the various 2-stroke or 4-stroke piston engines. Hence, the disc valve systems can be used for engines having a variety of power and size capabilities.

The Rotary Disc Valve engine can use any type of fuel, such as diesel or gasoline or any other type of fossil fuel. The engine can also be used in fuel cell engines powered by methanol, ethanol, natural gas, gasoline and compressed hydrogen. Above all, the engines can be used in electrically power motors too.

CHAPTER 13. CONCLUSION

With the Help of Disc Valve Rotary system, we can reduce noise and vibration during each cycle due to the elimination of tappets and cams. Rotary Disc Valve System is a system simple in construction with no complexity in design with operation similar to the conventional Internal Combustion Engine. Due to the removal of cams and camshaft, the system is simple in construction ,light weight and thus the cost is reduced.

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