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Study of Design & Manufacturing of Cam Operated Spring less Valve System for IC Engine

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ABSTRACT - *This paper represent to the spring less valve System for IC Engine. Dissimilar to the ordinary valve System spring less valve System utilizes two cams for every valve with substitution of spring. This component has an end cam which does not allow cam hop as regular valve System. In this work first we will discuss customary valve segment and its positive conditions and downsides and after that we will analyse about spring less valve System alongside its favourable circumstances and disservices. It will assist us with finding out how spring less valve System is prevalent than customary valve System. We are additionally going to discover the genuine significance of this spring less valve System at higher rpm of Engine and need of this System at higher rpm. This System improves the execution of IC Engine by lessening power utilization for defeating spring solidness and stay away from cam seize fast.*

Key Words: *Cam Operation, Spring less Valve, Valve Timing, over jump, Valve Float, etc*

1. INTRODUCTION

IC Engines uses valves to handle charge in and out of the cylinder for their operation. There are intake valves and exhaust valves which are to spring less be operate at right time when needed and remains close to seal the cylinder when compression and combustion is occurred. To do this opening and closing of valves cam and follower mechanism is used. In conventional valve train valves are fitted with metal spring. Opening of valve is done by cam profile which has raised section on its profile to open the valve and spring helps during closing of valve to follow cam profile during return stroke of follower.

The valves in a typical four stroke engine permit the air/fuel mixture into the cylinder at the beginning of the cycle and exhaust gases to be expelled at the end of the cycle. In a conventional four stroke engine, the opening of valve is carry out by cam and closed by return spring. An engine using cam follower mechanism has two cams and two followers, each of positive opening and closing without spring.

The regular valve spring framework is fulfilled for conventional mass-created Engines that don't rev exceedingly and are of a plan that requires low support. At the time of introductory spring less valve advancement, valve springs were a noteworthy restriction on Engine execution since they would part from metal weariness. The spring less valve framework was conceived to cure this issue. In addition, as most extreme rpm increments, higher spring power is required to foresee valve coast.

IC ENGINE VALVE MECHANISM

In Internal Combustion Engine there are two kinds of valves admission and fumes valves they are as appeared in fig. admission valve is insignificant more noteworthy in width since it needs to work at lower weight that is admission valve is opens when Engine begins to suck the charge because of this there is some negative weight amid suction stroke of Engine in this way to beat limitation to stream consumption valve is kept minimal greater in distance across. Where exhaust valve is working at higher weight subsequently it is minimal littler in distance across than admission valve.

There is more warmth age at fumes valve because of fumes gases which are at higher temperature in this manner we need predominant cooling at fumes valve.

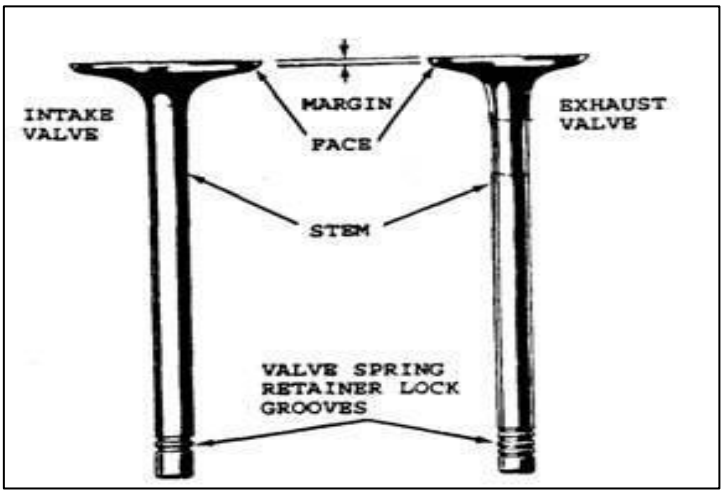


Fig - 1: Valves

As notice prior fumes valve is littler width thus there is less region which is in contact with valve situate this plan make issue amid warmth exchange in this manner cooling is significant in the event of fumes valve and there is no such issue if there should be an occurrence of admission valve since approaching air which is moderately cooler it helps in cooling of valve and furthermore the region of contact among valve and valve situate is additionally more prominent than fumes valve. Because of this there is issue of consuming of valve.

DISADVANTAGES OF VALVE SPRING MECHANISM

1. Harm to Engine valves of IC Engine opened by cam and shutting of valve is absolutely relies upon helical spring. There are odds of disappointment of springs at high rpm or there is odds of valve glide. In the event that this marvel is occurs cylinder and valves crashes on one another and this causes genuine harm to Engine. If there should arise an occurrence of multi barrel Engine harmed metal pieces goes to all chambers from admission complex. Because of this on the off chance that one of a valve spring fizzles it makes harm all Engine.

2. Prerequisite of firm spring-regular valve framework works on spring having some firmness this solidness is kept high to maintain a strategic distance from valve glide. Assembling of these springs is unsafe employment, exacting assessment required so that there ought not to be any deformity in spring and this expands cost of framework.

3. valve incitation isn't controlled-in valve spring system there is sure opening of valve by cam yet shutting of valve is absolutely relies on the spring. So we can't control shutting of valve by cam this causes valve skim at high rpm. What's more, because of valve drift we can't control the valve incitation.

4. overheating-in IC Engine chamber heaps of warmth is produced this warmth is exchanged to Engine parts as valves comes in direct contact with ignition they generally runs hot. This warmth is exchanged to valve seats which are fitted on barrel head and afterward conveyed by coursing coolant in chamber head. In any case, there is less time to do this since valve isn't generally in contact with seat in the event of drifting this time again gets decrease and causes overheating of valves.

5. Reduction in Engine yield control required to drive the camshaft is taken from wrench of Engine. As framework utilizes hardened spring for its activity, power required to open the valve is increasingly because of this there is control misfortune in Engine itself.

PROBLEM STATEMENT

1. Conventional system is useful up to a limit that is when engine rpm goes on increasing there is danger of cam jump and due to this valve starts to float.

2. Generally the damage is due to floating of valve.

3. Valves of IC engine opened by cam and closing of valve is totally depends on helical spring. There are chances of failure of springs at high rpm or there is chances of valve float. As shown in Figure 1.2

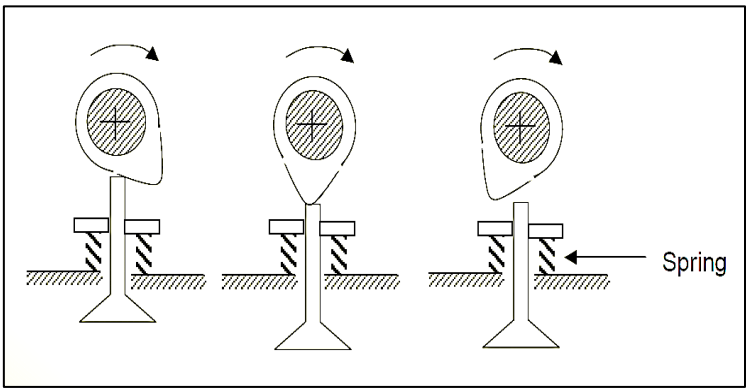


Fig - 2: Valve Floating

OBJECTIVES

The purpose of the modification of the valve system is to improve the Performance of IC engine.

The followings are the important objectives,

- To add the cam instead of spring in valve closing mechanism
- To avoid the over jump of the system of valve in IC engine

2. LITERATURE SURVEY

Kosuke Nagaya, et. Al [2015] [1]

They considered on the new sort motor valve control framework which has been displayed, in which both the valve lift and valve timing are controlled legitimately by Cam. The cam state of this framework is three-dimensional. The stature of the cam shifts along the hub of the pole. At the point when the ball screw turns, the camshaft slides in the hub heading, with the goal that the lift of the cam differs. The control strategy is displayed for the component, in which valve stage and the lift are controlled persistently. Test tests have been done for the framework.

Variable valve timing (VVT) is utilized in flash start car motors to improve efficiency, lessen NOx gas, and increment crest torque and power.

G. Dalpia, A. Rivola.[2000] [2]

Has inquired about on it that a lumped-parameter model of a motorbike motor's desmodromic valve train is produced for the reenactment of the dynamic conduct of such an extraordinary train. As an outcome, movement modifications may happen, making components flop in the best possible execution of their errands; high increasing velocities and dynamic feelings of anxiety may likewise create early exhaustion disappointments, and large amounts of vibration and commotion may emerge. In the specific of valve trains for superior motors, these dynamic impacts are especially significant, since they may cause genuine useful inconveniences, for example, hop and skip marvels, just as flaws. Consequently, expanding consideration is tended to This work concerns the planning arrangement of the twin chamber 'L' motors of Ducati hustling motorbikes, having twofold overhead camshafts, desmodromic valve trains and four valves for each barrel.

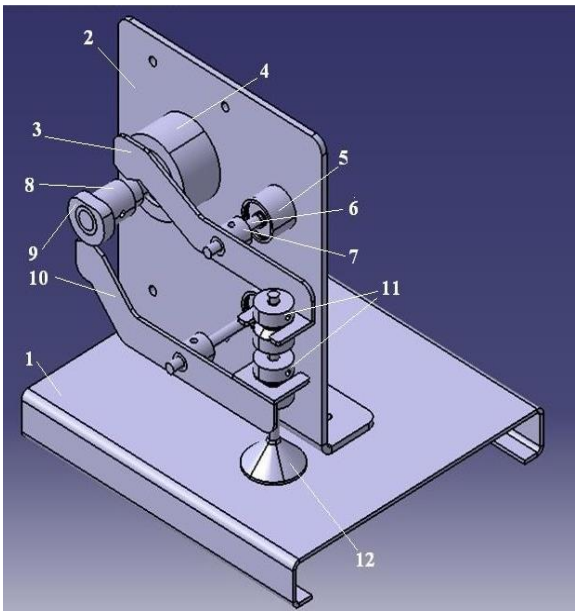
Jie Guo, et al [2012] [3]

They have investigated valve train elements model of inward burning motor has been created utilizing the kineto-elastodynamics strategy. The elements conduct for adaptable parts, for example, the valve springs in the valve train framework was depicted by the wave condition. The contact power at the cam/tappet interface was evaluated by the elasto - hydrodynamic oil hypothesis of limited line combination. Segment sub models were coordinated into the entire valve train model by coupling the relating contact and grating powers, and explained all the while thinking about transient impact of grease, just as the torsional and twisting vibrations of camshaft.

A. Rivola, M. Troncossi. [2007] [4]

They have taken a shot at the methodology to approve the model, in view of exploratory tests did on a test seat depicted here, is exhibited and examined. The examination between the numerical outcomes and the exploratory information demonstrates that the viability of the model is attractively accomplished. As referenced in the writing audits conveyed the principle reasons for these examinations were expected to ascertain conceivable devotee hopping off the cam, to decide the connection response powers, to research the effects of the supporter against its seat, to advance part configuration by exploring the dynamic reaction of the framework the segments have a place with as well as to give a device to blame diagnostics. Besides, expanding consideration has as of late been routed to the investigation of clamor, vibration, incompletely subject to the dynamic impacts emerging in the valve train frameworks and transmitted to the neighboring parts of the motor. The reaction exactness and the straightforwardness of the issue definition.

3. DESIGN OF PROTOTYPE MECHANISM FOR PROPOSED SYSTEM



Sr. No.	Part Name	Sr. No.	Part Name
1	Base Plate	7	Bush
2	End Plate	8	Cam Bush
3	Opening Rocker Arm	9	Cam
4	Bearing Holder 1	10	Closing Rocker Arm
5	Bearing Holder 2	11	Valve Holder
6	Shaft	12	Valve

Fig - 3: Cam Operated spring less valve mechanism

Figure 3 shows the spring less IC engine valve mechanism's Prototype model and table 1 shows the components of that prototype

WORKING

The electric motor is started and power is transmitted to the camshaft through gear pair and camshaft start to rotate. In case of IC engine this power is given by crankshaft of engine by connecting camshaft and crankshaft by chain, belt or gear.

The cams are fixed on camshaft and in this manner they additionally begins to pivot with shaft. There are two cams opening cam and shutting cam. These cams works rocker arms as opening cam pushes the opening rocker arm this will in general push the valve and opens it in the meantime shutting rocker arm does not confine the snapshot of opening rocker arm and it bolster the valve and maintain a strategic distance from free tumbling off valve.

At the point when valve lifts from its seat completely then it begins to return on seat for example it begins to close this is finished by shutting cam. shutting rocker arm begins to lift the valve by following the bend of shutting cam in the meantime opening cam does not limit the development of shutting cam, to accomplish this target we need to structure the cam profile with the end goal that the valve ought to work easily thusly there is connection between these two cam profiles. Thusly the opening and shutting of valve is managed without cam bounce on the grounds that the end of valve does not rely upon spring as in customary valve spring instrument.

Spring less component utilizes two separate cams one is for open and other is for close the valve. This component kills the cam hop wonders which lessens the danger of motor harm at fast. As in ordinary valve spring component some

intensity of motor is lost to defeat the spring power to work the valve this misfortune is limited in the event of spring less valve system which results in more shaft yield.

DESIGN CONSIDERATIONS

- **VALVE TIMING DIAGRAM**

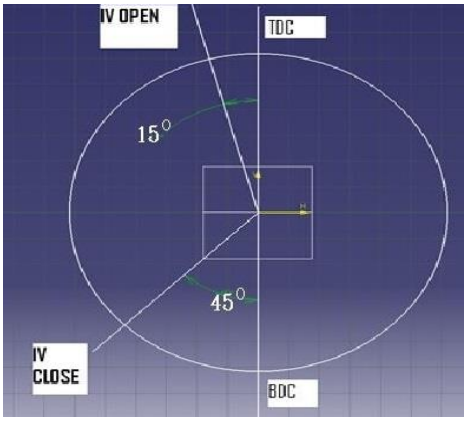


Fig. - 4 : Valve Timing Diagram

- **SHAFT DESIGN**

Shaft is design by using maximum shear stress theory

$$d^3 = \left(\sqrt{M^2 + T^2}\right)(16 \times \tau all)/\pi$$

Where,
D = diameter of shaft (mm),
M = bending moment (N/mm),
T = torque (N mm),
τall = allowable shear stress of shaft material (N/mm2)

$$= \frac{0.5 \times Syt}{F.O.S}$$

- **BEARING SELECTION**

The expression for equivalent dynamic load is
P = X Fr + YFa
P = equivalent dynamic load (N)
Fr = radial load (N)
Fa = axial load (N)
X = Radial load factor
Y= Axial load factor
The life of bearing is calculated as follows

$$L10 = \frac{60 \times n \times L10h}{10^6} \text{ million rev}$$

L10 = Life in million revolutions,
L10h = Rated bearing life in hrs,

N = speed of rotation in rpm,
Dynamic load carrying capacity is given by,

$$L10 = \left(\frac{C}{P}\right)P$$

C = Dynamic load carrying capacity (N),
P = 3(for ball bearing)

= 10/3(for roller bearing)

- **MOTOR SELECTION**

Power of motor is calculated by,

$$P = \frac{(2 \times \pi \times N \times T)}{60}$$

P=power (W),
T=Torque (Nm)
N=speed of rotation in rpm

- **GEAR SELECTION**

We use AC synchronization motor which runs at 60rpm but it is inconvenient to see the valve operation at 60rpm. Hence we reduce the speed to 30rpm by using gear pair of gear ratio 2:1.

$$\text{Gearratio} = \frac{Dg}{Dp} = \frac{Np}{Ng} = \frac{Zg}{Zp}$$

Where,
Dg=diameter of gear (mm),
Dp=diameter of pinion (mm),
Ng=speed of gear (mm),

Np=speed of pinion (mm),
Zg=Number of teeth of gear (mm),
Zp= Number of teeth of pinion (mm),

Module is calculated as,

M=d/z

m=module (mm)

Figure 5 shows the Opening and Closing Cams respectively which are going to be used in the prototype model of the spring less valve mechanism for IC engine.

ANALYSIS OF CAM

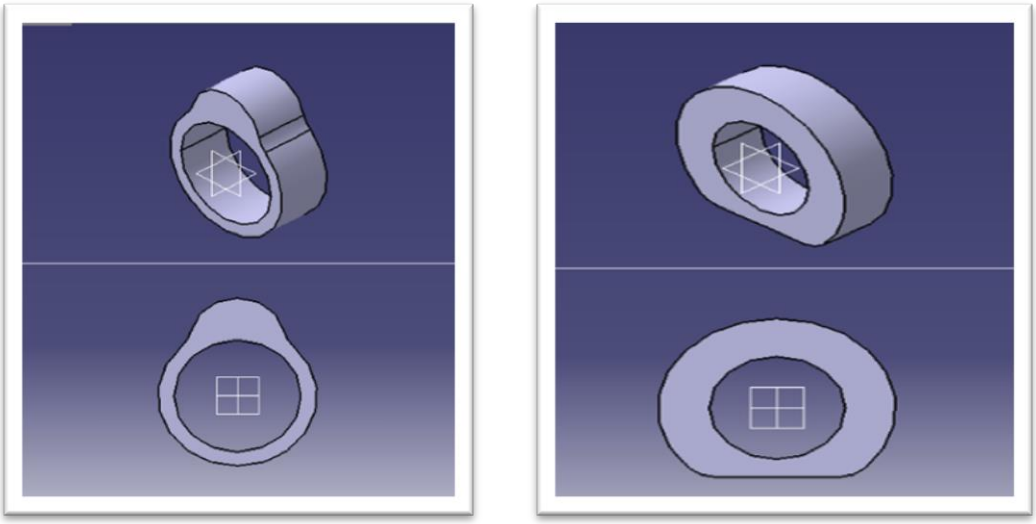


Fig. – 5 Opening and Closing Cams to be used respectively

- **Maximum Principle Stress**

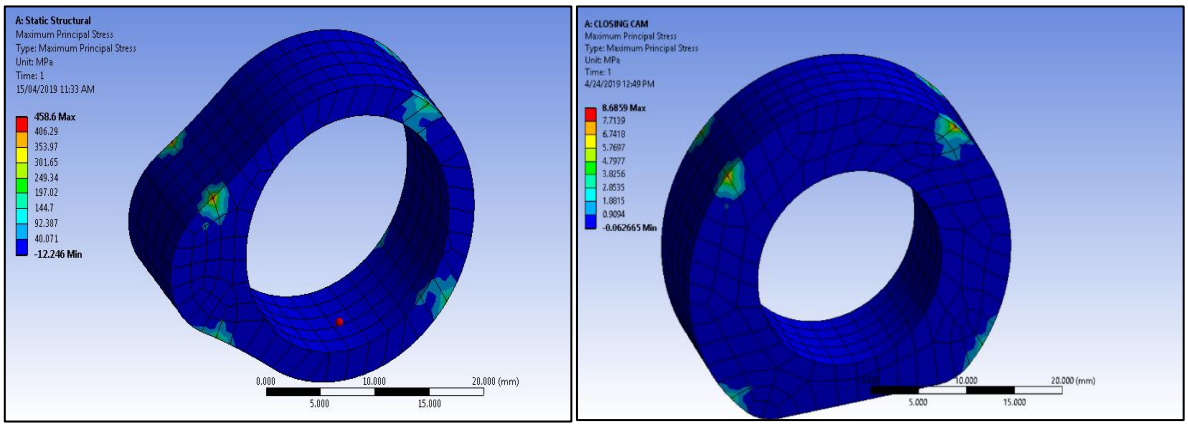


Fig. - 6 : Maximum Principle Stress

• Directional Deformation

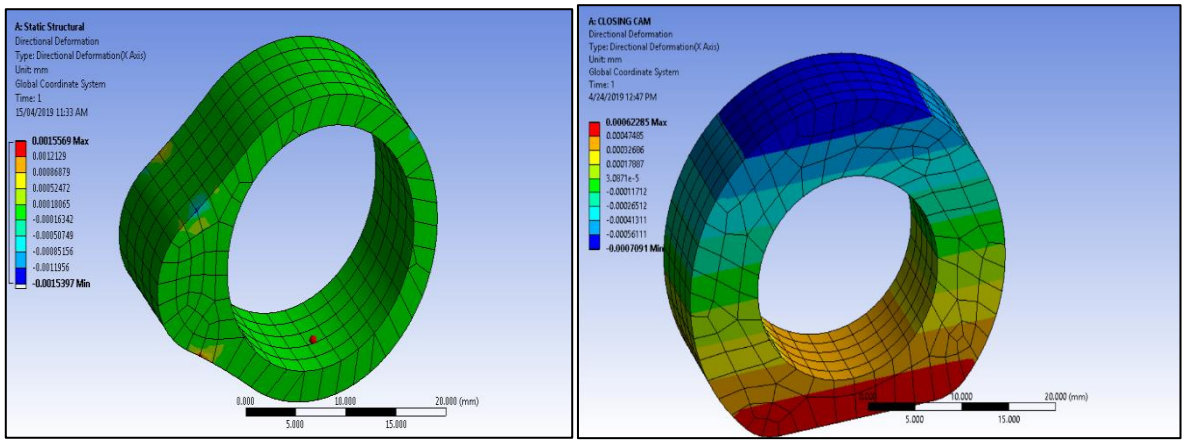
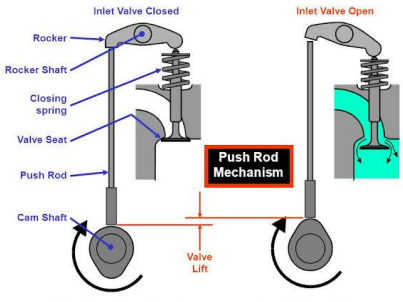
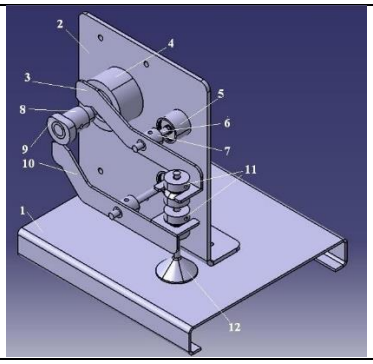


Fig. - 7 : Directional Deformation

THEORETICAL COMPARISON WITH CONVENTIONAL VALVE SYSTEM

Table 1.2 Comparison between conventional valve system and Cam operated spring less valve system

Sr. No.	Parameter	Conventional valve system	Cam operated spring less valve system
1	Diagrams		
2	Basic Arrangement	In conventional valve train, valves are fitted with metal spring. Opening of valve is done by cam profile which has raised section on its profile to open the valve and spring helps during closing of	In "Cam operated spring less valve system" the valve is open and closed with the help of opening and closing cam's.

		valve to follow cam profile during return stroke of follower.	
3.	Stiffness	For high speed engines to avoid cam jump we have to increase stiffness of springs. To achieve this, concentric springs are used and these springs are manufactured very carefully. Strict inspection is also required. These processes are very costly.	In this valve system there is no spring used for actuation of valve. Hence the problem with stiffness is not going to occur with this system
	Valve Floating	Most valves are opened by the cams and closed by springs. However, it takes time for the spring to 'unwind' and push the valve back. If the engine is going fast enough, the valve doesn't follow the cam and a gap appears momentarily. This means that the valve stays open slightly longer than it should do. As it simply cannot close fast enough.	In this cam operated spring less valve system the valve is opened and closed using cam only. When engine speed is maximum than usual the valve will open and close very quickly with the cam profiles. Hence in this system there in no chances of valve float.

4. CONCLUSIONS

By using spring less valve train we can control the movement of the IC engine valve accurately without any cam jump risk which improves engines performance. This valve train is especially suitable for engines with high rpm i.e. racing engines. This system also helps to improve engine output as there is absence of valve springs which takes some power from crank for its operation.

1] The system presented can control the valve timing and the valve lift continuously.
2] Although there are friction losses for cams, the present system has some advantages on the valve response stability, sound noise, control energy, prices, weight, and ability of control.

FUTURE SCOPE

Due to the Norms for Controlling Pollution we have to refine our engine to perform it better with minimum pollution, to achieve this objective we have to adopt new technologies such as variable valve timing. In spring less valve system we can also adopt this technology by some mechanism which gives us better performance at any speed with minimum pollution.

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