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Design and Modification of Cam Operated Spring-less Valve System in IC Engine

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***Abstract**: This project presents the spring less valve system used in the IC engines.This mechanism has a closing cam which does not allow cam jump as conventional valve system. It has helped us to find out how spring less valve system is better than conventional valve system. We have found out the real importance of this spring less system at higher rpm of engine and need of this system at higher rpm. This system improves the performance of IC engine by reducing power consumption for overcoming spring stiffness and avoid cam jump at high speed.*

***Keyword:** Springless valve system, closing cam, cam jump, IC Engine, Stiffness*

I. Introduction

1.1 Introduction to conventional Spring System

IC Engine uses valves to handle charge in and out of the cylinder for their operation. There are intake valves and exhaust valves which are to be spring operated 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 presently 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.

This spring helps the follower to follow the cam profile. But as rpm of engine increases, valves have to open and close fast this causes valve float or cam jump. To avoid this we have to use spring having more stiffness to fulfill the requirement and this leads to loss of engine power to overcome this stiffness of spring. The problem of loss of engine power is overcomed in spring less valve system which does not use springs for their operation and there is absence of cam jump phenomenon which results in better engine operation and high power output from engine. This gives freedom to engineers to design engine for higher rpm with no cam jump.

The valves in a typical four stroke engine allow 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, valves are opened by a 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 common valve spring system works fine for traditional mass-produced engines that do not revolve at high rpm and of a design that requires low maintenance. At the period of initial spring less valve development, valve springs were a major limitation on engine performance because they would break from metal fatigue. The spring less valve system was devised to remedy this problem. Furthermore, as rpm increases, higher spring force is required to prevent valve float.

1.2Problem Statement

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. In case of multi cylinder engine damaged metal pieces of spring goes to all cylinders from intake manifold. Due to this if one of a valve spring fails it causes damage to all engine. Conventional valve system operates on spring having some stiffness this stiffness is kept high to avoid valve float.

1.3 Objectives

The purpose of the modification of the valve system is to improve the efficiency 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

II. Literature Review

[1]Valve timing and valve lift control mechanism for engines Kosuke Nagaya, Hiroyuki Kobayashi, Kazuya Koike. [2012]

A new type engine valve control system has been presented, in which both the valve lift and valve timing are controlled directly by electric motors. A mechanism of the valve timing control system is made of planetary gears. The outer gear is the timing pulley which has a timing belt driven by the crankshaft of an engine. Two planetary gears are inside of the pulley. The gears engage with the inner gear of the pulley. The center of the disc, which has centers of the planetary gear, is connected to the camshaft. Then, the crank rotation is transmitted to the camshaft, and rotations of sun gear are added to the rotations of camshaft. This means that when rotation angle of the sun gear is controlled, the phase between the inlet valve and the exhaust valve can be controlled.

[2]A non-linear elastodynamic model of a desmodromic valve train G. Dalpiaz, A. Rivola. [2014]

A lumped-parameter model of a motorbike engine's desmodromic valve train is developed for the simulation of the dynamic behaviour of such an uncommon train. The model takes into account several non-linear effects and is highly time-varying. The estimation of the model parameters is discussed and the effectiveness of the model is assessed by a comparison with experimental results. The model is employed to predict the magnitude of forces, impacts and bounces, and to detect unacceptable dynamic phenomena; thus, it may be used as a tool both in design optimization and diagnostics. Many studies on modelling and dynamic response of exible mechanisms are present in the literature. They deal with mechanisms operating at such a high speed that the dynamic behaviour is deeply affected by link elastic exibility and mass distribution, as well as the effects of backlash and friction in joints.

[3]Investigation of dynamic characteristics of a valve train system Jie Guo Wenping Zhang, Dequan Zou. [2012]

A valve train dynamics model of internal combustion engine has been developed using the kineto-elastodynamics method. The dynamics behavior for flexible components such as the valve springs in the valve train system was described by the wave equation. The contact force at the cam/tappet interface was estimated by the elasto - hydrodynamic lubrication theory of finite line conjunction. Component submodels were integrated into the whole valve train model by coupling the corresponding contact and friction forces, and solved simultaneously considering transient effect of lubrication, as well as the torsional and bending vibrations of camshaft.

[4] Elastodynamic analysis of the desmodromic valve train of a racing motorbike engine by means of a combined lumped/finite element model A. Rivola, M. Troncossi, Dalpiaz, A. Carlini. [2016]

A combined lumped/finite element model of a portion of the desmodromic valve train of a racing motorbike engine was developed and validated in order to simulate the elastodynamic behaviour of such a particular timing system. The model includes the lumped parameter model of the belt transmission that drives the camshafts, the finite element model of the camshafts, and the lumped parameter model of two cam-valve mechanisms (one for each camshaft). The procedure to validate the model, based on experimental tests carried out on a test bench described here, is presented and discussed. The comparison between the numerical results and the experimental data shows that the effectiveness of the model is satisfactorily achieved. It will be possible, in a further study, to add the other cam-valve mechanisms and the missing external forces, in order to obtain a complete system model. Some possible applications of the presented model are provided in order to show how the overall model could be employed to perform both design optimisation and diagnostics.

III. Methodology

3.1 Model

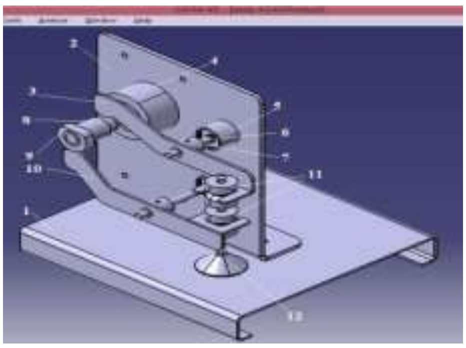
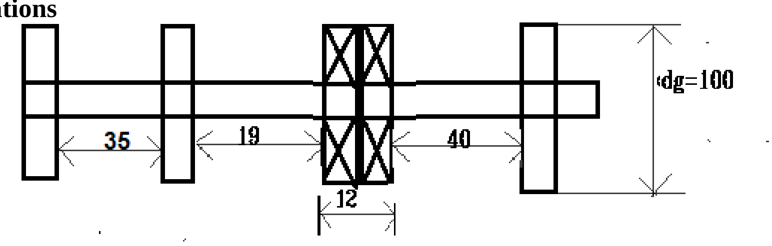


Fig.- spring less valve mechanism

1. Base Plate
2. End Plate
3. Opening rocker Arm
4. Bearing Holder 1
5. Bearing Holder 2
6. Shaft
7. Bush
8. Cam Bush
9. Cam
10. Closing Rocker Arm
11. Valve holder
12. Valve

3.2 Design Calculations



T=0.981Nm,
N=30RPM,
dg=100mm

$$P=\frac{2\pi NT}{60*1000}$$

P=6.1638W….(driving gear)

$$6.1638=\frac{2\pi 30T}{60*1000}$$

T=1.961Nm

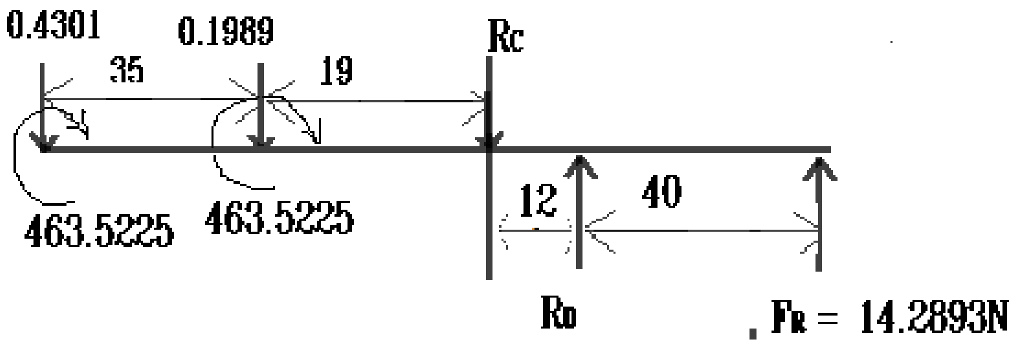
$$Ft==\frac{P}{V}=\frac{6.1638}{0.157}$$

$$V=\frac{\pi dN}{60*1000}$$

V=0.157m/s

Ft=39.2598N
Fr=Ft*tanϕ
=39.2598*tan20
Fr=14.2893N

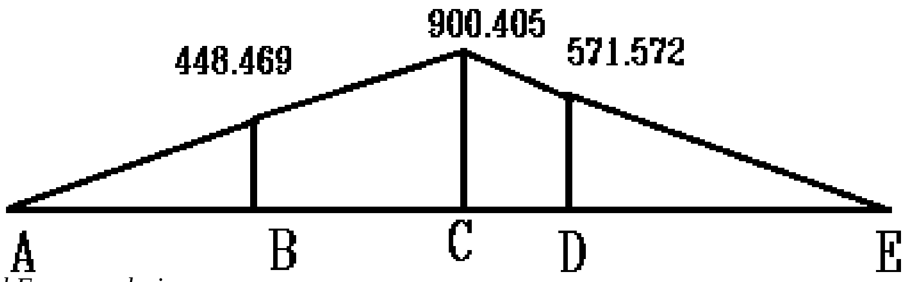
Vertical Force analysis



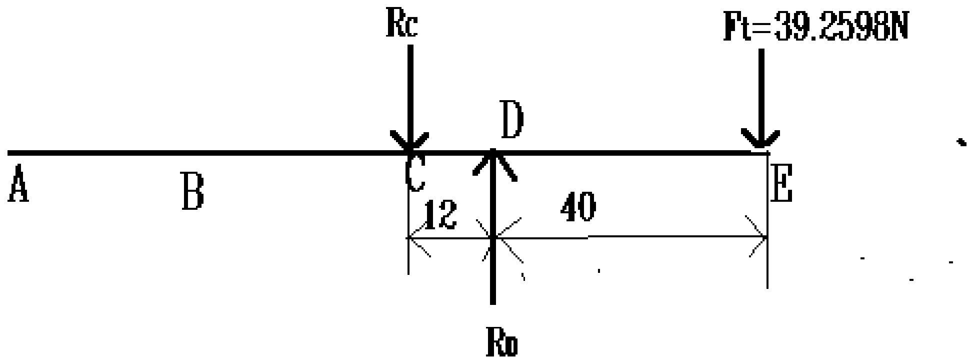
M @ D= (-0.4301*66) + 463.5225 + 463.5225- (0.1989*31) - Rc*12 - (14.2893*40)

- Rc*12=-320.9205
Rc= 26.7433 N
Fv=0
=-0 .4301– 0.1989 – 26.7433+RD + 14.2893
RD= 13.083

Bending Moment @ A = 0
Bending Moment @ B= 448.469 Nmm
Bending Moment @ C= 900.0405 Nmm
Bending Moment @ D = 571.572 Nmm
Bending Moment @ E = 0



A. Horizontal Force analysis



M @ C=39.2598*(40+12)-RD*12=0

RD*12 = - 2041.5096

RDH=170.1258N

Fv=0

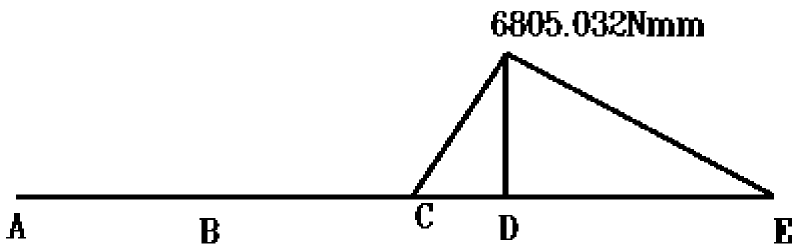
Fv= - RC+170.1258- 39.2598

RC=130.866N

Bending Moment @ C =0
Bending Moment @ D = 6805.032Nmm
Bending Moment @ E = 0
Net Moment at B = 448.468Nmm
Net Moment at C = 900.0405NmmNet
Moment at D=$\sqrt{(M@Dv)^2 + (M@DH)^2}$

$$\sqrt{(571.572)^2 + (6805.032)^2}$$

=6828.99Nmm



$$\tau = \frac{0.5*syt}{F.O.S} = 135 N/mm^2$$

$(\frac{\pi}{16})*d^3*135=\sqrt{M2+T2}$.... (According to maximum shear stress theory)

d=14mm

Selection of bearing

P =X Fr +Y Fa

$$Frc=\sqrt{(FrDV)^2+(FrDH)^{\wedge}2}$$

Frc = 133.571N

$$Frd=\sqrt{(FrDV)^2+(FrDH)^{\wedge}2}$$

Frd=170.628N

Fa=0

From Design data ,

X = Radial factor = 1

Pc=133.571N

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

$L10=(\frac{C}{P})^{\wedge}3$.....(for ball bearing)

From Design data = L10h = 12000h

$$L10=(\frac{C}{P})^{\wedge}3$$

L10 = 21.6 million rev.

$$L10=(\frac{C}{P})^{\wedge}3$$

C = P*L^(1/3)

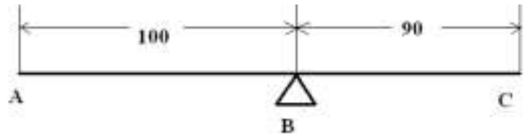
C = 133.571*21^(1/3)

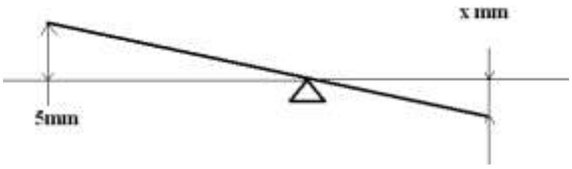
C = 371.988N

For 17 mm dia, following bearings are available

1. No.61803
2. No.6003
3. No.6203
4. No.6303
5. No. 6403

B. ROCKER ARM MECHANISM





By lever ratio,

$$\frac{100}{90}=\frac{5}{X}$$

X=4.5mm

3.3 Working

As the electric motor starts, power is transmitted to the camshaft through gear pair and camshaft starts rotating. 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 therefore they also starts to rotate with shaft. There are two cams, opening cam and closing cam. These cams operates rocker arms as opening cam pushes the opening rocker arm this tends to push the valve and opens it, at the same time closing rocker arm does not restrict the moment of opening rocker arm and it support the valve and avoid free falling of valve.

When valve lifts from its seat fully then it starts to return on seat i.e. it starts to close this is done by closing cam. closing rocker arm starts to lift the valve by following the curve of closing cam at the same time opening cam does not restrict the movement of closing cam, to achieve this objective we have to design the cam profile such that the valve should operate smoothly therefore there is relation between these two cam profiles. In this manner the opening and closing of valve is done without cam jump because the closing of valve does not depends on spring as in conventional valve spring mechanism.

Spring less mechanism uses two separate cams one is for open and other is for close the valve. This mechanism eliminates the cam jump phenomena which reduces the risk of engine damage at high speed. As in conventional valve spring mechanism some power of engine is lost to overcome the spring force to operate the valve this loss is minimized in case of spring less valve mechanism which results in more shaft output.

IV. Future Scope

Many internal combustion engines, such as those operating on four stroke principle are provided with at least one intake valve and at least one exhaust valve. The intake and exhaust valves are disposed in intake and exhaust passages. They are actuated to open and close the passages in order to control the flow of air and fuel into a combustion chamber of the engine and the flow of exhaust gases out of the combustion chamber. Various mechanisms exist to actuate the movement of the valves.

Spring less valve system is one of the mechanism which gives better solution to actuate the valve. In this system due to two i.e. opening and closing cams valve actuation is positive means without cam jump as in case of conventional mechanism closing of valve is totally depends on spring.

V. Conclusion

By using spring less valve train we can control the movement of the IC engine valve accurately without any cam jump which in turn 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 efficiency 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 controllability.

References

[1]. Kosuke Nagaya, Hiroyuki Kobayashi, Kazuya Koike,(2012),Valve Timing And Valve Lift Control Mechanism For Engines Department Of Mechanical Engineering, Gunma University, Japan, [pp 2-5]

[2]. G. Dalpiaz, A. Rivola, Non-Linear Elastodynamic Model of a Valve Train, (2014), International Journal Of Engineering Research &Technology [pp 5-11]

[3]. JieGuo Wenping Zhang, Dequan Zou,(2012),Investigation of dynamic characteristics of a valve train system, National School of Engineers of Sfax TUNISIA [pp 3-8]

[4]. 4.Rivola,M.Troncossi,G.Dalpiaz,A.Carlini.(2016),Elastodynamic analysis of the desmodromic valve train of a racing motorbike engine by means of a combined lumped/finite element model.[pp 4-8]

[5]. Design of Machinery, Chapter 8, Cam Design.[pp 432-556]

[6]. Khurmi and Gupta,Theory of Machines.[pp 774-832]