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Redesign of Intake Valve Mechanism of IC Engine to Improve Efficiency

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***Abstract*:- In conventional IC engine intake and exhaust valve is used. These valves are spring loaded. Opening of valve is operated by cam valve and closing of valve is done by spring. The aim of this paper is to build a fixture model in valve is operated without using springs. The spring loaded valve makes sure that the valve remains in contact with the cam and over jumps. But as periodically the stiffness of the spring decreases and the valve starts to jump. Engine has to overcome the force of valve spring to lift the valves, which in turn lead to power loss.**

This power usage to lift the valve by overcoming the spring load is eliminated by building a model which assists opening and closing of intake and outlet valve purely by cam action and not by using spring. This system also helps to improve engine output as valve springs are absent which take power from engine. The system can control the valve timing and the valve lift continuously. Despite the fact that cams have friction losses, the current method offers advantages in terms of valve response stability, sound noise, control energy, costs, weight, and controllability.

INTRODUCTION

Valves are used in IC engines for handling of charge in and out of the cylinder for operation. There are intake valves and exhaust valves that are springless that operate at the right time when needed and stay close to the cylinder when pressure and combustion occur. Cam and follower mechanism is used to do this opening and closing. Valves are fitted with metal spring in conventional valve train mechanism. Cam profile aids in valve opening by having a raised area on its profile, and spring aids in valve shutting by following cam profile during follower return stroke. [1] [2]

It is important to follow the cam profile by follower and this spring force press the follower tightly on cam profile to follow the profile of cam. However, as the engine's rpm rises, valves must open and close quickly, resulting in valve float or cam jump. To avoid this, we must employ a stiffer spring to meet the demand, which results in a loss of engine power to overcome the stiffness of the spring. These drawbacks are eliminated in a spring less valve system, which does not rely on springs for operation and eliminates the cam jump phenomenon, resulting in improved engine performance and high power production. Engineers may now design engines for higher rpm without having to worry about cam jump. [1]

Fig 1: Valve guide is provided for each poppet valve in the cylinder head, it is provided to make proper contact with valve seat. The valve guide is a cylinder-shaped piece of metal pressed or casted into the cylinder head, into which the valve reciprocates.

Fig 2: Valve seat is the surface where intake and exhaust valves rests during its operation. This is a key component of the engine; if it is not properly positioned, valve leakage may occur, affecting the engine compression ratio and, as a result, the engine's efficiency, performance, exhaust emissions, and life.

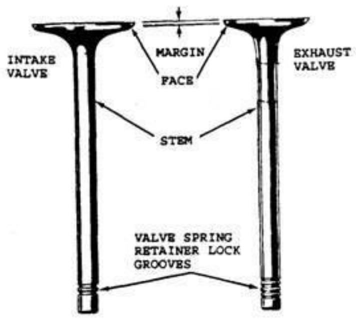

Figure 1: Valves

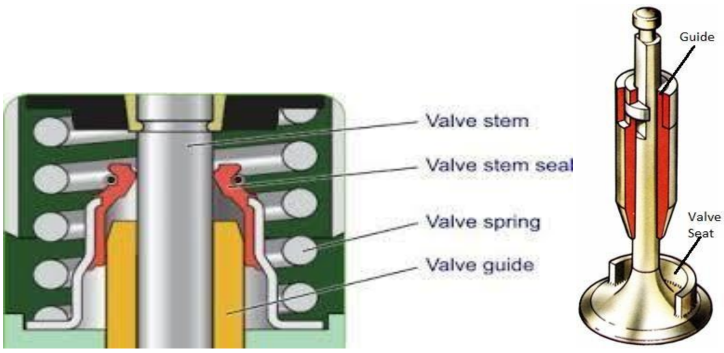

Figure 2: Valve seat and Valve guide

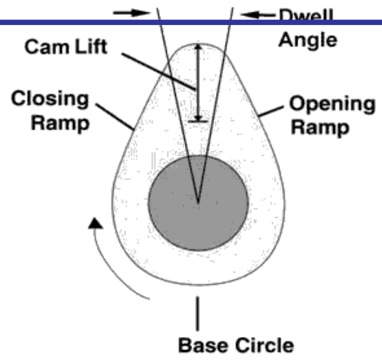

Figure 3: Cam and Follower

Fig 3: To operate the valves at right time cam and follower mechanism is used as shown in above figures. As shown in fig. cam has lobe shape at one of its side. This cam is present on camshaft the profile of cam is milled into the shaft called as camshaft. This camshaft is connected to crankshaft of engine by chain and sprocket or gear mechanism as shown in fig. cam is kept on follower

LITERATURE REVIEW

A non-linear elastodynamic model of a desmodromic valve trains G. Dalpiaz, A. Rivola. 2000 For the simulation of the dynamic behavior of such an unusual train, a lumped-parameter model of a motorcycle engine's desmodromic valve train is built. The model is highly time-varying and takes into consideration various non-linear effects. The estimation of model parameters is described, and the model's performance is evaluated by comparing it to experimental results. The model is used to forecast the amplitude of forces, impacts, and bounces, as well as to detect unwanted dynamic phenomena; as a result, it can be utilised for design optimization and diagnostics. Exile mechanisms have been studied extensively in terms of modeling and dynamic reaction. [1]

Investigation of dynamic characteristics of a valve train system Jie Guo Wenping Zhang, DequanZou. The kineto elasto dynamics method was used to create a valve train dynamics model for an internal combustion engine. The wave equation was used to represent the dynamics of flexible components in the valve train system, such as valve springs. The theory elasto-hydrodynamic lubrication of finite line conjunction was used to calculate the contact force at the cam/tappet interface. By linking the corresponding contact and friction forces, component sub models were integrated into the overall valve train model and solved simultaneously, taking into account the transitory effect of lubrication as well as the torsional and bending vibrations of the camshaft. [2]

Valve timing and valve lift control mechanism for engines Kosuke Nagaya, Hiroyuki Kobayashi, KazuyaKoike. 2006. A novel sort of engine valve control system has been developed, in which electric motors regulate both valve lift and valve timing. Planetary gears are used in the valve timing control system's mechanism. The timingpulley, which is powered by the crankshaft of an engine, is the outside gear. Inside the pulley are two planetary gears. [3]

Elastodynamic analysis of the desmodromic valve train of a racing motorbike engine by means of combined lumped/finite element model. A.Rivola, M.Troncossi, Dalpiaz, A.Carlini. A lumped / finite element model of the desmodromic valve section of a motorcycle racing engine was developed and validated to mimic the elastodynamic performance of a specific time system. The model includes an illuminated parameter model for moving the camshafts, a limited camshafts model, and an illuminated parameter model for two cam-valve systems (one per camshaft). The model validation process, based on the tests performed on the test bench described here, was presented and discussed. Comparisons between numerical results and test data show that model performance is satisfactory. It will be possible, in a further study, to add other cam-valve alternatives and non-existent power, in order to obtain a complete system model. [4]

Kinematic Design and Simulation of a Flexible Valve Lift Mechanism for an IC Engine by Manjunath Gowda, Harish Kumar and N.S.Venktesh Guptha. With a forced, intake charge such as a turbocharger, the engine can burn a lot of fuel. Fuel consumption is largely based on economy, running costs, and driving. A fully flexible valve actuation system of 80 and 90 taper turn in CAM is conceived and designed. So as to give variable valve displacement, flexibility and can be controlled. In the present work a TRI LOBED CAM is developed such that moving the camshaft axially at a slower pace depending on the operating conditions of the engine viz., minimum value displacement at lean loads/low engine speeds, medium valve displacement at intermediate loads and maximum valve displacement at high loads/high engine speeds. [5]

Design of Innovative Engine Valve: Background and Need by S. M. Muzakkir, M. G. Patil and Harish Hirani. To reduce the sensitivity of the engine speed to the valve train performance, standard overhead cam (DOHC) is used. However, this method is prone to softening problems and can lead to high friction and loss of wear. The paper presents current state of the engine valve technology. The issues concerning the optimum performance of the engine has been discussed and the need of an innovative engine has been identified and established. The next part of the paper presents three conceptual designs of the valve train for an internal combustion engine. [6]

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METHODOLOGY

This project was sponsored by Vedant Enterprises, Talwade, Pune. Following steps were performed

- A review of the literature was conducted on a number of study publications. These papers were regarding valves timing and valve mechanism, valve train, racing vehicle engine etc.
- After studying the papers thoroughly designing of the model was started with the guidance of senior members of the industry. Considering all the technical parameters and research papers were referred.
- After designing of the model it was inspected and required changes were made.
- The model was send for manufacturing.
- Total manufacturing cost calculation was done. It involved cost of raw material, actual manufacturing cost.
- Conclusion was carried at last and the objective of this paper was fulfilled.

Design calculation

1. Design cam profile by using following input data
   Dwell - 60
   Rise – 55
   Dwell - 10
   Return – 55

2. Design of shaft
   T=0.981Nm,
   $P = \frac{2\times\pi\times N\times T}{60}$
   P=6.1638W….(driving gear)
   Ft $=\frac{6.1638}{0.157}$
   Ft=39.2598N

3. Vertical force analysis
   M @ D

   - Rc*12=-320.9205
   Rc= 26.7433 N
   Fv=0
   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

4. Horizontal force analysis
   M @ C
   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

5. Bearing selection
   P =X Fr +Y Fa
   Frc = 133.571N
   L10 = (c/p)^3
   C =P*L^(1/3)
   C = 133.571*21.665)
   C = 371.988N
   For 17 mm dia. Following bearings are available

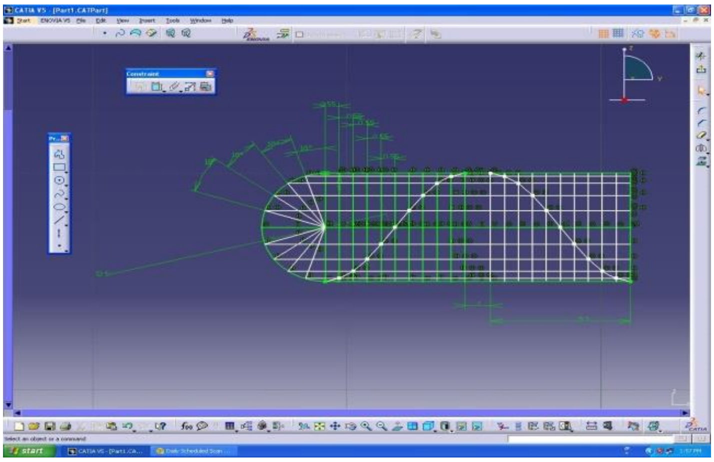

Figure 4: Design Calculation

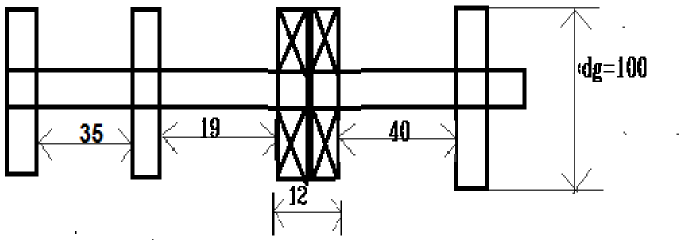

Figure 5: Design of shaft

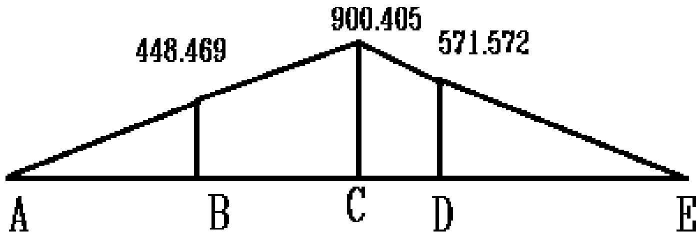

Figure 6: Vertical Force Analysis

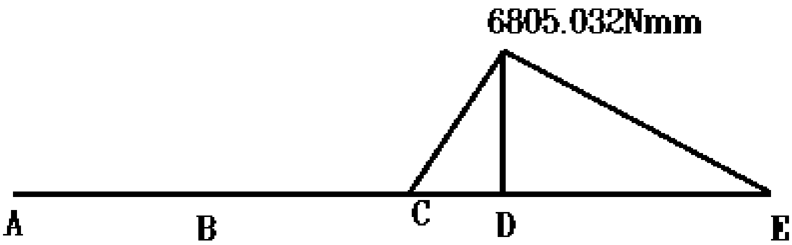

Figure 7: Horizontal Force Analysis

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

6. Rocker arm mechanism
By lever ratio,
(100/90)=(5/X)
X=90*5/100

X=4.5mm

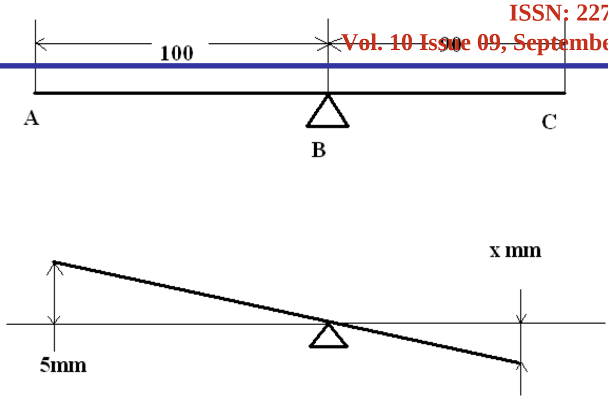

Figure 8: Rocker arm mechanism

7. Design
    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

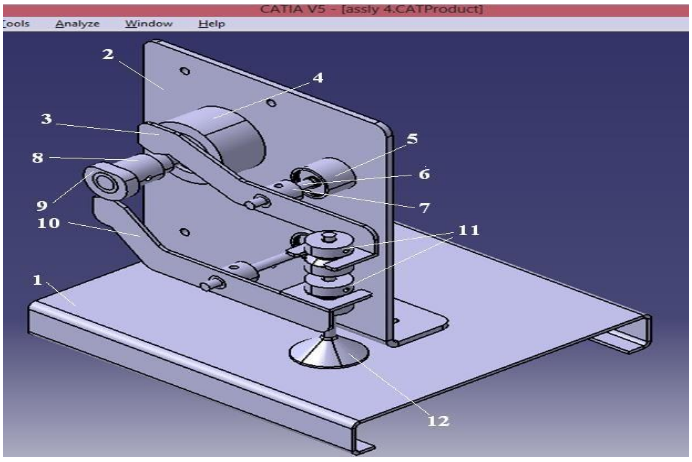

Figure 9: Catia v5 model design

8. Working of motor
The electric motor is turned on, and power is transferred to the camshaft via a gear pair, causing the camshaft to revolve. In an IC engine, this power is provided by the crankshaft, which is connected to the camshaft by a chain, belt, or gear. Because the cams are fixed to the camshaft, they begin to rotate with the shaft. There are two cams: one that opens and one that closes. These cams operates rocker arms in the following manner: the opening cam pushes the opening rocker arm, which tends to press the valve and open it; the closing rocker arm does not restrict the moment of opening rocker arm, and it supports the valve and prevents it from free falling. [3]

9. Total Cost
A) Raw material cost = Rs. 850
B) Machining cost = Rs. 10170
C) Standard component cost= Rs. 4530
D) Overhead cost= (5 % on (A+B+C)) = Rs.780

Total Cost = A+B+C+D = Rs. 16330

CONCLUSION

We can precisely control the movement of the IC engine valve without the possibility of cam jump by adopting a spring less valve train, which increases engine performance. This valve train is very well suited to high-rpm engines, such as racing engines. Because there are no valve springs, which require some power from the crank to operate; this technique also helps to boost engine output.
1] The presented technology can continuously control valve timing and valve lift.
2] Despite the fact that cams have friction losses, the current method has advantages in terms of valve response stability, sound noise, control energy, costs, weight, and controllability.

FUTURE SCOPE

Many internal combustion engines, such as those that operate on the four-stroke principle, have at least one intake and one exhaust valve. Intake and exhaust valves are located in the intake and exhaust passageways, respectively. They are actuated to open and close channels in order to control the flow of air and fuel into the engine's combustion chamber, as well as the flow of exhaust gases out. The valves can be moved using a variety of techniques.
One mechanism that provides a better solution to operate the valve is the spring less valve system. Valve actuation is positive in

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this system due to two i.e. opening and closing cams, i.e. no cam jump, whereas in a traditional mechanism, the closure of the valve is entirely dependent on the spring. There is a possibility of cam jump in a high-speed engine, which causes numerous faults and damages the engine, but this is eliminated in a spring less system, thus this system may function at high speeds without risk.

As a result of the Pollution Control Norms, we must develop our engine to perform better while emitting the least amount of pollution possible; to accomplish this, we must implement new technologies such as variable valve timing. We can also use this technology in a spring less valve system by using a mechanism that gives us superior performance at any speed with no pollution.

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