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Design and Fabrication of Valve Lapping Machine

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Abstract

Automobile maintenance is a major area in the industry of automobile and also a major income to the business. In present, Internal Combustion engine maintenance can be stated as a very important section in automobile maintenance and the valve lapping process that is subjected in this thesis is done during IC engine maintenance. The current methods used in most automobile maintenance businesses for valve lapping process are not effective and consume a lot of working hours. "Valve lapping Machine for Internal Combustion Engines" is a machine designed to overcome these problems by minimizing the human involvement in the process. The thesis consist of the background in designing the machine, methodologies used, results obtained by data analysis in order to optimize the design of the valve lapping machine. Lapping is a machining process in which two surfaces are rubbed together with an abrasive between them, by hand movement or using a machine. This can take two forms. The first type of lapping involves rubbing a brittle material such as glass against a surface such as iron or glass itself with an abrasive such as aluminum oxide, jeweller's rouge, optician's rouge, emery, silicon carbide, diamond, etc., between them.

Keywords Valve lapping; Engine valves; Cylinder head

1. INTRODUCTION

Valve lapping or the process of creating a good seat between engine valves and the corresponding valve seat area in the IC engine head is a task which have to be done very accurately. The importance of obtaining a good seat is that the air/fuel mixture or air is prevented from flowing in to the combustion chamber, same as the exhaust gas is prevented from flowing to the exhaust manifold from the combustion chamber until the right time. And also a good seat prevents compression leaks. The engine will lose its efficiency by huge percentages if any of the situations explained above happens. So as this is a very important task in IC engine maintenance, extra attention is given to this particular task by technicians. This process of valve lapping is typically done using a valve lapping stick or a power tool. As both of these tools are not very effective, these tools can be replaced by the ' Valve Lapping Machine for Internal Combustion Engines', specifically designed for the process of engine valve lapping. The machine employs a fully mechanical system which performs two different motions in two directions previously performed by hand when using valve lapping

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stick and power tool. Comparatively the valve lapping machine is very effective because the human involvement is very limited in the process.

PROBLEM STATEMENT:

The main purpose of the project is to minimize the human effort with excellent machines with precision although the time required for the process is the same for manual as well as the machine but, if we use a machine instead of the person the person can do another job by this time. Also the efforts which are given by employee will be reduced.

OBJECTIVES:

The main goal of this project is to design a machine both efficient and effective than previously used methods for valve lapping and to reduce the labor cost by reducing the human involvement in the process. The objectives that had to be achieved in order to achieve the main goal were designing the basic model of the machine designing the valve lapping mechanism, assembly of the whole machine by designing the parts needed, calculating and designing the cam needed, analyzing data and categorizing them in order to design valve holding pieces, analyzing data to obtain the specifications of the machine, obtaining two dc motors that has specific RPM values and deciding what materials must be used in order for the design to be durable and economical.

SCOPE:

To develop a new automatic operated machine of valve lapping. The new model will get good efficiency compared to old method. This machine will reduce manual effort because of the automation. No need of high skilled worker for the operation by using this machine.

2. LITERATURE REVIEW

MATERIAL REMOVAL MECHANISMS IN LAPPING AND POLISHING:

Polishing processes are critical to high value production processes such as IC manufacturing. The fundamental material removal mechanisms, however, are poorly understood. Technological outputs (e.g., surface finish, sub-surface damage, part shape) and throughput of lapping and polishing processes are affected by a large number of variables. Individual processes are well controlled within individual enterprises, yet there appears to be little ability to predict process performance a priori. As a first step toward improving process modeling, this paper reviews the fundamental mechanisms of material removal in lapping and polishing processes and identifies the physical scale of material removal processes in polishing such that it is difficult (practically impossible) to observe them directly. Much of what we know about the fundamental mechanisms involved in the process has been derived either by correlating macroscopic measurements of process outputs with models, or by extrapolation from experiments at scales which can conveniently be observed[1].

NEED OF LAPPING MACHINE FOR VALVE COMPONENT:

Lapping process is characterized by its low speed, low pressure, and low material removal rate. This process is used in achieving finer surfaces and closer fits, correction of minor imperfections, and maintaining close tolerances. During the process of lapping, the mechanisms of surface formation and removal rate are decisively influenced by the movement type of the individual grains within the lapping abrasive. A gate valve is used to start and stop the flow of fluid. So the wedge and seat ring of a valve are in continuous

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pressure of fluid flow and due to opening and closing of valve these component get wear and they need lapping during reconditioning. This paper will share the need, requirement and application of lapping during the reconditioning of valve[2].

ENGINE VALVE LAPPING:

The automobile maintenance is a major area in automobile industry. The Internal Combustion engine maintenance is one of the important sections. The valve lapping process is also one of the maintenance processes. The current method used for valve lapping process consumes lot of time to perform the lapping operation. So a separate valve lapping machine is designed to overcome the above problem. The lapping process is a critical operation used to do precision operation. The main parameters considered are pressure, relative velocity, abrasive size, material removal rate[3].

PETROL ENGINE EXHAUST VALVE DESIGN, ANALYSIS AND MANUFACTURING PROCESSES:

The aim of this paper is to design an exhaust valve for a four wheeler petrol engine using theoretical calculations. Manufacturing process that is 2D drawings is drafted from the calculations and 3D model and transient thermal analysis is to be done on the exhaust valve when valve is open and closed. Analysis is done in ANSYS. Analysis will be conduct when the study state condition is attained. Study state condition is attained at 5000 cycles at the time of when valve is closed is 127.651 sec valve is opened 127.659 sec. The material used for exhaust valve is EN52 steel. We are doing material optimization by doing analysis on both materials EN52 and EN59 .Static Modal analysis the exhaust valve to determine mode shapes of the valve for number of modes[4].

EFFECT OF EGR ON THE EXHAUST GAS TEMPERATURE AND EXHAUST OPACITY IN COMPRESSION IGNITION ENGINES:

In diesel engines, NOx formation is a highly temperature-dependent phenomenon and takes place when the temperature in the combustion chamber exceeds 2000 K. Therefore, in order to reduce NOx emissions in the exhaust, it is necessary to keep peak combustion temperatures under control. One simple way of reducing the NOx emission of a diesel engine is by late injection of fuel into the combustion chamber. This technique is effective but increases fuel consumption by 10–15%, which necessitates the use of more effective NOx reduction techniques like exhaust gas recirculation (EGR). Re-circulating part of the exhaust gas helps in reducing NOx, but appreciable particulate emissions are observed at high loads, hence there is a trade-off between NOx and smoke emission. To get maximum benefit from this trade-off, a particulate trap may be used to reduce the amount of unburnt particulates in EGR, which in turn reduce the particulate emission also[5].

ENGINE VALVES:

There are two kinds of engine valves, intake/inlet valves and exhaust/outlet valves. These valves could be identified easily in a cylinder head. Inlet valves are usually bigger than exhaust valves. Although more than one inlet valve and exhaust valve can be present for a single cylinder. There are different designs for inlet valves and exhaust valves. The following figure shows a detailed diagram of a valve[4].

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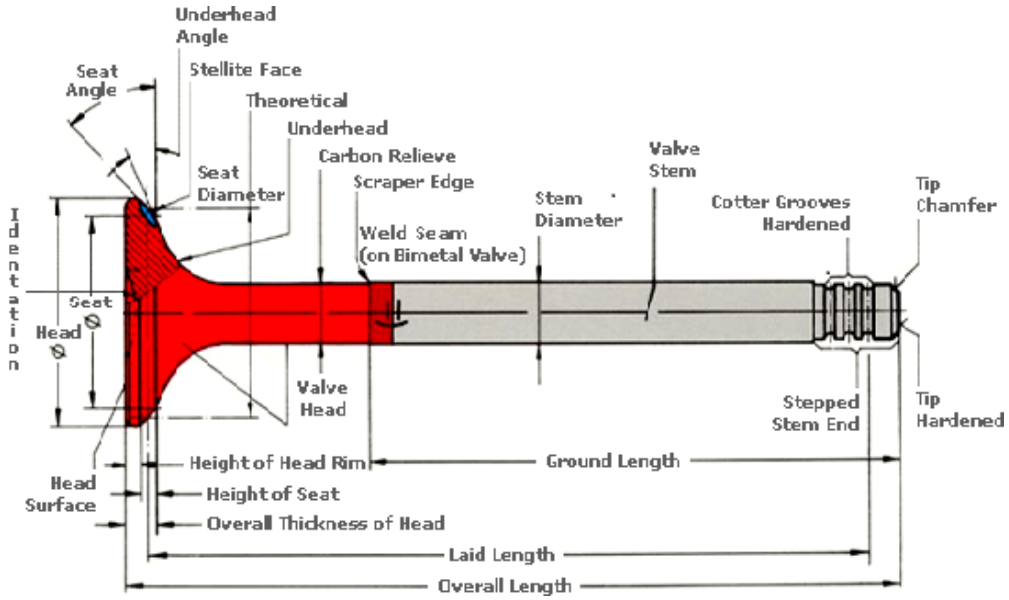

Fig 1:Detailed diagram of an engine valve[4]

CYLINDER HEAD:

Cylinder head is the casting which seals the combustion end of the cylinder block and the inlet and exhaust valves and their ports are positioned in the cylinder head for air/fuel mixture intake and exhaust of the combustion products. Cylinder head also facilitate overhead cam shafts if present and otherwise it facilitate rocker arms and valve springs.

LAPPING COMPOUND:

Lapping compound is applied to the valve seat before beginning of the process. Lapping compound wears surfaces of the valve and the valve seat of the cylinder block smoothing both surfaces and creating a good seat. A lapping compound tube usually has two types. The two types named as fine and coarse. Technician decides which type of compound has to be used by observing the valve seat. If the valve seat has rough edges, coarse compound is used. Otherwise fine compound is used obtain a smooth surface.

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Fig 2:Lapping Compound

VALVES LAPPING STICKS AND ITS MOTION:

There are valve sticks is cleaned using reciprocating motion with osciallations in-out.The valve sticks is lubricated by lapping compound due to that the exhaust compond gets removed from the valve sticks and valve.Because of that the valve and sticks of exhaust of combustion engine gets cleaned and the efficiency of the engine is increased.

Fig 3:Lapped & Non-Lapped valve

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In hand lapping process, the valve lapping sticks are the tools used to lap valves. The valve is attached to sucker at the tip of the stick and the lapping compound is applied before the process begins. This is very hard process to undergo and it will take approximately half an hour to lap one valve of an engine. The technician have to decide whether to apply compound from observing the valve seat area time to time. This method is still used in garages.

Fig 4:Hand Valve Lapping Process

Using the valve lapping power tool is much more efficient than the valve lapping by hand movement. It will take less than 30 minutes to lap a valve using the power tool. But still we have to hold the power tool in position for lapping process, which is somewhat hard labor to undergo. Power tools work using an electric motor or pneumatically using compressed air.

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Fig 5:Power tool Valve Lapping Process

3.DESIGN OF MACHINE:

MACHINE BED:

Machine bed is the base of the valve lapping machine. The cylinder head can be initially kept on the machine bed for measuring or observing purposes and the bed is designed to accommodate a cylinder head without any problem.

MACHINE STAND:

Machine stand is assembled to the machine bed in one end. Other end of the machine stand is the mounting for the valve lapping mechanism and also the holding bracket for motor, mounted near the same end. Therefore, allowing the access to any valve position of a cylinder head placed on machine bed. The load generated while the valve lapping process is transmitted to machine bed through the machine stand and the integrity of the structure is a very important factor to consider when designing. Lower end of machine stand which is assembled to machine bed is one of the areas of the machine with highest stress concentration.

CAM AND CAM FOLLOWER:

Cam is the main part responsible for the vertical movement of the valve lapping mechanism. Actually, a cam works as a system that consist with a follower, a cam drive and a follower system. The vertical motion is gained by the valve lapping mechanism when the cam is rotated by the rotary motion. DC motor which is the cam drive and the rotary motion is then converted in to linear motion using the shape of cam and it is transmitted to the valve mechanism through the cam follower. The vertical motion of the valve lapping mechanism helps to break the contact between valve seat and the corresponding surface of a cylinder head. The importance of this action is the rotary motion is converted into linear motion. Cam follower is tensioned using a spring in the valve lapping mechanism and as the cam rotates, follower gain space to move upwards and when the cam nose area returns follower move downwards creating a linear motion.

SPRING CONSTRAINT:

The contact between follower and cam profile is maintained by spring. The valve lapping machine for internal combustion engines is mainly consist of three main units. The base, the machine stand and the valve lapping mechanism.

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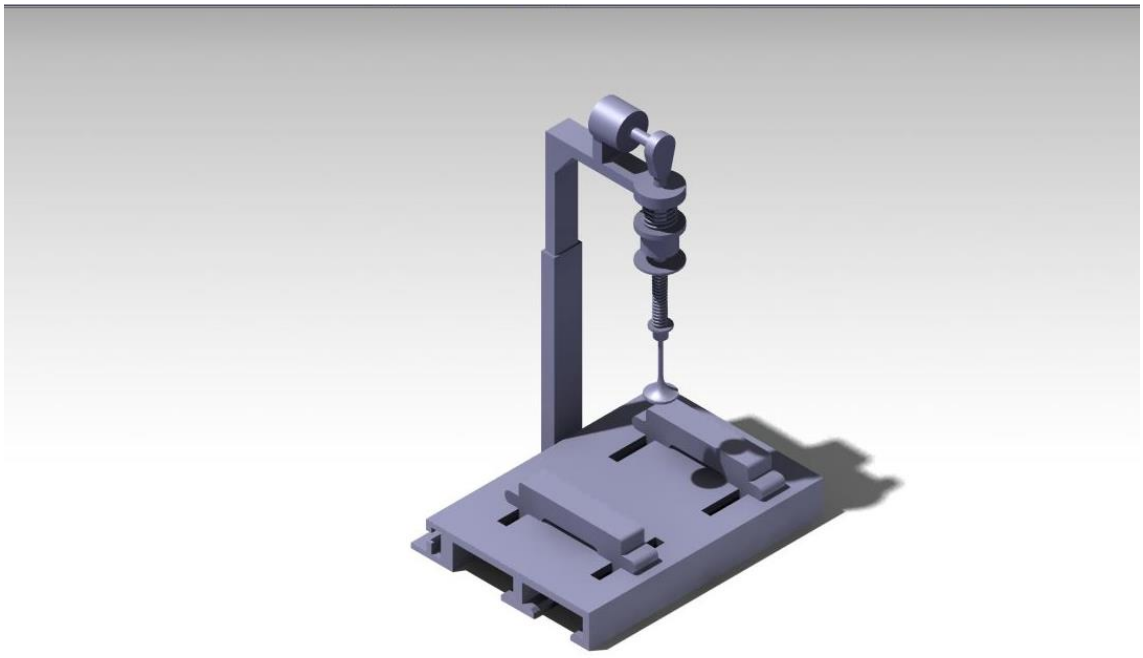

Fig 6:Catia Model of Valve Lapping Machine

Load = 300 N, τ = 350 N, Deflection = 25 mm, G = 73.6 × 10^3 N/m^2, Spring index(C) = 8

(1) Stiffness of spring (k):

K = Load/deflection, K =W/δ

K = 12 N/mm

(2) Shear stress factor:

Ks = 1 + 1/2C

Ks = 1.0625

(3) Resultant of shear stress:

$\tau = (8\times W\times D/ \pi \times d3) \times K_s$

Spring index (C) = D/d

d = 4.307 mm = 5 mm

D = 8×5 = 40 mm

(4) Deflection:

δ = (8×W×D3×n)/(G×d4)

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n =7.48 = 8

Assuming Square & Grounded side spring;

Total No. of Coil = n+2

n' = 8 + 2 = 1

(5) Solid length of spring:

Ls = n' × d = 10 × 5 = 50 mm

(6) Free length of spring:

Lf = Ls + δmax + 15 × δmax

Lf = 50 + 25 + [0.15 × 25]

Lf = 78.25 mm

(7) Pitch of coil:

P = Free length / (n'-1)

P = 80 / (10-1) = 80 / 9 = 8.88 mm

4.RESULT AND CONCLUSION

The proposed model can provide benefit in the lapping of valve. Valve lapping mechanism is implemented replacing manual labour. There is no presence of human intervention in the mechanism. The mechanism can be used automatically. The various components required for the machine are designed. The dimensions of machine bed and spring are calculated.

REFERENCES

[1] Evans C. J., Paul E., Dornfeld, David, Lucca, D. A., Byrne , G.," Material removal mechanism in lapping and polishing", Laboratory for Manufacturing and Sustainability, (2003).

[2] S. M. Fulmali[1] , R. B. Chadge[2],"Need of Lapping Machine for Valve Component", International Journal Of Modern Engineering Research, Vol. 2, Issue 6, (2012).

[3] S. Divya[1], R. Pavithran[2], S. Vijay[3],"Engine Valve Lapping", International Journal Of Research In Engineering, Science and Management, Vol. 2, Issue 5 , (2019).

[4] B Seshagiri Rao, D Gopi Chandu,"Petrol Exhaust Valve Design, Analysis And Manufacturing Processes", Vol. 3, No. 4, (2014).

[5] Avinash Kumar Agrawal[1], Shrawan Kumar Singh[2], Shailendra Sinha, Mritunjay Kumar Shukla, "Effect Of EGR On The Exhaust Gas Temperature And Exhaust Opacity In Compression Ignition Engines", (2003).

[6] Design Of Machine Elements, Author-V. B. Bhandari.

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