Design And Manufacture Of Pokayoke For Stud And Push Rod Holes Present On Cylinder Head

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Abstract — The design ensures that the stud and pushrod holes on the cylinder head are present, are properly aligned as well as checks whether these holes are of proper diameter or not before it undergoes further process. If a head completes it cycle but is having a defect in stud hole or push rod hole, then it can cause a major problem while assembling it with the block. Hence, the design ensures the precision of these holes and avoid any further problem while its assembly. The design decreases human work, increases efficiency and precision thus decreases the probability it will cause problem while engine assembly. The design was tested on some cylinder head and the probability of error came to an almost zero. This machine helped in reducing manual labor time and also decreased probability of error due to human.

Keywords — pokayoke, cylinder head, cylinder block, stud holes, push rod holes.

I. INTRODUCTION

Cylinder Head
In an internal combustion engine, the cylinder head sits above the cylinders on top of the cylinder block. It closes in the top of the cylinder, forming the combustion chamber. This joint is sealed by a head gasket. In most engines, the head also provides space for the passages that feed air and fuel to the cylinder, and that allow the exhaust to escape. The head can also be a place to mount the valves, spark plugs, and fuel injectors. [1]

Internally, the cylinder head has passages called ports or tracts for the fuel/air mixture to travel to the inlet valves from the intake manifold, and for exhaust gases to travel from the exhaust valves to the exhaust manifold. In a water-cooled engine, the cylinder head also contains integral ducts and passages for the engines' coolant - usually a mixture of water and antifreeze - to facilitate the transfer of excess heat away from the head, and therefore the engine in general. [1]

Fig 1.1 View of Engine comprising of Head, Gasket and Block

In the overhead valve (OHV) design, the cylinder head contains the poppet valves and the spark plugs, along with tracts or 'ports' for the inlet and exhaust gases. The operation of the valves is initiated by the engine's camshaft, which is sited within the cylinder block, and its moment of operation is transmitted to the valves' pushrods, and then rocker arms mounted on a rocker shaft - the rocker arms and shaft also being located within the cylinder head. [1]

Fig 1.2 View of a Cylinder Head

In the overhead camshaft (OHC) design, the cylinder head contains the valves, spark plugs and inlet/exhaust tracts just like the OHV engine, but the camshaft is now also contained within the cylinder head. The camshaft may be seated centrally between each offset row of inlet and exhaust valves, and still also utilizing rocker arms (but without any pushrods), or the camshaft may be seated directly above the valves eliminating the rocker arms and utilizing 'bucket' tappets. [1]
**Poka-Yoke**

Poka-yoke is a Japanese term that means "mistake-proofing" or "inadvertent error prevention". The key word in the second translation, often omitted, is "inadvertent". There is no Poka Yoke solution that protects against an operator’s sabotage, but sabotage is a rare behavior among people. A poka-yoke is any mechanism in a lean manufacturing process that helps an equipment operator avoid (yokeru) mistakes (poka). Its purpose is to eliminate product defects by preventing, correcting, or drawing attention to human errors as they occur. The concept was formalized, and the term adopted, by Shigeo Shingo as part of the Toyota Production System. It was originally described as baka-yoke, but as this means "fool-proofing" the name was changed to the milder poka-yoke. Poka-yoke can be implemented at any step of a manufacturing process where something can go wrong or an error can be made. For example, a fixture that holds pieces for processing might be modified to only allow pieces to be held in the correct orientation, or a digital counter might track the number of spot welds on each piece to ensure that the worker executes the correct number of welds. [2]-[10]

**II. METHODOLOGY**

Firstly, the designs as shown in the next section were planned in Creo 2.0. The design includes cylinder head and cylinder block with protrusions in form of studs. After the designs a scrape cylinder block was taken and sectioned accordingly. Then studs of correct measurement were taken and welded in position of studs so as to get a correct position of where the studs are on the head. This block was then connected with a pneumatic cylinder for up and down motion of the block. This arrangement of block will be placed on the line and as head pass it will be checked by this poka-yoke. After the manufacturing the machine was tested on some heads and the probability of error decreased to an almost zero.

![Fig. 1 Final Assembly of Poka-Yoke](image)

**III. DESIGN**

The purpose is to design a poka-yoke for stud hole and push rod hole missing on the cylinder head.

**Stud Hole:**

Stud holes are provided on the head so as for studs to pass through them and to tighten the head on the block with gasket in between. They are 17 in number in a 4SP head having 12 mm diameter. Studies act as guide pins when aligning items such as gaskets, engine covers, etc. Studs are available (ARP for example) with “bullet” noses, where a slightly diminished diameter bare tip is featured. This greatly eases nut installation, allowing the nut to be dropped into position before thread engagement begins. [11]

**Push Rod Holes:**

Push rod holes house the push rods going from head till the end of the block. The pushrods and lifters work with the camshaft and rocker arms to open the engine’s valves. They are 8 in number on a 4SP head.

3.1 Objective

While casting sometimes stud hole and push rod holes are missing or not properly aligned throughout the head. Also sometimes they are not of the correct diameter. The design ensures the presence of these holes, their alignment as well as checks whether the holes are of proper diameter or not before it undergoes further process. If a head completes it cycle but is having a defect in stud hole or push rod hole, then it can cause a major problem while assembling it with the block. Hence, the design ensures the precision of these holes and avoid any further problem while its assembly.

3.2 Design of poka-yoke

The model consists of:-

- A sectioned block
- Studs
- Head (Job to be checked)
- Pneumatic Cylinder
- Frame

The design has a sectioned block which is considered as standard testing device for stud holes push rod holes missing and alignment from cylinder head. Block has protrusions in form of studs which are bolted according to standard design of stud holes and push rod holes. Block is connected to pneumatic cylinder for vertical movement of block.

For testing when head comes in line it is being stopped at correct position just below block. Block will then move vertically down and studs connected to it will go through the stud holes and push rod holes of job. If there is perfectly smooth movement of stud through heads there will be an OK signal and job will move further in line for further testing. This OK signal ensures the perfect alignment of stud
holes and push rod holes in job and no stud holes and push rod holes are missing from job. If studs from block cannot be through to job due to improper alignment stud holes and push rod holes of job or missing of any one of the holes the process will not be completed and there will be no OK signal for job to move further which means that the given job is defected and is removed to avoid further problem in assembly.

Thus this mechanism can be beneficiary for checking missing and alignment of stud holes and push rod holes in cylinder head using a standard block having perfectly alignment of stud holes and push rod holes according to design of manufacturing.

IV. IMPLEMENTATION IN MANUFACTURING

Poka-yoke can be implemented at any step of a manufacturing process where something can go wrong or an error can be made. For example, this mechanism can be introduced after oil poka yoke or intermediate washing in line. The contact method identifies product defects by testing the missing and alignment of stud holes and push rod holes.

Either the operator is alerted when a mistake is about to be made, or the poka-yoke device actually prevents the mistake from being made. A methodical approach to build up poka-yoke countermeasures has been proposed by the Applied Problem Solving (APS) methodology, which consists of a three-step analysis of the risks to be managed:

1. Identification of the need
2. Identification of possible mistakes
3. Management of mistakes before satisfying the need

This approach can be used to emphasize the technical aspect of finding effective solutions during brainstorming sessions. [2]-[10]

V. BENEFITS OF DESIGN

A typical feature of Poka Yoke solutions is that they don’t let an error in a process happen. But that is just one of their advantages.
• Less time spent on training workers
• Elimination of visual inspection for stud holes and push rod holes missing
• Unburdening of operators from repetitive operations
• Promotion of the work improvement-oriented approach and actions
• A reduced number of rejects
• Immediate action when a problem occurs
• 100% built-in quality control
• Avoid future problem during assembly due to missing or improper alignment of stud holes and push rod holes [2]-[10]

VI. CONCLUSION

The design checks the alignment, or presence and dimensions of stud and push rod holes. If head passes through the mechanism, it means that holes are perfect and it confirms no manufacturing defect. Hence, there will be no problem in further assembly. The design also save time from visual inspecting any defect with holes and hence increases the productivity and accuracy.

REFERENCES