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Production Technology of the Motor Head Jawa 50

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Abstract

This paper is concerned with the model of a head for Jawa 50 pioneer. The introduction deals with the comparison of motorcycles. Furthermore, the introduction describes what is happening inside the combustion chamber. In the next section, the optimum temperature and operation are described, as well as the combustion chamber (the location of the spark plugs). The paper also looks at the assembly of the head on the motorcycle and the compression ratio. The following part describes the choice of material for casting and the workpiece. In the concluding section the results of the work are presented.

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Keywords: Jawa 50; cylinder head; combustion space; cooling heads; compression ratio

1. Introduction

The heads were made in several variants in Inventor 2008 and then the best two were selected. Out of these, the better one was chosen, based on the simpler construction. For machining, it was necessary to design a die, into which a model of the head is clamped on the machine, and then machined. These products were designed also in variants, out of which the best have been selected. Mainly, the possible innovations on the heads were examined, e.g. increasing the cooling efficiency of the head of the motorcycle by means of designing a modification of the shape, increasing the performance parameters through the original combustion chamber and improving combustion of the mixture between the head and the piston. Further, I will consider the best material for machining the head and also the material for the cast.

Motorcycles are the smallest and lightest motor vehicles that offer fast transportation. Besides small mopeds,

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there are also heavy racing machines, capable of speeds over 500 km/h. These motor vehicles use liquid (petrol + lubricant) inside the combustion chamber and cylinder heads, transform this liquid into the drive, and then into the kinetic energy of the motorcycle. The rectilinear movement (plunger) is changed into rotational motion (crankshaft). Two-stroke engines have 2 strokes and one revolution of the crankshaft in one working cycle.

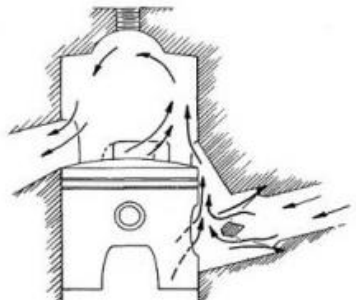


Fig 1.When the piston moves downwards, the mixture reaches in the combustion chamber. The combustion chamber is between the head and the cylinder [1].

The conditions leading to detonation are: high-octane fuel, high compression, engine speed, air humidity, air mixture (oxygen content in the air), high air temperature, combustion chamber shape, good spark from the spark plug, etc. Therefore, different engines with the same compression ratios are have different octane requirements.

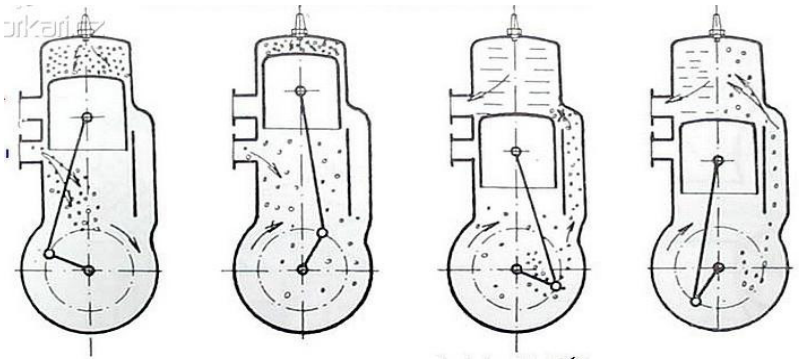


Fig. 2. The principle of operation of a two-stroke engine [2].

2 Head cooling

At the first sight the cylinder head does not seem like an important part of the engine, but the opposite is true, because the very design has a large influence on how well the engine will run. When burning the fuel within the combustion chamber and cylinder head large amounts of heat are produced. If the engine temperature gets too high, the motor becomes less efficient and could be damaged if the exact parts become wider or they even size up. The optimal temperature, which should be maintained by cooling, should range between 170 ° - 190 ° C. To avoid overheating of the engine cooling heads or water cooling systems are used. The head and cylinder are made of aluminum alloy, thanks to which the weight of the entire system and the heat transfer is reduced. The air-cooled head has ribs on the outer side which increase the surface area of the cooling system (this cooling method is called direct cooling). It is clear that cooling does not require any special maintenance and is therefore error-free (there is no need to supply a coolant which could freeze at low temperatures).

Fig. 3. Various structural solutions of the cooling heads for motorcycles Jawa [3].

2.1. Combustion space

The most important is the shape of the combustion chamber (ventricle) and the location of the spark plugs. The combustion chamber (chamber) must be as small as possible, because the smaller the space, the slower the heat loss and thanks to that the efficiency of the engine increases. In addition, the combustion chamber must be burnished. The entire inner surface of the head must be polished to a high gloss, which prevents the formation of carbon on the walls and improves the irrigation of the engine. The standard head volume is 6.5 ml to 5.5 ml, in our case, the second option was preferred.

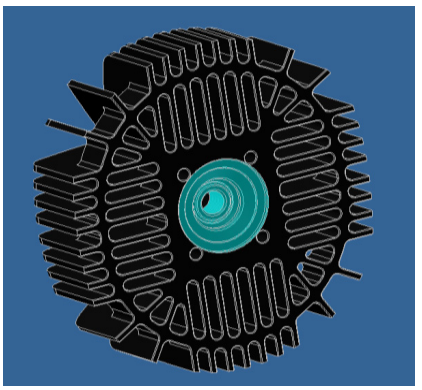
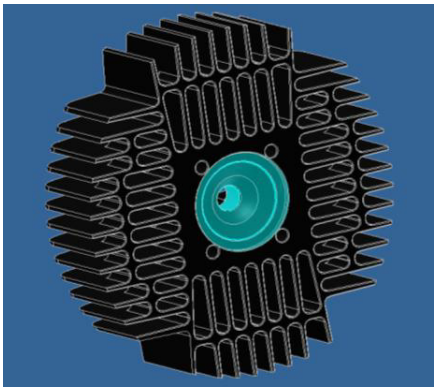
a  b 

Fig. 4. The combustion chamber (a): The star-head; (b): Serrated head.

The hole for the combustion candle can be virtually anywhere. The best location for the spark plug is not in the middle (ie. the center hole plug is located parallel to the axis of the movement of the piston – because of the other possible adjustments that are performed on these engines (such as reducing head, advance measurement, etc..). Further, it reduces the flame movement inside throughout the combustion chamber to a minimum.

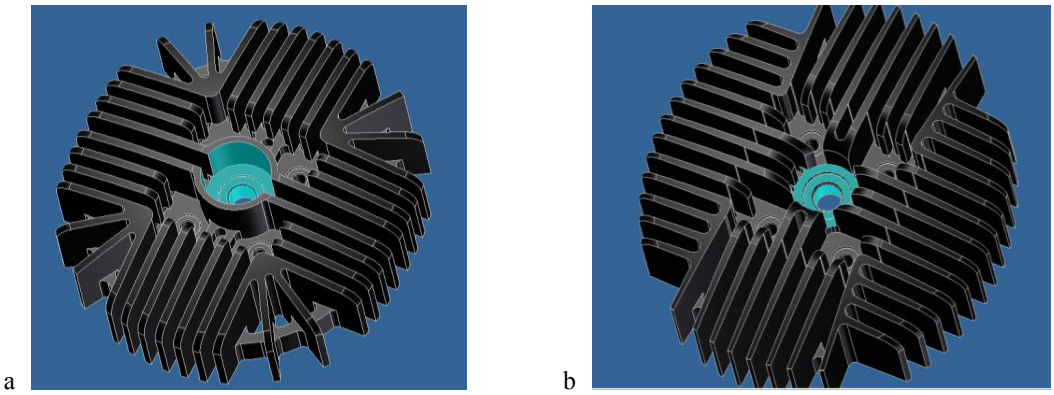


Fig. 5. Centrally located spark plug hole (a): The star-head; (b): Serrated head.

For the serial production of motorcycles, the hole for the spark plugs is made centrally at the highest point of the head, and for racing motorcycles the holes are built for two candles at an angle. This is because if there is a defect on the spark plug, the defective candle quickly throws tick to the functional candle and the mixture burns. The angle of the spark plug is not so important, because it just serves the availability of the fresh mixture during compression and advance.

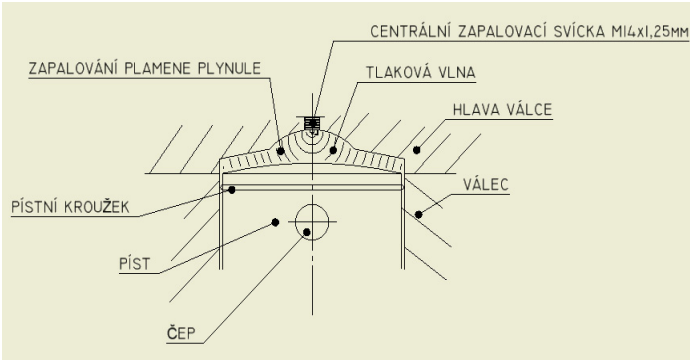


Fig. 6. The combustion chamber with central spark supporting good combustion [7].

2.2 Assembly of Head

The head is cautiously deployed to guide the cylinder with 4 screws (bolts). There is no need to put a gasket (seal) under the head, if the head is ground. If this is not the case, it is necessary to install a seal between the contact surfaces of the head and the cylinder, the thickness should be 0.6 mm (the seal material is aluminium foil or klingerit i.e. paper gasket). Then a washer and the nut M6 are used on each screw. The nut is tightened in the same way as in the car, crosswise. The nut should not be tightened too strongly, because this is done only after the first run. The matrix should not be tightened on the engine with operating temperature. Only after the engine has cooled down, the nut is tightened firmly.

Removing the cylinder and the head are operations made in order to check they work well, but also when we want to check the work of the piston, the piston pin, rings and the connecting rod. It is necessary to periodically clean the cooling fins from contaminants, such as dust, oil, etc. Dirt and dust mostly stick to the connections of various parts of the engine, which reduces the efficiency of heat transfer from the head. The maintenance and operation are simple, even for those consumers or owners who do not have too much knowledge about it. What is important, though, is the fact that the engine should be let running for quite a long time when the vehicle does not move.

Fig. 7. Mounting the head for motorcycle Jawa 50.

2.3. Compression ratio [4]

The compression ratio is a design feature of the engine. It has a significant influence on the performance and thermal efficiency of the engine by increasing of which the efficiency rises. In combustion engines it is the ratio between the volume of the engine cylinder before compression (piston is closest to the crankshaft – i.e. bottom centre) and the volume after compression (piston is farthest from the crankshaft – i.e. TDC). Or it can be defined as the ratio between the volume of the sucked mixture and the mixture compressed. The compression ratio of gasoline (petrol) engines ranges from 8: 1 to 13: 1. As a result of such high compression, the sucked air becomes extremely hot, making the injected fuel ignite immediately.

$$\varepsilon_k = \frac{V_k + V_z}{V_k}$$

V_k – volume the compression chamber
V_z – stroke volume

3 Material cast and machined

The currents of the mixture within the cylinder head and combustion chamber basically flow in one direction through the piston they spread on the cylinder wall, because they contain a lubricant. However, there are some areas that are not adequately cooled or lubricated and there is local overheating. The same applies to the inner surface of the combustion chamber of the head. The more conductive material is used, the more easily this place can be removed, since local heat is discharged into the entire surface of the head.

3.1 Material of the workpiece

Having consulted knowledgeable and experienced professionals in the field, the material for this type of head was selected, which is aluminium alloy EN AW 7075 (AlZnMgCu1.5). Aluminium materials are characterized by low weight and easy machinability and heat transfer. This material is used by companies to manufacture prototypes of various engine parts in the automotive and motorcycle industry for dynamically loaded machine parts.

Fig .8. The Aluminium rods EN AW 7075 [5].

This material is produced using a cast side, which is then further heat treated to rid the internal material stresses. The blocks are further cut or rolling out to the desired thickness. Then, they are coated with PE foil. These materials are mainly used in machinery for the manufacture of cutting and pressing tools, blow moulding and foaming forms, machine parts machine with high exposure or baseboards, as well as in engineering, automobile, motorcycle, construction, motorcycle, marine and aerospace industry. [6]

Fig 9. Ordered and purchased semifinished ALFUN a.s. METAL SERVICE CENTER (EN AW 7075 D190-72 mm, 4x (cca 5,2kg).

3.1. Materials Cast

In practice, the heads of engines manufactured in series production are made as die castings (usually silicon alloys, slightly different from the alloys used for rolled materials). The heads are cast into a metal mold. The alloy must be light with good heat conductivity.

Heads in earlier times were cast in the sand (including cheaper production model). The head is cast with the combustion chamber. In order to avoid surface pores, the combustion chamber is not further treated. Finishing operations are made only on the bottom of the base when the face is aligned. Further, 4 holes for bolts with a socket are drilled. The hole for the plug is made, and finally the thread of M14x1,25 is cut.

Various elements are added to the alloy (some foundries use guaranteed material). Some founders add to the alloy turnings of Cu = copper, in the form of either brass or bronze (= in the form of chips it is easily melted in the molten bath of aluminium).

Fig. 10. Sample Chart Fan heads after casting.

4 The structural design

The proposal was based on the dimensions which we agreed on with a colleague - fundamental dimensions were chosen on the basis of previously manufactured and time-tested heads. After consultations with a professional, a few heads were designed and modelled in Autodesk Inventor Professional, 2008. After selecting the best two, these were made in CATIA P3 V5R19. They were chosen with regard to easy manufacturability in laboratories of KTO.

All measurements were made in Autodesk Inventor (or CATIA), the material for the model in Inventor was selected so that it was similar to that of which the head would actually be cut. The material in Inventor was chosen because it was possible to determine the approximate weight and other parameters.

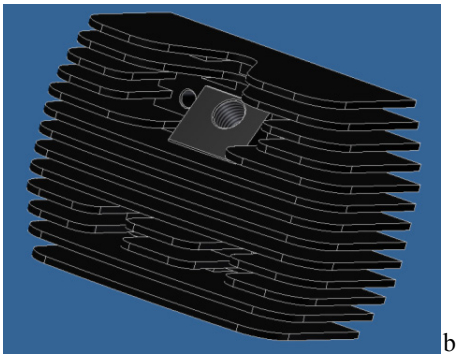
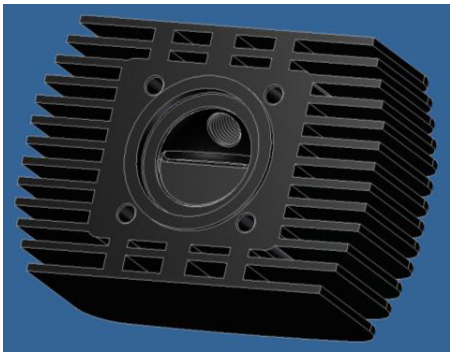
a  b 

Fig. 11. Model racing head: (a) front; (b) from behind.

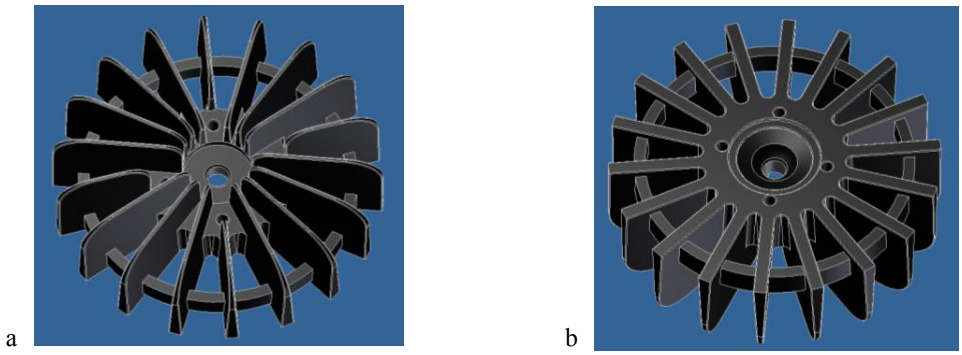


Fig. 12. Model serrated head: (a) front; (b) from behind.

4.1 Model of the head for machining in CATIA

After consulting the supervisor of my Bachelor thesis, the following two models were selected. They are modelled in Inventor 2008, transferred to CATIA P3 V5R19 and then machined. The heads were designed with the help and guidance given by a specialist, who has been involved in this work for more than half of his life, and was willing to provide a lot of valuable advice concerning, among other things, the design and size of the compression chamber.

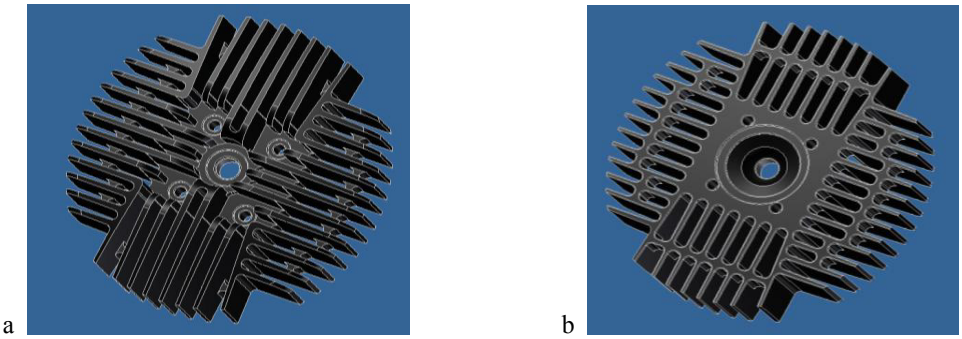


Fig. 13. The modified fan-shaped head: (a) front; (b) from behind.

Parameters of the head:: Outer diameter 180 mm, width 56 mm, weight 0.41 kg, 5.5 ml volume of the combustion chamber.

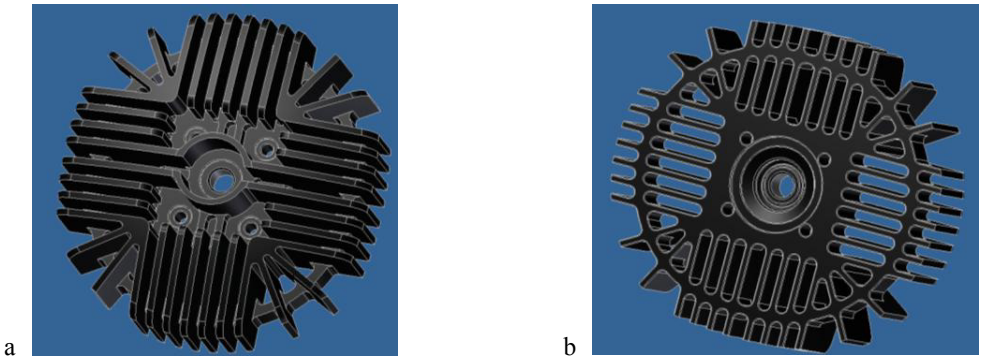


Fig. 14. The modified star-head: (a) front; (b) from behind.

Parameters of the head:: Outer diameter 180 mm, width 57 mm, weight 1,3 kg, the volume of the combustion chamber 5.5 ml

5 Head of production in the laboratory KTO

Since the production of the head itself was very time-consuming, it was decided that only two fan-shaped heads will be made in the laboratories of KTO.

Fig. 15. The winning head.

Conclusion

The problem was to find a good model the combustion space. It was further necessary to suggest the appropriate shape of the ribs. The ribs were designed so as to have the greatest cooling surface. The combustion space was created in the optimum range. The work is divided into theoretical and practical parts. The heads were modelled in several versions and was eventually selected the one that was best in regard to simplicity. Because the production of both of these heads would be very time consuming. The winning head is in the picture above. The theoretical part deals with the problem of describing and modeling of machining heads 50 Jawa motorcycle pioneer. Because at the time of the creation of this work has not been tested head on the engine brake. The head was only tested in operation which has stood the test very well. Prerequisite increase cooling efficiency head of the motorcycle would have to be measured using a portable thermometer. In the future we want to produce a second head. The head will have different combustion space and there will be a comparison of the two heads.

Acknowledgment

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