METHOD FOR MANUFACTURING ENGINE VALVE OF INTERNAL COMBUSTION ENGINE

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Abstract : A method of manufacturing a valve for an internal combustion engine, comprising: a primary forging step for forming a generally disk-shape valve head and a secondary forging step for forming a valve face (16) by forging the periphery of the valve head to create radial slip deformations along the periphery of the disk-shape valve head. In the primary forging step, a tapered face (16a) is formed on the periphery of the disk-shape valve head. In the thickness adjustment step, only the front end of the disk-shape valve head is machined. Dense grain flow lines induced in the tapered face (16a) in the primary forging are grown more densely in the secondary forging, enhancing the hardness of the valve face. Thus, a rectangular corner of the disk-shape valve head needs not be tapered, which facilitates saving the valve material and reducing thickness adjustment time.

IndexTerms **- Internal Combustion Engine, Forging, Valve.**

I. INTRODUCTION

A **valve** is a device that regulates, directs or controls the flow of a fluid (gases, liquids, fluidized solids, or slurries) by opening, closing, or partially obstructing various passageways. Valves are technically fittings, but are usually discussed as a separate category. In Automobiles the valves are designed to engines for the combustion of fuel, a valve typically used to control the timing and quantity of gas or vapor flow into an engine. The selection of valves in automobiles depend upon the type of fuel they use, and also on type of combustion. There are different types of valves used in Automobiles for different operations.

The valve which allows mixture into the cylinder is the inlet valve; the one through which the spent gases escape is the exhaust valve. They are designed to open and close at precise moments, to allow the engine to run efficiently at all speeds.

2. FUNCTION OF A VALVE:

The valves in an engine have numerous functions. First, they must permit the intake of fuel and air. Then they must seal compression. After the explosion the exhaust valve must permit the burned gases to leave the combustion chamber. The function of valves is different in type stroke in a Engine, Basically we have two types of stroke engine, they are

1. Two Stroke Engine and
2. Four Stroke Engine

In a **two-stroke engine**, one of the **two strokes** combines the intake **stroke** and the compression **stroke**, while the other **stroke** combines the combustion **stroke** and the exhaust **stroke**.As the piston reaches the top of the cylinder, the mixture in the cylinder is compressed to the point of ignition.

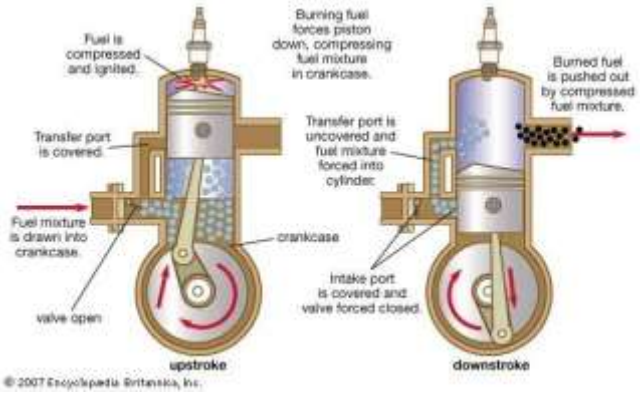

Fig 1:Function of valves in two Stroke Engine.

A four-stroke engine (also known as four cycle) is an internal combustion(IC) engine in which the piston completes four separate strokes while turning a crankshaft. A stroke refers to the full travel of the piston along the cylinder, in either direction. The four separate strokes are termed:

1) Intake
2) Compression
3) Combustion
4) Exhaust

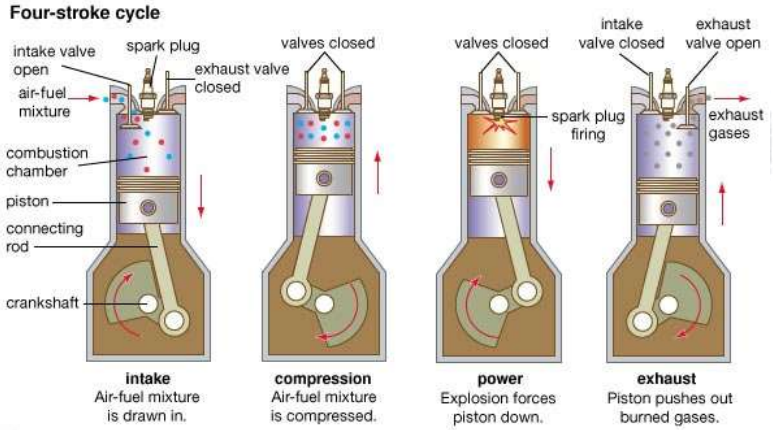

Fig 2: Function of Engine valves in Four stroke Engine.

The manufacturing of engine valves in companies follows following steps to produce the product with high efficiency, the steps involved are

1. Requirements of the customer
2. Design
3. Analysis
4. Production
5. Finishing
6. Quality check
7. Customer satisfactory
8. Final product

3. METHOD FOR MANUFACTURINGVALVE FOR I.C ENGINE

Task of a valve which is used in internal combustion engines is basically to help charge fresh air into combustion chamber and discharge mixture of fired fuel and air out of engine. Valve is one of the most critical parts in engine because they stand extreme temperatures, pressures and hitting impact. Because temperature which intake and exhaust valves stand is different from each other; different materials, structure and manufacturing methods are implemented on each valve. Manufacturing of the valves includes various methods such as forging, machining, welding, nitriding, coating etc. This paper explains alternative engine valve manufacturing methods, critical parameters for each manufacturing stage, potential failure modes and some corrective actions which can be taken. During study, various methods which are alternative of each other to produce engine valves were tried. Advantages & disadvantages, difficulties, failure modes and best way to correct them are recorded. To understand impact of critical process parameters on valve quality such as temperature, time, layer thickness for nitriding, work rest blade slope angle and material for center less grinding, seat angle for seat wear etc. many tested valves were inspected to find valve's surface defects under magnifier glasses and to understand valve's micro structure under microscope.

Comprising: a primary forging step for forming a generally disk-shape valve head; a thickness adjusting step of machining an excessively thick portion to adjust the thickness of the disk-shape valve head; and a secondary forging step for forming a valve face (16) by forging the periphery of the valve head to create radial slip deformations along the periphery of the disk-shape valve head.

In the primary forging step, a tapered face (16a) is formed on the periphery of the disk-shape valve head. In the thickness adjustment step, only the front end of the disk-shape valve head is machined. Dense grain flow be tapered, which facilitates saving the valve material and reducing thickness adjustment time.

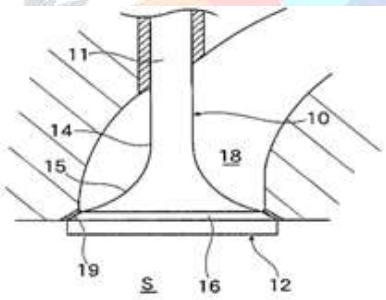

Fig 3: A rectangular corner of the disk-shape valve head.

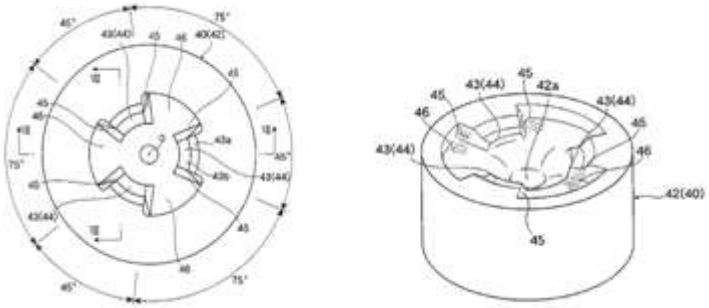

Fig 4: Disk-Shape valve head

A method of manufacturing a valve for an internal combustion engine, comprising:

a step of primary forging in which a bulging portion at one end of a rod material is forged to form a generally disk-shape valve head of the valve.

A step of secondary forging in which a periphery of the disk-shape valve head is forged to create therein radial slip deformations by means of a secondary forging die unit having a second die and a second punch, the periphery being associated with a valve face that comes into contact with a valve seat of the internal combustion engine, the method characterized in that.

THE VALVE MANUFACTURING METHOD COMPRISES:

1. a step of primary forging in which a bulging portion at one end of a rod material is forged to form a generally disk-shape valve head by means of a primary forging die unit having a first die and a first punch;
2. a step of adjusting the thickness of the disk-shape valve head by machining an excessively thick portion thereof; and
3. a step of secondary forging in which a periphery of the disk-shape valve head is further forged to create therein slip deformations by means of a secondary forging die unit having a second die and a second punch.

In the peripheral surface layer of the disk-shape valve head subjected to the primary forging, hardness of the layer is enhanced by dense grain flow lines created along the surface as shown in Fig.(a). However, if, in the thickness adjustment step, the peripheral corner of the disk-shape valve head is tapered (tapered corner referred to as tapered face) along a phantom line L1-L1 as shown in Fig.(a), the grain flow lines running along the surface layer of the disk-shape valve head are cut, exposing less hardened inner layers on the tapered face.

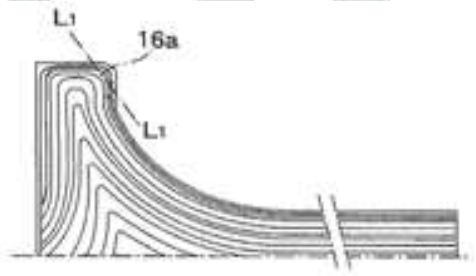

Fig 5: Secondary forging step to create radial slip deformations.

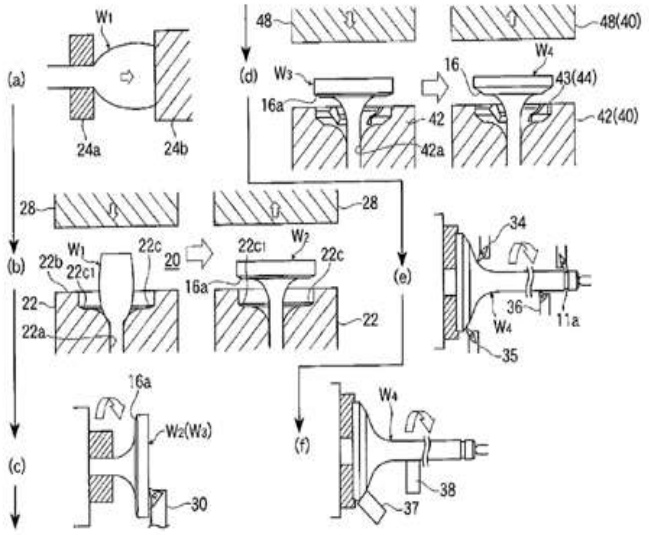

Fig 6: The entire process of manufacturing valve.

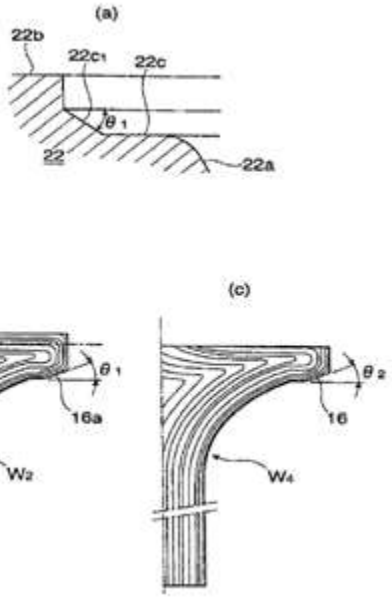

Fig 7: Grain flow lines formed in a valve head in the secondary forging.

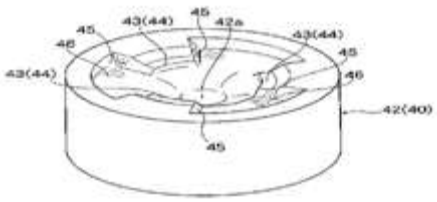

Fig 8: Perspective view of a die unit use in secondary forging step.

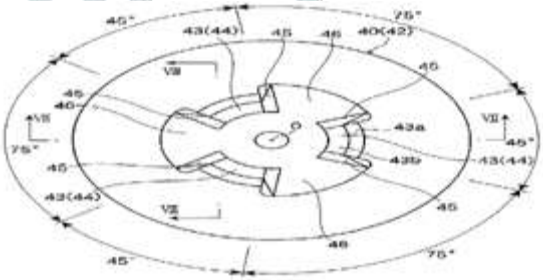

Fig 9: View of pressing face of die.

(a) Inventive method 1

direction of depth (mm)	Diameter of umbrella section About 70 mm: Near inner periphery	Intermediate point	Near outer periphery
0.5	519	508	525
1.0	530	503	536
1.5	536	530	548
2.0	536	542	554
3.0	519	554	554
4.0	498	536	554
5.0	483	503	503

(b) Comparative method 1

direction of depth (mm)	Diameter of umbrella section About 70 mm: Near inner periphery	Intermediate point	Near outer periphery
0.5	493	483	498
1.0	503	478	503
1.5	505	498	519
2.0	503	508	519
3.0	493	519	525
4.0	473	508	525
5.0	455	478	478

(c)

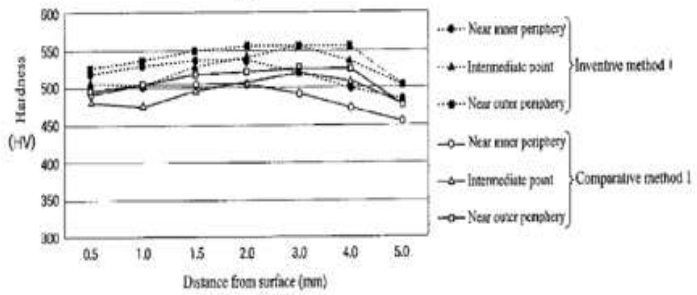

Fig 10: Compares the results of hardness.

(a) Inventive method 3

direction of depth (mm)	Diameter of umbrella section About 70 mm: Near inner periphery	Intermediate point	Near outer periphery
0.5	455	456	468
1.0	473	450	473
1.5	478	473	488
2.0	478	483	493
3.0	459	493	493
4.0	442	473	493
5.0	433	450	450

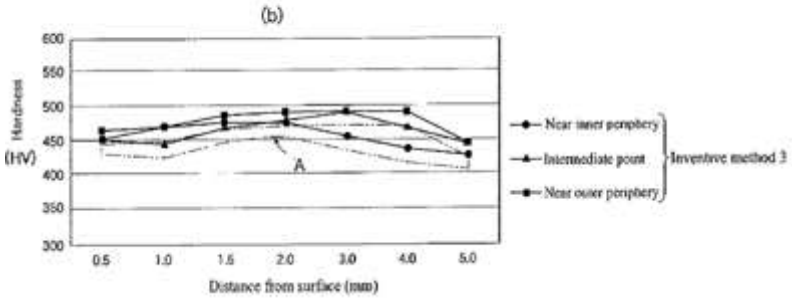

Fig.11: Hardness measurement.

4. CONCLUSION:

The valve faces of valves manufactured by the inventive method have hardness in range from 493 to 433 HV (from 429 to 336 HV), lower than the hardness of valves manufactured by the method 1 (or 2) in the range from 525-483 HV (504-380 HV) by about 50 HV (70 HV) The difference seems to arise from the difference in die units used in the secondary forging.

In other words, the pressing force per unit area applied to a valve material by a conventional die unit in the secondary forging step of the inventive method 3, is smaller than that applied by the die unit 40 of the inventive method 1, so that the hardness of a valve face obtained in the inventive method 3, is smaller than that obtained by the inventive method 1,by about 50(70) HV.

Results of hardness tests performed on valve faces having diameters of 70 mm and 160 mm, formed by conventional methods (comparative methods 3 and 4) are not presented here. However, since the hardness of a tapered face 16a of a disk-shape valve head formed by the comparative method 1, is smaller than that formed by the inventive method 2, by about 30(20) HV.

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