VALVETRAIN

Introduction

Valve train control the gas flowing into and out of the engine cylinder. The camshaft and valve spring make up the mechanism that lifts and closes the valves. The valve train determines the performance characteristics of four stroke- cycle engines.

Valve Train

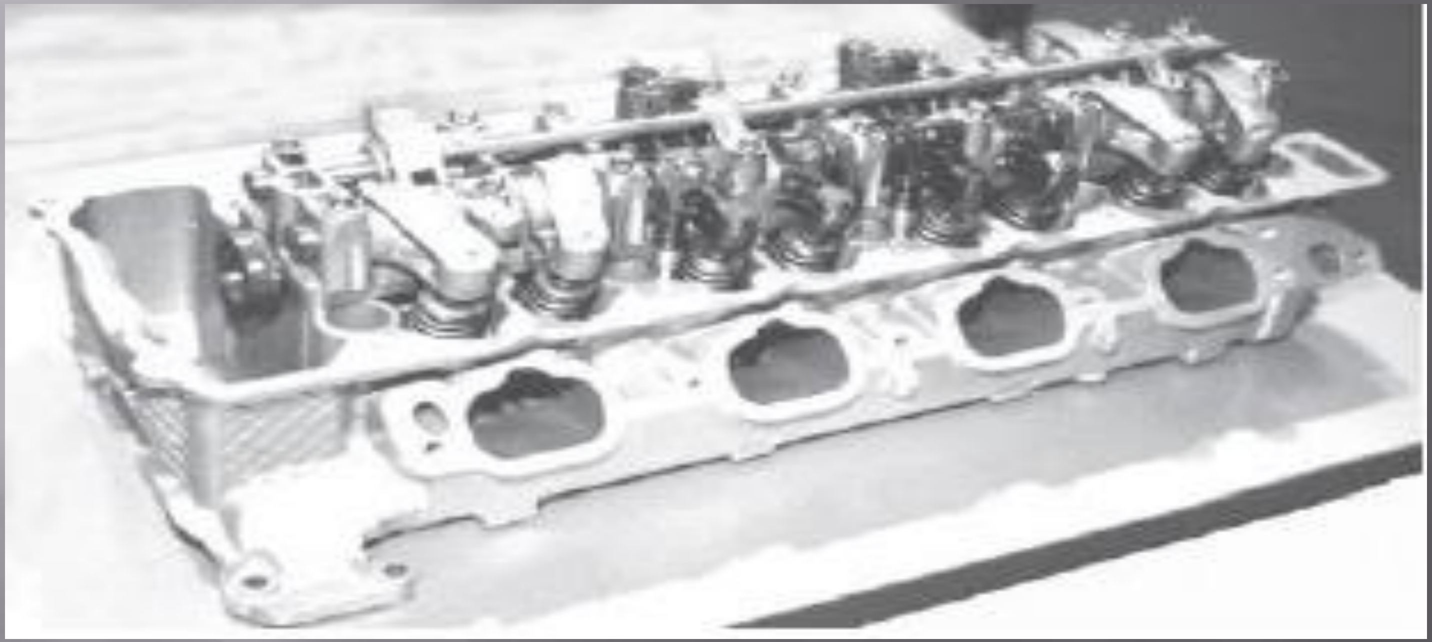


Figure 4.7: Cylinder head with the valve train

Valve Train Operation

- The valve train consists mainly of valves, valve springs and camshafts.
- At low camshaft revolutions, the valve spring can follow the valve lift easily so that the valve moves regularly.
- At high revolutions, it is more difficult for the valve and valve spring to follow the cam. **Valve float** is the term given to unwanted movements of the valve and valve spring due to their inertial weights. To avoid this, the load of the valve spring should be set high. The load applied at the longest length is called the **set load**, and the valve spring is always set to have a high compressive stress above set load conditions.

Valve Type

There are two types of valve:

Inlet valves

Exhaust valves

Note: The commonly used **poppet valve** is mushroom-shaped.

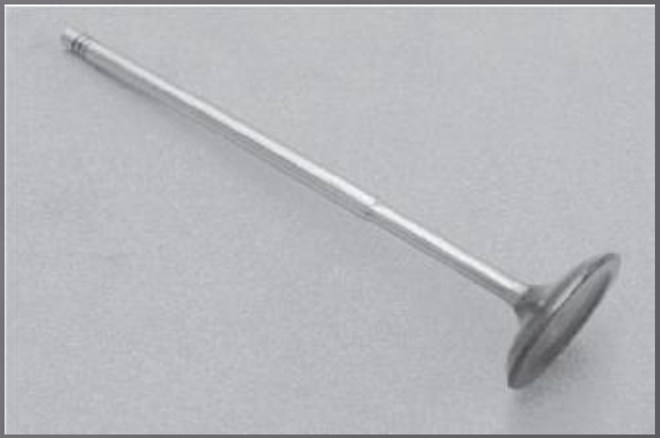


Figure 4.1: Exhaust valve.

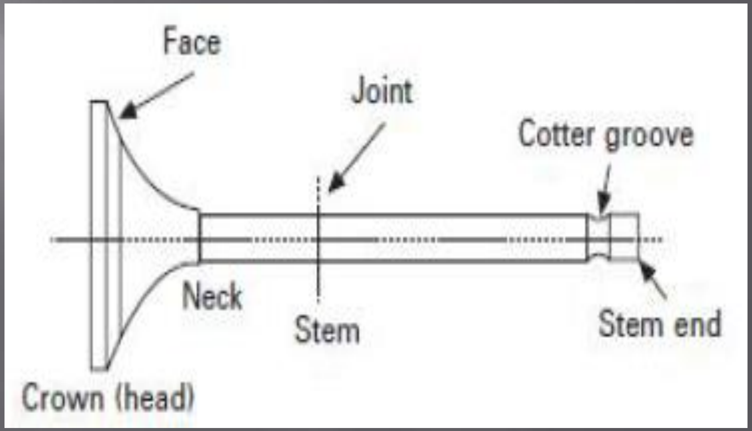


Figure 4.2: Nomenclatures of the valves

Note: A cotter which fixes the valve spring retainer to the valve, is inserted into the cotter groove.

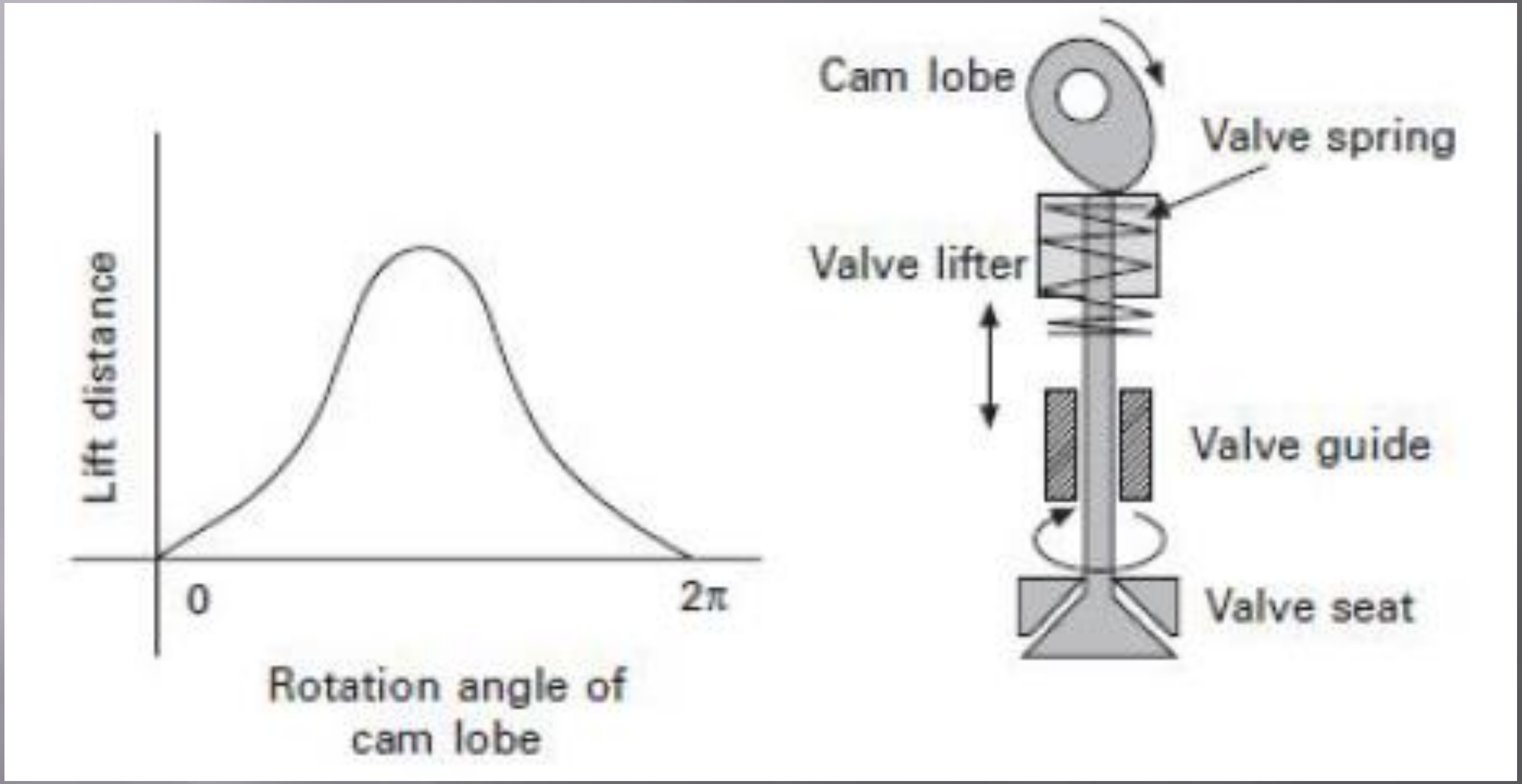
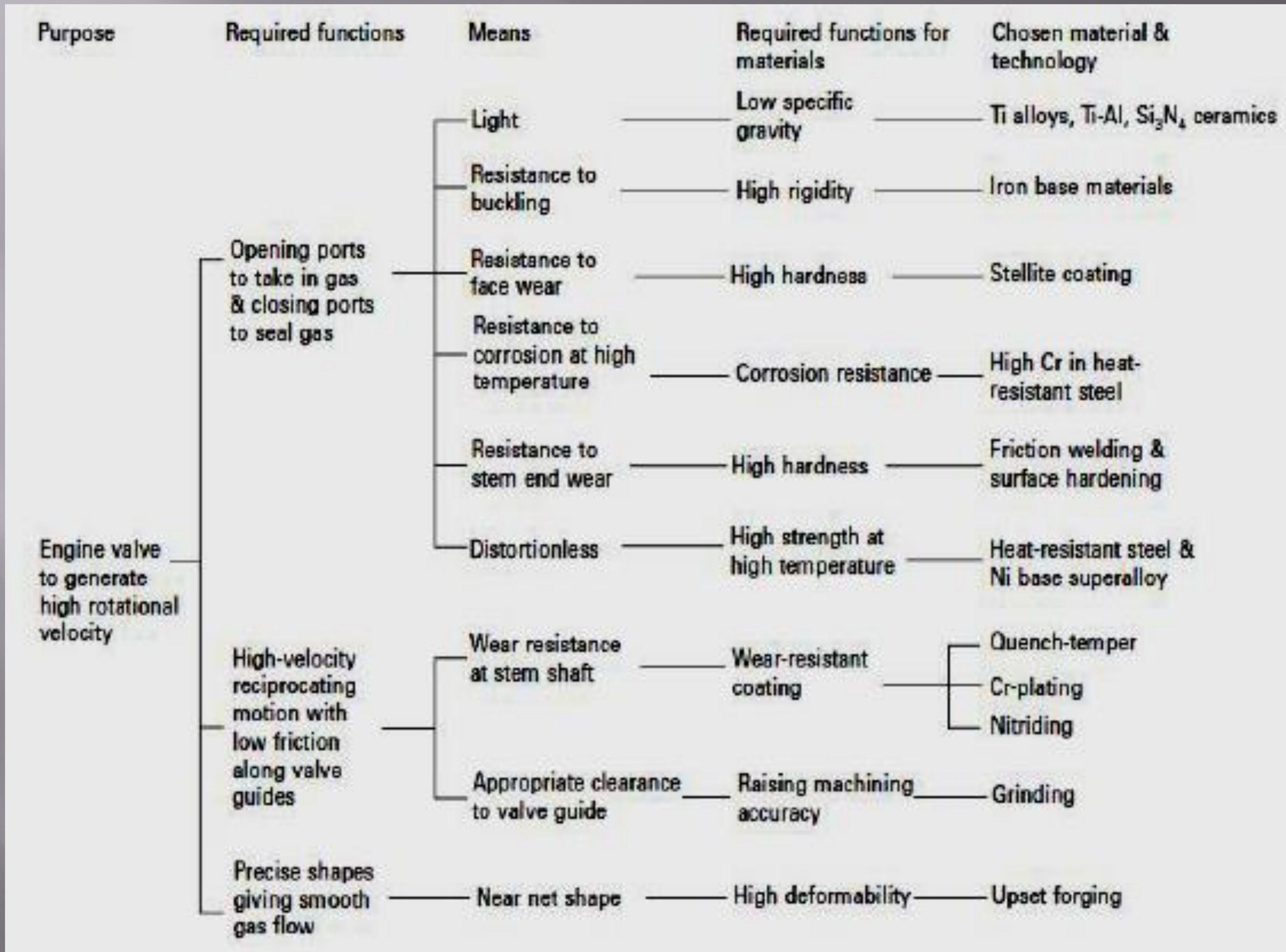


Figure 4.3: Rough sketch of a valve train showing valve lift distance in the valve timing diagram. The lift distance (vertical arrow) given by the cam lobe is the displacement along the axial direction of the valve.

Note: One revolution of the camshaft gives the amount of valve lift shown in Figure 4.3

FUNCTIONS OF VALVES



TEMPERATURE DISTRIBUTION IN VALVES

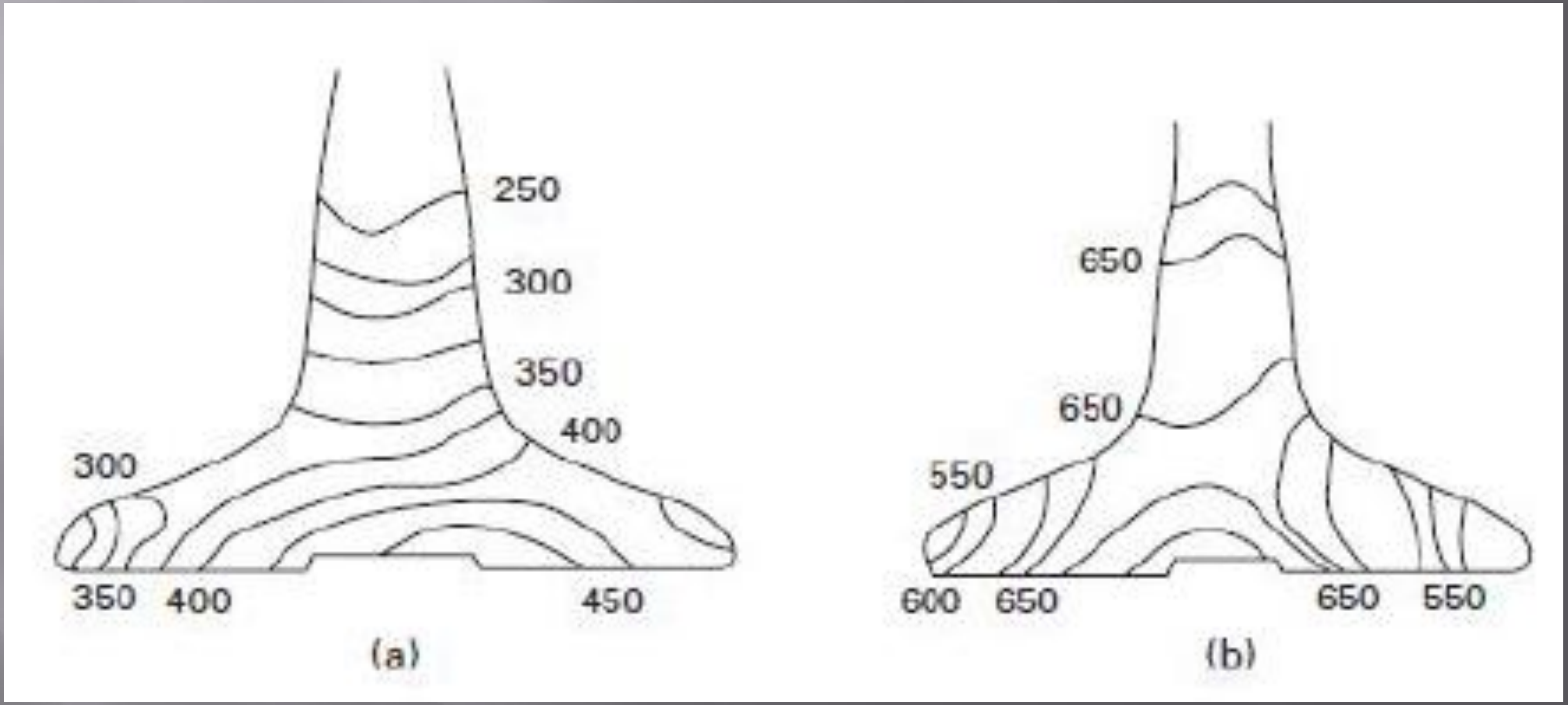


Figure 4.5: Temperature distribution (°C) of valves during operation. An air-cooled 200 cm^3 engine. (a) Inlet valve (30 ϕmm). (b) Exhaust valve (26 ϕmm).

Valve Operation

The valve stem moves in the valve guide and also revolves slowly around the stem. The revolving torque is generated by the expansion and contraction of the valve spring.

An engine basically needs one inlet valve and one exhaust valve per cylinder but most modern engines use four valves per cylinder. This multivalve configuration raises power output, because the increased inlet area gives a higher volume of gas flow. Contemporary five-valve engines use three inlet valves and two exhaust valves to increase trapping efficiency at medium revolutions

Valves and Valve Train

Figure 4.6: Double springs installed in a bucket type valve lifter.

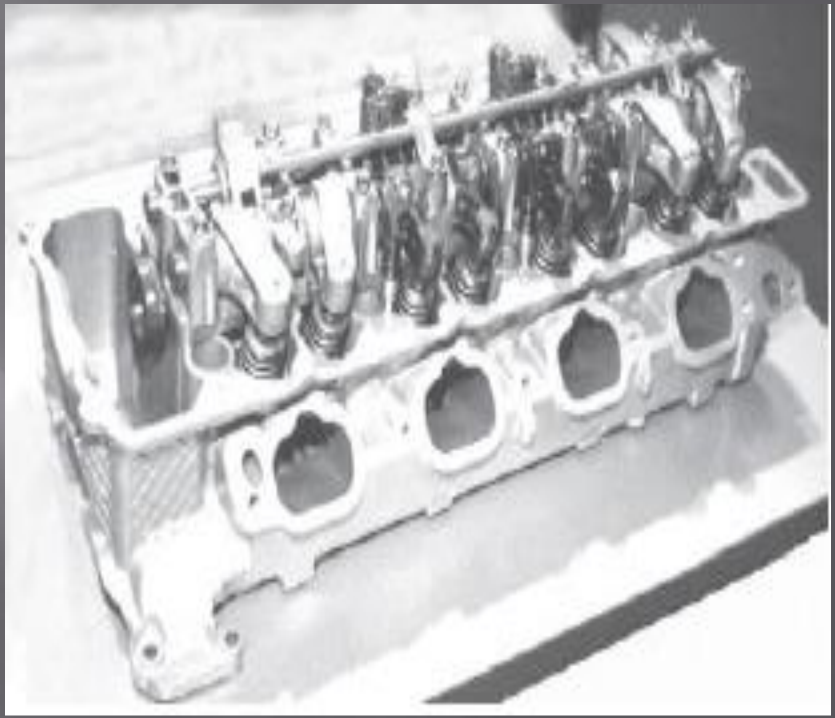


Figure 4.7: Cylinder head with the valve train

Intake and Exhaust Valves

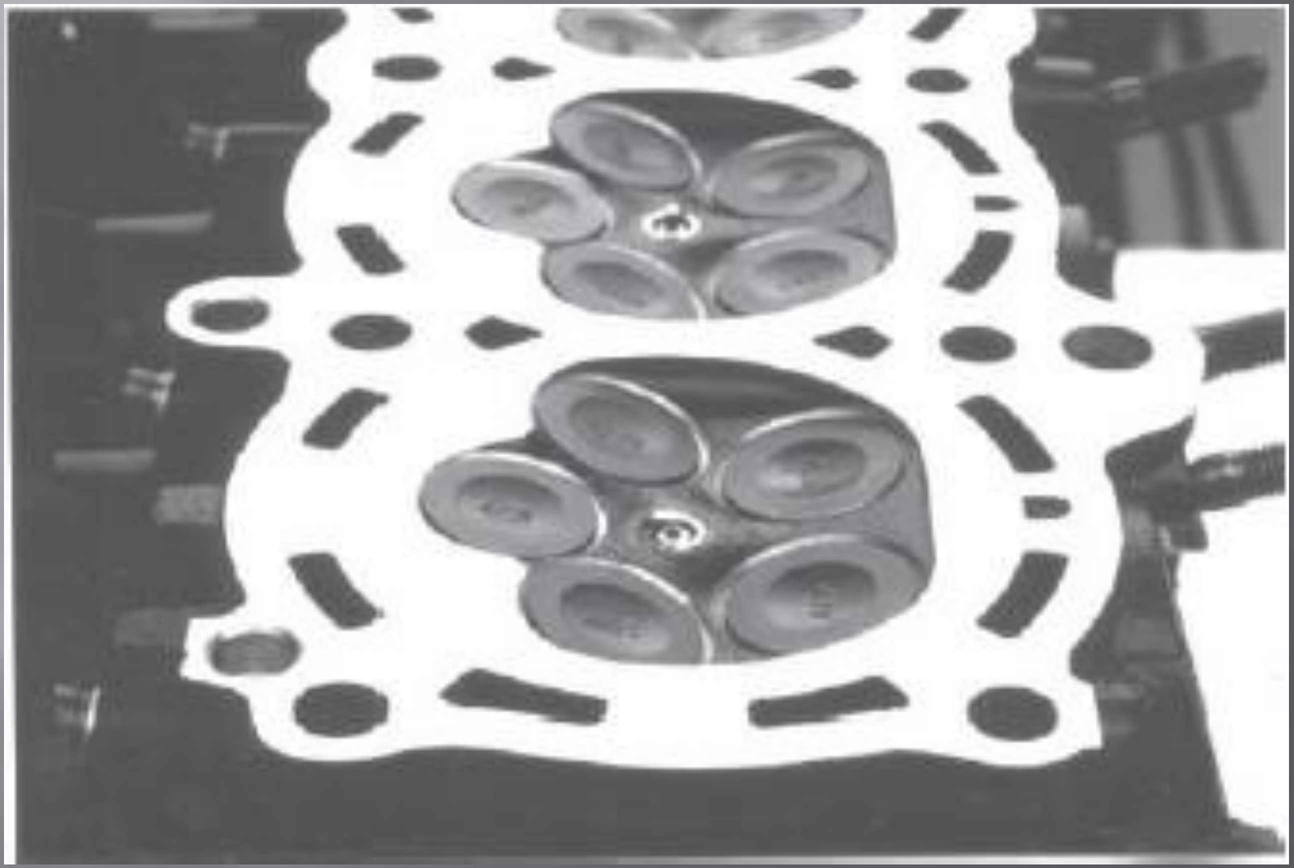


Figure 4.8: Cylinder head observed from the combustion chamber side.

Valve Design and Operation

- The shape of the neck, from the crown to the valve stem, ensures that the gas runs smoothly.
- The valve typically receives an acceleration of 2000 m/s^2 under high temperatures.
- Valves must be of light weight to allow the rapid reciprocating motion.
- In modern vehicles, various valve crown shapes are used.
- High-performance engines generally use recessed (vertical section is shown in Figure 4.5) or tulip crown shapes.

Valve Design and Operation Contd

- The shape of the valve crown controls the flexibility of the valve face.
- Some high-speed engines need a flexible valve so that the valve does not bounce off its seat when closing.
- The recessed or tulip valve is elastically flexible as well as light.

Valve Materials

- The exhaust valve, exhaust gas turbine and honeycomb always operate under red-hot conditions. For these parts, iron based heat-resistant alloys, nickel-based super-alloys and ceramics are functionally competitive.
- The exhaust valve seat, brake pad and friction plate (for a dry clutch), do not receive lubricating oil during operation, so these operate in the tribology area, where composite materials are most suitable.

VALVE SPRING

INTRODUCTION

The valve spring is a helical spring used to close the poppet valve and maintain an air-tight seal by forcing the valve to the valve seat.

Figure 5.1: Valve Spring

Valve Spring Description and Operation

- Generally, coil springs of a wire diameter below 5 mm ϕ are cold-formed at room temperature, while wires above 11 mm are normally hot-formed.
- Compression valve springs are provided with the ends plain and ground in the valve seat.
- A spring accumulates kinetic energy during contraction and the energy is dissipated upon expansion. There are many types, shapes and sizes of steel springs.

Surge in Valve Springs

- Another resistance phenomenon that occurs at high revolutions is surging, due to resonance.
- **Surging** occurs when each turn of the coil spring vibrates up and down at high frequency, independently of the motion of the entire spring. It takes place when the natural frequency of the valve spring coincides with the particular rotational speed of the engine.

Effect of Surge and the Remedy

- Surging occurs at high revolutions, and the surging stress generated is superimposed on the normal stress. The total stress is likely to exceed the allowable fatigue limit of the spring material and can break the spring.
- A variable pitch spring reduces the risk of surging. This spring has two portions along the length, a roughly coiled portion and a densely coiled portion, which ensures that the natural frequency of the spring is not constant and therefore not susceptible to resonance.

Spring Materials

- Valve springs use the superior characteristics of steel.
- Ti alloys is used to reduce weight, but steels will continue to be used for the majority of springs for the foreseeable future.