TYPES OF VALVES

- 1. INLET VALVES
- 2. EXHAUST VALVES

INLET VALVES: THESE VALVES ARE USED TO ALLOW FRESH AIR OR MIXTURE INTO CYLINDER. THERE ARE AT LEAST ONLY ONE INLET VALVE ON EACH CYLINDER HEAD. ON EQUAL NUMBER VALVE HEADS INLET VALVES ARE LARGER IN DIAMETER THAN EXHAUST VALVES.
TYPICAL INLET AND EXHAUST VALVES AND VALVE GUIDES
EXHAUST VALVES:

- Exhaust valves are used to allow burnt and unburnt gasses to escape atmosphere. Exhaust valves are normally smaller than inlet valves in diameter. There must be at least one exhaust valve for each cylinder.
VALVE TERMS

- **Valve seat**: Valve head is sitting on this circular hard disk to maintain a good leak proof seal when closed. It has 30 or 45 degrees sit angle.
- **Valve Guide**: Made from good quality bronze material for guiding and lubricating valve stem during engine operation.
- **Valve spring**: High grade steel is used to load valve to close during dweel period of cam lobe.
- **Seal**: A rubber seal is mounted at the end of valve guide to prevent oil leakage into cylinder during operation of engine.
- **Collet**: These two semi conical parts are used to lock spring and valve.
Valve Mechanism components
Valve Mechanism
Different Valve assemblies

DOHC direct tappet acting

OHC Rocker direct tappet acting
Different Valve assemblies (cont.)
CAMSHAFTS

- CAM SHAFT IS A FORGED STEEL SHAFT WHICH CARRIES CAM LOBES FOR INLET AND EXHAUST VALVES. ALL CYCLE TIMING OF THE ENGINE IS PROFILED ON THE CAM LOBE. SURFACE OF THE LOBES ARE GRINDED AND VERY HARD WHERE INSIDE IS SOFTER.
Power Boosting by Valve Mechanism Modification

- Power production from an Engine can be increased by phasing camshafts or changing valve stroke. Below systems are used for this purpose:

1. Vanos / Double Vanos
2. Timing Variator
3. VVTi
4. VTEC
1. Vanos/double-Vanos.

- Smoother idling, greater torque, elastic power: double-Vanos varies the camshaft timing to optimise power output throughout the rev range. Whatever your speed, you benefit from better performance, improved fuel efficiency and lower emissions.

The name Vanos is derived from the German term "variable Nockenwellensteuerung", meaning variable camshaft control. The double-Vanos system continuously adjusts the camshaft positions for both the intake and the exhaust valves. This results in significantly higher torque at low engine speeds and more power at higher engine speeds, while also reducing fuel consumption and emissions.
At lower engine speeds, the position of the camshaft is moved so the valves are opened later, as this improves idling quality and smooth power development. As the engine speed increases, the valves are opened earlier: this enhances torque, reduces fuel consumption and lowers emissions. At high engine speeds, the valves are opened later again, because this allows full power delivery.

Double-Vanos also controls the amount of exhaust gas that is re-circulated back to the intake manifold, enhancing fuel economy. The system uses a special set of parameters in the engine's warming-up phase in order to help the catalytic converter reach its ideal operating temperature more quickly, lowering emissions. The entire process is controlled by the vehicle's Digital Motor Electronics (DME). BMW first introduced the breakthrough Vanos technology in 1992. Double-Vanos entered production in 1997.
DOUBLE VANOS SYSTEM
2. TIMING VARIATOR

- A timing variator (electronic control and hydraulic activation) is fitted to the intake camshaft of a car engine. This device allows the timing graph (intake stage) to be altered according to engine load requirement. This parameter is processed by the control unit on the basis of electronic signals received by the airflow meter and rpm sensor, and sent as a command to the timing variator control solenoid. This device consists of a main assembly fitted to the intake camshaft. It alters the angular position of the camshaft in relation to the drive pulley. The following schematic shows a typical diagram of Timing Variator Control Solenoid.
TIMING VARIATOR

1 - Timing variator control solenoid
2 – Timing variator control valve
3 – Valve counter-spring
4 – Piston
5 – Pinion
6 – Camshaft
7 – Piston counterspring
8 – Solenoid control relay
3. VVT-i SYSTEMS

- VVTi SYSTEM IS A CAM PHASING SYSTEM THAT CAN BE APPLIED ON BOTH INLET AND EXHAUST CAM SHAFTS.
VVT i Engines

- This movement is controlled by engine management system according to need, and actuated by hydraulic valve gears.

- Note that cam-phasing VVT cannot vary the duration of valve opening. It just allows earlier or later valve opening. Earlier open results in earlier close, of course. It also cannot vary the valve lift, unlike cam-changing VVT. However, cam-phasing VVT is the simplest
4. VTEC SYSTEM

**VTEC** - STANDS FOR VALVE TIMING ELECTRONIC CONTROL. IT IS A SYSTEM TO SET OPTIMUM VALVE TIMING BY CONTINUOUSLY CHANGING THE TIMING TO OPEN/CLOSE INTAKE AND EXHAUST VALVE IN RESPONSE TO THE ENGINE LOAD, ROTATION AND OTHER OPERATING CONDITIONS. SYSTEM INCREASES VALVE OVERLAP AND ENABLES PARTIAL REINTAKE OF EXHAUST GAS AND REDUCES INTAKE LOSS. THE FUEL ECONOMY IS ENHANCED AND EMISSION OF NOx AND HC IS REDUCED.
THE COMBUSTION ENVIRONMENT IS ONE OF THE MOST IMPORTANT FACTORS TO DETERMINE AN ENGINE'S PERFORMANCE. THE COMBUSTION ENVIRONMENT INSIDE AN ENGINE IS LARGELY INFLUENCED BY THE VALVE SETTINGS - WHEN THEY OPEN (TIMING) AND HOW MUCH THEY OPEN (LIFT). IN HIGH PERFORMANCE ENGINES, THE VALVES ARE SET TO OPEN WIDE FOR A LONG DURATION, OR HIGH LIFT. THIS ALLOWS A RICH MIX OF FUEL AND AIR TO FLOW INTO THE COMBUSTION CHAMBER, GENERATING HIGH POWER AT HIGH REVs.
• **3 STAGE VTEC**: this variant uses three different cam profiles that literally operate in three stages. Each one controls a different valve timing and lift pattern.

**i-VTEC**: which stands for *Intelligent VTEC* is the Japanese manufacturer’s most successful valve actuation system to date and saw broad implementation in production models. The i-VTEC system was introduced in 2001 and uses continuously variable intake valve timing and computer controlled management for optimized torque output and fuel efficiency.
AVTEC: Advanced VTEC was announced by Honda in 2006 and seeks to combine the benefits of the i-VTEC system with continuously variable phase control, which is meant to respond to the driver’s power needs independent of engine speed. Honda announced the AVTEC system will allow for 13 percent better fuel economy over i-VTEC and 75 percent lower emissions than the 2005 standards. As of early 2010, the AVTEC system still hasn’t been implemented in production vehicles.
3 STAGE VTEC SYSTEM
At low rpm the outer rocker arms (E and F) are not slaved to the mid-rocker arm (G). Instead, the two outer cam lobes (A and B) directly actuate the outer rockers, and through these rockers, the valves. The outer cam lobes have a mild profile for good low-speed driveability, reduced emissions, and improved fuel economy. The mid-rocker arm is following the center high-rpm cam lobe (C), but because it's not connected to anything, there's no added effect on the valve timing.
AT HIGH RPM

High rpm: At a certain rpm threshold (typically between 5,000 and 6,000 rpm), the engine computer sends a signal to a valve which opens and allows oil pressure to move an internal piston (D) in the direction shown by the arrow. This links the outer and mid-rocker arms together like a skewer, causing the three rocker arms to move as a single unit. Since the center, high-rpm cam lobe extends farther than the outer, low-rpm lobes, it now controls the motions of all the rockers,
i-VTEC Cylinder Head
Several engine manufacturers are experimenting with systems that would allow infinite variability in valve timing and reduce this mechanical friction. For example, imagine that each valve had a solenoid on it that could open and close the valve using computer control rather than relying on a camshaft. With this type of system, you would get maximum engine performance at every RPM. Camless valvetrain systems have long been investigated by BMW and Fiat, and are currently being prototyped by Valeo and Ricardo. Something to look forward to in the future!
Valve Timing Diagram

- Inlet valve opens 16 degree BTDC closes 55 degree ABDC. Exhaust valve opens 55 degrees BBDC and closes 16 degrees ATDC. Inlet and exhaust valves are staying open for 32 degrees this is called Valve Overlap.
Sample valve timing diagram