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ADVANCE VALVE TECHNOLOGY IN I C ENGIN

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INTRODUCTION:

Engine the heart of automobiles:

Engine provides controllable shaft power for necessary applications.

Camshaft the heart of engine:

Cam is mechanical link, which gives desired motion to follower. In case of 4-stroke engine cam provides necessary actuation to the engine valves in relation with crankshaft and piston position.

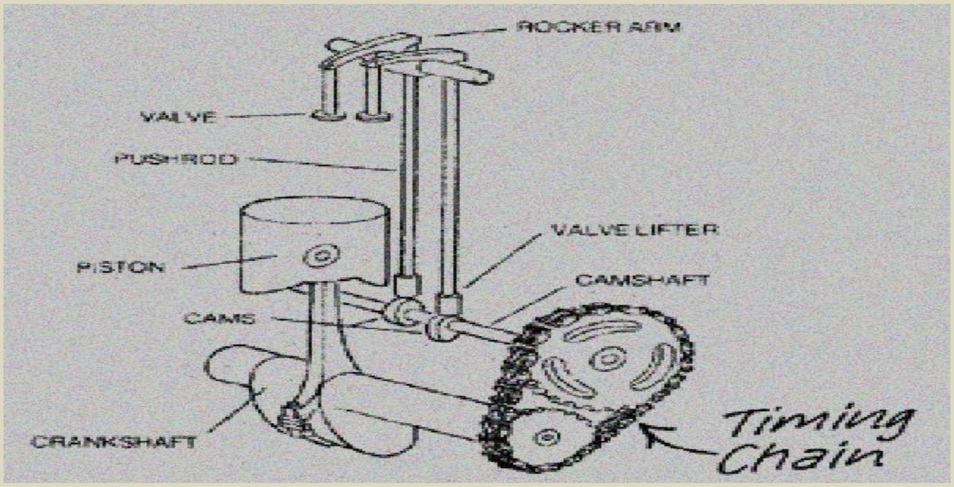

Fig.1:- Traditional valve train

How camshaft controls the engine performance:

Power output and performance of engine depends on Amount of fuel burnt in Internal Combustion Engine for specific period which is function of,

1) Opening available………..Valve lift

2) Duration of opening……...Valve timing

1) High RPM operation:

At high RPM time available for charge to enter in the cylinder and exhaust gases to expel out is very less. So in order to provide effective operation the valve overlap must be high.

Low RPM operation:

At low RPM in order to provide the smooth idling and better torque zero valve overlap is required.

Necessity and objectives of Advance valves in Internal combustion Engine:

1. Cheapest & simplest because each camshaft needs only one phasing actuator.
2. Continuous VVT improves torque delivery across the whole rev range.
3. By varying the camshaft rotation and amount of overlap, the engine can have excellent performance at both low and high speeds
4. Reduction in engine emissions.
5. More precise air fuel ratio control.
6. Optimizing combustion with high swirl induction makes the engines more efficient

Cam Changing VVT :

WORKING PRINCIPLE:

The shape of cam is changed as per the operating conditions of engine.

V-Tec-variable valve timing and lift electronic control:

Three stage V-Tec:

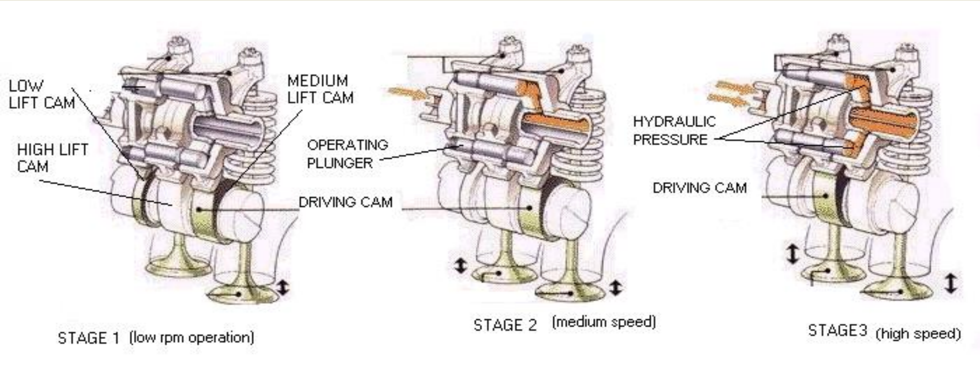

Fig. 2:- V-Tec operation

CONSTRUCTION:

The mechanism has 3 cams with different timing and lift profile the middle cam (fast timing, high lift), as shown in the above diagram, is the largest; the right hand side cam (slow timing, medium lift) is medium sized; the left hand side cam (slow timing, low lift) is the smallest.

OPERATION:

Stage 1 (low speed): the 3 pieces of rocker arms moves independently. Therefore the low-lift left cam drives the left rocker arm, which actuates the left inlet valve. The medium-lift right cam drives the right rocker arm, which actuates the right inlet valve. Both cams' timing is relatively slow compare with the middle cam, which actuates no valve now.

Stage 2 (medium speed): hydraulic pressure (painted orange in the picture) connects the left and right rocker arms together, leaving the middle rocker arm and cam to run on their own. Since the right cam is larger than the left cam, those connected rocker arms are actually driven by the right cam. As a result, both inlet valves obtain slow timing but medium lift.

Stage 3 (high speed): hydraulic pressure connects all 3 rocker arms together. Since the middle cam is the largest, both inlet valves are actually driven by that fast cam. Therefore, fast timing and high lift are obtained in both valves.

Merits:

1. Powerful at top end

Demerits:

1. Limited to 2 or three stages.
2. Non continues
3. No improvement to torque.
4. Complex.

CASE STUDY OF CAM-PHASING VVT BY HONDA

Cam-phasing VVT is the simplest, cheapest and most commonly used mechanism at this moment. Basically, it varies the valve timing by shifting the phase angle of camshafts. For example, at high speed, the inlet camshaft will be rotated in advance by 30° so to enable earlier intake. This movement is controlled by engine management system according to need, and actuated by hydraulic valve gears. .

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.

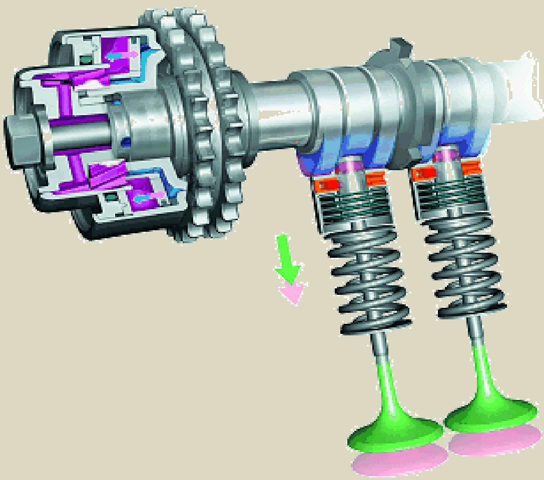

Fig. 3:- Valve positions of cam changing VVT

Merits:

1) Cheapest & simplest because each camshaft needs only one phasing actuator.

2) Continuous VVT improves torque delivery across the whole rev range.

Demerits:

1) Lack of variable lift and variable valve opening duration, thus less top end power than cam-changing VVT.

CASE STUDY OF CAM PHASING VVT BY BMW:

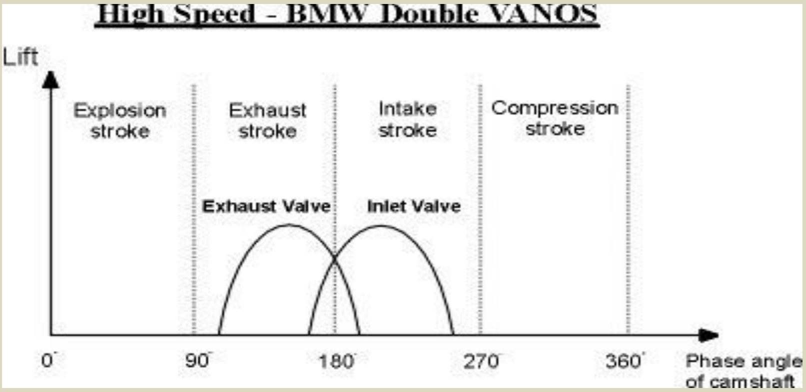

Chart 1:- Valve positions of cam changing VVT

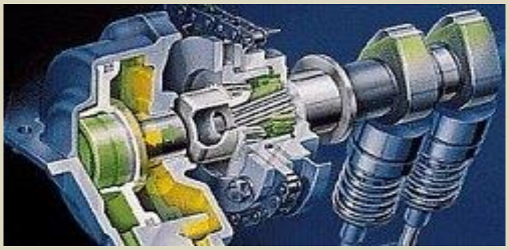

Fig. 4:- Cam phasing actuator in cam phasing VVT.

Construction &operation:

The end of camshaft incorporates a gear thread. The thread is coupled by a cap which can move towards and away from the camshaft. Because the gear thread is not in parallel to the axis of camshaft, phase angle will shift forward if the cap is pushed towards the camshaft. Similarly pulling the cap away from the camshaft results in shifting the phase angle backward.

Whether push or pull is determined by the hydraulic pressure. There are 2 chambers right beside the cap and they are filled with liquid (these chambers are colored green and yellow respectively in the picture) A thin piston separates these 2 chambers, the former attaches rigidly to the cap. Liquid enter the chambers via electromagnetic valves which controls the hydraulic pressure acting on which chambers. For instance, if the engine management system signals the valve at the green chamber open, then hydraulic pressure acts on the thin piston and push the latter, accompany with the cap, towards the camshaft, thus shift the phase angle forward. Continuous variation in timing is easily implemented by positioning the cap at a suitable distance according to engine speed. Optimizing combustion with high swirl induction makes these engines even more efficient.

Demerits: Complex and expensive4.3 hyper v-Tec BY HONDA AUTOMOBILES.

CAM PHASING VVT BY PORSHE:

Fig. 5:-Vario-cam Plus uses hydraulic phasing actuator and variable tappets

Construction and Operation:

It uses timing chain to vary the phase angle of camshaft, thus provided 3-stage variable valve timing. This design doesn’t allow as much variation to phase angle. The addition of variable valve lift is implemented by using variable hydraulic tappets. As shown in the picture, each valve is served by 3 cam lobes - the center one has obviously less lift (3 mm only) and shorter duration for valve opening. In other words, it is the "slow" cam. The outer two cam lobes are exactly the same, with fast timing and high lift (10 mm). Selection of cam lobes is made by the variable tappet, which actually consists of an inner tappet and an outer (ring-shape) tappet. They could by locked together by a hydraulic-operated pin passing through them. In this way, the "fast" cam lobes actuate the valve, providing high lift and long duration opening. If the tappets are not locked together, the valve will be actuated by the "slow" cam lobe via the inner tappet. The outer tappet will move independent of the valve lifter.

As seen, the variable lift mechanism is unusually simple and space saving. The variable tappets are just marginally heavier than ordinary tappets and engage nearly no more space.

Advantage:

1. VVT improves torque delivery at low / medium speed; Variable lift and duration lift high rev power.

Disadvantage:

1. More complex and expensive

Who use it?

Porsche 911 Turbo, 911 Carrera 3.6

ADVANTAGES:

Mechanically a very simple cam less engine. .

1. No gears, camshaft, cams, push rods or rocker arms.
2. Greatly reduced mechanical losses.
3. Fewer moving parts.

Microcomputer control of the valve and ignition timing.

1. Cycle skipping & hit and miss operations are practical to save fuel.
2. Very easy starting by holding the exhaust valve open when cranking.
3. Dynamically controlled spark advance.
4. Simple and low cost electronics
5. The "Electronic Throttle" function reduces pumping losses and saves fuel.

Electronic Throttle

1. The intake and exhaust valve timing can be changed to control the engine's speed and power.
2. That a speed range of 1400 to 8000+ RPM is achievable without manifold throttling.

TECHNOLOGY LIMITATIONS:

The liming factor in the current design is the time it takes the valves to close. The valves are not closing as fast as they should. The closing time, especially of the intake valve, decreases with speed because the mixture is being pushed back out of the valve port and, in effect, assists the valve spring in closing the valve. But that means late intake valve closing and less mixture in the cylinder. If you close the exhaust valve early it closes quicker but you don't get all the exhaust gases out. What it all means is that to get better and more consistent breathing it need either stronger valve springs.

OTHER LIMITATIONS

1. More time is required to close valves. Use of high stiffness spring will increase the power and hence reduce the net power output of engine.
2. High stiffness returns spring will require high capacity to perform operation.
3. Less volumetric efficiency at high speed

CONCLUSIONS:

1. Powerful at top end
2. Cheapest & simplest because each camshaft needs only one phasing actuator.
3. Continuous VVT improves torque delivery across the whole range.
4. By varying the camshaft rotation and amount of overlap, the engine can have excellent performance at both low and high speeds
5. Reduction in engine emissions.
6. More precise air-fuel ratio control.
7. Optimizing combustion with high swirl induction makes these engines even more efficient.
8. Continuous VVT improves torque delivery across the whole rev range