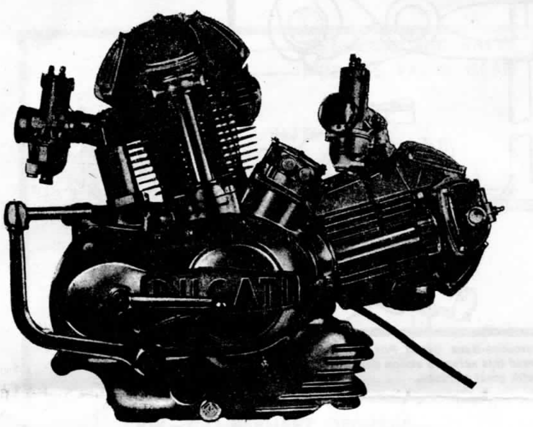
TECHNICAL



DESMODROMICS

(Editor's note: On occassion we find magazine articles we think will be of interest to Ducati owners. This article, which appeared in the May 1976 issue of Motor Cycle World, is one of them. We secured permission from Clif Gromer, editor of that publication to reprint the article here. Hope you enjoy it.)

For many years the concentional method of operating poppet valves has been to knock them off their seats with cams and return them by springs. While no one would call this practice the most perfect or desirable, it has worked remarkably well. Although this cam and spring method is totally effective on a standard "touring" engine, it has some limitations at the rotational speeds attained by modern racing engines.

Any convention valve gear has a critical point beyond which the valve will no longer follow the contour of the cam. Such waywardness has two forms. The first is known as valve float and is due to the inertia of the valve system. Each side of the cam lobe has two stages —acceleration and deceleration. The acceleration stage gets the valve on the move from its seat or from its open dwell, and the deceleration stage slows the valve as it approaches full lift or its seat.

If the reciprocating mass of the valve train is high, the deceleration provided by the cam profile may, during the second stage of opening or closing, exceed that which the spring pressure can exert on the valve, in which case the valve motion becomes inaccurate because contact between the cam and its follower is temporarily lost.

The second form of valve operation nonconformity is known as valve bounce. Valve springs, like any other elastic media, have a natural tendency of vibration. If the frequency coincides with that of the valve operation a state of resonance occurs in the form of surging of the springs. When the critical speed for resonance is reached, the return surge of the spring bounces the calve off its seat as soon as it has arrived. This bounce can even occur several times with diminishing amplitude during the closing dwell of the valve before all the energy of vibration is used up.

This failure of the valve to follow the contour of the cam has serious consequences. Mechanical noise is increased, the cam will show a great amount of wear, and there is a chance of valve-spring breakage. Even worse, though, is that in a high-compression engine, there is always the chance of the valve touching the piston with disastrous results to both.

To acheive the quickest possible opening and closing without valve float or bounce, the valve gear on a racing engine is lightened and greater poundage springs are used. Also "revkits," which employ the use of spring actions against the pushrods to assist the closing of valves are employed —especially in the case of American V-8 engines modified for racing use.

One of the related problems of the cam-valvespring setup is the amount of power the system absorbs. The friction losses are quite high, particularly in a racing engine with high-tension springs, and the horsepower required to push open the springs is substantial. In view of these limitations, it is not surprising that there have been various attempts through the years to evolve a more satisfactory method of valve control.

One of the more successful systems developed is the "desmodromic" method, which comes from the French word desmodromique, which means to force to follow a contour. The first known patent for a desmodromic system was by an Englishman, F. H. Arnott, in 1910.

Nothing much became of Arnott's patent, though, and it was left to the 1914 French Delage Grand Prix car to really put the positive valve control method into the history books. The Delage system had two cams inside a stirrup-shaped tappet, and one cam opened the valve and the other "inverse" cam pulled the valve shut. There was a small "tolerance" spring to ensure that the valve was pulled into its seat, because the desmodromic setup only closed the valve to within a few thousandths of an inch. The Delage desmodromic system was not too sucessful and was dropped.

During the 1920's and 1930's, there were other desmodromic patents taken out in Europe, but most came to rest only in the history books. One of the most interesting was the Bignan Sport method developed in the middle 1920's. The Bignan system used a bevel gear driven face cam or swash plate that was provided with a V section periphery. Motion was conveyed from cam to valve by a cross head running on a guide. The cross head carried a pair of oppositely inclined rollers, one of which ran on each face of the swash plate periphery.

Since those early days, interest in desmodromic valve operation became rather sporadic until the fabulously successful Mercedes Benz Grand Prix cars of 1954-55 made their appearence. The great German racing cars had 260 horsepower, 2.5 liter engines, and the desmodromic system utilized was both unique and utterly reliable. Two cams per valve were used on the Mercedes engine, and each cam had its own rocker. The rockers were pivoted side by side on a common shaft in a "sissors" disposition. The opening rocker abutted on a sholder, part way down the stem, and the closing rocker bore on a collar near the end of the stem.

The original design embodied final closure of the valves by springs, but the springs were dispensed with after tests revealed them to be unnecessary. All that was required was a few thousandths clearence and the pressure inside the cylinder pushed the valve onto its seat. The opening cam is of convential form, while the closing cam is an inversion of the opening cam.

In practice, it was necessary to machine the cams to exceptionally close tolerances, lest the opening and closing cams would pull against each other. With the complete in-line eight-cylinder head assembled on the bench, it was said that a mere flip of the fingers could turn the engine's camshaft through a complete cycle. While no official figures are available from the Mercedes factory, it was rumored that some 30 HP was gained over a standard valve-spring engine.

Since 1955 desmodromic developement has been relatively inactive in the racing car field and is now strong in the two wheeled version of the sport. The next significant experiment was completed in 1958 by the famous British Norton concern, a truly great name in international road racing. Norton's efforts in desmodromics never went beyond the experimental stage, although the original idea was to apply it to their production "Manx" racing machine, but they nonetheless created a milestone as their system was so much simpler than Mercedes.

Because the Manx model already had a tried and proven double-overhead camshaft engine, it was decided to use the intermediate gear wheels to mount the "inverted" cams. The opening cams bore directly on the valve tappets, while the closing cams operated through short, forked rockers. Thus it was possible to do away with the sissors-type rocker arms that Mercedes used, and the head was kept smaller and more compact.

Bert Hopwood, who was chief design engineer at the time, stated that standard Manx valve timings were used