



raising



twins

Twin overhead camshafts and Alfa Romeo engines belong together – a bond celebrated in the new 1.8 Twin Spark 16V power unit

There seems to be an element of tautology in the expression twin-cam Alfa Romeo. Does it not follow – did it not always – as a matter of course that an Alfa Romeo engine must, as though compelled by a dominant gene somewhere in its inheritance, have two overhead camshafts?

No, as a matter of fact. There have been many Alfa Romeo aero-engines with no camshafts at all, for the perfectly proper reason that they were radial engines. Even if we confine our survey to cars, then we find that from 1920 (when, with engineer Nicola Romeo taking charge of the company, his name was added to that of Alfa) until 1928 Alfa Romeo production-car engines had only one camshaft, and in the early days it was not even overhead.

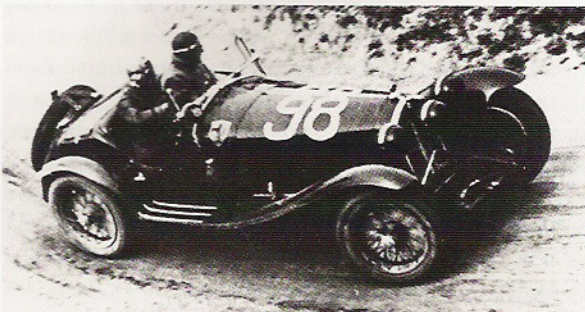
As always, it depends what we mean; it all turns on what we implied when we said what we did. Twin-cam, forsooth? A cam, remember, is merely an eccentric. I mean no offence – some of my best friends are eccentrics – but such a cam is merely an off-centre protuberance designed to move something, such as a valve, in a predetermined cyclic sequence by pushing against it as the cam revolves. There has surely never been an Alfa Romeo car without eight cams, at the very least, lodged somewhere in its vitals; but we are really talking about the shafts upon which they were arrayed, like pegs upon a washing-line.

It was in 1928, when the Models 6C 1500 Sport and Super Sport first stepped upon a darkened stage and made it incandescent by their presence, that the history of the twin-overhead-camshaft Alfa Romeo began. It has never since faltered.

Again, it depends what we mean. There is no denying that this eccentric duplexity can be arrived at by semantic duplicity: the little AlfaSud flat-four engine of 1972, and the more expansive V6 engine of 1980, did indeed have two overhead camshafts, but each surmounted only one of the two banks of cylinders. That is cheating; that is why there is a subtle distinction between two and twin: the head that is truly noble wears twin camshafts in its crown.

Never mind. Notwithstanding those two engines, and also the single-camshaft touring versions of the original 1500 and the 1750 which succeeded it, Alfa Romeo car production has, since, 1928, always included engines with twin overhead camshafts. That is a proud record indeed, one that no other manufacturer in the world can rival.

If there be pride to be taken in it, there must be something good about it. Indeed there is, so much so that nowadays



outside America there are very few car engines made without at least one overhead camshaft. Yet it was by no means always the case; so what are the ideals which kept Alfa Romeo a beacon of enlightenment in the long dark ages through which the car has struggled to reach modernity?

Efficiency is the ticket. Volumetric efficiency, a measure of how well the engine breathes its air in and gases out; combustion efficiency, a measure of how well it harvests the energy latent in its fuel; mechanical efficiency, a measure of how well it can sustain its duties: these are the three rules of thumb which govern the performance of an engine. If three thumbs should strike you as unnatural and excessive, then the first two – breathing and burning – may be grouped together as being concerned with the cavities within the engine (the cylinders and their combustion chambers) and the holes or passages (inlet and exhaust ports) through which they communicate with the outside air. The other thumb may then rule over mechanical efficiency, which is concerned with the metal surrounding and serving those cavities.

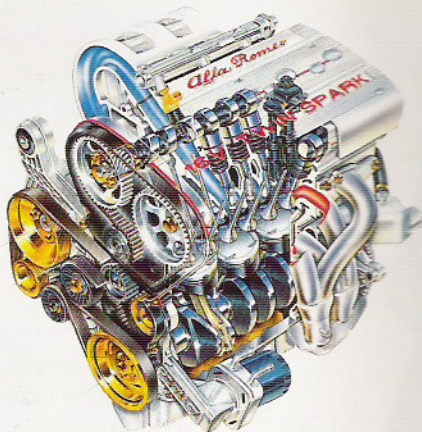
Crucial to that service are the valves, which open and close the inlet ports to admit air and fuel to the cylinders, and in due course open and close the exhaust ports to allow the gases produced by combustion of that fuel in that air to clear out and make way for a fresh charge. The more air that can be admitted in a given time, the more fuel may be burned in it and correspondingly the more power can be developed. So the faster those valves can operate (always supposing that the rest of the engine can keep up with them, which in an engine as well designed as an Alfa Romeo is not a problem) the better. For the flow to be fast and free, and the burning itself to be efficient, the combustion chamber must be of a certain shape, the spark plug must be in a particular place, and the inlet and exhaust ports need to be opposite each other.

Then there is the machinery to consider. Those valves must be large enough and open wide enough to allow gas flow to be generous and unimpeded, yet when closed they must maintain a gastight seal despite the tremendous pressures of combustion. They must maintain their properties despite the searing heat to which they are subjected. They must be light enough to open as fast as possible, yet never exceed the limits of acceleration and velocity which would prejudice the effectiveness of the springs which keep them in contact with the cams which prod them; and those springs must be strong enough to return them to their seats at the right time and hold them there against any tendency to bounce or flutter, yet not so strong as to impose heavy loads on any of the mechanism, such as might either wear it down or slow it down. The whole apparatus must work precisely, without deformation, without departing from the prescribed plots of time and motion, even though each valve may open and close several thousand times a minute even though the duration of

opening may be less than a hundredth of a second; and the whole assembly must be able to keep this up for hours on end, for months without attention, and for years without replacement. It is a tall order.

The sum of all these necessities could only be met by adopting the system that had been shown in motor racing to be the most efficacious. All the essentials were embodied as early as 1905 in an American racer built by Premier to the design of one George A Weidely, except that he gave it only one overhead camshaft. The use of two was inspired, either by a syndicate working for Peugeot or by the Hispano-Suiza designer Marc Birkigt (and this is not the place to enquire into the old controversy about stolen ideas and original thinking), in 1912. It had proved entirely convincing by 1921, when Fiat redrew the racing engine to provide the best imaginable performance within the dictates of contemporary regulations and technology.

In the following year, the Grand Prix Fiat utterly slaughtered all opposition. Suddenly the racing Fiat engine –



with twin overhead camshafts and steeply inclined valves opposing each other across an hemispherical combustion chamber with a central spark plug – was the thing to copy. Among the first to do so was the firm of Alfa Romeo, one of whose drivers (an impressive and already influential man by the name of Enzo Ferrari) arranged for two leading Fiat engineers – designer, Bazzi, and racing team manager, Jano – to be tempted away from the murk and mists of wintry Turin to the mists and murk of wintry Milan. Within a couple of sweat-laden and nerve-racking

summers, the P2 Alfa Romeo had picked up the torch that Fiat now declined to carry, and successfully fought off racing challengers for years to come. The real challenge came outside racing: was it feasible to embody the design and morphology of the racing Alfa Romeo engine in a car for the road? It was a very tall order indeed.

To the greater part of the motor industry, it was practically impossible during the the first half of our century. Until urged by the relentless spur of war, neither technology nor education provided for the metals, the lubricants, the understanding of gas dynamics or the chemistry of fuels and combustion, nor even the electrical subtleties of ignition, that would together make it feasible. Most engines were designed to be dismantled for decarbonising and valve adjustment or even replacement after only a few thousand miles; to simplify this, commonplace cars for commonplace customers had side-valve engines of abysmal efficiency. In the boardrooms and drawing offices of factories from Detroit to Dresden, from Rolls-Royce to Rosengart, the overhead-camshaft engine was decried as too impractical, too costly, too noisy; the most that could be sanctioned in such places was the clumsy compromise of overhead valves, usually set vertically and in line, operated by a camshaft left where it had been originally

located for operating side-valves, down in the crankcase.

Alfa Romeo had done that in the early 1920s, and been very successful at it. Yet it was a compromise, and clumsy: the additional weight of the necessary pushrods and rockers, with all their extra bearings and pivots and clearances, added to the total mass that had to be moved by the cams and controlled by the valve springs, while detracting from the precision with which the valves moved. Without even more rockers and associated problems, the valves could not be put where they ought to be, so breathing suffered; so did combustion, because with the valves badly located the combustion chamber could not be the right shape.

Jano did not doubt what ought to be done, and the directors did not hesitate to support him. To make for the public a car which reflected the reputation that Alfa Romeo had already won in racing, it was necessary to make a car which in chassis and engine echoed the design principles which made the racing Alfa Romeo not merely notable but noble. In 1925 the new six-cylinder 1500 made its debut: the architecture of the engine would have done credit to any contemporary racer, except that the cylinder head had its valves in line – but they were operated by the most direct and precise means possible, by a camshaft located immediately above them. All the mass and mess of pushrods and rockers and their appurtenances was eliminated.

It was to prove a transitional design, calculated to excite and appease the customer who would like an overhead-camshaft engine but was a bit afraid of the responsibilities that a full racing-style design might impose on him. The customers, once they had tasted the excitement of driving something so stimulating and encouraging were soon ready to go the rest of the way: in 1928 the Sport and Super Sport versions were crowned with twin overhead camshafts working directly on inclined valves of generous size opposed in hemispherical combustion chambers featuring central spark plugs. Nothing conceptually superior would be seen in a production car engine for the next 40 years.

Shamefaced rivals, most of whose cars were built up in large quantities and built down to a price, were not slow to criticise these arrangements. The gears by which the camshaft was driven at half-speed from the crankshaft so far below were infernally noisy, and their adjustment was critical. More noise still seemed to emanate from the cams and valves themselves, simply because their position in the roof of the engine made their noise harder to stifle than when their work was being done in the basement. When the time came for a 'top overhaul' (although, to be fair, Alfa Romeo valvegear stayed in adjustment for longer than most other types), there was a lot of work involved in dismantling and reassembling the cylinder head and all its attendant intricacies. Owners were not dismayed; if all this was the price of enjoying the most noble of engines, it was a price well worth paying. Merely to see the components, when doing an overhaul, was to take further pride

in one's purchase; as for the noise, a wonderful whoop and howl which piled musical harmonics upon the fundamental notes of the exhaust and, in some cases, upon the scream of a supercharger, it was not without its own peculiar charm.

Thereafter, there was always a twin-overhead-camshaft Alfa Romeo in the catalogue. Its efficacy was unchallengeable: racing proved it, a quick trip to visit friends at the other end of some Appenine pass proved it, the performance of military staff cars in the highlands of East Africa proved it. Jano went, other designers succeeded him in their turns, but always the epitome of Alfa Romeo philosophy was this type of engine.

Today, after a lifetime of experience and development, the archetypal Alfa Romeo engine has changed in details but not in concept. The mechanical noise has disappeared; so has the need for frequent adjustments and overhauls. Current concern for environmental cleanliness and the conservation of oil and other resources has encouraged the use of four valves per cylinder, although it was the pursuit of even higher levels of power and speed which had prompted their use. The same

public-spirited concern tends to limit engine speeds to levels which could nowadays easily be attained by engines having only one overhead camshaft, but still it remains better to have two.

Among the advantages of the twin-camshaft head is the fact that the layout leaves the space between the banks of valves free for the insertion of spark plugs, or downdraught inlet ports (never an Alfa Romeo feature, as it happens), or coolant conduits, as well as giving the designer complete freedom to choose whatever angle he likes between the inlet and exhaust valves. There is

something else, something being seen today as more than ever desirable: given separate camshafts for operating the inlet and exhaust valves, it is possible to vary their phasing, to alter the timing of their respective events in relation to each other. By this means (and all it requires is a fairly simple mechanism to advance or retard one camshaft, though it can be even better to modulate both of them) the engine can be given different performance characteristics according to whether it be running at high speeds or at low, whether under light load or with the utmost power being demanded of it. In this way the engine can behave like a rabid racer or a compliant potterer, on demand – and never disgrace itself in terms of economy or emissions when playing either role.

The variable camshaft-phasing is a technique that is gaining popularity very rapidly indeed. Some of the more famous firms in the motor industry are adopting it, most recently in Britain after earlier demonstrations of its effectiveness in Japan and Germany. The main requirement is quite simple: the engine must have twin camshafts – and it is taken for granted nowadays, though it took some people a terribly long time to learn, that they should be overhead.

As might also have been taken for granted – and certainly it should come as no surprise – it was done first by Alfa Romeo. Some genes just cannot help being dominant. ■

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