

No one makes V4 engines any more, at least not for cars. Every four-pot has the cylinders in a line nowadays, apart from Subaru's flat-fours. Not many carmakers made them in the past, either, apart from Ford with its rough 60° unit and Russia's Zaphorozhets. And Lancia.

Lancia loved V4s. Company founder Vincenzo Lancia loved vee-engines of all cylinder-counts, actually, patenting his particular take on a V8 in 1915 and building his first V8s and V12s shortly afterwards. Indeed, it wasn't until the flat-four Flavia of 1961 that a post-1920s production Lancia lacked a vee-engine, and even that unit (the inspiration for Subaru's engines, incidentally) could be regarded as a 180° V4 if you were so minded. Then came the Fiat inline-engined Beta and that, apart from some final flickers from the flat-four Gamma, was that, as far as 'proper' Lancias were concerned.

It was the V4-engined Lambda, conceived in 1919, that set Lancia on the road to success. That engine was a typical Lancia vee, with a narrow vee-angle and a separate crankpin for each connecting rod, unlike a typical American 90° V8 in which crankpins of opposite cylinders are shared. Thus it was not so much a V4 as a staggered, compressed inline four, with the 'opposite' cylinders not really opposite at all.

However you design it, a V4 has inherent balance problems less evident in a V6 or a V8 for which there are 'correct' vee-angles that allow the major out-of-balance forces to cancel each other out. The Lancia approach was to keep the angle as narrow as possible, to minimise the out-of-balance forces, so they are little greater than those of an inline four. Why, then, have a V4 at all? That's a hard question to answer for the Lambda and many later Lancias, but with the launch of the Fulvia in 1963 it all made sense.

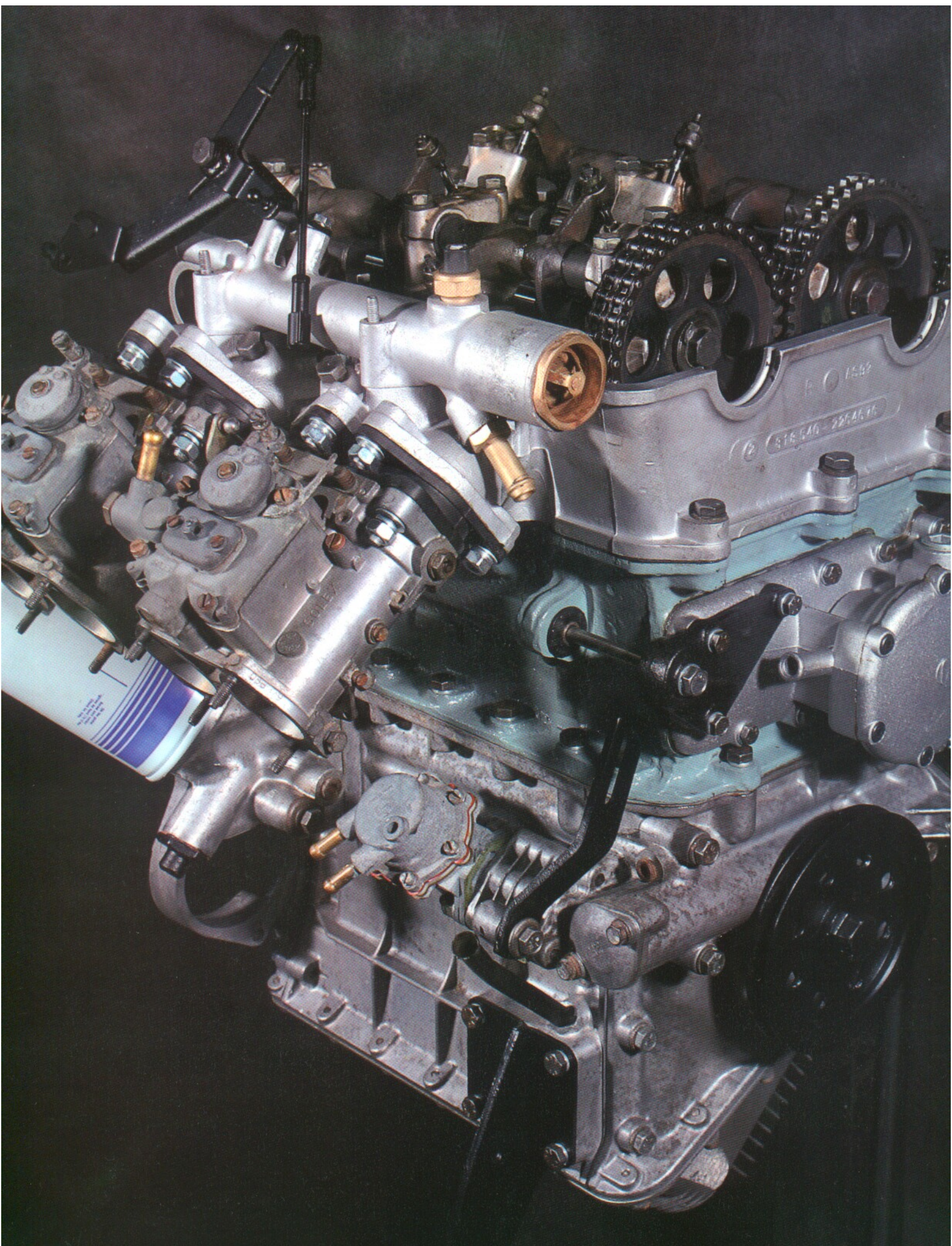
The engine design's longitudinal compactness was perfect for Lancia's new, Appia-replacing small car because, as with the Flavia flat-four before it, the 1216cc V4 had to hang ahead of the front axle line in a

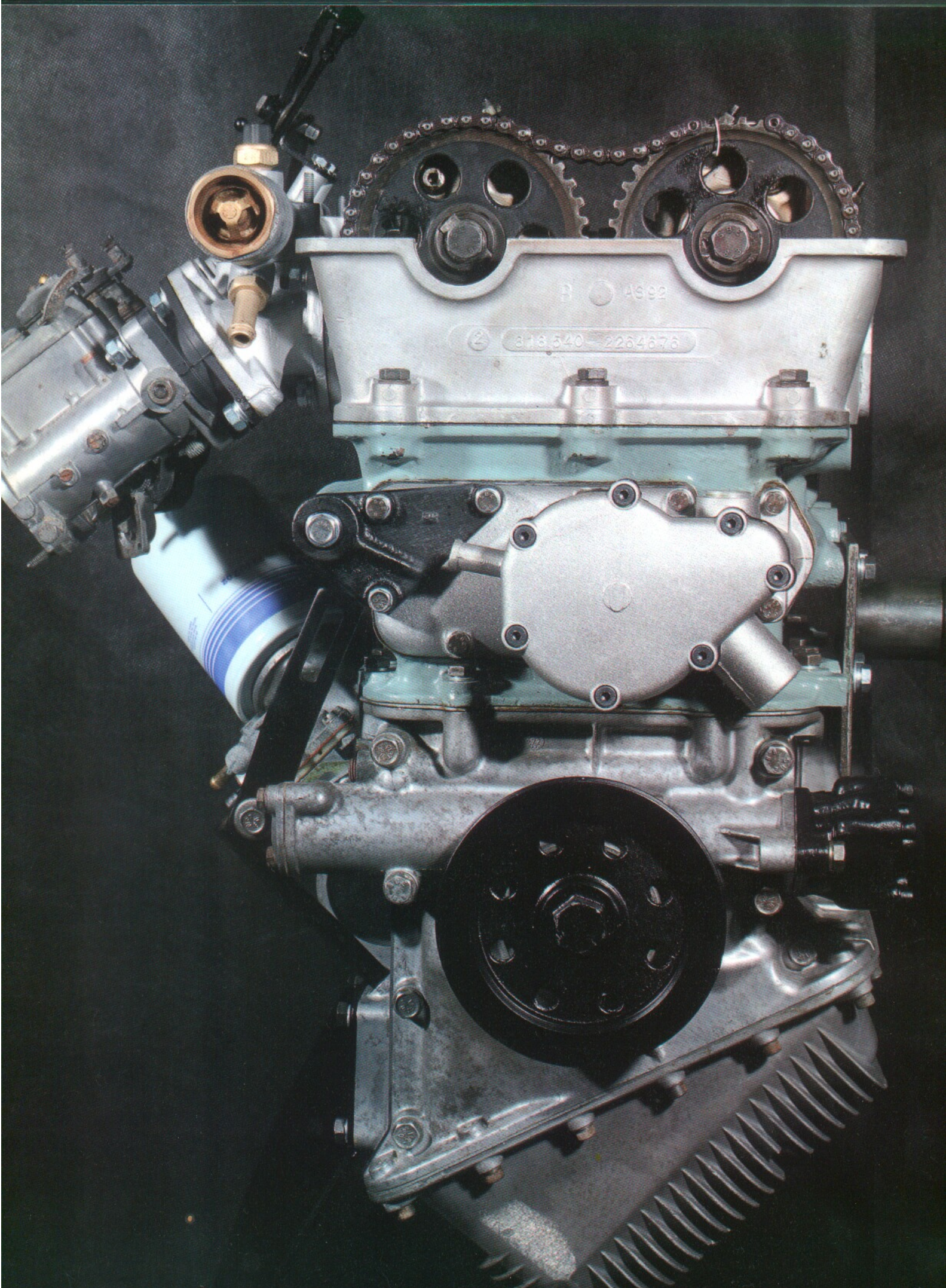
Milestone Engines

LANCIA FULVIA V4

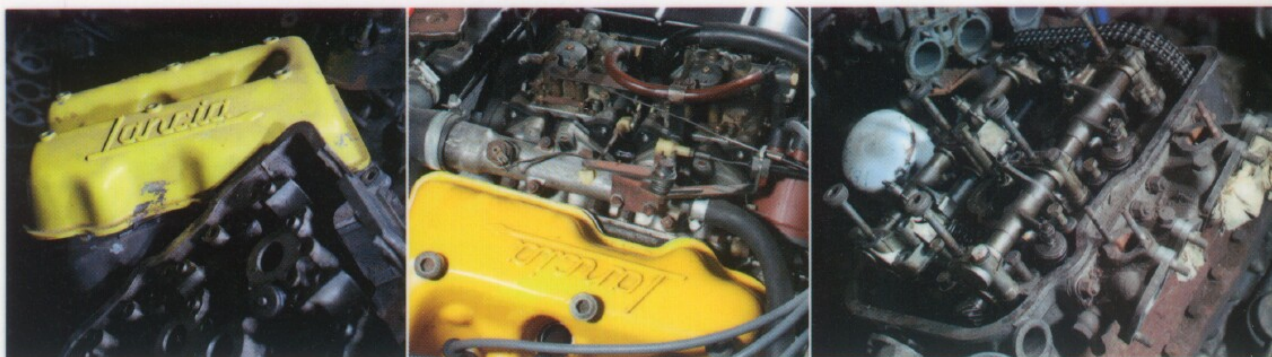
An investigation into Lancia's fascination
for the narrow-angle V4

Story by John Simister
Photography by Michael Ward





FAR RIGHT: Part of Omicron's stockpile of Lancia Fulvia engines
CENTRE: A completed engine as fitted to a Fulvia Sport Zagato



front-wheel drive layout. Both engines were designed under Professor Antonio Fessia, who had supplanted Vittorio Jano of Aurelia, Appia and Alfa 8C fame, but the Fulvia still retained crucial Lancia V4 features such as the narrow vee-angle (12 degrees, 45 minutes and 28 seconds in this case, a truly arcane figure in its lack of rounded-offness) and the one-piece cylinder head.

Otherwise, though, the engine was quite different

castings. But it makes sense here, because it allows optimum strength with minimal weight, achieved by making the block from cast iron and the crankcase, cylinder head and the sump and cam cover which seal them from cast aluminium. When you see how the crankcase is designed asymmetrically, to reconcile a level sump face with a 45° block face, it makes yet more sense.

Looking at the Fulvia now, you just know that no major car manufacturer would consider such an eclectic design again

from that of its Appia ancestor. The valves, for example, were actuated by overhead camshafts instead of by long pushrods, not a camshaft per bank as is sometimes supposed but one inlet and one exhaust camshaft, as in a normal twin-cam inline four. In fact, the whole engine looked a little like an Alfa Giulietta twin-cam which had been topologically squeezed in several directions at once.

Look at a Fulvia engine now, and you just know that no major carmaker would consider such an eclectic design ever again. It would be far too expensive to make and far too inflexible for use in other applications. For this was an engine designed for the Fulvia alone; that's why it not only leans 45° to the left (seen from inside the car), to the benefit of the bonnet line and the centre of gravity, but is also tilted six degrees backwards, revealed by the twist in the inlet manifold needed to keep the carburettor/s level.

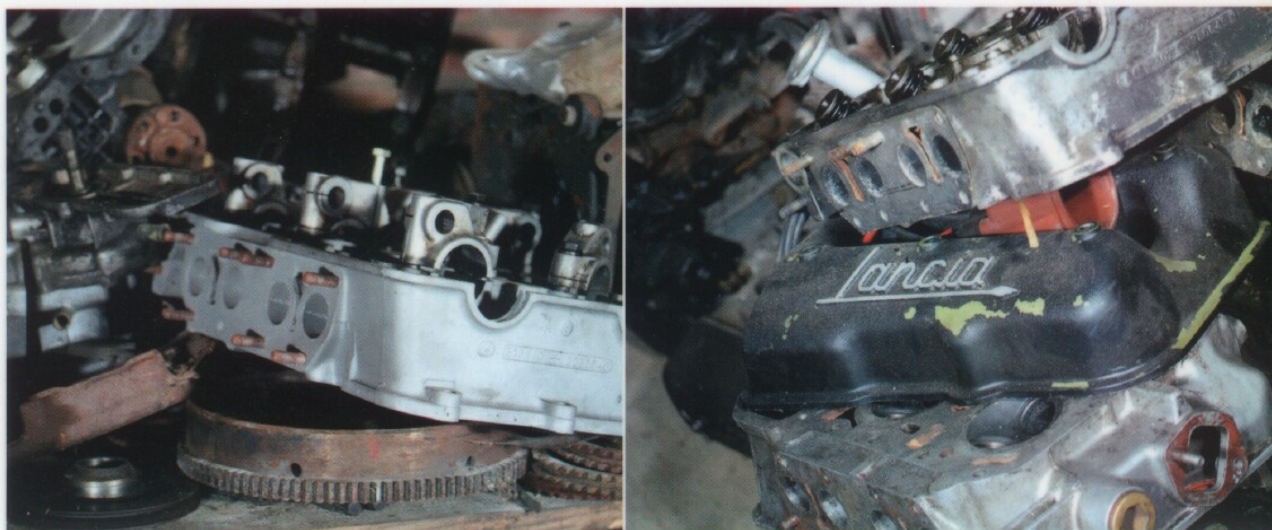
In a surprising throwback to vintage times, the cylinder block and the crankcase are separate

This asymmetry brings its own snags, though. Martin Cliffe of Omicron, the Norfolk temple of all things Lancia which provided the engine and parts pictured here, explains. "It makes the engine's expansion uneven, which causes problems with the centre main bearing [of three]. You just have to accept that it has a limited life."

Still, you look at the lovely castings and you can forgive this engine a lot. The sump is beautifully finned and its rear end completes a full circle of rigid union with the bellhousing. There are more fins on the mounting block for the mechanical fuel pump, designed to dissipate heat and reduce fuel vaporisation. "It's a nice idea but it doesn't really work," says Cliffe. The cam cover, too, is a fine piece of sculpture, whether in naked aluminium, crackle-black or, for a hot HF version, bright yellow (plus blue stripe up to 1970).

Remove that cam cover by undoing six knurled screws and you'll see why the paired rubber seals

FAR RIGHT: Cam covers were either naked aluminium, bright yellow for the HF version, or crackle-black like this sad-looking item in the spares pile



around the spark plugs are called 'spectacle gaskets'. And then you'll wonder how the valve gear can possibly stay together at the 7800rpm or so that the rally cars' engines used to hit on the way to their many big wins. There's a rocker shaft above each camshaft, whose rockers – polished if it's an early HF engine – actuate valves whose stems are splayed from their partners' by 60° to make a proper part-spherical combustion chamber. But how can the inlet rockers reach the inlet valves of the cylinders positioned on the far, exhaust side of the engine? And, indeed, vice-versa?

Via short, needle-like pushrods which slide in extensions to the rocker-shaft housings, which also form the camshafts' bearing caps. Should the pushrods' guides wear, there would be a mayhem of misalignment, but they don't. The camshafts' timing is adjusted by means of vernier sprockets with multiple dowel holes, except in the last Fulvias in which such precision was deemed unnecessary by the cost-cutting Fiat masters by then in control. They also reduced the strength of the many small cylinder-head bolts that give an evenly-spread clamping force.

You'll probably by now have noticed another flaw in the Fulvia engine's design. Two of the inlet ports are longer than the other two, and the same is true of the exhaust ports. Does it matter? "Not really," says Martin Cliffe. "Lancia could have compensated for this in the exhaust manifold, but didn't. On the inlet side, all you could really do is alter the length of the trumpets [if using a pair of sidedraught carburettors], but Lancia never did it. We tried it on a racer and it wasn't beneficial."

It's these uneven port lengths which give the Fulvia its engaging, rather dirty, secondary beat when driven with gusto. You might have thought it was the vee engine layout, but in fact the Fulvia engine has exactly even firing intervals thanks to a crankshaft with throws suitably arranged to account for the vee-angle. The piston crowns are similarly angled to make them flush with the block's flat top deck, making them heavier than is ideal, and the fact that the axis of the cylinder bores is not at a right-angle to the deck makes this a tricky engine to rebore. Get the angle even minutely wrong and it will feel horribly rough.

As for ancillaries, the distributor is driven by a skew

gear from the back of the inlet camshaft, the oil and fuel pumps similarly from the front of the crankshaft and the water pump very neatly by the duplex timing chain. Its seals must be in good shape or water and oil will swap places.

All Fulvias have an elegant, tubular, four-into-two exhaust manifold whose two downpipes join some way down the line. On the inlet side, the first saloons with just 58bhp used a single, dual-choke downdraught Solex but soon all Fulvias featured a pair of twin-choke, sidedraught Solexes of specially narrow construction. Dell'Orto tooled up as an alternative supplier but Lancia didn't go ahead with the contract. A pair of Fulvia-specific Dell'Orto 35 DHLBs is a much-prized Fulvia improvement today, because they're more durable than the Solexes.

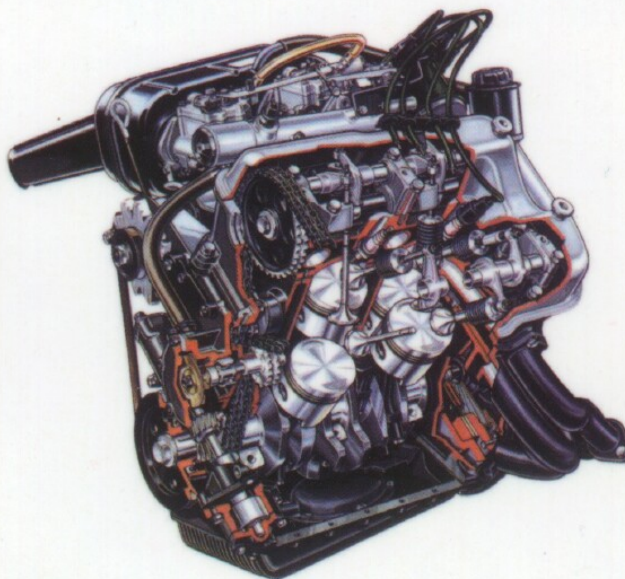
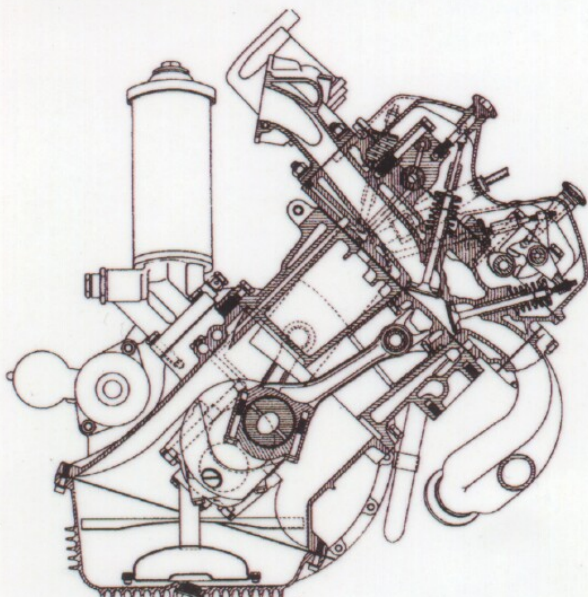
Lancia quickly realised the initial 58bhp wasn't enough, and with the pair of Solexes power rose first

The piston crowns are angled to make them flush with the cylinder block's flat top deck

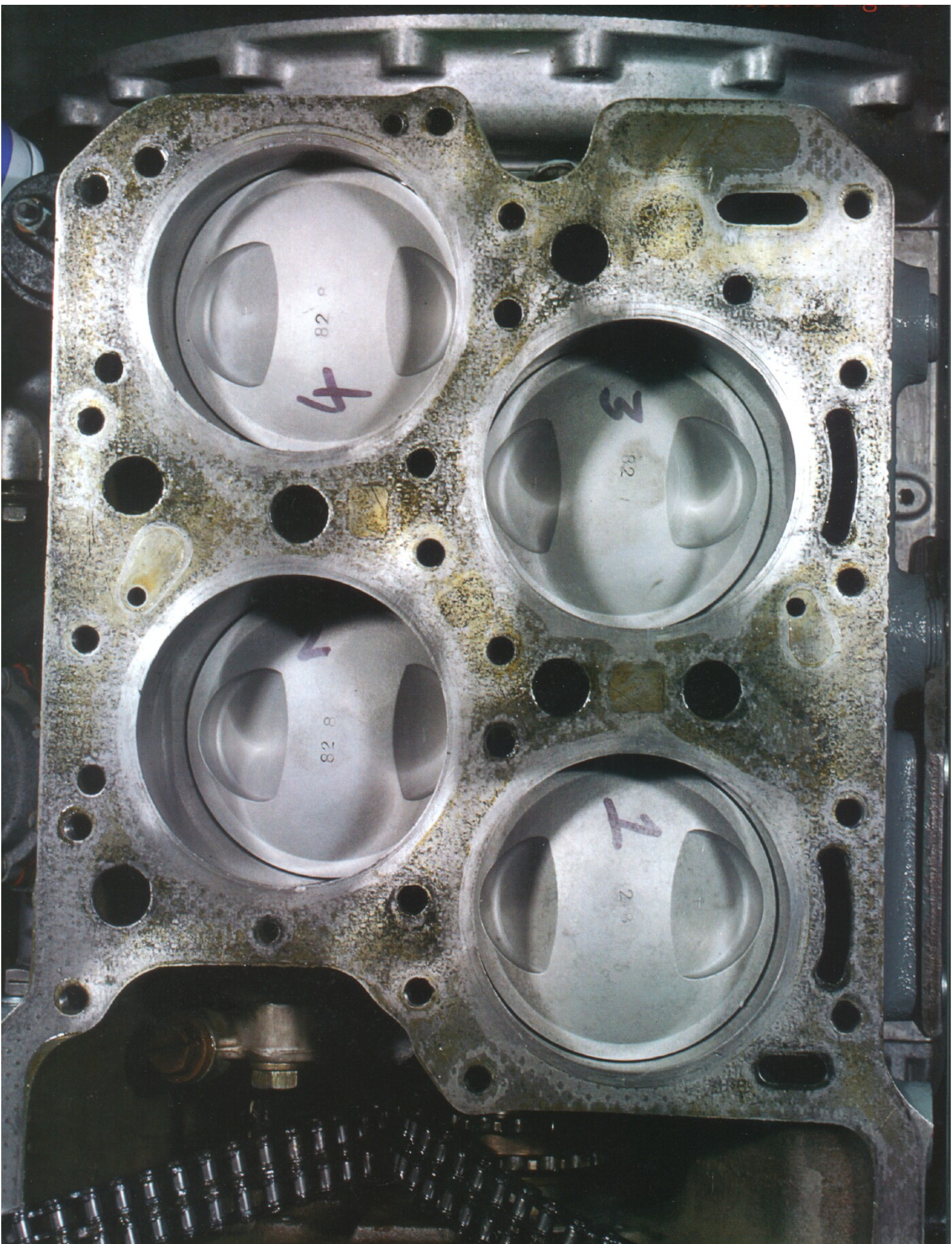
to 71 and then to 80bhp. The 1216cc engine briefly gave way to a 1231cc unit, still oversquare but with a slightly smaller bore and a longer stroke, which seemed bizarre until that same longer stroke was in 1967 matched to a bore bigger than the original to give 1298cc. That became the standard Fulvia capacity, giving first 87 and later an impressive 90bhp with the help of 35mm instead of 32mm carburettors, right up to the last coupe of 1976.

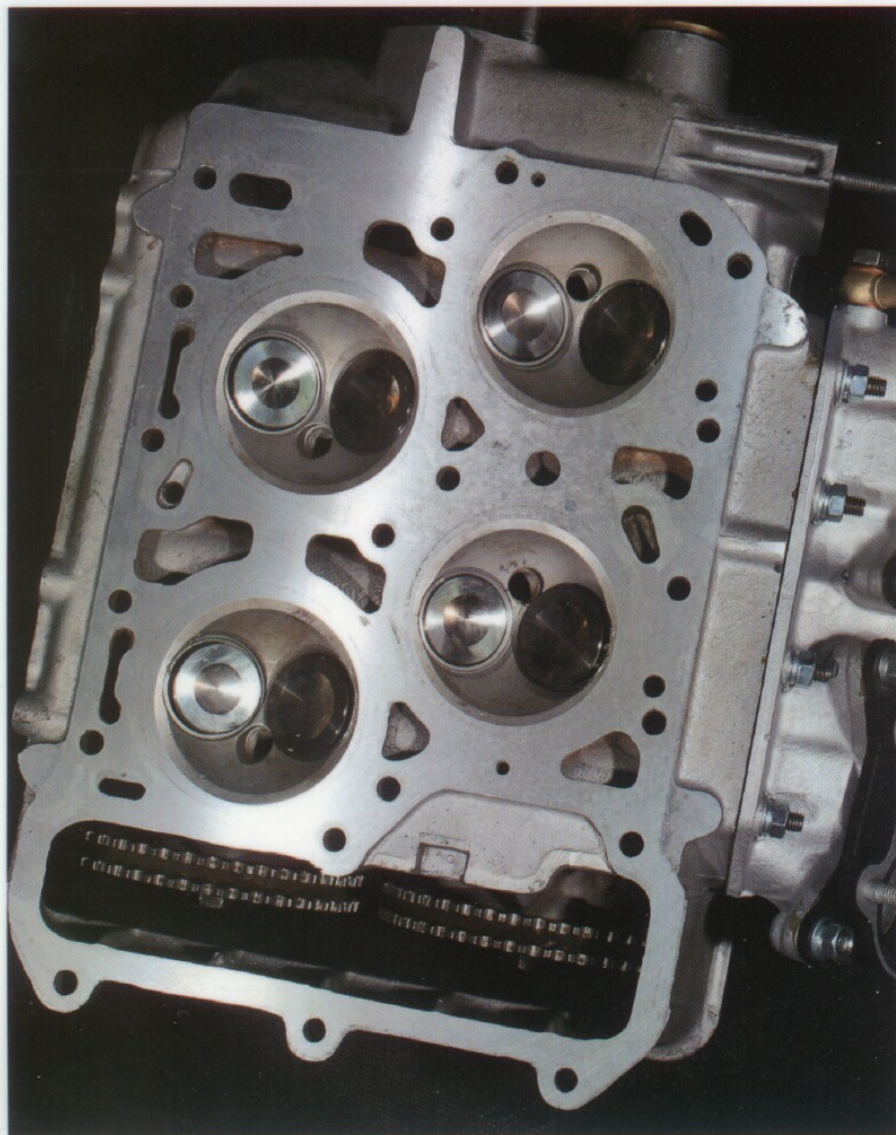
Standard? Yes, but not exclusive, because the rally cars were demanding rather more. Initially, these too had standard-size engines, tuned in roadgoing HF 'homologation special' guise to 88bhp in the 1.2, 101bhp in the 1.3. What was really needed, though, was a 1.6.

This duly arrived for 1969 as a 1584cc unit with a bigger bore, a longer stroke and a fractionally narrower vee-angle of 11 degrees and 20 minutes. The block, head and crankshaft were all new, and Solex designed some unique 42 DDHF carburettors with 42mm barrels. The valves were bigger than a 1.3's, had thinner stems



LEFT: These cut-away drawings serve to illustrate the narrow angle vee of the cylinders and the engine's steep 45° inclination to the left of the car. It was also inclined six degrees to the rear





ABOVE: A resurfaced head awaits fitment

TOP RIGHT: Strange, angled piston crown design

ABOVE RIGHT: Spare gearbox, anybody?



and were kept in place by valve caps drilled for lightness, and the smaller space between the valve heads called for tiny motorcycle-type spark plugs.

The first 600 or so Fulvia 1.6 HF 'Fanalone' coupes had, so homologation records suggest, specially-tuned *variante 1016* engines with more aggressive camshaft timing and carburettor barrels bored to 45mm. The result was a revvy 132bhp, whereas the subsequent 1.6-litre road cars gave 115bhp and 113lb ft of torque using the same camshafts as a 1.3, which themselves had quite racy timing.

worked out had they been developed fully, but the Fulvia's breathing restrictions meant it could never quite match the ultimate power-per-litre figures of an Alfa twin-cam despite carburettors typically larger for a given engine capacity.

To drive a good Fulvia today is to drive a car whose engine is its beating heart, not merely a propulsion module. The four separate throttles are the gateway to the crackle and fizz that overlay the mechanical activity beneath that shapely cam cover, and Fessia's calculations have ensured that it really is no less

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THANKS

Thanks to Martin Cliffe at Omicron for knowledge and the photographed engine, and to Chris Hopkins of the Lancia Motor Club for library diagrams.
www.omicron.uk.com

That 132bhp grew to 158bhp by the time of the final rally cars in 1973 with the help of 48 DCOE Webers and the biggest-bore exhaust manifold that could be squeezed between the exhaust ports. Fitting DCOEs called for a new inlet manifold with splayed-out inlet tracts to take the wider carburettors, resulting in four different tract lengths, but this didn't seem to matter much. It would be interesting to see how the factory's various experimental fuel-injection systems would have

smooth than a typical inline four. There's also the knowledge that Lancia's most-replicated V4 is an engine created with almost no regard for cost, a precision jewel engineered to a standard much higher than it really needed to be.

That philosophy applied to the rest of the Fulvia, too, which is a major reason why Lancia ran out of money. It's also why we love them today, for we'll never see an engine like this again. **AI**