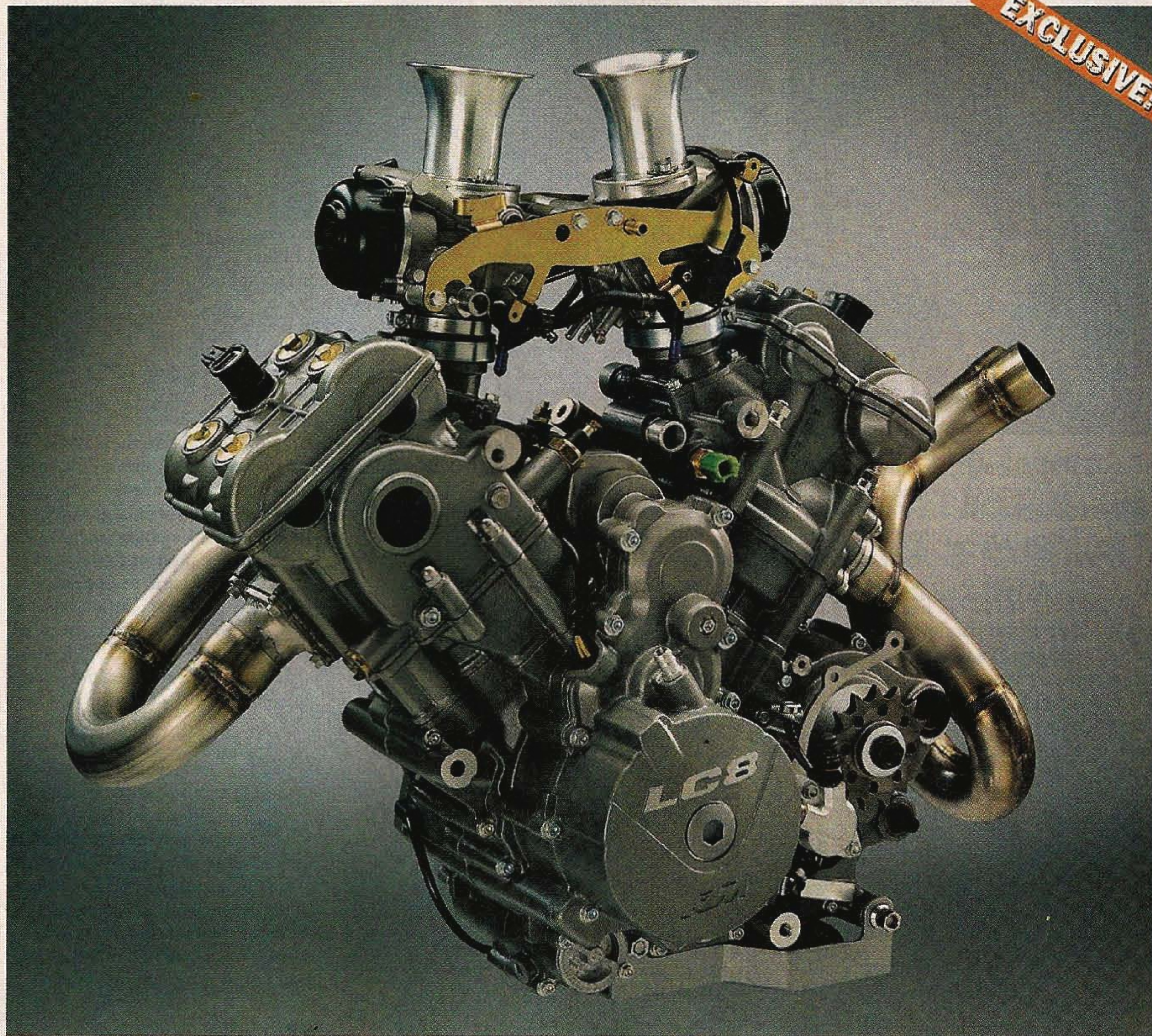


From bankruptcy to boom times within a decade, off-road powerhouse KTM prepares to jump headlong into the big-bore streetbike world with a lightweight and potent open-class V-twin of its own

By Alan Cathcart. Photos By Kyoichi Nakamura

EXCLUSIVE!



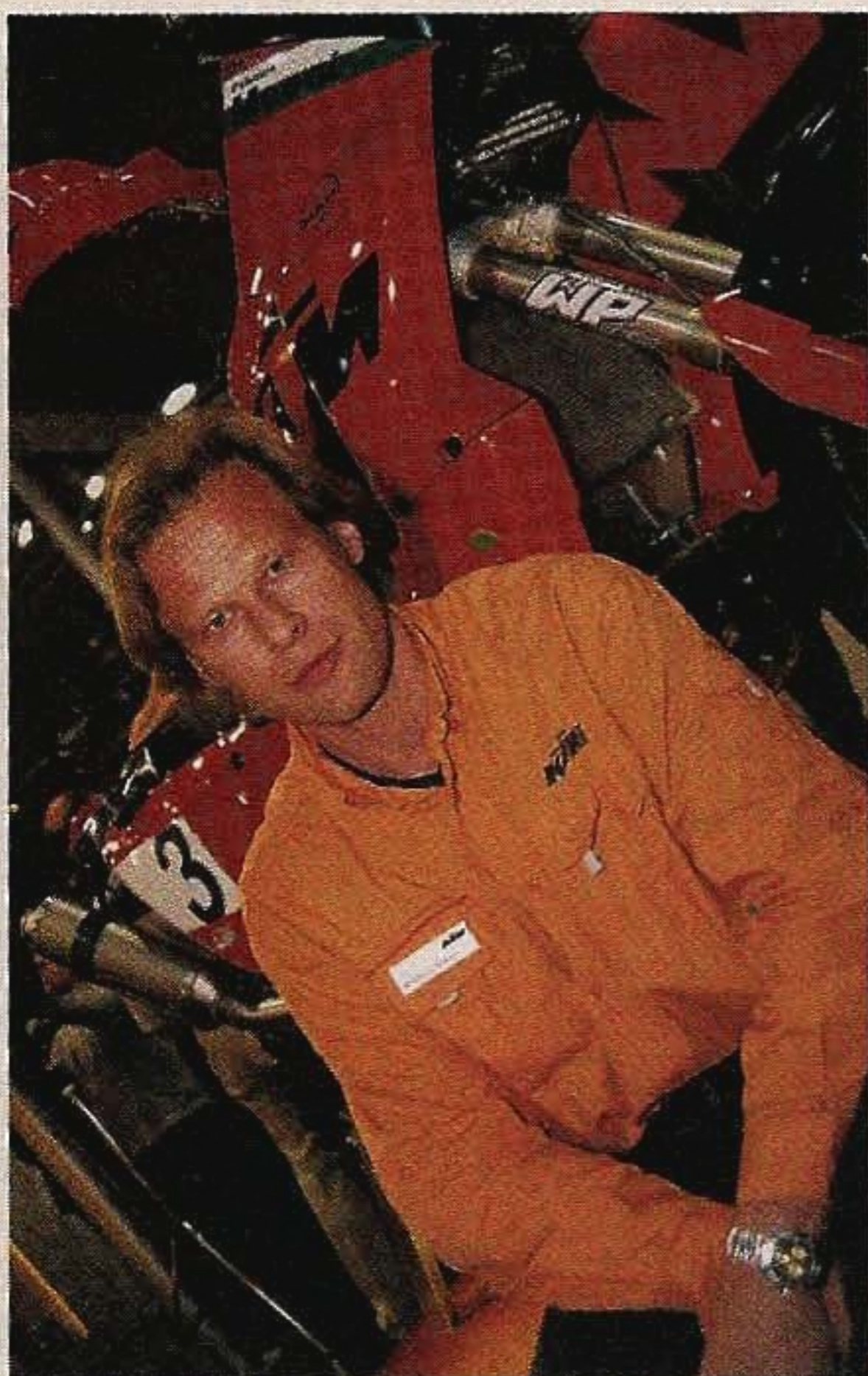
KTM Goes

**BIG!**



■ NO DOUBT ABOUT IT, KTM IS ON A ROLL. AFTER TRADING bankruptcy for boom times during the past decade, the Austrian kings of the off-road world have earned a worldwide reputation for excellence on the back of big-time racing success. It's a path similar to that followed by their streetbike counterparts at Ducati.

And just last year, seemingly from nowhere, came the all-new LC8, a liquid-cooled, DOHC, eight-valve, 75-degree V-twin that will form the



**Engineering Chief Wolfgang Felber (left) teamed with ex-Rotax Engineer Claus Holweg (not shown) to build the LC8 twin in record time, while Managing Director Stefan Pierer (above) helped guide KTM back from the brink of bankruptcy.**

basis for a whole range of sporty KTM streetbikes. First up will be the 950 Adventurer, available across the globe this September, which is basically a two-wheel equivalent of the Subaru WRX rally car. Then, later in 2003, KTM will begin production of the Duke V2 street rod, first seen in prototype form in our March '02 issue (page 23).

It's no secret KTM has been working for most of the last decade to expand its model range with a V-twin. The V-twin dream first found expression shortly after KTM boss Stefan Pierer and his colleagues took over the insolvent company in early '92 and began the spectacular turnaround. At the Cologne show that year came a one-off special called the Bepono, built by two engineering students by combining a pair of cylinders from a KTM LC4 single on a special bottom end.

Another teaser came in '96, when word spread that KTM had commissioned a Stuttgart-based design firm named Kraft to pen an adventure-tourer, possibly powered by the 60-degree 900cc V-twin being developed for Aprilia by Pierer. Aprilia balked, however—

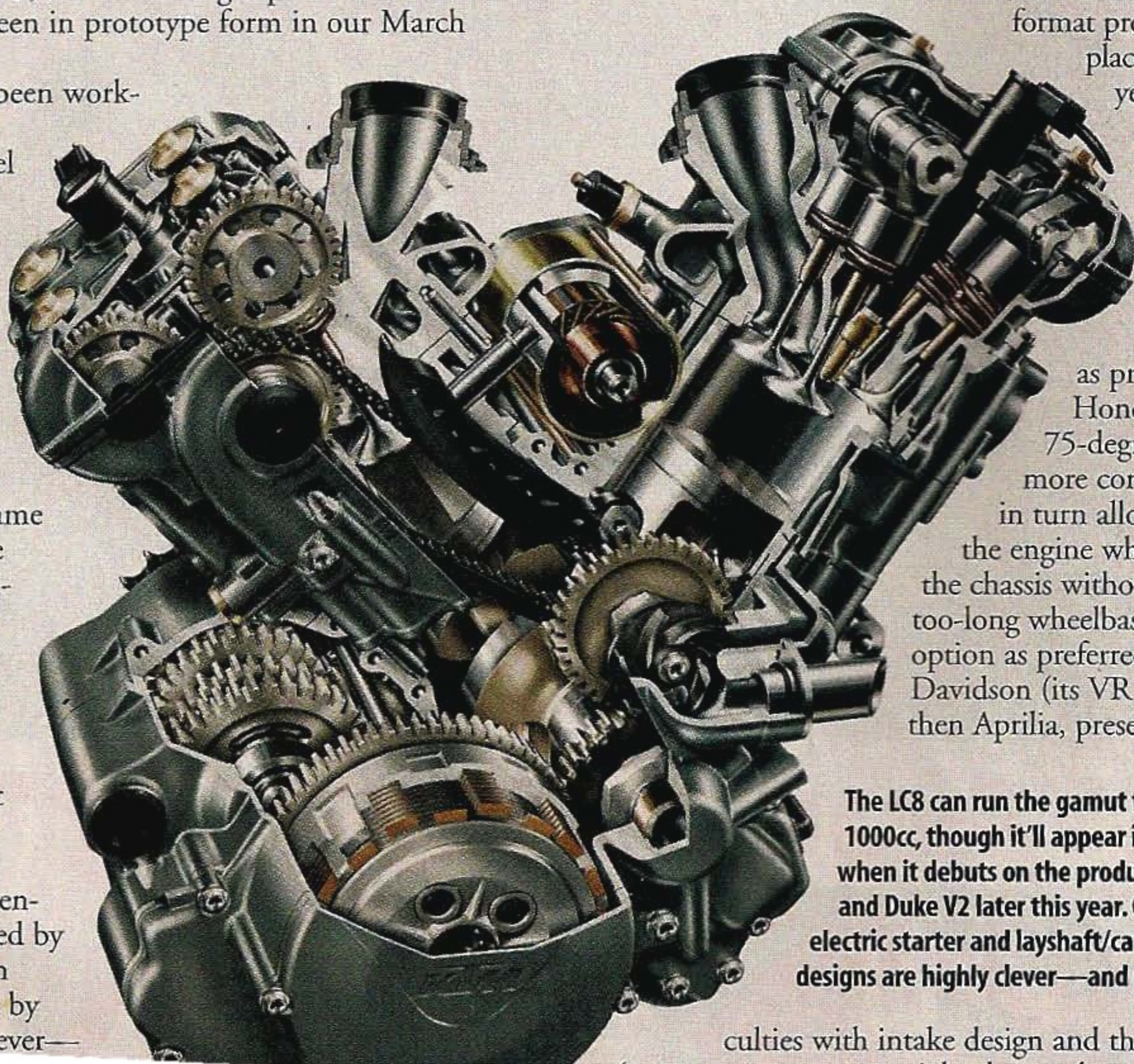
tion. Even though KTM by now owned Husaberg, this plan was also aborted once KTM had been successfully refloated on the stock market by Pierer and his colleagues.

But in early '98 the company grew in strength, and the need to expand its hitherto single-cylinder range with a twin-cylinder product line became a priority. Pierer commissioned Chief Engineer Wolfgang Felber to make preliminary

studies of twin-cylinder engine formats and vehicle concepts. "Our idea wasn't so much to build a better V-twin, but to develop a versatile twin-cylinder engine concept which had the potential to be used in off-road bikes as well as on the street, without any compromises in either application," 39-year-old Felber says, himself a former 250cc Grand Prix racer on Rotax tandem-twin two-strokes, then German Supermono champion with his self-built and self-tuned KTM single racer. "In fact, we made studies of several other concepts, including not just many kinds of V-twins but also some that might seem a bit strange, like a horizontal as well as parallel-twin, crossways and lengthways Boxer motors, and even a tandem-twin like the 250 GP bike I used to race! But eventually we concluded that a 75-degree V-twin was the best option, especially in terms of following KTM's established policy of going racing first with a prototype version, then bringing an identical-

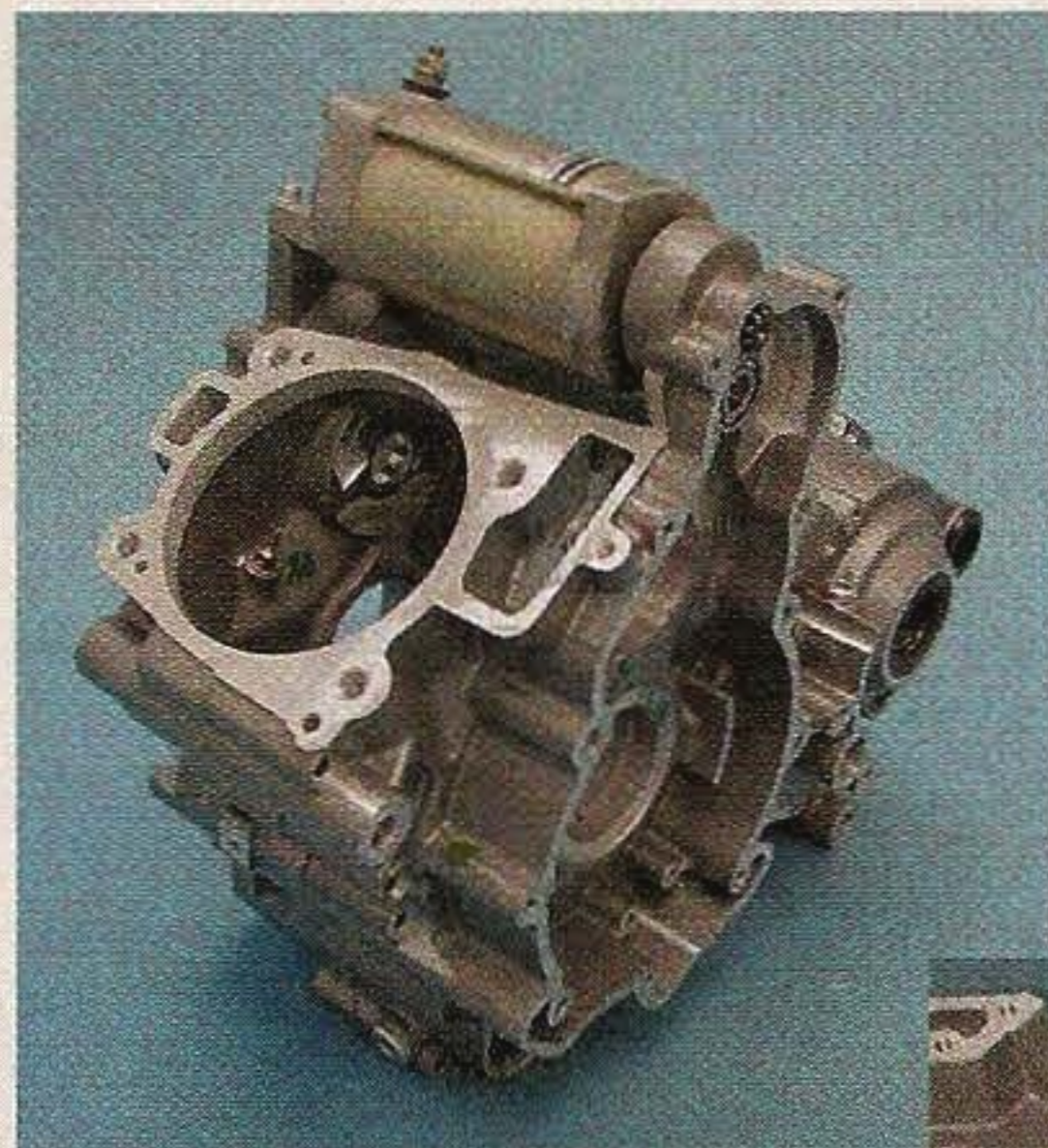
format product to the marketplace in succeeding years. Plus, it had the added advantage of allowing us to build a V-twin not like the others."

Indeed, for compared with a 90-degree format as practiced by Ducati, Honda and Suzuki, the 75-degree design offered a more compact layout, which in turn allowed KTM to place the engine where they wanted in the chassis without resulting in a too-long wheelbase. The 60-degree option as preferred by first Harley-Davidson (its VR1000 race engine), then Aprilia, presented potential diffi-

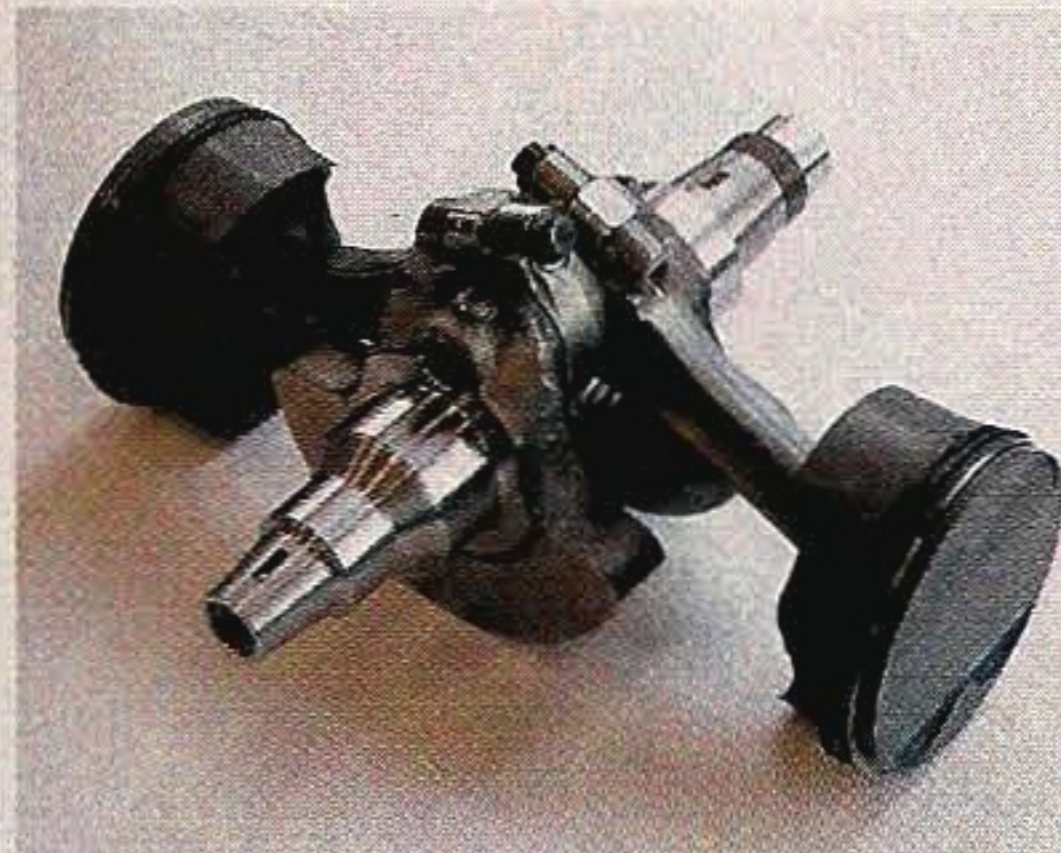


**The LC8 can run the gamut from 800cc to 1000cc, though it'll appear in 942cc guise when it debuts on the production Adventurer and Duke V2 later this year. Center-mount electric starter and layshaft/cam-drive designs are highly clever—and patented.**

culties with intake design and throttle-body location



Above: The vertically split crankcase displays its center-mount electric-starter assembly. Above, right: Cylinder heads are much smaller than those of KTM's competitors. Right: Six-speed tranny will be standard on both bikes. Far right: LC8 crankshaft is light and connects to nearly skirtless pistons.

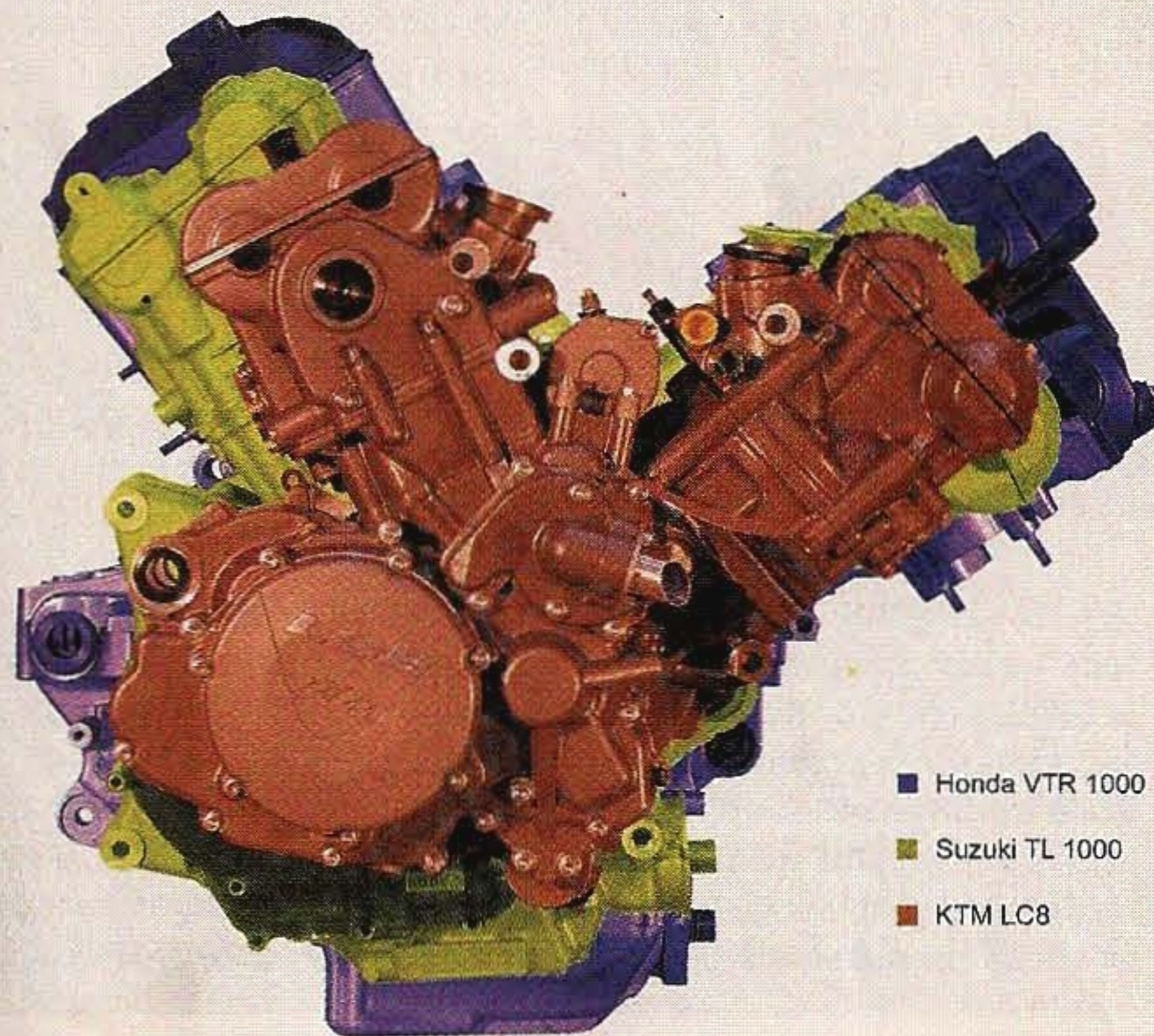


How well he and the rest of Felber's team succeeded may be judged by comparing the dry weight of the LC8 motor (without carbs/throttle bodies) with that of its various V-twin competitors. The 75-degree KTM (fitted with a single balance shaft) scales in at just 123 pounds, compared with 150 pounds for the 60-degree Aprilia/Rotax (complete with twin counterbalancers), 161 pounds for both the 90-degree Honda VTR1000 and Suzuki TL1000, 165 pounds for an old-style 90-degree Ducati *Desmoquattro* engine (though 158 pounds for the new *Testastretta* design), and 167 pounds for the lightest version available of the flat-twin BMW Boxer—the latter quintet featuring perfect primary balance, so no

and water pump, for which we needed more space than on a 60-degree or even a 72-degree V-twin angle like Voxan's. It's only a matter of millimeters, but compare this with an L-twin like a Ducati, and you can see the benefits of focusing on this in terms of bulk and [ease of] installation."

So by August '98 the decision was made to go with a 75-degree V-twin design, but with special emphasis on light weight and, especially, compact build. To do so, KTM decided to assume the entire R&D process in-house, and hired Claus Holweg as LC8 project manager fresh from their Austrian rivals Rotax, where he had headed up the R&D team that had developed the recently launched RSV Mille engine for Aprilia. This meant he already had several years of accumulated V-twin expertise under his wings, which helped shorten the time scale for development. The LC8 engine went from a blank computer screen to its first dyno run in August '99 in exactly 12 months—a remarkable achievement. "My work on the Aprilia project was at an end, but I already had many ideas I wanted to put into metal in making a second-generation V-twin that would be even better," Holweg says. "My goal was to make the engine as light and compact as possible, but as safe as necessary in terms of durability. It was a very exciting engineering challenge."

**...compared with a 90-degree format as practiced by Ducati, Honda and Suzuki, the 75-degree design offered a more compact layout....**



■ Honda VTR 1000  
■ Suzuki TL 1000  
■ KTM LC8

Not only is the 123-pound LC8 engine significantly lighter than Honda's or Suzuki's (or Ducati's or Aprilia's) designs, it's also physically smaller, which allows optimal chassis positioning. The lack of sump is evident in this illustration.

balance weights.

This makes the LC8 between 17 percent and 26 percent lighter than its rivals, achieved without extensive use of magnesium, which is confined to the cam covers (nowhere else, for fear of stone damage in off-road use). Add to that the Austrian motor's compact build, and it's hard not to applaud the extent of the R&D team's achievement in creating such an intelligent, rational, stripped-down design, without compromising reliability or performance. Winning the '01 Egypt Rally first time out in the hands of



Although disguised, this Duke V2 prototype packs a serious, street-smart look. (And the styling prototypes seen by the author are gorgeous!)



## Trying the Twin

Surviving the Sahara aboard Fabrizio Meoni's LC8-powered 950 Rally factory racer

INVITING THE LIKES OF YOURS truly—whose sand skills are limited to building castles on the beach at St. Tropez—to ride Fabrizio Meoni's Dakar-winning works KTM 950 Rally racer in a desert setting is the off-road equivalent of asking a journalist who's never ridden on slick tires

to pedal Tino Rossi's factory Honda around Phillip Island or Suzuka—at speed.

KTM's insistence that I try out the prototype of its LC8 V-twin-engined desert sled—as a window to the Austrian firm's future world of multicylinder motorcycles for

street use powered by the same engine—meant journeying to its southern Tunisian test base in Douz, where once the roads end there's a thousand miles of sand dunes to cross before you see another stretch of tarmac.

In fact, I was joining KTM's works rally team the week after it had won the Rally Tunisia in the same dominant style as it had triumphed in Dakar earlier in the year, with Spaniard Nani Roma taking victory in his first race aboard the LC8-powered racebike after Italian teammate Fabrizio Meoni, who'd

previously scored V-twin victory for KTM on both of the 950 Rally's previous outings, fell in Tunisia, separated a shoulder and retired. Tough

for Meoni—but at least it meant that by the time I came to ride his bike in the sands south of Douz, it had already had a bit of practice at tipping over on its side.

It was about to get a lot more.... Still, after KTM's other desert V-twin maestro Giovanni Sala took pity and insisted I sit behind him for a 10-minute master class on how to ride the dunes, I started to get the hang of it.

### FIRST RIDE

Fabrizio Meoni (in the wake of an arduous 120,000-kilometer test program), followed by the new 950 Rally V-twin's dominant victory in the hands of the Italian works rider in the grueling '02 Paris-Dakar marathon, is proof enough of that.

The dry-sump LC8 engine is vertically split, not only to save weight (no need for long engine bolts to hold everything together), but also as the easiest way of arranging the crankshaft and twin gearbox shafts on different planes to reduce the overall length of the engine, R1-style. The three-liter oil tank doubles as the oil radiator, positioned ahead of the front cylinder, with twin oil pumps mounted on a single shaft located beneath the multiplate oil-bath clutch (a wet-sump design wasn't considered because of the four-inch reduction in ground clearance this would entail, unacceptable for off-road applications); oil supply to the engine

is even maintained when the bike is lying on the ground and the engine running!

The cylinders are evenly located on the crankcase, not rotated as on a Honda or Suzuki Vee. "I did a lot of experimentation with wheel clearance and weight distribution," Felber says, "and it turned out this format allows 300mm of front-wheel travel, as well as an ideal configuration for the oil tank, radiator, everything. But we also looked from the beginning at a street application, and on the Duke with a shorter fork, less travel and a 17-inch front wheel—instead of a 21-inch wheel on the off-road bike—we were able to shorten the frame and improve front-end weight bias, as well as lowering the center of gravity by placing the battery in the lost space in front of the engine, all without compromising wheel clearance."

So what did I learn about the KTM's all-new LC8 V-twin motor, the powerplant that will make its customer debut this coming September in the 950 Adventurer before going into production in 2003 in the Duke V2? First, KTM has built an engine that not only loves to rev, but one that offers significant amounts of readily available torque throughout the rev band. The result is so refined, responsive and user-friendly you'd swear it was fuel injected. It's not.

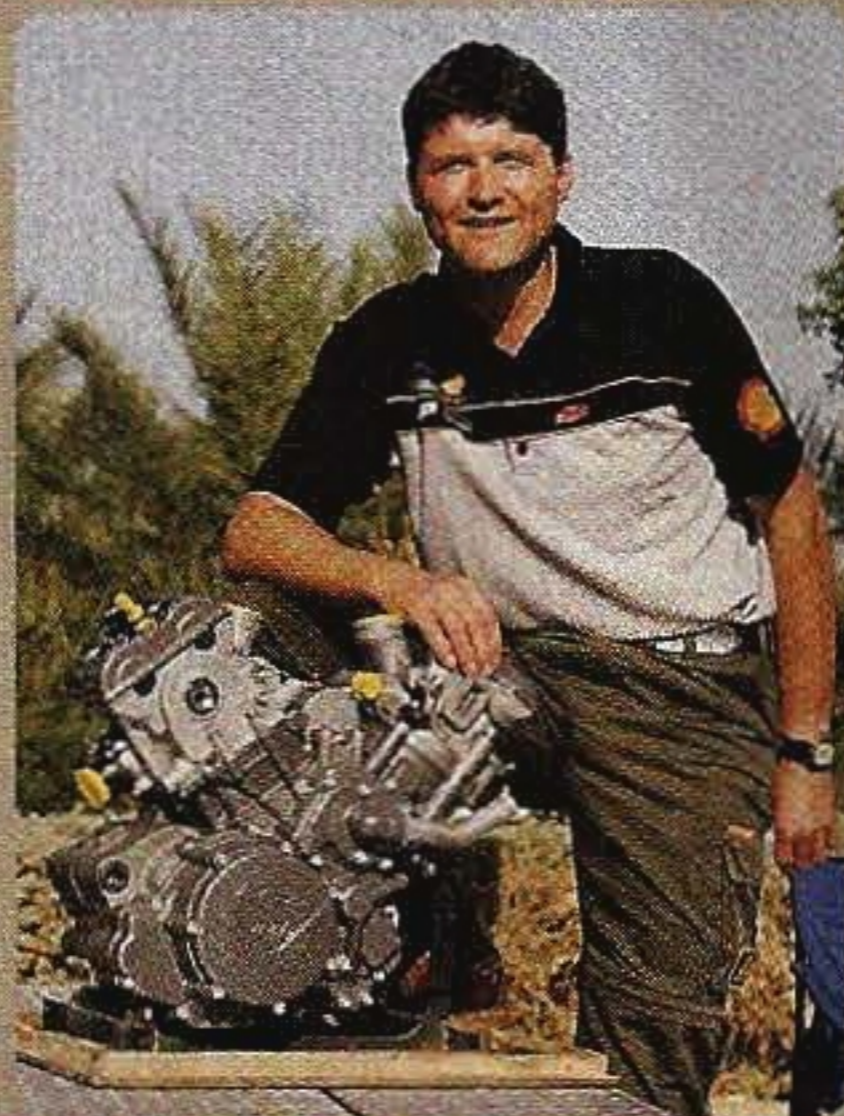
The light-action throttle is extremely responsive and offers crisp yet controllable pickup that's enough to convince you there's a pair of flatslides at the end of the cables—except for the fact the 950 Rally comes fitted with a pair of 43mm Keihin CVs (though the Duke V2 will offer fuel injection). There's no tachometer fitted, so I couldn't tell how hard I was revving it. But no matter what gear you throw at it, or how hard you rev it, the LC8 pulls strong and cleanly, even when I tried to buzz the 9500-rpm rev-limiter on the road back to base camp.

The 75-degree LC8 delivers absolutely no undue vibration in spite of being rigidly mounted in the open-loop frame (there are no rubber mounts), so the single balance shaft does its stuff perfectly. Winding it flat out in sixth gear revealed excellent top-end power; I didn't reach Sala's maximum telemetry-confirmed top speed of 125 mph on the 17-mile straight leading back toward civilization, but I did get it motoring along well.

There's no doubt the LC8 will make an absolutely fantastic streetbike motor, even with some of the desert racer's monster torque traded for some extra top-end power, which the Duke V2 will surely offer. The engine has a distinctive exhaust note compared with other V-twins; it's robust and muscular,



Above: Sir Alan takes a break after wrestling with KTM's rally-winning desert sled. Left: Claus Holweg, the ex-Rotax man who designed Aprilia's 60-degree V-twin, poses with his latest creation, the LC8 twin. It's small, no?



but also higher pitched, not only more so than the 90-degree brigade but also the 60-degree Aprilia/Rotax. And that's at all revs, not just higher up, though I must say a group of Rallies leaving the parking lot one morning *did* sound like Turn One at an AMA dirt-track national.

The responsiveness of the KTM

engine down low in the rev range is a key factor in overcoming the only significant downside of the V-twin when fitted to a dirt-going machine: the fact that it places inherently more weight on the front wheel than, say, one of the Austrian firm's single-cylinder engines. (I kept washing out the front wheel on the Rally racer, until Sala taught me to not chop the throttle entering turns.) Still, that front-end weight bias is just what's needed where streetbikes are concerned, especially so with the Duke V2's long swingarm.

The LC8 is so eager-revving and crisply responsive off the bottom you'd swear KTM had lightened the crank considerably to do this, which it has. The trick is that it's

done so without sacrificing torque, and that's the measure of KTM's achievement in developing this powerful yet responsive V-twin engine, which at the same time is small, light, compact and versatile in spite of its near-1000cc capacity.

Take it from me. After surviving the Sahara and riding the KTM LC8 racer in its perhaps somewhat esoteric but undoubtedly effective first application, I'm convinced this is the debut of an extremely significant powertrain design, one that will set new standards for V-twin engineering, and one that will make other companies sit up and finally take notice.

Really, I can't wait to ride the streetbike version. —A.C.

The LC8 uses a forged, one-piece plain-bearing crankshaft weighing less than 11 pounds—it's lighter than KTM's own LC4 crank, and more than seven pounds less than a Suzuki TL1000 unit, for example—with small, semicircular flywheels and short, H-section forged-steel conrods mounted on a common crankpin. These carry three-ring Elko forged pistons (a subsidiary of Mahle), and weigh 378 grams each without bolts, deliver 11.5:1 compression, and have a flat top and short skirt: Total height of the piston is just 46mm. "For sure we lose a little by having such a light crank," Felber admits, "but from the beginning we tried to create a very responsive engine for sportbike applications; it doesn't matter whether it's a streetbike or off-road bike, it's the same. Due to the very short stroke and small crankshaft, we put a lot of effort into ensuring it ran smoothly and had good torque at

low rpm. We use the same-size flywheels on the off-road carburetor version as on the fuel-injected road-bike version." The crank carries a spur gear on the left side driving the multipurpose layshaft positioned between the cylinders, whose five-function design is typical of the refined rationality of the LC8's design. Thus, it not only carries the twin opposed counterbalancer weights needed to eliminate the primary vibration endemic in a 75-degree V-twin, it also drives the water pump and centrifugal engine breather, as well as acting as an idler wheel for the starter motor, and the composite chain and gear drive to the twin overhead camshafts. A six-speed transmission with gear primary drive is employed on all versions of the LC8; no five-speed for off-road use, though internal ratios and overall gearing will be varied according to the application.



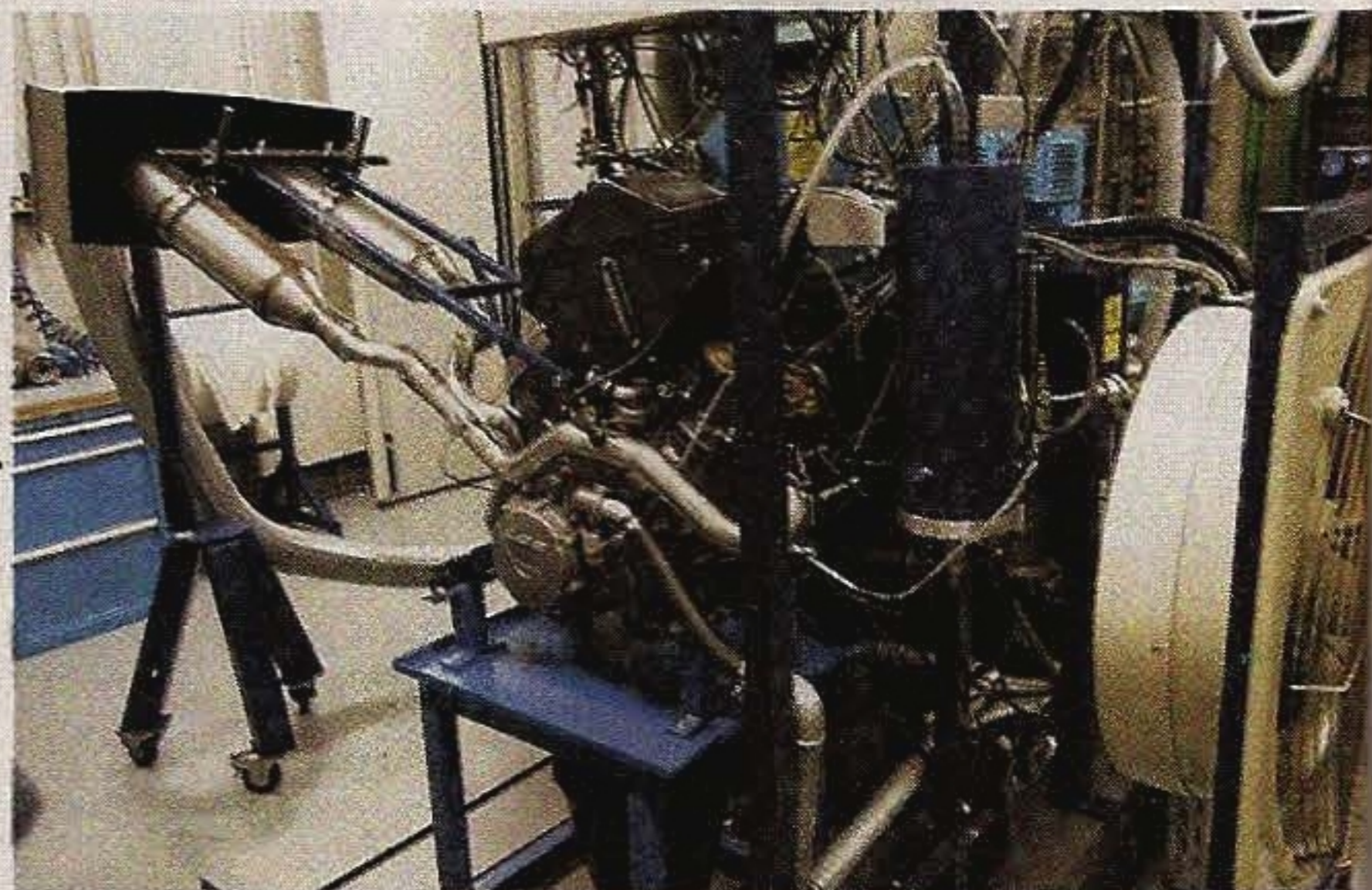
The LC8 employs all-new symmetrical four-valve cylinder heads rather than a derivation of the firm's existing top ends, fitted with bucket tappets and steel valves (38mm inlets/33mm exhausts), each with double valve springs and sitting at a total included angle of just 22 degrees—very flat, in accordance with the best Formula 1 principles. Viewed from above, the steep downdraft and knife-edged port divisions are really noticeable. "Our main target for design of the cylinder heads was always to maximize compactness by having the smallest possible drive gears on the camshafts, as well as a cam-drive mechanism capable of very high revs," Felber says. "We wanted to avoid having the very large cam wheels needed to achieve a 2:1 ratio with direct chain drive, like on a Honda Varadero engine." For this reason the LC8 employs short hydraulically tensioned offset cam chains, driven off sprockets mounted at either end of the multipurpose layshaft. The cam chains run to an intermediate gear located in each cylinder head, which in turn drives the two small cam wheels at the end of each camshaft. The cam-drive layout is broadly similar to that of the Suzuki TL1000 but is more compact.

In prototype 950 Rally/Adventure form, as well as the Duke V2 guise in which it will make its tarmac debut at the Intermot Show in September, the LC8 engine measures 100mm x 60mm for a capacity of 942cc, but the design was conceived to accom-

**Above: LC8-engined Adventurer prototypes take shape in KTM's R&D facility at Matighofen, Austria. The upcoming Duke V2 will utilize a similar chassis but with different bodywork, wheels and ancillary details. Right: An LC8 engine on the test bench.**

modate various capacities ranging from 800cc to 1000cc. There's room to increase bore to 103mm, for example, making an even shorter-stroke 999cc Superbike version a realistic option. According to Felber, while Meoni's Dakar-winning dirt sled and its 950 Adventure customer clone both employ 43.5mm Keihin CV carbs and a Denso CDI, KTM will use fuel injection and a fully mapped engine-management system on the Duke V2, being developed in conjunction with a proven supplier who is, however, new to EFI, with throttle bodies ranging from 48mm to 52mm in diameter (final size has yet to be chosen) and a single injector per cylinder located beneath the throttle butterfly. In this first tarmac application, power from the 942cc engine will rise to approximately 120 hp at the crankshaft, Felber says, compared with the current output of the carbureted off-road engine of 102 hp at 8000 rpm, which produces maximum torque at 6000 rpm, with a linear curve.

Although the engine has the swingarm pivoting in the crankcases (as well as in the frame) for extra rigidity, it's not a stressed chassis member, Felber says. "We didn't want to have this because in off-road use we have controlled deformation of the frame in order to reduce rider fatigue," he explains, "and if you use the engine as part of the chassis in such a situation, it risks problems with the base gaskets and cylinder head gaskets; crankcase cracking is also possible unless you make them very strong, and heavy. The engine increases the torsional stiffness of the frame by around 30 percent, but it's not a load-carrying component in the frame." But the LC8's compact design not only permits greater freedom of choice in positioning the engine in the frame, it also allows a long swingarm (as on Yamaha's YZF-R1) for improved traction. "I see a motorcycle as a total



package," Felber says. "It's not enough to have just a good engine or a good chassis, but to work together to make an effective entire product. Here at KTM we always make sure our engine designers and frame builders work together all the way through the project, not just have occasional meetings to let each other know what's going on! It's the only way to be sure you have the most effective package as a whole."

## ...it's hard not to believe that this is a Superbike engine in the making.

Fair enough—but after seeing the fruits of KTM's efforts so far to build a better twin, and the success of their engineers in making a proven effective package for off-road use, it's hard not to believe that this is a Superbike engine in the making. The LC8 motor has all the attributes in terms of architecture, weight and potential performance to allow the Austrian company to produce a 250 GP-sized sportbike weighing well under 396 pounds, but with more than 130 horsepower available in street guise. KTM might then go Superbike racing, while working all the time on their future 75-degree V-four MotoGP contender—and prototype four-cylinder sporting streetbike. Don't bet against it.... **MC**