ORIGINAL

B 9/5/86

Buell MOTOR COMPANY

August 14,1986

12BS

01-22-N11B-2321

Administrator
NHTSA
400 Seventh Street SW
Washington, DC 20590
Attention: VIN Coordinator

Dear Coordinator,

Pursuant to the telephone call from your office we are updating our VIN format. Your office informed us that the eigth character list that we had provided in our letter of March 12,1986 had an error in that we were using the character "I" for one horsepower range. Since "I" is not a permissible character, we will eliminate it from the list, and move all following letters up one as follows:

Identifying Characters	Nominal Horsepower	Horsepower Range Covered
H	79	72 to 86
J	95	86 to 104
K	115	104 to 126
L	139	126 to 152
M	168	152 to 184
N	204	184 to 224

Please advise us of any further information that might be required.

Yours truly,
Buell Motor Co.

Erik F. Buell
President

EFB/kep
cc

S64 W31751 Highway X, Mukwonago, Wisconsin 53149 (414) 392-3170

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B 4/2/86 pg

Buell MOTOR COMPANY

Administrator
NHTSA
400 Seventh Street SW
Washington, DC 20590
Attention: VIN Coordinator

3-12-86
Ref. 86031201

Dear Coordinator;

Buell Motor Company is a new American manufacturer of motorcycles. Our first production street legal model is the Buell RR-1000. Enclosed is some literature describing the vehicle.

As per Title 49 Part 565 we are providing each vehicle with a vehicle identification number. The Society of Automotive Engineers was contacted by us as per 565.5(c), and has assigned us the following manufacturer identifiers: the first through third characters of each VIN will be 1B9; the twelth through fourteenth characters will be 133.

As per 565.4(b), the fourth through eighth characters in our VINs will follow the following format. The fourth character identifies the type of motorcycle: R stands for road, T stands for touring, K stands for standard, and D stands for dual purpose. The fifth character stands for the line of motorcycle, in this case R. The sixth and seventh characters identify the motor type as per the following code: 00 through 05 identify BMW motors, 06 through 09 identify Cagiva motors, 10 through 15 identify Harley-Davidson motors, 16 through 25 identify Honda motors, 26 through 35 identify Kawasaki motors, 36 through 45 identify Suzuki motors, 46 through 55 identify Yamaha motors, 56 through 69 are unassigned, and 70 through 99 will identify our motors. The eighth character denotes motor horsepower by the following code, based on the 10% accuracy criteria:

Identifying Character	Nominal Horsepower	Horsepower Range Covered
A	24	22 to 26
B	28	26 to 30
C	33	30 to 36
D	39	36 to 42

S64 W31751 Highway X, Mukwonago, Wisconsin 53149 (414) 392-3170

E	46	42 to 50
F	55	50 to 60
G	66	60 to 72
H	79	72 to 86
I	95	86 to 104
J	115	104 to 126
K	139	126 to 152
L	168	152 to 184
M	204	184 to 224

This far exceeds the range of horsepowers available from our company in the near future, but will be updated if necessary as per 565.5(d).

The ninth and tenth characters will be assigned as per 565.4(c) and 565.4(d)(1) respectively.

The eleventh character represents plant of manufacture and at the present time this would be represented by the number 1 for our only plant, which is located at S64W31751 Road X, Mukwonago,WI.,53149.

The fifteenth through seventeenth characters will designate the specific number sequentially assigned to a vehicle by our company during the process of manufacture.

As an example, the serial number of our first vehicle will be: 1B9RR10G2G1133001.

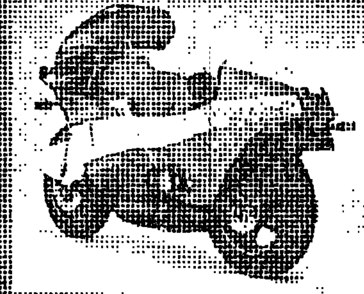
Please advise us of any further information required.

Yours truly,
Buell Motor Co.

Erik F. Buell, President

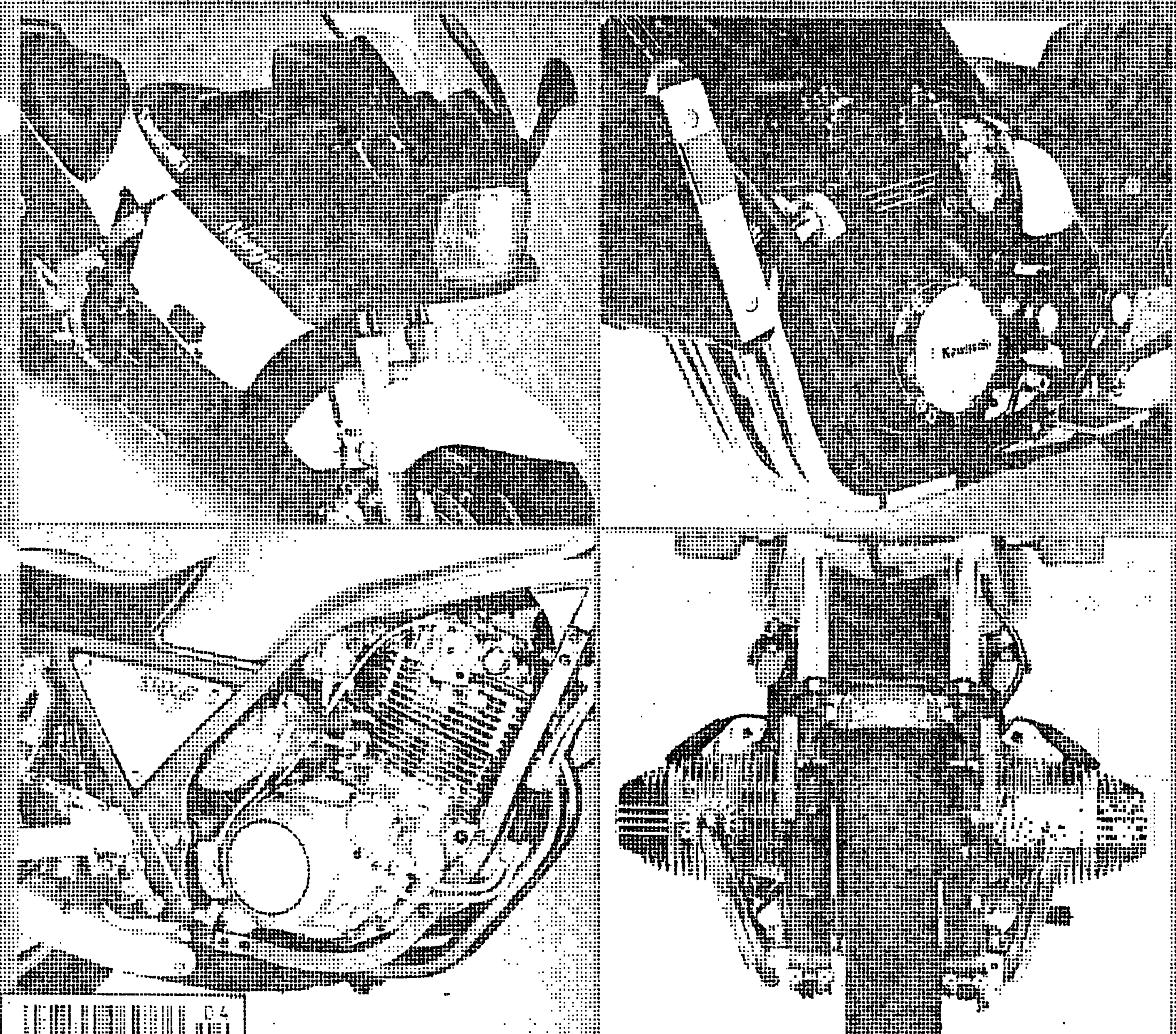
cc. Wisconsin Dept. of Trans.

Cycle



America's Newest, Brightest, Fastest V-Twin

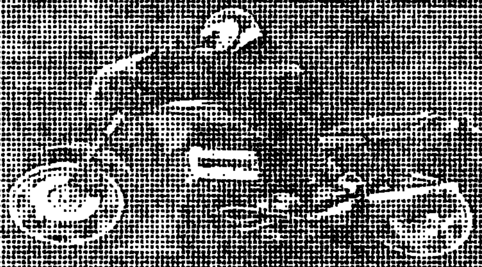
Kawasaki's Ninja & Jr. Eliminator
Yamaha SRX-6 & BMW R65

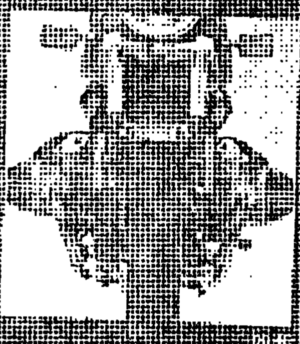


BMW K75 Triple: Smaller Is Better

Cycle

April 1986 Volume XXXVII No. 4





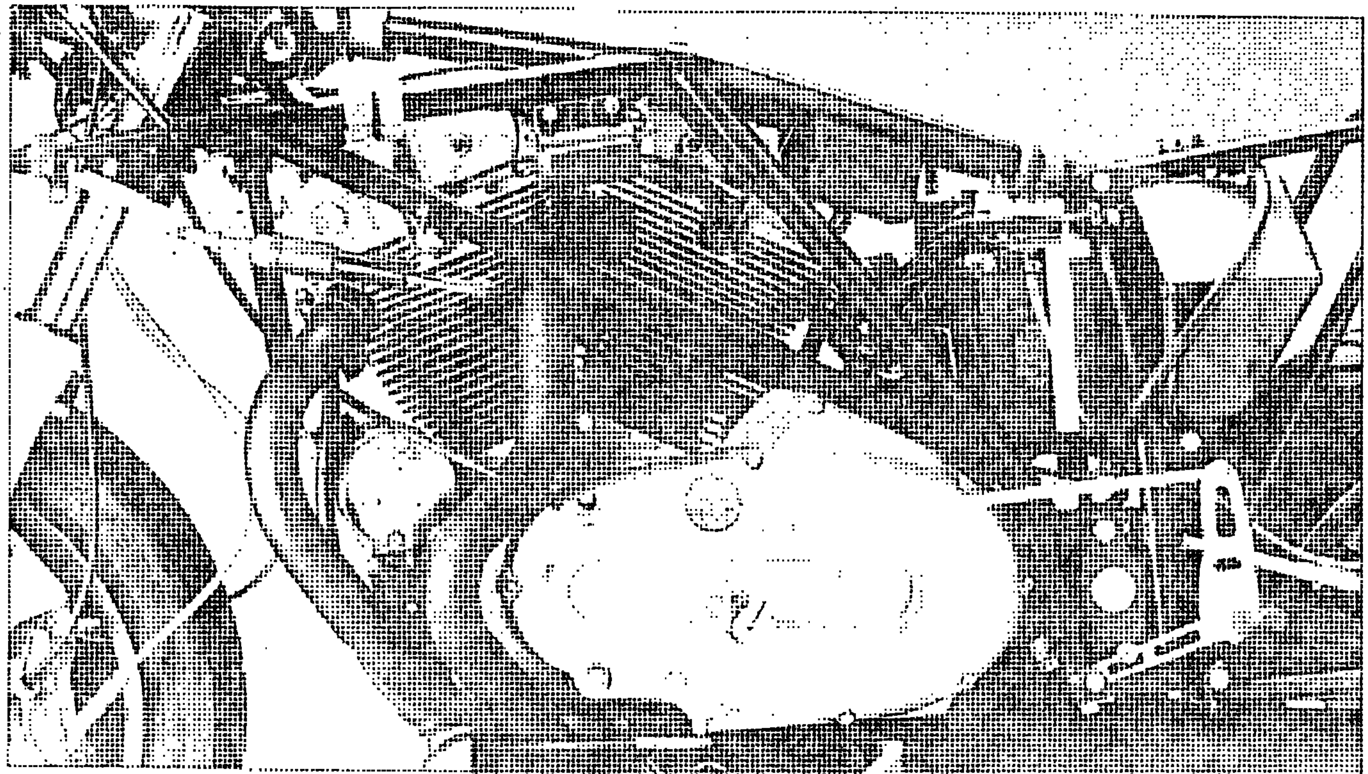
ROAD TESTS

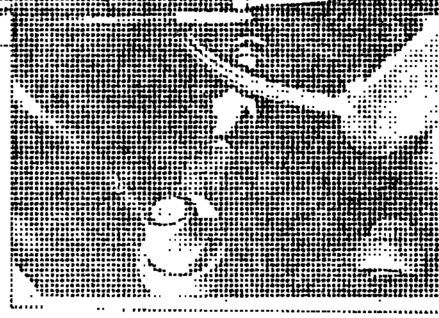
SHORTS

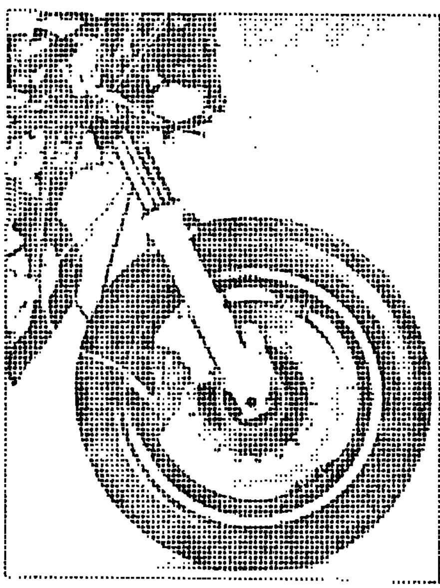
SPECIAL FEATURE

FEATURES

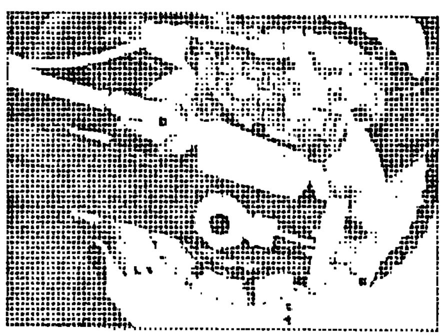
DEPARTMENTS

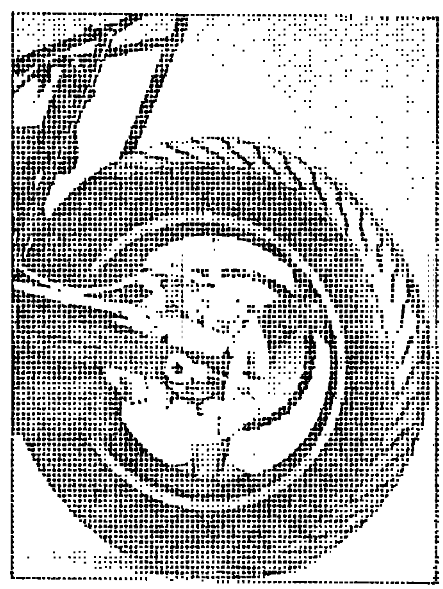






[illegible] Marzocchi fork. [illegible] calipers.





sections of tubing, investigating their influence on the torsional stiffness of the whole frame. Suspicious of the current crop of square-tube chassis (he calls them "lawn-chair frames"), Buell was delighted to discover that, size for size, round tubing yields a stiffer chassis in torsion.

Why use square tubing at all? In GP racing where the square-tube fashion began, it was probably more important to fabricate chassis quickly in the hectic period from 1980 to 1983 than it was to have the ultimate in stiffness. Scarfing tubes for joints in round tubing requires the use of a milling machine, or at least tedious hand-filing, whereas a vise and hacksaw work fine on square tubes. Racing has moved on into massive sheet-metal pressings such as Yamaha's "Delta Box" chassis, but the fashion in square tubes for street machines may have a year or so yet to run.

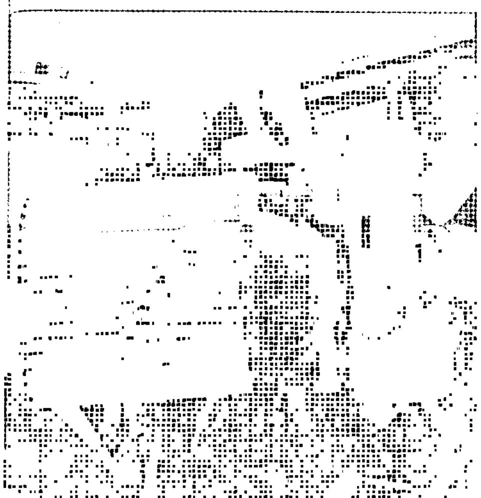
In the simulation Buell's design gave excellent torsional rigidity—1500 pounds per inch of deflection at the tire. Here too, he flies in the face of accepted ideas. The gurus of motorcycle handling dynamics will tell you this is 10 times the rigidity needed to make a machine stable against high-speed weave oscillation, and possibly even *too stiff* under some circumstances. Never mind. Every time racing and street bike chassis are made stiffer, the machines become safer to ride and easier to maneuver.

What about the machine's looks? If you're accustomed to current styling, fancifully inspired by needle-nosed supersonic aircraft, you'll probably think the Buell's rounded shapes strange. But despite what your instincts tell you, the Buell bike's bulbous, organic shape is characteristic of good *sub-sonic* streamlining, and it will have a far lower drag coefficient than what Buell calls the "Star-Wars/Samurai wedges"—the current crop of styling department-streamlined Japanese Superbikes. Although it should be possible to achieve a drag figure of 0.45 or lower, according to Buell, current streamlined production motorcycles have figures in the 0.6 range, just like transit-mix trucks.

The key to low drag is to recover from

(Continued on page [illegible])

disturbances behind them, dissipating their power in wake energy, heating the air by their passage. Some are worse yet, having snowplow-like shapes that throw out wakes *much larger* than their own cross sections. Almost none have a desirable shape with the largest cross-section well forward, leaving most of the length available to taper top and sides inward in an attempt to recover airflow energy by "putting the airflow back together" behind the machine.



Dual constraints determine the unconventional shape of the Buell machine: good airflow and racing rules that require the rider to be completely visible from either side. From the front, he is completely *invisible;* neither his knees nor elbows jut into the airstream like airdams, creating turbulence and a larger wake. Panels behind the rider's back and legs taper inward gradually, inviting the airflow to remain attached, down to the smallest possible cross-section before dropping it off as a turbulent wake. Buell based his streamlining setup on H-D's Cal Tech wind tunnel study of 1968–69 (which allowed a 50-bhp flathead to achieve 146 mph) and on later work sponsored by Can-Am for its 125cc Bonneville bike (which went nearly as fast on much less power).

As Kawasaki attempted in 1981 on its KR500, Buell has made the front fender a guide-plate for the cooling air inlet as well as a deflector to smooth the airflow past the lumpy wheel and brakes, outward onto the forward fairing surfaces. Top speed won't be a problem if the target drag coefficient is reached.

Buell's next goal was handling and braking. The machine rolls on light 16-inch Dymag racing wheels, a 3.5-inch rim width at the front and a four-inch at the rear. Buell is, after all, the importer for this English wheel maker. These wheels turn on Buell's preferred very large axles—a 20mm at the front and 25mm at the rear. No sense in making a rigid chassis only to throw rigidity away with small, flimsy axles. A pair of Buell-made 320mm stainless-clad aluminum brake discs are gripped by the latest four-piston Lockheed calipers at the front; a single 220mm bimetal disc takes care of the rear.

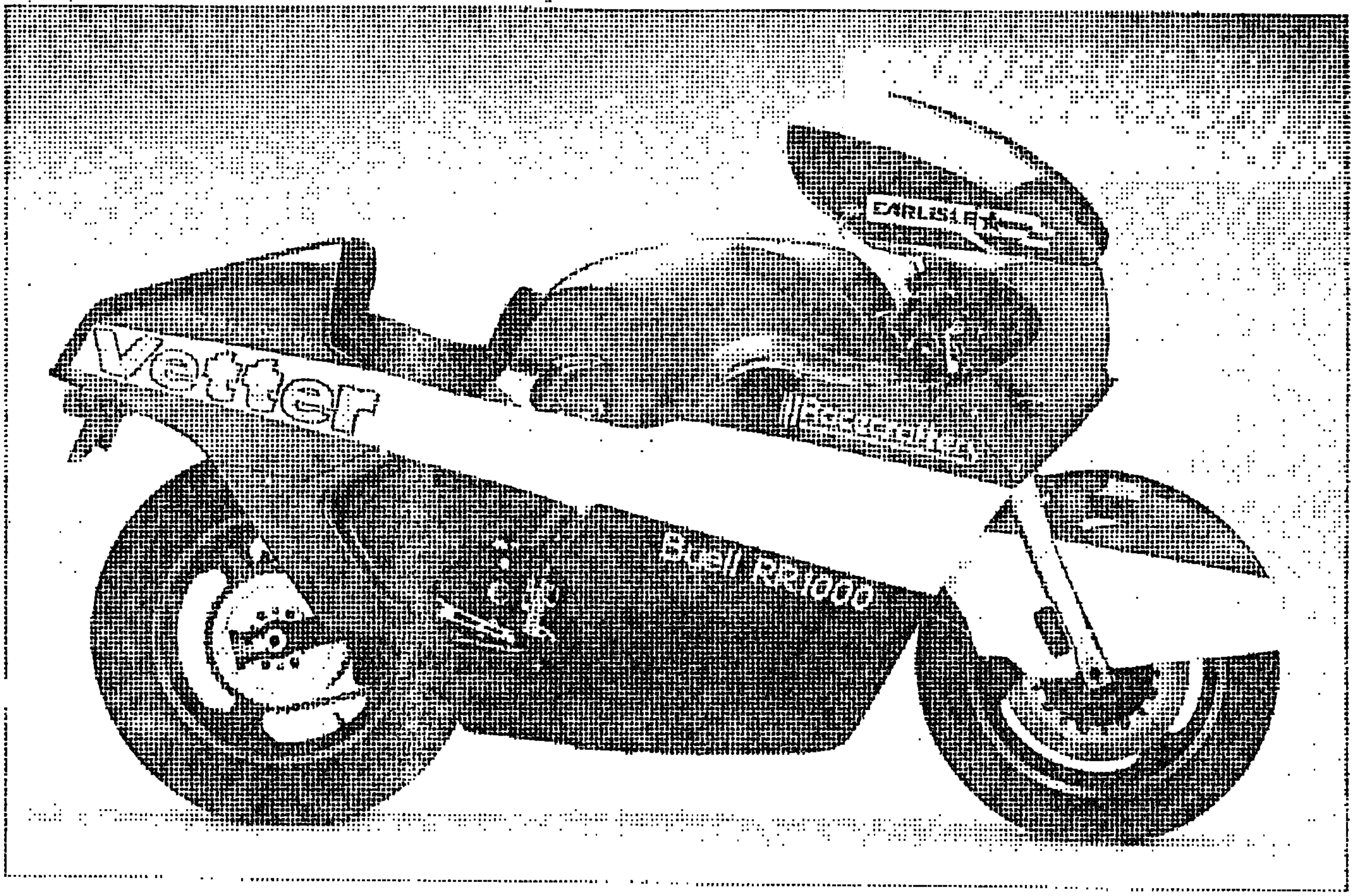
A steep 25-degree steering-head angle, like those on recent race bikes, assists steering response; yet despite this steep head, chassis rigidity and suspension quality is such that, according to Buell, the machine can be ridden hands-off at 100 mph with no trace of oscillation, even when the bars are struck sharply to excite them.

Fork and swing arm, just as much part of the chassis as is the main beam, must be similarly rigid. A Marzocchi adjustable-damping fork with fat 42mm tubes holds up the front, equipped with Buell's electrically activated anti-dive system. Solenoid valves switched by brake lever movement reduce the fork legs' internal air volume when the brakes go on, making the front end harder to bottom but not interfering with normal damping. The rear uses a braced swing arm, and geometry alone produces a rising-rate suspension, eliminating the weight and complication of a linkage.

As the final element in quick steering, Buell chose a race bike's short 53-inch wheelbase. This necessitated crowding the wheels so close to the engine that one tire nearly polishes the front cylinder while the other threatens the gearbox. Since no room remained for a conventionally mounted rear suspension unit, the remote-reservoir pressurized Works Performance unit now resides *under* the engine, operated in reverse—as the wheel rises on compression, the shock *extends.*

Although Buell used special pieces freely—pegs, foot controls, tank—he did incorporate standard H-D electrics and street parts where appropriate.

Buell's remarkable motorcycle shows us that today's performance doesn't really have to depend on the engine. As discovered in automobile engineering decades ago, we are now finding that motorcycle performance depends more on weight, tire grip and handling qualities than on squeezing the bitter dregs of horsepower. Here is a thoroughly modern chassis, with the latest in race-quality hardware, wrapped around an engine whose major strength is the loyalty it elicits from its many partisans. Yet the chassis doesn't care where the power comes from or whose name is on it; its job is to get that power to the ground. It may be hard to imagine traditional Harley owners on Buell's machine, or to imagine it in traditional Harley environs. No matter: Buell's careful work shows, and his ideas shine oh so much brighter than blind tradition.



BATTLE TWIN

Erik Buell is America's other motorcycle maker. He used some Bell/Vetter money, an XR1000 engine and his own furious genius to create the Battle Twin.

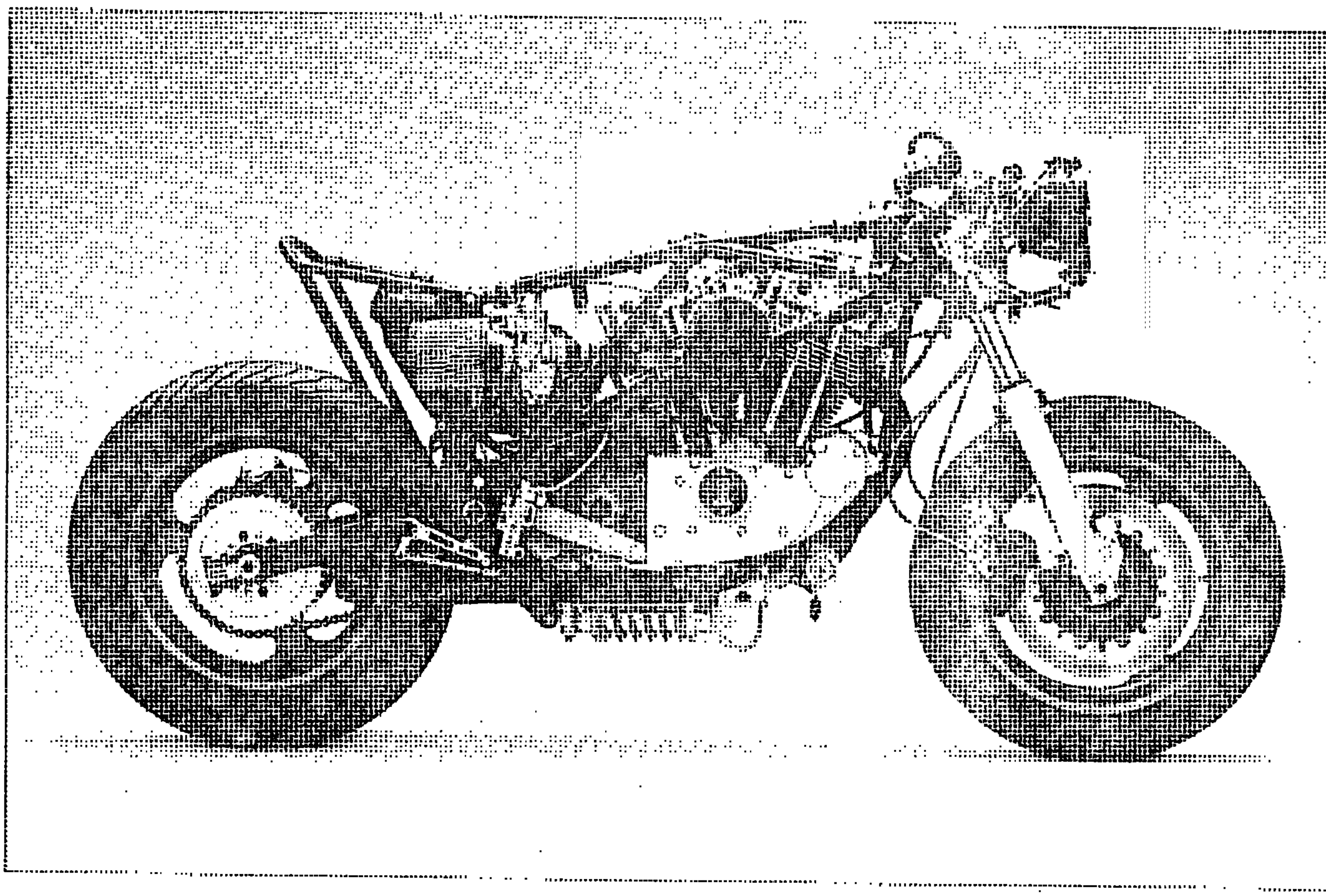
By Kevin Cameron

[illegible] Here is an American-made Superbike. The marriage of a traditional American engine—the Harley Sportster 1000—with a high-technology chassis has bred a street-legal, 395-pound, 80-horsepower machine on a quick-turning 53-inch wheelbase. The builder? Erik Buell, a free-lance engineer known to some as "America's other motorcycle manufacturer."

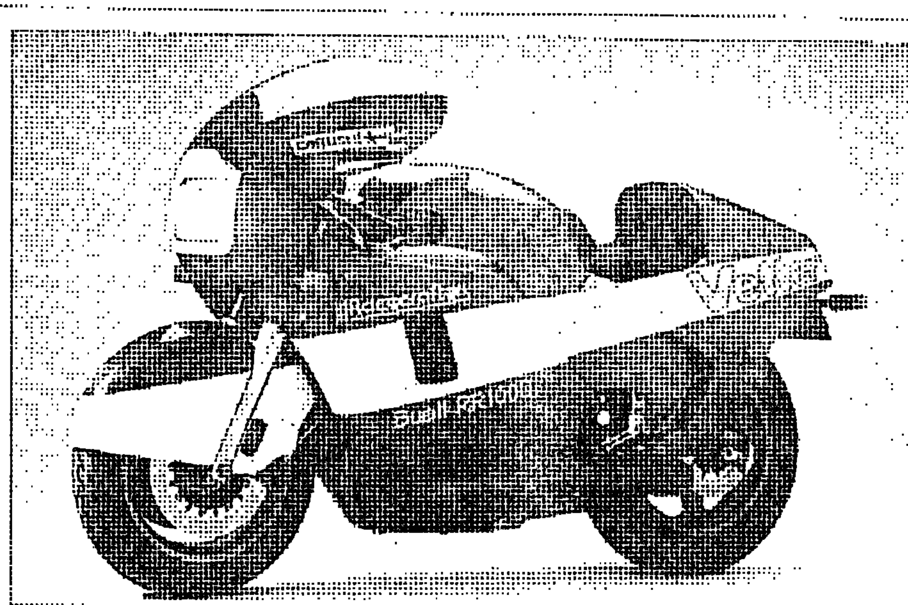
Skeptical? If the union of Sportster engine and high tech engineering seems untenable, consider this: Buell first addressed the engine's considerable limitations—vibration, limited power output, substantial bulk and weight—to achieve performance goals worthy of the Japanese. Though clearly road race inspired, Buell's machine incorporates vibration-control technology that is complex and effective; the big engine mates with a tiny chassis that compromises neither rigidity nor the short wheelbase needed for instant response. Despite the 200-pound engine, an economy of weight elsewhere adds only another 195 pounds for a total far less than that of most sport bikes. This hand-made machine blends modern performance with a civilized, traditional quality, at once familiar and exotic.

Officially, Bell/Vetter's Rex Marsee initiated this project to show that "Vetter is not just a fairing company," and Harley Davidson provided two engines on speculation. Bell/Vetter commissioned the bike; Buell designed and built it. Such modest *input*, though laudable, simply can't explain this project's astounding *output*. Beginning in September 1985, Buell, a man willing to throw his own furniture onto the fire that drives his progress, took a bare three months to construct his machine, working like a madman and funding the project himself when money ran low.

In many ways this fascinating motorcycle was distilled from disillusionment. Buell is a single-minded engineer with a passion for making hardware as good as the laws of physics say it can be. When he discovered that the business of making money generally takes precedence in corporations over the business of creating exciting machinery, he quit his stint at Harley-Davidson and set off on his own. Buell saw this new project as an opportunity to do what he'd always wanted when he was in Milwaukee: create a bike that offered



For maximum rigidity from a given weight, Buell used only straight chrome-moly tubes in his chassis. He sneers at square-tube aluminum chassis, calling them "lawn-chair frames."



BATTLE TWIN

true performance for the loyal Harley partisans.

Besides being an engineer, Buell is also an ex-racer. He knows that the present form and capabilities of super-sports machines come straight from the track, and by aiming his new high-performance street bike at a potential racing future, he could stay in touch with a solid, reliable reality, uncontaminated by ballyhoo.

First, Buell's creation could be an instant challenger in the AMA's Battle of the Twins road races (three have been ordered for this already), and if 50 could be sold, the Buell RR1000 would also qualify as an AMA Superbike. According to Superbike rules, the upper limit for multis is 750cc with a minimum weight of 390 pounds; for twins like Buell's a lean 320 pounds is the limit.

Compare the numbers: Figuring about 580 pounds for a race-ready 130-horsepower Japanese four with rider and fuel, we get a power-to-weight ratio of 4.5 pounds per horsepower. Although horsepower figures for a developed H-D Evolution 1000 engine with downdraft heads aren't available yet, we do know that the Harley XR750 dirt-tracker engine gives close to 90 bhp. Of course, we can't just scale this up because the bigger engine wasn't designed as a racer and can't reach high rpm, but a sincere and effective effort might get just over 100 bhp. Add another "if" for weight reduction down to the 320-pound limit, and we have 510 pounds/105 bhp, which works out to 4.9 pounds per horsepower. That's close, dangerously close for a real H-D partisan. Certain people would work three shifts to put those numbers together.

Generally, today's approach to per-

Battle Twin *Continued from page 31*

the air any energy the motion of your vehicle puts into it. As a vehicle moves, it pushes the air aside, imparting to it both velocity and pressure energy. The turbulent wake of an unstreamlined vehicle is just this pressure and velocity energy unrecovered. This large, energetic wave makes "drafting" possible. Obviously, the smaller this disordered wake, the less energy it contains and the smaller the power loss to the vehicle. "Conservative flow" is a name for the unattainable ultimate, the state in which every molecule of air disturbed by the vehicle is eventually replaced exactly, with its original energy and no more.

The zeppelin-like shape approaches conservative flow most closely; the pressure against the front of it, created in pushing the air aside, is exactly balanced by the pressure on the rear, created as the smoothly disturbed air rushes back together and stops—there is *no* turbulent wake. This balance means it takes *zero net force* to drive our zeppelin in this ideal flow state. In practice, however, because air has viscosity and adheres to the vehicle's surface, the ideal is unreachable but enticing.

Most motorcycles, making no attempt to close their wakes, trail huge formance treats weight and bulk as secondary to engine power. The H-D engine called for a departure from the norm because in no way could it match, Clydesdale for Clydesdale, the Japanese designs. Getting an impressive power-to-weight ratio would require cutting weight; achieving competitive top speed would require extensive streamlining; and ensuring the ability to slip away from larger machines in difficult situations would require the right kind of accelerative power.

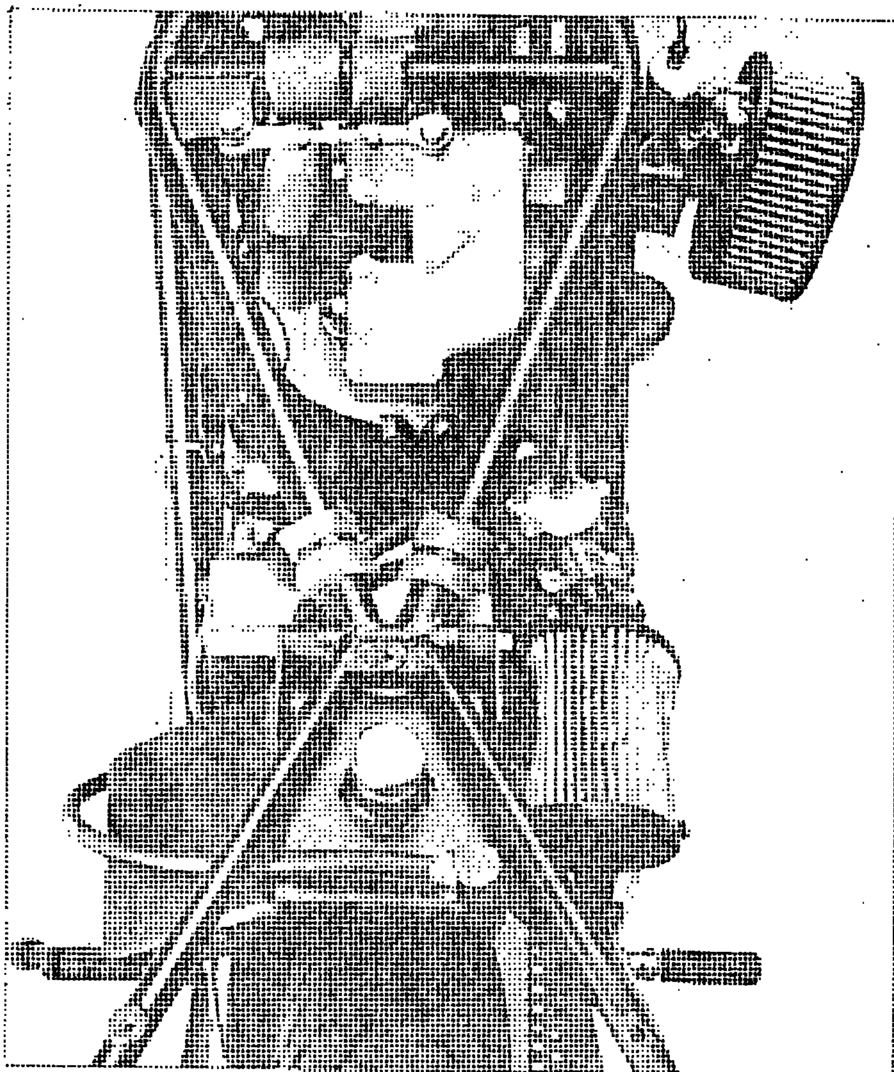
The first part of acceleration, the part that begins with the machine still leaned far over in a turn, is the most valuable to a racer. A mile per hour added here raises the average speed all the way to the next turn, whereas a mile per hour added to top speed aids only at the far end of the straight, and then just a little bit. Two factors determine how hard a bike can accelerate out of a corner: First, a motorcycle with a stiff chassis and the best suspension technology can accept throttle earlier in a turn than can a more compromised machine. Second, the easier the engine is to use, the sooner its power can be applied. Whatever else the big H-D may lack, it has super-wide torque. Furthermore, when torque varies little from just off idle to peak power, this also helps acceleration.

Weight versus engine thrust rules the second part of acceleration, the straight-up part. Buell figured he'd have to get his machine under 400 pounds to offset the horsepower advantage of the big-four bikes. Since the engine already weighed 200 pounds and its pounding vibration was akin to that of a huge single, weight reduction would require more than just thinner tubing and smaller bolts—parts likely to fatigue and break. Buell needed to engineer around the vibration and toward both light weight and stiffness.

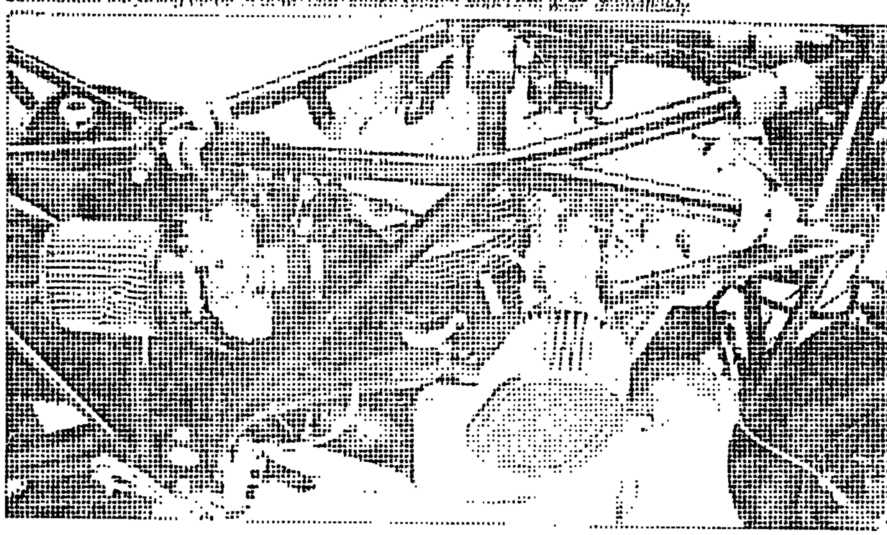
The old, heavy, tube-and-lug H-D chassis, at 75 pounds or more, could take the pounding the engine delivers. Fortunately it's a type of vibration easy to isolate. Because the engine's two connecting rods do not lie next to each other on the single crankpin, but are interlocked as fork and blade, its vibration is confined to a single, vertical plane through the wheels, and the engine doesn't twist and rock.

Norton engineers controlled the single-plane vibration of the old Commando 750/850 twins with their isolastic mounting system. The goal was to permit back-and-forth and up-and-down motions without allowing the engine to twist and squirm. Thus they moved the swing arm to the back of the engine-gearbox and hung the resulting unit between two pairs of rubber-donut mounts. A system of large adjustable-clearance urethane washers constrained this package so that it could

[illegible]



The triangulated [illegible] of Buell's frame is [illegible] and light, but the [illegible] bodywork must bulge to accommodate the [illegible]. A [illegible] would [illegible] dramatically.



move only in the plane of the chassis. In this way, the front and rear wheels remained always in the same plane—necessary for handling and stability—but the engine could orbit around its own crankshaft in vibrating, with most of the pounding stopping at the rubber mounts.

Recent Harley models similarly pivot the swing arm from the back of the gearbox. The engine gearbox unit itself then pivots on a pair of firm rubber mounts concentric with the swing-arm axis, and the front of the engine hangs from more rubber. Two features of this design prevent the engine/gearbox/swing arm from wagging or twisting: first, as the front of the engine vibrates up and down, the rear pair of firm rubber mounts permits rotation but dis-

BATTLE TWIN

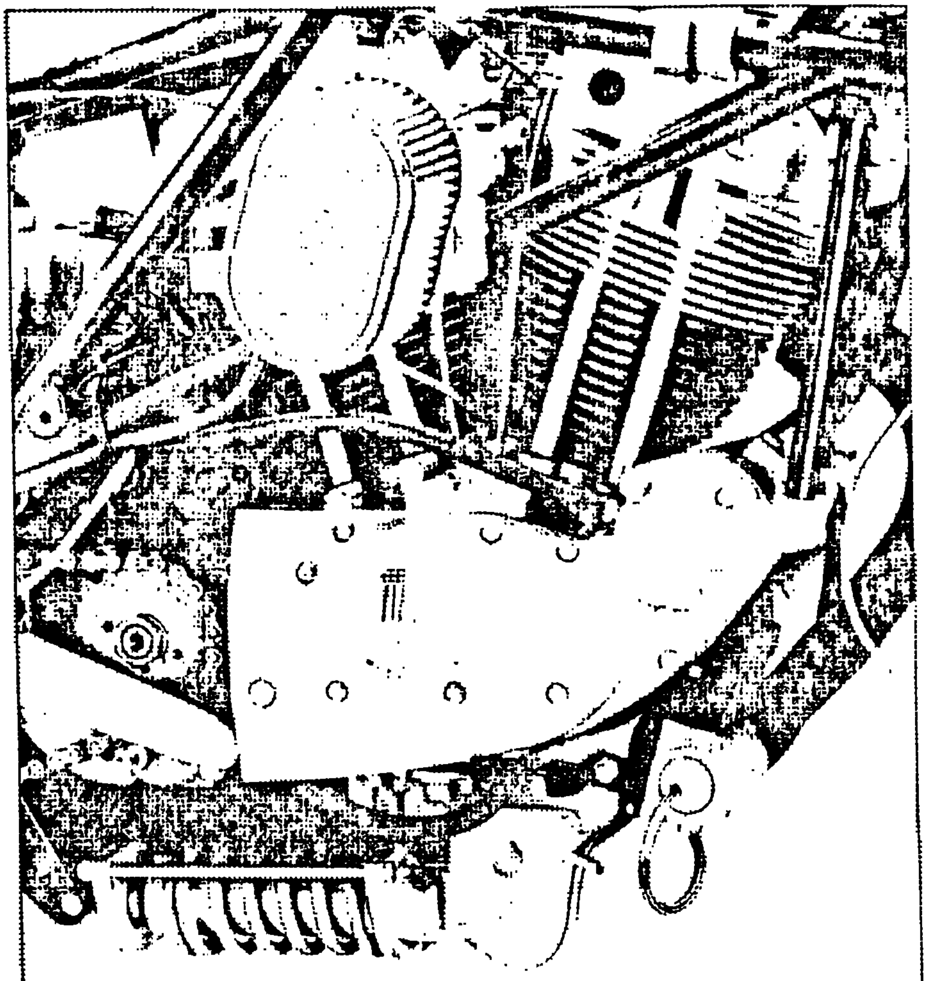
courages other motions. Second, at the front of the engine a pair of horizontal ball-jointed links prevents any lateral or twisting motion while allowing up-and-down, back-and-forth vibration in a single plane. Such chassis currently weigh about 60 pounds.

Buell, who needed the ultimate in vibration isolation for the lightest of chassis, took the design even further. He eliminated the compliance of H-D's rear pair of rubber mounts and used *four* ball-jointed horizontal links that completely define the engine's motions, limiting them to a single plane. In his design, rubber mounts with no structural function carry the engine's weight, and through this link system the engine's lateral rigidity transmits lateral forces from the rear tire forward to the front. Vibration isolated, Buell could then use the light chassis he needed without fear that the engine would destroy it.

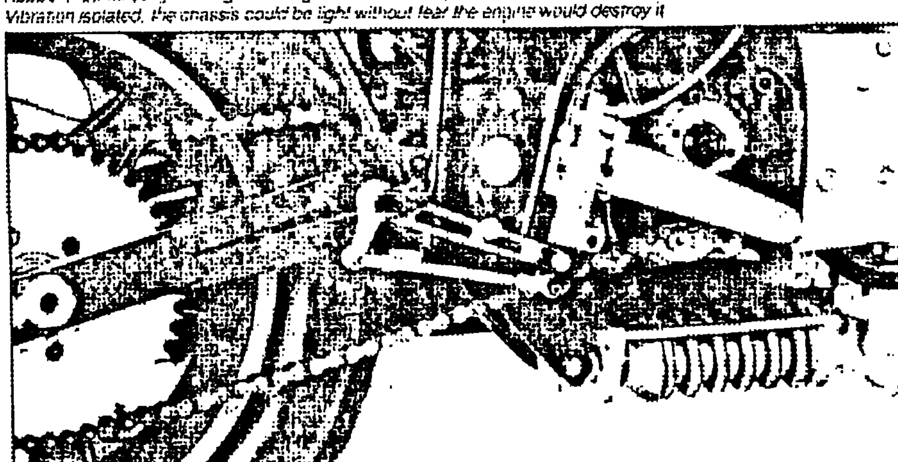
For maximum rigidity from a given weight, Buell used only straight tubes in this chassis design. The resulting triangulated beam envelops the engine's cylinders and heads but facilitates service by allowing the engine to be quickly unlinked from the chassis, and the design accepts either the Sportster 1000 or the upcoming Evolution 1000 engine. (The first bike, shown here, uses an engine from the now discontinued XR1000 series.) The Sportster currently gives more power than the Evolution, but a switch to downdraft-carbureted Evolution heads would yield more power than either. Buell's frame provides "windows" for such carburetion to emerge, but for now, the bike still has the famous Harley bulge in order to accommodate the current Sportster intake system.

With access to Harley-Davidson's computers, Buell could check his chassis design, running a finite element analysis program. Stress calculations are difficult for shapes other than regular geometric forms like tubes and shells, so finite element analysis breaks up a complex shape into an assembly of many much smaller, simpler shapes (the "finite elements") for which calculations are then straightforward. The program makes conditions agree at all element boundaries; what remains is stress behavior for the entire shape.

Aside from checking stress concentrations, Buell used the computer to redesign electronically his chassis using various materials, sizes, and cross-



Rubber mounts carry the engine's weight while four ball-jointed links confine the V-twin's motion to a single plane. Vibration isolated, the chassis could be light without fear the engine would destroy it



With no room for a conventionally mounted rear shock, the Works Performance unit resides under the engine and operates in reverse—extending as the rear wheel compresses. Geometry alone provides a rising-rate action