Fire Power Now!

The Shocking Truth

Yesterday's electronic fantasies are today's standard practice. Mike Maxwell studies the state of the art

"High-tech biking" is a fine phrase. It sparkles on the page, irridescent with overtones of electronic wizardry and exotic engineering.

Forget it. And avoid being too easily impressed by four-valve cylinders, fuel injection or air suspension. They've all been done before . . . long before.

The truth is unpalatable. Motorcycles are still today the most conservative, traditional and plain old-fashioned vehicles on the road.

Motorcycles have always had the back end of automotive technology. Diesel trucks have used turbochargers for decades. Cars first used electronic fuel injection back in 1967. And though it may seem strange in the face of whizz-bang techno-claims in the ads, bikes are still at the tail of the queue for engineering innovation.

One reason is in the very nature of motorcycles. Production runs may be huge, the stakes high. But making bikes remains something of a cottage industry: inward-looking, introverted; with the prime contenders imitating one another in the effort to excel.

Another is the innate conservatism of the people who buy bikes - us. There have been various and notable attempts at radical scoots: from Ner-A-Car to Quasar, from five-cylinder Megola to rotary-engined Suzuki RE5.

Without exception, they were rejected by the biking public. And while car design progressed in great leaps - encompassing independent suspension, hydraulic brakes, monocoque construction and electronic ancillaries - bike design stayed put.

It wasn't all bad - bike engineers are way out in front at coaxing high bhp from small lightweight engines; and they are the kings of revs per minute. But in developing in a separate stream from the car engineers, they missed out on a huge pool of design and development. For instance, Yamaha's mighty XS11 - that paragon of low-speed power delivery - is the *only* motorcycle ever to have had a vacuum advance-retard mechanism - a useful device universal on cars since before World War Two.

Things are changing, slightly. The latest example of cross-pollenation, Kawasaki's miracle-chip fuel injection, is the most portentous. It is with the coming of the micro-electronic age that more components and more techniques will be shared.

It's as good a time as any to join in, and indeed the process of integration is well advanced, though it's only just hitting the streets. It is only logical that, as with cars, we're going to see more and more microchip processors and mini-computers on modern motorcycles.

Electronic devices have definite advantages over their mechanically operated counterparts in that they do not wear out. This does not mean they are immune to failure, merely that they are static components and thus not subjected to the same stresses as moving parts. Theoretically, an electronic component under ideal conditions should last the mechanical life of the machine. But,due to the complex interconnected systems of electronic control, one component failure can lead to a chain reaction and devastate the rest.

Among the electrical gadgetry becoming prevalent on motorcycle engines are electronic ignition systems and, more recently, electronic fuel injection.

FUEL INJECTION

The original electronic fuel injection system was pioneered in the United States, at Bendix. The idea was taken up by Bosch in Germany, who further developed and refined it before putting it into practical use. Later Bosch sold the manufacturing rights to Datsun Nissan in Japan, who put it to use in their four-wheelers. Kawasaki adapted the Nissan fuel injection to fit on to their 1-litre roadburner, the KZ1000H. Though the Kawasaki system is not the only one available for bikes, it is the only production machine to be equipped with such a unit. Others have been made, from the primitive Wal Phillips' gravity fed injector, to the more sophisticated Piper-RDA electronic fuel injection system. However, most of the after-market items have been designed for competition use, and are thus not overly concerned with such niceties as consistently smooth idling, emission control and even throttle response. Despite this, companies such as Piper Engineering will make a kit to suit a road bike, given the necessary details (and money - about £350.)

Although there are a number of car manufacturers who make electronic injection units, or use proprietary items, these are not readily adapted for use on bikes, though the broad principle is the same.

The basic principle of fuel injection is to push fuel under pressure through a nozzle and then get the finely atomised particles into the combustion chamber. The quantity of fuel allowed through the nozzle is metered according to the needs of the engine, which is where the electronic gadgetry comes in. The injectors themselves can be placed in the head itself, in the inlet tract or further up the venturi. There are various arguments in favour of any of these positions and much depends on what sort of use the machine is to be put to.

Setting the injector in the head itself is most common in car engines, especially diesels. This has the advantage of spreading the charge evenly throughout the chamber, making for better combustion and consequently a cleaner burning engine. The disadvantage with this system is that the charge for each cylinder must be injected at its compression stroke, which leads to more complex and expensive circuitry than a system which can inject before the inlet valve, in response to the ignition pulse of the HT coils. Also the injectors of the former have to be constructed from temperature resistant materials — again, an expensive measure.

Situating the injector outside the combustion chamber, but close to the valve, means a portion of the charge can be injected before the inlet valve opens and the balance can be added once it has opened. Kawasaki opted for this system because it involves a less complex electronic circuit to operate it, and also less durable, that is, cheaper, injector nozzles.

By placing the injector well up the venturi, advantage can be taken of the air-flow through the induction manifold to cool and accelerate the charge before it enters the combustion chamber. The disadvantage is that at low engine speeds the atomised fuel tends to recondense in the inlet tract, resulting in an undesirably dense charge entering the combustion chamber and flooding the engine, or causing the idle to become erratic.

The Kawasaki system is essentially a compromise. It has been designed to maintain the performance the buying public expects from a 1-litre bike, and still pass the increasingly stringent emission control laws in America. The claims of improved economy, better throttle response and more horsepower are almost incidental to the former consideration, and in some instances, almost undetectable.

It works like this. In the inlet tract of each cylinder is an electronically actuated, rapid response injector nozzle. Each of the four nozzles is supplied with fuel at a constant pressure by means of an electric pump. A switch opens and closes the injector, and the amount of fuel is metered by the duration of the switchgear. The more fuel the engine needs, the longer the switch stays open. The fuel supply is not modulated by a variation in the injector's aperture, it is a strictly on/off device, only the period of opening can vary.

Determining this duration is where the fun begins. Under different loads, at different temperatures, the engine requires different amounts of fuel. To determine what is required there are a number of sensors built into the machine which inform the control box. These signals are processed by the components in the box which feed the information through a programmed "memory". This is computed, the fuel requirements determined and signals sent to the solenoid which actuates the injector's fuel valve. More fuel means the solenoid is fed current for a fractionally longer period, less fuel means less time.

The primary impulse determining when the solenoid must open the fuel valve is triggered from the ignition system. Every time the current to the coil is interrupted (when the engine fires) the control module kicks all four injectors into action. Because of the firing order on the Kawasaki, the nozzles only deliver half the fuel requirement of the motor. The balance is injected on the next firing stroke. This means only two cylinders receive the full charge through the open inlet valve at any time, while the other two, with their inlet valves closed, get their first half charge.

Thus, as the engine speed rises, so does the frequency of the injector's operation. But that is only one part of the fuel delivery control. The other signals allow the control module to shorten or extend the output pulses which determine how long the solenoid holds the valve open.

The most important of these secondary signals is the one which tells the "box" how much air is going into the motor. This is measured in an air-flow chamber situated between the air filter and the plenum chamber. The meter itself is a hinged, lightly sprung gate, which opens wider as the air-flow increases past it. A contact arm transfers this movement to a built in rheostat (a switch for passing a variable current), and the flow rate is translated into an electrical impulse for the benefit of the control box.

Fitted to the gate is a mechanism for shutting off the fuel pump should the air-flow cease. Also built into the air-flow meter is a small probe which monitors the ambient temperature of the incoming draught, hotter air dictating a leaner mixture and thus a shorter duration of valve opening.

Thus we now have a situation where the injection rate is linked to the engine speed, and the duration of the squirts is determined by the signals from the air-flow meter and the ambient temperature sensor. The correct mixture for a clean burning engine under these variable conditions is contained in the memory, and it sends out the appropriate signals.

However, this does not cover all conditions, cold starts for example. Fitting a choke would accomplish nothing. The line pressure regulator would simply compensate for the lack of air-flow, and the mixture would remain normal.

This problem is overcome by yet another temperature probe situated in the head. When the motor is cold, it sends a signal to the box, which compensates by enriching the mixture. Once the motor is warm, it cuts out.

Another problem is supplying fuel when the motor is idling and requires a richer mixture. This is sorted out by allowing air through a bypass passage in the air-flow meter, and a contact in the switchbox on the left hand side of the throttle shaft. This contact informs the control box that the butterflies in the venturi are closed, and the mixture is enriched accordingly.

This switchbox has another two contacts in it. Besides informing the control module to enrich the idle mixture, it also tells the "brain" that the machine is cruising normally, or that it is accelerating hard and needs a richer charge than the air-flow meter is dictating. The electronic brain therefore is a series of circuits switched into action by the demands of the engine. Under particular conditions — idling, cold starts and acceleration - the principal circuit is overridden by the secondary switches, otherwise it operates according to the information fed to it from the air-flow meter and ambient temperature sensor.

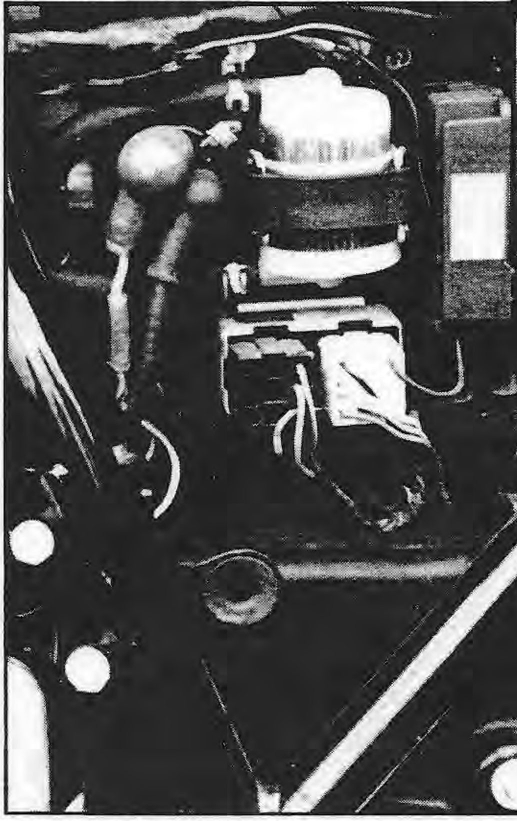
The next interesting part of the fuel injection is the fuel supply. As mentioned earlier this is pumped under pressure through the injectors. This pressure is maintained at a constant 36lb *higher* than the pressure in the inlet manifold. The reason being that the injectors have been placed directly in the stream of the manifold vacuum. If this was not done and instead related to atmospheric pressure, then there would be a vacuum-assisted increase in the injector's flow rate when the throttle closed and a corresponding decrease when it opened. This is exactly the opposite of what is required under those circumstances by the engine.

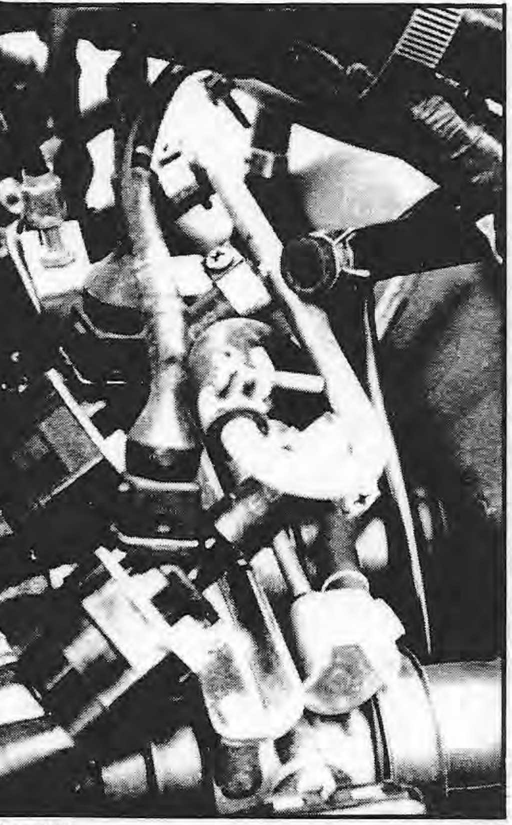
Basically, all fuel injections work along these lines, and indeed are constructed according to the principles laid down in the original Bendix patent. However, there are considerable variations in the switching circuitry of the metering devices, since each system is tailored to the requirements of the particular motor to which it is fitted and its performance specifications. What Kawasaki sought to do with their system is maintain the performance level of the early Z1 and still meet the necessary emission control legislation.

They have only scratched the surface. The further possibilities are mind-boggling. The bike is fitted with a plug-in control box which determines ignition timing and fuel supply. To feed in different tuning characteristics, just plug in another box. You have a different bike.

Before exploring this further, it's important to see how electronic ignition fits into the overall picture.


Kawasaki's Black Box


The fuel filter lurking behind the side cover keeps the petrol pure


Kawasaki injectors and throttle switch

ELECTRONIC IGNITION

When it comes to igniting the mixture in the combustion chamber two things are paramount. The first is a healthy spark to detonate the charge and the second is to ensure it takes place at the optimum moment in the cycle.

On most machinery, these functions are largely dealt with mechanically. A set of contact breakers, or points, are opened and closed directly by a cam. A low-tension primary current passes through these points, and the break in contact triggers the coils. At this point, the action has become electrical.

There is another mechanical contrivance involved, though: the automatic-advance bobweights. Centrifugal force throws these outwards as the revs rise: a mechanical linkage advances the ignition as a result.

These things are fine when everything is in perfect order. By their very nature, though, they are subject to inaccuracies and to wear. Their performance, and the precision of engine function control, decays as they wear out.

As the points begin to open, the current that has been flowing through them jumps the gap before they are fully apart. This arcing affects both the timing and the strength of the spark. At low revs it produces inaccurate timing and a weak spark which can result in difficult starting and erratic idling. At high revs the voltage fluctuations in each cycle can result in a scattering of the spark, which causes the engine to run roughly.

Another problem with points at high revs — 10 000rpm or more — is that the spring holding them together cannot sustain accurate operation and they float and bounce. This causes inaccurate timing and incorrect dwell (the period for which the points are closed). Furthermore, the fibre heel of the points can wear, and the continuous arcing of the points causes them to become pitted and worn.

Electronic ignition systems dispense with some or all of the wearing parts, and also eliminate the electrical shortcomings of contact breaker ignition.

There are two main types of electronic ignition. These are capacitor discharge (CDI), and points assisted ignition (PAI).

The true electronic ignitions eliminate the mechanical component and substitute a static electronic switch, a thyristor. Without getting too technical, this is a type of diode which acts as a switch when it is energised. By adding complex electronic programmes, the advance curve of the engine's ignition can also be accurately controlled thus eliminating the mechanical advance/retard bobweights, and evading another source of wear.

This function is also achieved through a set of static components thereby disposing of another source of mechanical trouble.

The sensors, or pick-ups, that send the necessary signals to the control unit are electronically triggered. There is no contact between the rotating and the stationary parts, thus nothing to wear out. The impulse is either triggered by a magnet passing a coil (as in the Boyer-Bransden system) or by a blade which breaks the beam from a light emitting diode as with the Martek, or the Lumenition set-up.

Two Motoplat electronic ignitions

What this does is switch the current to the control unit on and off. This cut out activates the thyristor which switches the impulse to the high tension circuit, and the coil then releases a spark to the plug, exactly as if the current had been cut off through the points only more accurately.

The advantage of having the coil energised through these static components is twofold. Because of the complete lack of fluctuation, the coil can be receiving current for a longer and consistent duration, and the electronic components charge it quicker. This results in a uniformly strong spark throughout the rev range of the engine.

In a points-assisted system the points are still retained as the crucial switch, and thus most of the faults inherent with the system go with it. What it does is eliminate the current from the battery, and instead feeds a much lower current through the points via a series of transistors and diodes. This eliminates the arcing and the problems associated with it. So you get an improved spark and less frequent maintenance intervals.

True electronic ignition systems are further divided into self-generating and battery powered units. The self generating units are found mainly on competition machinery where the current they produce doesn't have to cope with the additional burden of a lights supply. They are consequently bulkier than the battery powered units, since they have to have a generating system built into them.

For roadgoing machinery we are concerned with the battery operated systems. They rely on the current from the battery to activate and keep them operational. They are essentially complex electronic switching devices, which store and transfer current. They receive signals from the sensors and are programmed to react accordingly.

The main problem is that when electronic ignition systems fail they cannot be easily repaired, and certainly not at the roadside. To diagnose a problem a lot of costly labour and complex electronic testing equipment has to be used so it is often better to simply replace the entire unit. However, as the systems are developed and become more reliable the problem may become remote.

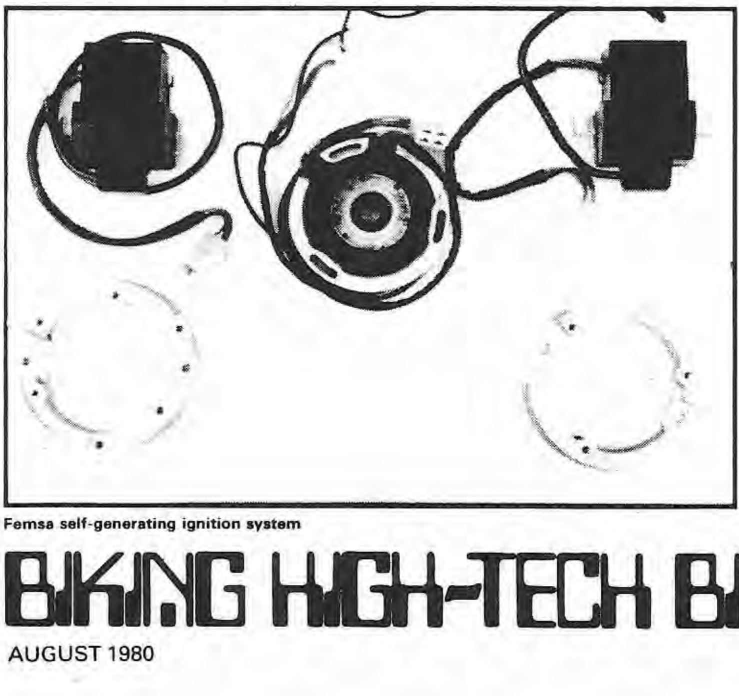
CONCLUSION

So where does all this electronic wizardry leave us? Somewhat bemused and befuddled no doubt. However, it's not that difficult to comprehend. The main advantage of electronically controlled fuel injection and ignition is not that it is less likely to go wrong, though this is true. It is that the vital functions of the engine - sparks and mixture - are much more accurately controlled in the first place, and much less prone to going out of adjustment.

With increasing technological advances in the field of micro-electronics the stuff is bound to get better, and cheaper. It makes the emission control legislation easier to handle without emasculating the performance of the machinery. With fuel getting more expensive it makes good sense to design systems that make an engine more fuel efficient. If all that logic doesn't persuade you, well bad luck. It's all part of the techno-biking of the future.

It is easily demonstrable how much more efficient electronically monitored systems are over their mechanical counterparts, what is less acceptable is that it takes maintenance - albeit infrequent - beyond the realm of the amateur and into the court of the expert. This is going to make things more expensive in terms of labour costs. However, this is weighed against the efficiency and reliability of the units, and will probably balance out in the end.

What the future holds is anybody's guess. Perhaps high performance tuning is going to be a new concept in micro-computer programming. You nip down to your local dealer and get yourself a road-and-track microchip, which you simply slot into the control module and your bike is instantly transformed into a high speed roadburner. You could carry an assortment of programmes under the saddle, and set the bike to perform according to conditions. As the end of the month draws near and money gets scarce, you dial in the economy programme, until you have to make a high speed getaway from a robot-controlled police officer, then you switch it over to turbo-power. Ah, the curse of a lively imagination, it makes any dismal future look bright!



Femsa self-generating ignition system

Boyer-Bransden battery powered electronic ignition for 3 and 4 cylinder bikes

Old Dog, New Tricks

John Cutts shoots the works with Kawasaki's new main-line injector

Every morning on each of the dozens of local Los Angeles radio stations, they broadcast a smog warning, "The composition of your air for today is as follows . . ." When the smog reaches certain unacceptable levels, they broadcast a warning which advises people to stay indoors, since it's not considered safe to be out on the streets. In high summer this happens with alarming regularity. Given a dry, hot, windless day, you can sit high up in a central state park and just see the huge grey smog cloud hanging menacingly over Hollywood and Beverley Hills. When it's that bad, it tickles the back of your throat and irritates your eyes. It is most certainly a distressing medium in which to breathe. And it is caused quite simply by the density of internal combustion exhaust fumes. Heavy traffic causes smog.

They worry a lot about the state of the air in the US of A. They worry a lot about whether it's clean enough and whether indeed it is at all fit to breathe. Some years ago the politics of pollution produced emission controls. No more dirty fuel soaked hydrocarbon skylines. No more dirty engines. No more dirty motorcycles. The Japanese (who are never slow in these matters) soon wised up to the legislative drift - clean up or die. Goodbye two-strokes.

This year heralds an important development in the history of emission controls, and the history of the motorcycle. For the logical extension - fuel injection - has arrived and it is Kawasaki's Z1000 that has got there first. The new KZ1000H meets all the rules. It does better than that - it exceeds them. All home-built in a country where the local people aren't even allowed to ride anything bigger than a 750 anyway. Isn't that strange? But then it's a strange country, Japan. When they're not producing some of the world's most advanced technology they indulge in some odd and perverse things, like going whaling.

Still. The Japanese have always had a fine economic eye for giving the American punter what he wants (or rather what he's allowed to want within the law). Give the public the protection of emissions legislation and eventually there evolves a need for a fuel-injected 1000cc superbike. Kawasaki had both the existing muscle and the technology to do it. Here it is.

We are looking at a new legend - the world's first fuel-injected production motorcycle. And it is only fitting that a legendary engine, the Z1000, should once again demonstrate its inherent versatility by being the first to accept a bank of injectors instead of a rack of carbs.

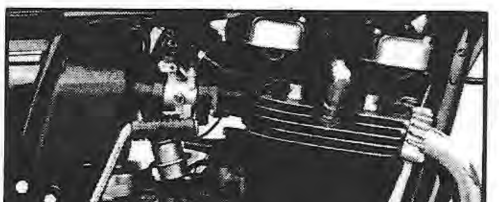
In a long line of Killer King Zeds (be they 903 or 1015cc) this one is the most powerful yet. A single salient fact says it all. The claimed crankshaft brake horsepower figure for this bike is a big 96 at 8000rpm. The latest variant in the colourful adventures of this almost perfect and unburstable engine, delivers more power ponies than anything else in the range, bar that fat grandmother, the Z13.

That power increase (up 3bhp from the Mk11A) is entirely due to the efficiency of the fuel injection system. It works, and damn well.

Don't let the attraction of the extra power hide the ambition though. Whatever the advertising brochure claims, the basic criteria Kawasaki aimed at satisfying with this bike was American emissions control legislation. The other claims for the wonders of fuel injection are technically valid, though hardly earth shattering.

Smoother acceleration? (So what?) Better combustion? (How can you tell?) Quicker throttle response? (Who's kidding who?) Improved fuel consumption? (Yeah, OK. That one's of real benefit, even if it's only slight.)

In fact, behind the up front claims lies a more substantial argument. Fuel injection systems are more efficient and less prone to breakdown. But is that consideration worth £350 more than the price of the virtually indentical stablemate, the Mk11? Well, let's see.



The Z1000H is a Z1000Mk11 with fuel injection and a bigger alternator, all other changes are cosmetic. Elsewhere in this issue, Mike Maxwell explains the techology in detail, so here, I'm going to concentrate almost exclusively on the quality of the ride. The view from the driving seat. Right. What does the fuel injection have going for it?

Smoother acceleration? Well yes, it is pretty smooth, but then so it should be, because the precisely metered fuel system injects exactly what the engine needs at any given moment. It's smoother than any other Z1000, but not by that much since they're all pretty capable of smoothing out the power pulses these days. Let's say this one is less harsh. It still exhibits a little driveline snatch and it still vibrates. Anywhere above 4500rpm, the mirrors are useless. But it's not uncomfortable and it's pretty easy to live with such a high speed buzz, even on a long trip. So it's smooth enough and it certainly accelerates. Low 12 second standing quarters testify to its potency.

Better combustion? Hell, I don't really know, but I believe them because the theory says there should be and because not once in two weeks and 2000 miles did the big Kwacker show any signs of bad ignition or misfire.

Quicker throttle response? This claim is interesting, if a touch confused. Sure it's slightly quicker than other Mikuni carbed Z1000s, but it's still nowhere near as quick as some quick action throttle and Dell 'Orto carbed Dukes and Guzzis. It picks up cleanly and quickly, but it still takes a fraction of a second because of the memory lag between the throttle valves, the little grey electronic control box in the tail, and the injectors. You can beat the 'putor with your hand and it's not as quick as any halfway decent set of pumper carbs and their neat squirt of fuel, though of course, in terms of fuel consumption and fuel efficiency, it's more precise. Realistically it doesn't matter. The H picks up fast enough for anyone not intending to run the bike at a dragstrip. But if it's not that important (or that good) why draw attention to it?

Improved fuel consumption? Again, this is all a bit relative, both to previous Z1000s and to the sort of rider you are. I averaged 45mpg cruising around town and hit a low of 28mpg at the track. The Mk11 we had last year averaged 30mpg at the track and 42mpg in town. So the regular 40 plus figures we got in town are a slight improvement. There again, they might well have slipped in an ultra lean test programme for their demonstration bikes (only kidding chaps). Contrary to what I was astonished to read elsewhere, it's certainly not worse than previous incarnations. How the hell can it be? It's pretty thirsty if you red-line it all the time, but on a bike this quick that isn't necessary.

Anyway, that's the complete list of claims made by Kawasaki for their fuel injection and you can clearly argue two ways. One is to say that it doesn't add up to much. The other is to say that the injection system must be better, simply because it's more accurate and precise. Either way, you have to accept that fuel injection is the face of the future and it is here to stay. And first time out Kawasaki seem to have got it right.

In terms of the ride the engine gives, it's the pick up that really impresses. Open the throttle anywhere above 2000rpm and the abundance of torque (65.8ft/lb at 7000rpm) cuts in smoothly and quickly. There's little in the way of hesitation and there's no suggestion of load. The mill just churns out fluid power and keeps climbing. It does run lean around town. After only a short run the engine and plugs seemed dangerously hot. It can't be so however, since both exhausts were slightly wet inside the silencers and the right-hand pipe was inexplicably smoking on the overdrive and under hard acceleration.

But for the nice new head castings to house the injectors, the H mill is identical to the Mk11, except for an uprated alternator (up to 245 watts compared to 220), an increase necessitated by the increased electrical demand from the rubber mounted control box . . . air temperature, engine temperature, air flow rate, fuel flow rate, throttle valve position, degree of nozzle opening, pressure regulators, pumps, sensors, relays . . . all told there's one hell of a lot of electrical information flying around, all carried to a little hardware package with a preset programme developed to cope with ambient conditions. You can see most of The ▶

Business under the left-hand sidepanel which houses the line filter (transparent), the fuse box and a terrifying mass of snaky wiring.

The fuel injection helps the bike to a top speed of over 130mph and considerably boosts both low and mid range torque. It's fast everywhere. I found it better to use the higher gears around town because it's safer, more economic and because there's so much torque that you don't need to red-line it to extract muscle performance. Much of my reticence in really gassing it up however, stems from the dubious handling, more of which later. From the engine side of things it makes sense to feed the power in smoothly and quickly up through the gears and to make the motor really hum on the down-changes. you don't bugger around with 96bhp and 580lb of two-wheeled missile, except in dead straight lines on dead empty roads.

Apparently, the injection system as a whole weighs only 1½lb more than a bank of four 28mm Mikunis - so how come the wet weight for this bike is over 10lb up?

To conclude. The fuel injection does its job and it's got slight advantages over similar carbed models. Absolutely no complaints. Except one.

One of the injection principles employed by Kawasaki on this bike involves a pressure regulator which ensures that any excess fuel travelling along the high pressure fuel line to the injectors is returned to the tank. This has one wholly undesirable characteristic which surfaces every time the main tank runs out, and before you switch on to reserve. What happens after 100 miles or so is that you get an audible warning that the main three-gallon tank is about to run out. It sounds like a steel band playing inside the tank. Ping, pink, ping, pong, BOOM! In fact, it's the sound of air being pumped around the system by the fuel pump and being forced under pressure back into the tank where you, not unnaturally, get a series of small air pocket explosions.

The first time this occurred I wasn't at all clued-in to what was happening. Half a mile down the road, the engine stuttered and died. I pulled over, turned on the reserve flow, gassed it up a bit and hit the button. Nothing. Half an hour later it still wouldn't start, not on the button, not on the kick, not even after a bump. I suspected I'd somehow flooded it, but the plugs were dry and hot and the sparks were plentiful. It turned over, but it just wouldn't catch. The problem had to be some sort of air lock, since only after I'd disconnected the fuel lines betwixt and between the clear plastic bowl line filter, the fuel pump and the main tank, did it fire up again. It was annoying to say the least. Next time it went on to reserve, I still got the petrol/air/tank symphony, but no problem in immediately turning on the reserve supply.

Right, the deduction about induction is over, let's have a look at the rest of the bike. For the record, the only other non-cosmetic change between this bike and the Mk11 is the addition of a much needed quartz halogen headlight. The rolling chassis, the frame and the suspension, are identical, except that this time out it has to carry more weight. At nearly 580lb wet, the H is a big mother to hustle around. It feels heavy and it's worth being very smooth to get the best out of the strictly limited handling. Turn the power on in straight lines, pick the right line into every curve and you can go through smoothly (if a trifle slowly) and it all hangs together. You have to get it right and you have to be smooth because there's precious little room for error. Stuff it into a fast turn at speed and you're going to start thinking about P&M frames and alternative suspension.

An an exercise in discipline I spent two days really getting to learn the bike before exploring the power. It was a futile experiment. As soon as I became confident of exploiting the considerable power, the handling shattered my composure. The back wheel started sliding away from the perfect radial line all the time and under all conditions - with drive, without drive, in various gears, at various speeds. It felt like the wheel alignment was out. In fact, it was the tyres. The Dunlop Gold Seals are very sensitive to correct pressures and it's worth checking them at least twice a week and ensuring that the rear has a minimum of 32psi in it. They're also very twitchy over white lines and cat's eyes. The wise man will replace them as soon as money allows, since they effectively ruin the ride.

With the tyres so bad it's difficult to evaluate the suspension. Difficult, but not impossible. The non-adjustable spring/oil front forks bottom out pretty regularly. However, they're nowhere near as deficient as the rear springing where the spring rates seem way too light for the hefty job they have to do, and the damping is mushy. Pathetic really. Nearly every time I write a Japanese road test these days the back suspension seems to come in for exactly the same criticism.

Generally, the suspension is fine, but if you load it up and subject it to something other than around town conditions, it lets you down badly. For city streets, sweeping country lanes and almost everywhere, the suspension/frame is fine and the ride good. It's the one time when you encounter a really tight series of bends which have to be strung together that you suddenly realise it's not man enough for the job. I'm beginning to think that maybe our handling course is too tough for these bikes, but that's silly . . . if the Italian bikes can go round it without making the rider scare himself shitless, why can't the Japanese?

The spring preload on the rear shocks is five-way adjustable with no provision for adjustable damping. Position two or three was fine around town (as was the ride) but useless on the track. Bumping it up to maximum didn't help either. You could touch the pegs down on both sides, but there's always an awful feeling that it's going to let go and just slide away.

The brakes are up to Kawasaki's usual high standards. The back one's a bit fierce, so it's advisable to adjust the pedal height. There's also a strange pattering from the front wheel when braking from low speeds. From high speeds it's fine, but if you brake in a straight line from say, 40mph, the forks seem to pick up some sort of unsavoury resonance and the wheel patters. It's puzzling because it doesn't happen when you're driving hard.

It steers well enough and the fairly wide bars give an extremely light feel to the front wheel. The riding position is fine, upright and forward, and helps you cope with the mass of dead weight you have to persuade to go round corners.

The cosmetic side of things is mucho impressive. It all looks lower and narrower than before. The gold anodised wheels look just right, contrasting with the black forks and the narrow, elegant tank with its gold and white pinstriping, as well as the matt black engine. The best looking Z1000 ever? Yeah, I think so.

Whether you think the aesthetics plus the wonders of fuel injection are worth £350 more than the Mk11 though, will largely depend on your feelings for modern technology and micro computers. Some relevant points to consider: none of the technology impinges on the ride. During the whole test programme, apart from our one unusual problem with the reserve supply, nothing went wrong or ever showed any sign of being amiss. It ran smoothly and perfectly.

I liked the bike because it's fast and it's comfortable and it has an exemplary range of power. The fuel injection claims may not amount to much, but it is undoubtedly more efficient and it does add 3bhp to an engine which is, unbelievably, getting better all the time. It is a beautiful motor. I wish I could say the same about the chassis. It's well designed, but not practical for a bike of this weight.

Undoubtedly, fuel injection is the way of the future and will, in time, introduce a whole new breed of clean-breathing, fire-eating superbikes. Incredibly fast bikes with fuel-injected muscle. This is the first and it's heartening to see an engine as classically perfect as Kawasaki's Z1000 get a shot in the arm, and an injection of tomorrow's technology. The road to the future begins here.

Kawasaki Z1000 Fuel Injection
£2399

PERFORMANCE
Maximum Speed - 131.1mph
Standing Quarter Mile - 12.24 sec
Fuel Consumption - Hard Riding - 28.5mpg
Cruising - 45mpg
Best Full-Tank Range - 130 miles (see text)

ENGINE
Type - air-cooled, DOHC, four cylinder, four-stroke
Displacement - 1015cc
Power - 96bhp at 8000rpm
Torque - 65.8ft/lb at 7000rpm
Bore & Stroke - 70 x 66mm
Compression Ratio - 8.7:1
Induction - electronic fuel injection
Exhaust - four into two
Oil System - wet sump (3.7 litres)
Ignition - battery/coil (transistorised)

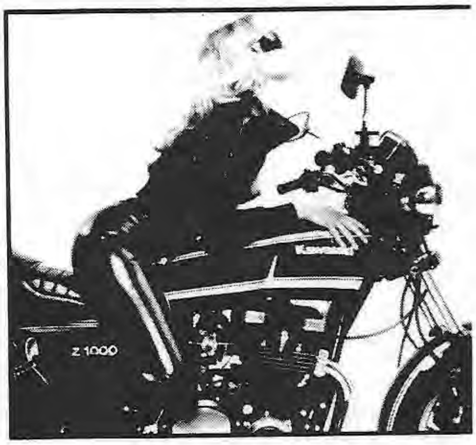
TRANSMISSION
Clutch - wet multiplate
Primary Drive - gear
Final Drive - chain

CHASSIS
Frame - duplex cradle
Front Suspension - telehydraulic forks
Rear Suspension - swing-arm/shox (five way adjustable sprin preload)
Wheelbase - 58.7in
Ground Clearance - 6in
Trail - 3.43in
Castor - 26 degrees
Seat Height - 32in
Weight (wet) - 574lb
Fuel Capacity - 3.81 gall
Tyres - Dunlop Gold Seals 3.25V x 19 (front) 4.00V x 18 (rear
Brakes - triple drilled discs (9.8in) with sintered pads

INSTRUMENTS
160mph speedo (dual rated); 11 000 rpm tachometer red-lined
8500rpm; neutral, high beam, oil pressure and indicator lights

EQUIPMENT
Electrical - 12V/14 a/h
Lighting - 60/55 (H4)

Test Bike Supplied by Kawasaki Motors (UK) Ltd, Deal Avenu
Trading Estate, Slough, Berks.




MLR
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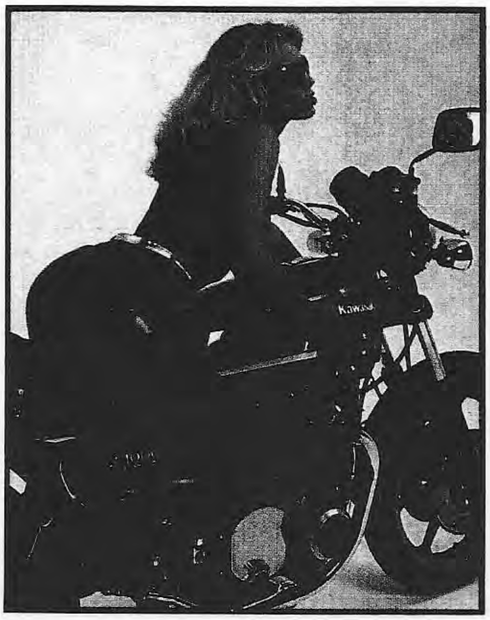
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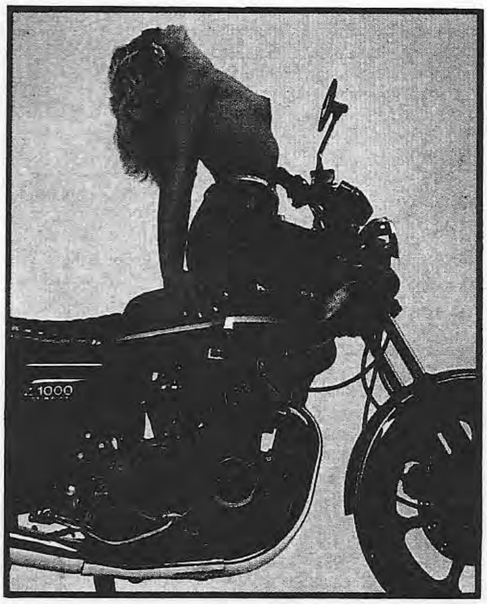
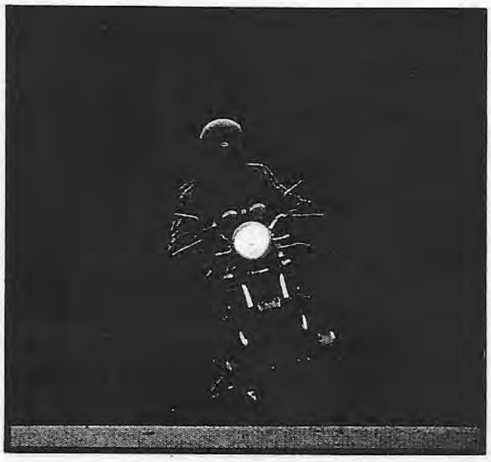

Z1000


Z 1000

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