CYCLE WORLD

ON YAMAHA Street Bikes

1970-1974



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XS-650 • RS-350 • 200-CS3B • CS5 • 100-LS2
RZ201 W'kel • TX500 & 750 • RD250A • RD350
TA125 Road Racer • RD350B • XS2 • XS650B

YAMAHA'S COUNTERBALANCED, DISC-BRAKED, DOUBLE OVERHEAD CAM, TWO-CYLINDER AND (AHA!!) SOMEWHAT SELF-DIAGNOSTIC MOTORCYCLE

RIDING AN INNOVATIVE PROTOTYPE

BY DAN HUNT

IT MAY SEEM curious that Yamaha is spending money developing yet another four-stroke Twin, when the whole world is going to multis.

On the other hand, Yamaha may be smart and we don't know it. After all, the big Twin, by which I mean any vertical Twin of 650 to 750cc displacement, is a popular size and shape of bike. Not too large for a hop up the block. Not so small that it can't smoke off anything on up to about a small-block Corvette, costing four times as much money.

With the new TX750, Yamaha seems to have rethought the whole idea of what the Big Twin is supposed to be. Fiddling around with public preconceptions must make that company more than a little nervous.

A ride on the bike tells you that Yamaha is only incidentally pitting this Twin against other Twins—like Bonnevilles, Commandos, Lightnings and dohc 450s. The TX750's real goal is a flanking assault on the expensive segment of the multi-cylinder which, of course, includes Honda's 500 and 750 Fours, Kawasaki's 750 Three, the British Triples, and Suzuki's big waterpumper.

The idea of anyone competing against the big multis with a Twin may seem preposterous. Unless you can make the Twin as good as or almost as good as the multis and offer it for less

IS THIS THE BIRTH OF COMPUTERIZED SERVICING?

WOULD YOU BE more likely to buy a motorcycle if it could tell you in a few seconds what it was that ailed it? Yamaha is betting that you will, and has made the opening move with a diagnostic panel on its prototype TX750. If the consumer and the rest of the industry responds positively, a new era will be upon us.

"Diagnostics" is not entirely new. Volkswagen owners are getting acquainted with a system which yields an instantaneous reading of the several points in the automobile. This system is basically oriented to the service technician, who plugs a lead from an expensive computer console into a multi-pronged receptacle in the automobile engine compartment.

After going through a prescribed testing routine, the technician has secured readouts for 15 or 16 conditions—i.e., battery voltage under various loads, operation of all lights, engine compression, condition of the ignition system, alternator charging, and front end alignment.

While VW's system only probes the surface of the automobile's condition, the hook-up between car and computer provides for about 150 different pieces of information. If

money. For the multi class, what is good is "smooth." And you know that typical vertical Twins are inherently not smooth. They vibrate, either because of primary imbalance created as the pistons churn up-and-down in unison, or because of eccentric vibration patterns created by 180-degree crankshaft layouts.

Many ways have been contrived to civilize the Twin. BMW succeeded in fair fashion by opposing cylinders horizontally and tolerating a small amount of rocking couple and throttle-induced torque reaction. Harley-Davidson went to a 45-degree V pattern and didn't succeed at all. Moto Guzzi and Ducati have chosen the 90-degree V, which is better but by no means perfect, due to a strong horizontal force vector.

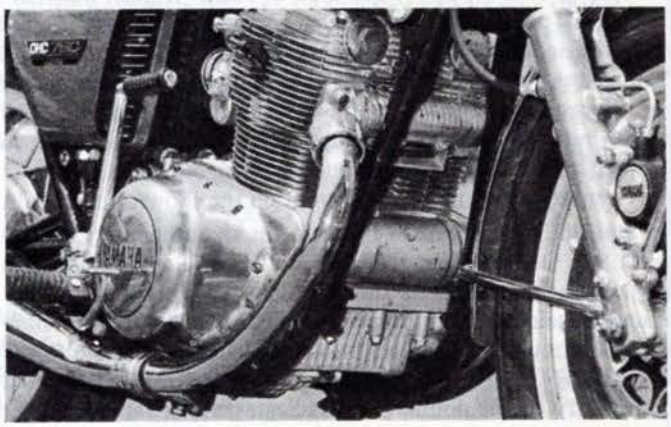
Now it appears that Yamaha has made the whole thing academic by using the vertical Twin configuration with a new twist. Counterbalancing.

In principle, it's a simple measure. Yamaha uses chain-driven internal bobweights which counter the primary imbalances created by the vertical Twin arrangement. The bobweights, being off-center, swing in opposition to the pistons, etc.

The result is smoothness beyond belief. Shut your eyes and you are on a Four. It couldn't be a Twin. The engine doesn't lope or rock the bike at idle. The handlebars don't feel like they're carrying live house current when you're pushing along at 5000 rpm. The image in the rear view mirror doesn't fragment into myriad circular patterns when you crank the TX up to the 7000 rpm redline when running through the gears.

To shatter the bubbles a bit, it should be noted that Yamaha doesn't come by that smoothness without paying for it. Bobweights are exactly what they say they are—weights.>





Yamaha's method of incorporating exhaust crosstube into a bolt-on "manifold" eliminates possible cracking, blueing of joints. Clever idea.

these possible readouts are intelligently exploited, the advantages in terms of time saved and increased objectivity and accuracy of diagnosis are great. The diagnostician hands you the readout sheet and it's up to you *what* points you fix and *where* you'll have it fixed.

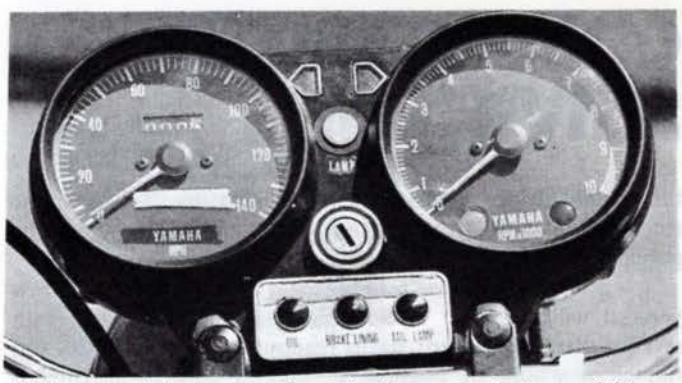
Yamaha's system is hardly a system at this stage. It is a promise. A challenge to the motorcycle industry. An invitation to a dialogue of oneupmanship.

As such, it is a consumer-oriented system in its present form. Out there, below the speedometer, you may read three gauges that tell you a) your oil pressure, b) rear brake lining condition and c) taillight operation.

Oil pressure is no big deal, but in the context of the other two lights, is most definitely a diagnostic light, rather than one that indicates transient condition. The taillight indicator is not a strikingly difficult one to devise—you merely wire the indicator lamp in series with the tail lamp—and you can take it or leave it (you'll probably leave it if you find looking over your shoulder a less costly alternative).

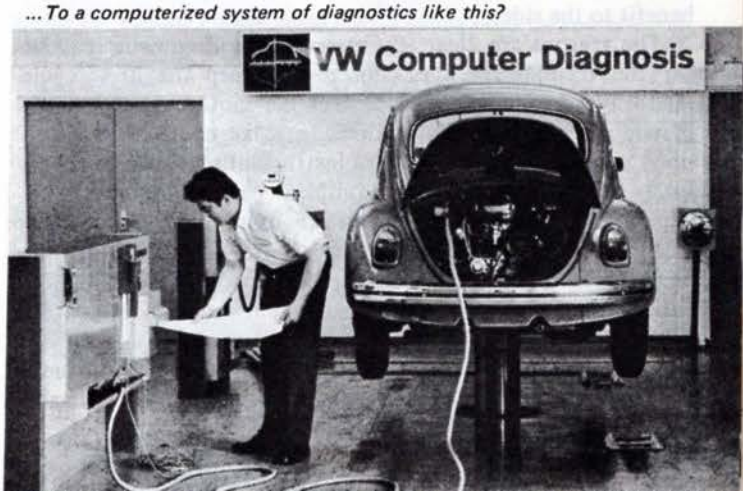
The clincher though is the brake lining indicator light which comes on when the lining gets low. Here, for the first time in motorcycling history, the rider is given instant and specific warning of the impending failure of an important component *before* the failure occurs.

It is common knowledge that a worn rear brake lining is not dangerous (in that the front brake does most of the work), and so you may wonder why Yamaha goes to the trouble. In one way, it is the typical sales gimmick. Another blinking gew-gaw to woo a fickle buying public. But in the long-term view of



Will motorcycle instrumentation evolve from a simple cluster of lights...

...To a computerized system of diagnostics like this?



INNOVATIVE PROTOTYPE

The TX's curb weight is 520 lb., which is even more than the Honda 750 Four (500 lb.) and only a few pounds less than the Suzuki Watercooled 750 (524 lb.).

The extra weight will tend to inhibit the performance of the TX750, which doesn't have as impressive a power-to-weight ratio as its predecessor, the SX-2. To compensate for this, Yamaha is playing with lower gearing than normal. Taking 7000 rpm as the upper limit, the particular machine we rode was geared for about 101 mph in 5th.

On the usual Twin, this high revving could create a great deal of discomfort at highway speeds, yet the counterbalanced Yamaha can get by quite nicely because the comfort factor isn't dependent on the rpm at which the engine is turning. The overall ratios for public consumption have yet to be chosen, so keep in mind that the ones published in our data panel are only tentative and may be different on the showroom models.

Yamaha hopes to cash in with this smooth, heavy motorcycle by underselling the big multis, and offering a less bothersome package. As the bike is a Twin, it is somewhat easier to maintain than a Three or a Four. The TX750 has only two carburetors to balance, two spark plugs, two pistons and two sets of rings, fewer bearing surfaces, etc. The added complexity of the double overhead camshaft or the bobweight system will be a minor factor in respect to maintenance.

While Yamaha would have preferred to drive the double bobweights by gear, to avoid the adjustment schedule of chain drive, they found the gears too noisy in earlier prototypes. Switching to chain drive silenced the machine, from which emanates now the sporting sounds of whirring and clicking camshafts, noticeable but pleasant.

Yamaha's disc-brake system features double-acting caliper arrangement, and an additional disc may be easily fitted on the other fork.



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things, that little gimmick is also a market test. To get public reaction you have to put it out on the handlebars where the public can see it.

Ironically, if the brake lining light is successful, in a few years it will disappear into a black box under the seat with several other component status readout junctions. Why? Even though it would be possible to build a 20-item instrument panel on the motorcycle, it would be costly and of dubious benefit to the rider.

The reasons are clear. By reserving the diagnostic readout for the technician's eyes alone, you keep the motorcycle relatively simple. You also protect the motorcycle from the individual who is overly anxious to make conclusions based upon a complex combination of instrument readouts. And you lower manufacturing cost; complex panels, besides being expensive in themselves, also have extra power and space requirements. By instead offering a junction box which may be joined with an external diagnostic console, you externalize the extra power supply and component needs. The console provides its own power for the tests to be made.

It is amazing how much information may be culled from a mechanical entity by relatively simple means. The Yamaha brake lining light, for example, consists of a wire running to a contact fixed near the brake shoe actuating cam. When the lining wears down, the cam turns far enough to make electrical contact. The motorcycle frame is used as electrical ground so only one wire is needed to reach the sensor.

The brake lining readout is what may be termed a "yes or no" situation. Yes, the lining is good. No, the lining is not good. Any situation like this offers an extremely simple situation for computer analysis.

If and when Yamaha or other manufacturers get to the external console stage, however, they will want to take more complex measurements. For example, cylinder pressure without the engine firing is one example of a measurement that defies simple "good" or "not good" diagnosis. It is rather an acceptable *range* of cylinder pressure which must be subjectively interpreted before you can flatly declare that the patient needs a valve job.

If you hand test a cylinder, you are in effect taking an analog, or progressively quantitative, reading which is not diagnostic in itself. You are functioning as part of the instrument to make the diagnosis. Your mind is programmed by the shop manual. It tells you that the reading will be 125 to 150 psi. Below 125 psi, something's really wrong. Readout: valve job.

If, instead, you mechanize this whole process, you must invent a diagnostic instrument which works essentially as a simple computer. The sensor gives a continuous reading along the scale from 125 to 150 psi. An electronic device known as a

YAMAHA TX750

SPECIFICATIONS

List price	N.A.
Suspension, front	telescopic fork
Suspension, rear	swinging arm
Tire, front	3.50-19
Tire, rear	4.00-18
Brake, front, diameter, width, in.	11.5, 1.75
Engine, type	dohc vertical Twin
Bore x stroke, in., mm	3.15 x 2.91, 80 x 74
Piston displacement, cu. in., cc	45.4, 743
Compression ratio	8.4:1
Claimed bhp @ rpm	63 @ 6500
Claimed torque @ rpm, lb.-ft.,	50.0
Carburetion	(2) 30mm Solex Mikuni
Ignition	battery, coil
Oil system	wet sump
Oil capacity, pt.	6.3
Fuel capacity, U.S. gal.	3.5
Recommended fuel	regular/premium
Starting system	electric, kick
Lighting system	12V alternator
Air filtration	fiber screen
Clutch	multi-disc, wet
Final drive	single-row chain
Gear ratios, overall:1	
5th	5.28
4th	6.05
3rd	7.18
2nd	8.58
1st	13.59
Wheelbase, in.	57.5
Seat height, in.	31.7
Seat width, in.	11.5
Handlebar width, in.	30.0
Footpeg height, in.	13.0
Ground clearance, in.	6.0 (at side stand)
Curb weight (w/half-tank fuel), lb.	520
Weight bias, front/rear, percent	45.5/54.5
Test weight (fuel and rider), lb.	680
Computed top speed in gears (@ 7000 rpm), mph:	
5th	101
4th	87
3rd	74
2nd	62
1st	39
Mph/1000 rpm, top gear	14.4
Engine revolutions/mile, top gear	4165
Piston speed (@ 7000 rpm), ft./min.	3393
Lb./hp with (160 lb. rider)	10.8

comparator converts the reading to a piece or "bit" of warning information only if the psi drops below the lower acceptable limit. Readout: valve job. If no readout at all: wait and we'll run it through the machine again at the next maintenance period.

In eliminating the progressive reading, you preclude the astute borderline diagnoses possible for a clever mechanic. However, it is debatable how useful a clever mechanic is. If he tells you that your cylinder pressure was 127 psi and although the bike is running okay now, you'll need a valve job in 3000 miles, is he really telling you anything you are going to act upon? I doubt it, unless of course you are an absolute perfectionist. Like most people, you'll let it slide for several weeks until you absolutely need it.

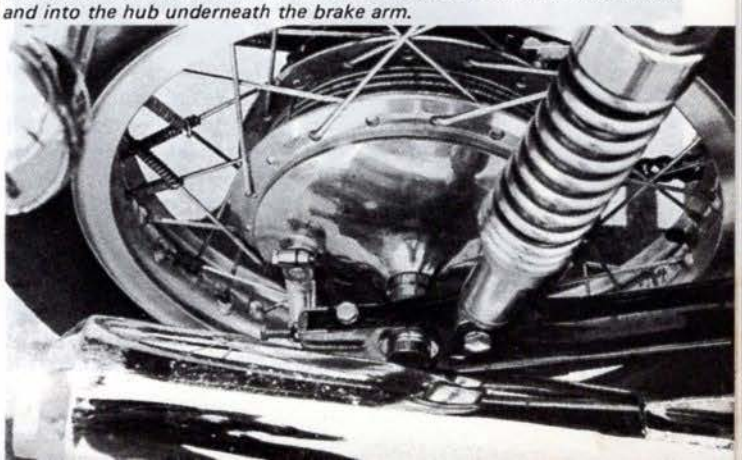
Much better for most people that they receive a cut and dried absolutist shmear from a computer for a ten-dollar bill than a terse, secretive check from a disinterested tune-up man at two or three times the price.

Indeed, when the inputs to the computer console reach a certain number, the console may be programmed to deliver quite sophisticated gradations of advice to the machine owner. For instance, combine comparator interpretations of dwell angle, plug voltage and fuel mixture to deduce the extent and cost of a proposed tune-up.

The major expense to the consumer is the inclusion of all these sensing devices on the motorcycle. Whether or not it is worthwhile depends on several things: Cost of installation versus cost of the machine to be sold. Type of machine: Is it



Wiring for Yamaha's brake lining light is strung along the swinging arm and into the hub underneath the brake arm.



INNOVATIVE PROTOTYPE

The TX750 handles quite well for a machine of its weight. The frame is based on the excellent double cradle frame that houses Yamaha's two-stroke 350 roadster and helps make it one of the best handling bikes you can buy. But even with the excellent frame, Yamaha must design excellent suspension to overcome the heavings created by 520 lb.

At the front end, they've done quite well with a set of double damping forks styled in the Ceriani tradition. At the rear, the rebound damping is inadequate and thus you feel slight amounts of unexpected wiggling over rough surfaces.

There is a trace of designed-in tendency to straighten when the bike is pitched hard into a short radius turn. It can be overcome well enough to move the bike around fast, and is not as noticeable in high-speed bends. It remains there as a safety factor for the novice rider—to prevent him from destroying a fifteen hundred dollar investment while rounding a 30 mph corner on the way to the drugstore. Some people won't like this trait completely, but they only have to tolerate it at up to 40 mph or so.

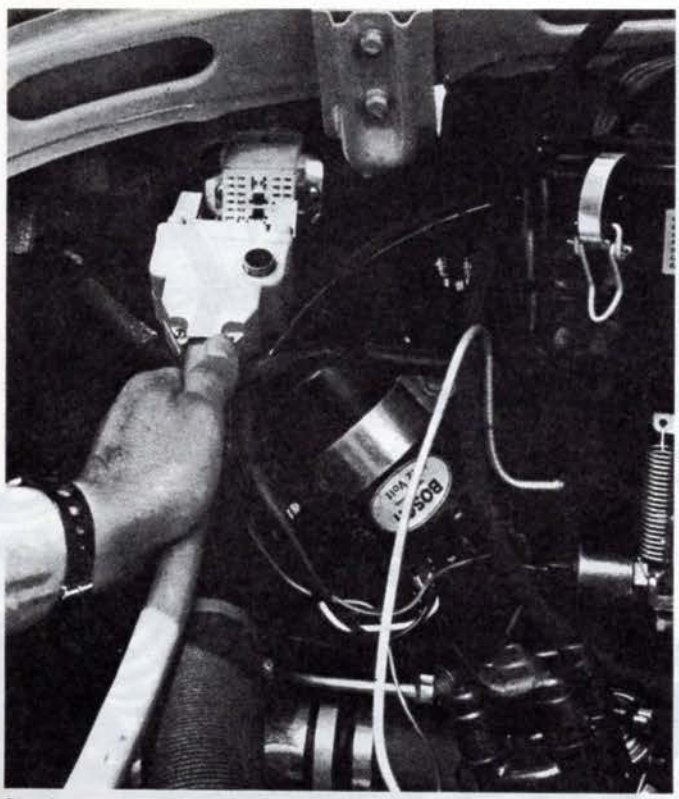
The hydraulically actuated front disc brake is an absolute necessity on this machine and seems reasonably adequate for the 750's weight and its intended usage. Its pads are double acting, which allows more rigid mounting of the calipers. In a single-caliper disc brake assembly, the mounting arm must have a certain amount of give to allow the stationary brake puck to center itself with the rotation of the disc.

A double-acting puck system, being self-centering with a rigid mounting, helps prevent either puck from dragging on the disc and reduces feedback of any distortions or flaws in the disc itself. In certain instances, it may dampen all or part of the high frequency oscillations that cause disc brakes to squeal.

Yamaha apparently thinks that some TX750 riders will want even more brake than the present set-up provides, as the left fork leg has been provided with all the necessary protrusions and holes to mount a mirror image of the brake already there. So if you want the feeling that the hand of God has reached out to pull you down almost instantaneously, Yamaha has left you the option.

While all these mechanical niceties are appealing, and make for a fine machine for touring or freeway commuting, the most devastating innovation on Yamaha's new bike may have to do with the little three-light idiot panel you can see next to the handlebars. It may seem like a gimmick, this panel which tells you about your oil pressure, taillight and brake lining condition, but it isn't.

In effect, that panel opens a new era in motorcycling—the era of diagnostics. Much has been said about this new vehicular science, which promises a quick way to diagnose the source of many actual or potential mechanical ills. In a way, it is much more earthshaking than the fact that Yamaha has finally civilized the vertical Twin, so Yamaha's "diagnostic panel" receives full treatment in the adjoining article.



Plug-in terminal for VW's system handles 150 bits of information, but is small enough for motorcycle application.

COMPUTERIZED SERVICING?

the sort of bike that is primarily owner-maintained? Number of miles that a machine like this is ridden: If the annual mileage figure is low, then there is not much value in an electric sensor readout for long-term maintenance items.

The choice of items to be measured must be made carefully. Furthermore, it is extremely important that there be a consensus among manufacturers on what constitutes a proper plug-in diagnostic system. Having each manufacturer develop his own system with total disregard for the others is to invite chaos in the service industry and resentment at both the rider and dealer level.

The introduction of the VW system to the automobile world has posed the same problem, which was the subject of a recent national meeting of engineers and government agency people in San Francisco. By encouraging a cross-breeding and exchange of ideas the government hopes to extract the maximum possible benefit from this new science.

The benefit is there, to be sure, for all you have to do is figure how much labor it would cost you to have a Yamaha mechanic dismount your rear wheel and check the brake lining. The labor charge would just about cover the cost of materials used for Yamaha's new sensor.

To me, that's progress.



5	Yamaha XS650 Road Test	*Cycle World*	March	1970
11	Yamaha R5 350 Road Test	*Cycle World*	June	1970
15	Yamaha 200 CS3B Road Test	*Cycle World*	June	1971
19	Yamaha XS2 Road Test	*Cycle World*	Nov.	1971
23	Yamaha 200CS5 and 100LS2 Road Test	*Cycle World*	April	1972
26	Yamaha TX750	*Cycle World*	Oct.	1972
31	Yamaha TX750 Road Test	*Cycle World*	Dec.	1972
36	Yamaha RD350 Road Test	*Cycle World*	Feb.	1973
40	Yamaha RZ201 Wankel	*Cycle World*	Feb.	1973
42	A Different Approach	*Cycle World*	May	1973
45	Yamaha TX500 Road Test	*Cycle World*	Sept.	1973
50	Yamaha Street and Trail Minis Road Test	*Cycle World*	Sept.	1973
54	Yamaha RD250A Road Test	*Cycle World*	Dec.	1973
58	Yamaha TA125 Road Racer	*Cycle World*	March	1974
62	An Over-the-Counter Cafe Racer	*Cycle World*	June	1974
64	Yamaha RD350B Road Test	*Cycle World*	Nov.	1974
69	Yamaha RD350: A Step Further	*Cycle World*	Nov.	1974
76	Yamaha XS650B Road Test	*Cycle World*	Dec.	1974



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