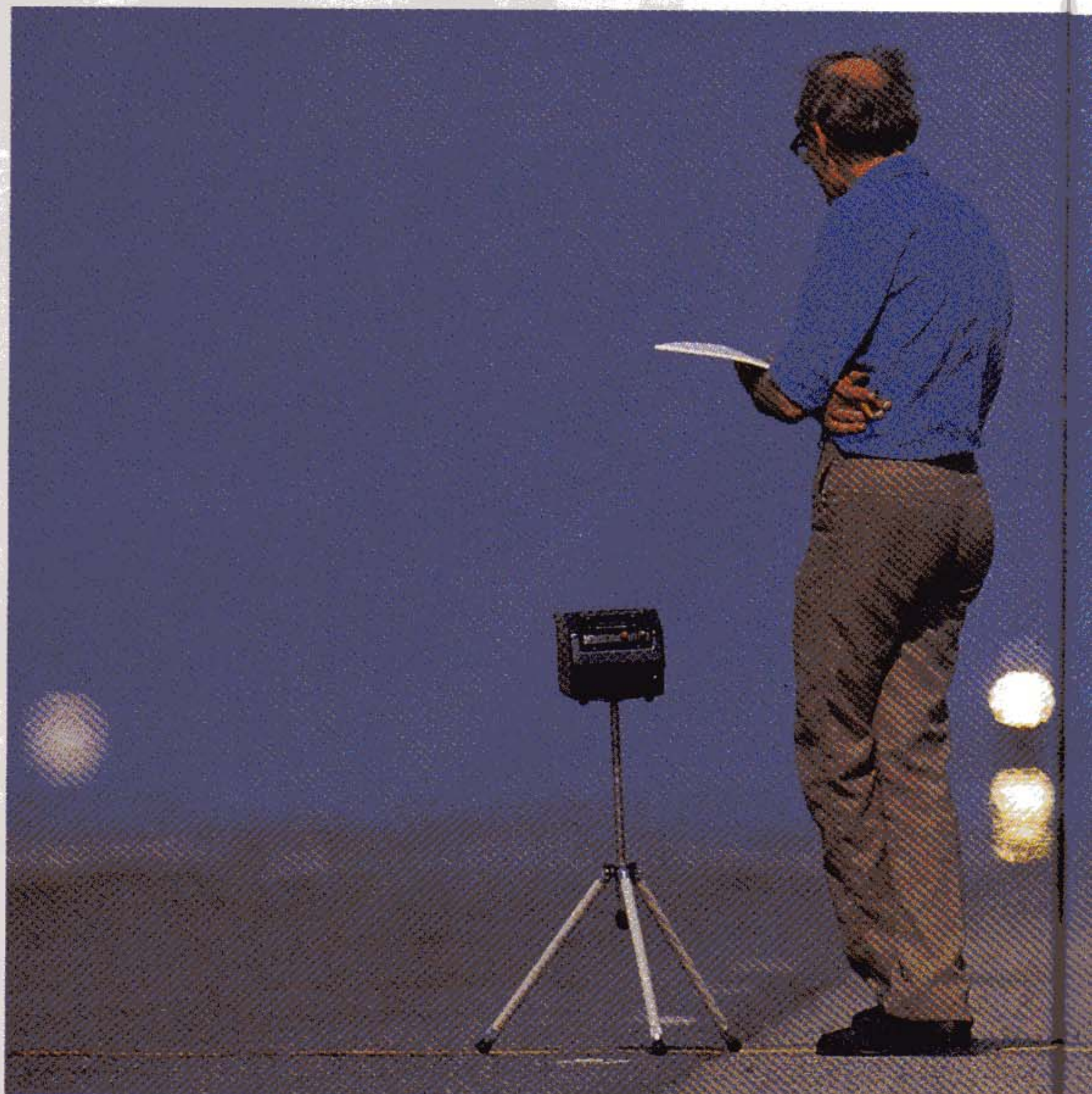
POWER UP

Race kits show the way that factories go about tuning their engines. But even they can't escape from the fact that you need ever more power for smaller and smaller increases in speed. Or can they? Is the air box about to be officially reinstated?



Once upon a time, if a factory had a half-decent bike they would tune it and go racing with it. If it was successful, they would develop it some more and maybe make some of the parts available to private racers. Sometimes they would build whole replicas of the previous year's works bikes.

Now there is a tendency to build a full racer and then offer a detuned and civilized version as an (expensive) accompanying road bike. Plus the inevitable race kit to take it back to where it came from.

The RC30 was the first. Ducati's 888 is, so far, the most expensive. The Yamaha OW01 is somewhere in between.

You could argue that the base engines from all three machines came from roadster designs, but the concept of the whole bike is racer. They didn't take a road bike and convert it into a racer, they designed a racer and used a few convenient items from the roadster range.

The way factories tune engines is very different to what an individual can do. An individual can improve existing parts, to make them lighter, to flow more air, to burn the fuel efficiently. The factory can do this but they can also change materials, alter castings and so on. If you already have the patterns it is relatively easy to make small alterations, or to obtain something like pistons before they have been machined, or to change the material specification.

But do they run any better? You'd expect them to, because anything an individual tuner can do can be done at the factory anyway. The factory is made up of individuals and some of them know about engines. In fact, the bikes are not as fast as you might expect. The power delivery is less peaky and there is a wide power band (even though they are able to make different gear ratios to suit the engine characteristics). The bikes we looked at ran as if they had been tuned with much restraint, by a very responsible sort of person.

YAMAHA 0W01

Based on the sloping block, five-valve FZ? Well, sort of, except that the bore and stroke are different and the block slopes at a different angle, but yes, the motor can trace its ancestry back via the '88 YZF750 racer to the original roadster.

Steve Parrish brought a couple of the Loctite Mitsui machines — the standard one scheduled for Geoff Johnson to ride at the TT, known as the

The fully-kitted OW01 is not so far removed from the road bike, but finding that extra 12mph takes a lot of horsepower.

road bike, and the kitted version on which Terry Rymer finished second at Donington — which we ran on the dyno and speed tested at Bruntingthorpe.

Originally the road bike was jetted very lean and needed to be richened up considerably before it produced 109bhp. It peaked at 12,600rpm and gave peak torque at 9,000. The kitted engine gave more everywhere; maximum power of 129bhp happened at 12,000 while peak torque was virtually constant between 9,000 and 11,000rpm.

The road bike managed 157.5mph and the racer reached 169mph with absolutely no wind assistance.

So how do these bikes vary from the 90-horsepower, 150mph basic FZ? And is it possible to encourage this sort of output from an FZ? The answer to the second question is Yes; the fastest four-stroke at the NW200 was Steve Linsdell's FZ which hit 172mph.

The OW01 motor is even more over-square than the RC30. It measures at 72 x 46 and the main reason for this was to reduce the inertia loadings at high speed. Although peak power was at 12,600 on the road bike and at a lower speed on the race engine, the rev limiter is set at 13,800rpm. This, and the way Steve Linsdell got the extra top end on his 750, suggests there is some extra to come . . . but more of that later.

Engine stresses were obviously an important factor. Yamaha use forged, two-ring pistons and titanium alloy rods (which you would expect to be about 15% lighter, significantly stronger and about six times the price of steel). Ironically most of the failures so far have involved the connecting rods. Whether this is a design, material or manufacturing fault, or whether it is due to incorrect assembly or over-revving (rev limiters do not prevent riders shifting down too early) nobody has yet said. However it is a problem of some concern; the solution doesn't seem to be known at this point — late May — and the possibility of a rod failing at the TT and depositing a sump-full of oil to mark the spot is not a pleasant prospect. The factory are working flat out and may come up with a solution before the TT. They are happy with the standard bikes but as an interim measure they recommend that the mileage/running time on the kitted bikes is monitored and the rods be replaced at a given interval. Obviously the kitted bikes will have new rods before the TT — unless the factory find a better answer first.

As well as the usual procedures for matching and fitting

The Honda race kit is pretty extensive and includes a lot of cycle parts as well as the necessary engine bits. This kit was supplied by Padgetts and doesn't include the optional, short swing arm.

Padgetts also supply the race kit for the OW01 — in essence, all it contains is the noisy tail pipe and the carb kit but you can have refinements like oversize pistons if you really must.

con-rods, titanium alloy needs a couple of extra measures. It galls easily when the bolts are tightened, so washers must be fitted under the nuts and the surface lubricated with molybdenum grease. After heat treatment the rods are usually shot peened to compress the surface layer, removing imperfections and improving the fatigue strength. The hardened surfaces, round the big- and small-end eyes may also be PTFE coated. Subsequent scratches or surface damage may lead to galling and seizure, or may reduce the rod's endurance limit.

As the assembly is critical, Yamaha recommend measuring bolt stretch instead of tightening torque (not uncommon practice on racing engines). The bolts are tightened until they have stretched by $170\mu \pm 25\mu$ (μ – micron or micro-metre — is one-millionth of a metre or one-thousandth of a millimetre).

The two-ring pistons bring the compression to about 12.5:1 but it is up to the engine builder to match the head volumes, get the deck heights level and to adjust the squish clearance — the factory leave a fairly generous clearance and make no recommendation. They do advise a minimum amount of hand grinding in the ports, to remove the steps and bumps rather than change the shape.

The bigger bore (compared to last year) leaves room for bigger valves and there is an oversized piston set, out to the full 72.35mm for those who want the last cubic millimetre. Piston service life is 3,000km.

The race kit includes a silencer, carb bellmouths and a jet kit, racing ignition system, a small diameter alternator for endurance machines, and racing grade spark plugs — NGK R217-9, 10, 11 or 12.

The valve clearances are opened up, where you or I would put washers under the clutch springs the factory make stronger springs and, apart from altering the gearing, that's about it.

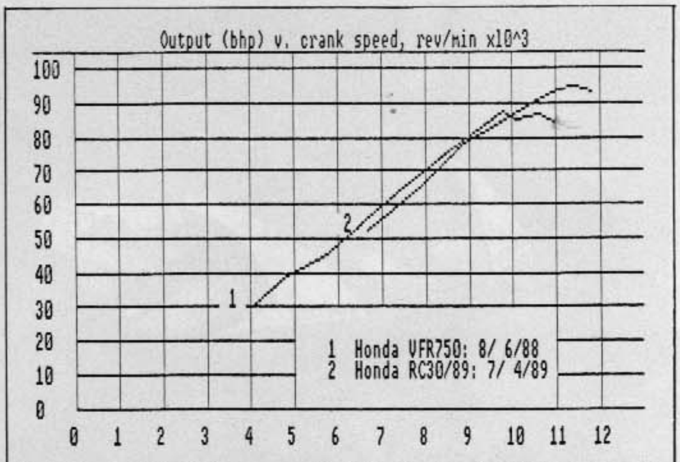
The carb kit is interesting. They supply bigger needle jets and different needles and leave the choice of main jet up to the owner. On the dyno, the vacuum pistons were fully lifted at just over 10,000 above which point the engine ran progressively weaker. Using bigger main jets didn't make enough difference but did make it go over-rich at lower speeds.

The only way LEDAR could persuade more fuel to flow at high rpm was to make some different needle jets, with a screen at the top to increase the depression on the jet. This was the set-up which gave 129bhp.

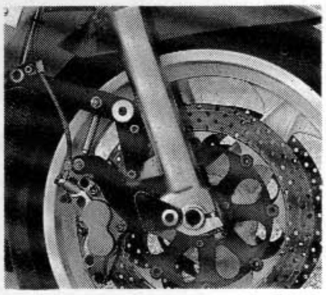
What wasn't known at the time was whether the air flow increased when the bike was in motion and whether this affected the mixture strength. If more air goes into the engine it naturally tends to weaken the mixture; but if it travels faster through the carburettor it will draw off more fuel, tending to richen the mixture; and if the float bowl is vented to higher (or lower) pressure it will supply more (or less) fuel. So, high-speed air being rammed into the intake scoops could make the mixture go rich or go lean depending on what happens inside the carburettors.

We fitted some manometers — U-tubes — and some pitot-static tubes made by Airflow Developments Limited, in High Wycombe. On the road bike the under-tank pressure rose by 8 inches of water when it was travelling at 130mph — enough to alter the power by only 2%, but certainly enough to affect the carburation. Yamaha have fitted a foam rubber dam to prevent this pressure rise getting to the airbox intake. Ironically it built up the same pressure when the air scoops were blanked off. On the road bike they are purely cosmetic.

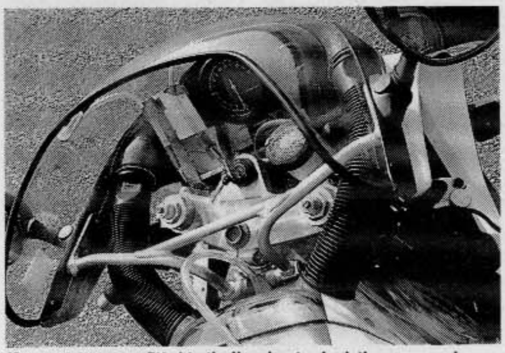
The racer, which is completely open around the carbs and has a rubber heat shield between the engine and the carb compartment, also built up a 3-inch head of pressure.



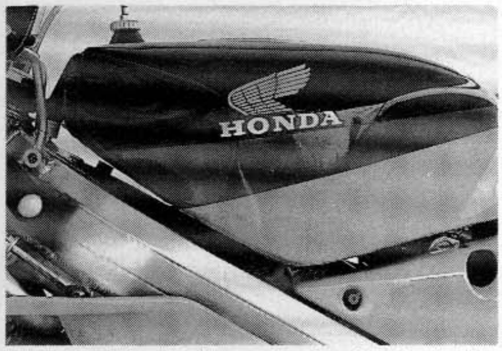
The RC30 motor is to all intents a conventionally tuned version of a VFR750. More top-end traded for a small loss in the middle. The race kit takes this a substantial step further, up to 116bhp with the exhaust and carb kit, up to 120 with the cams and things.



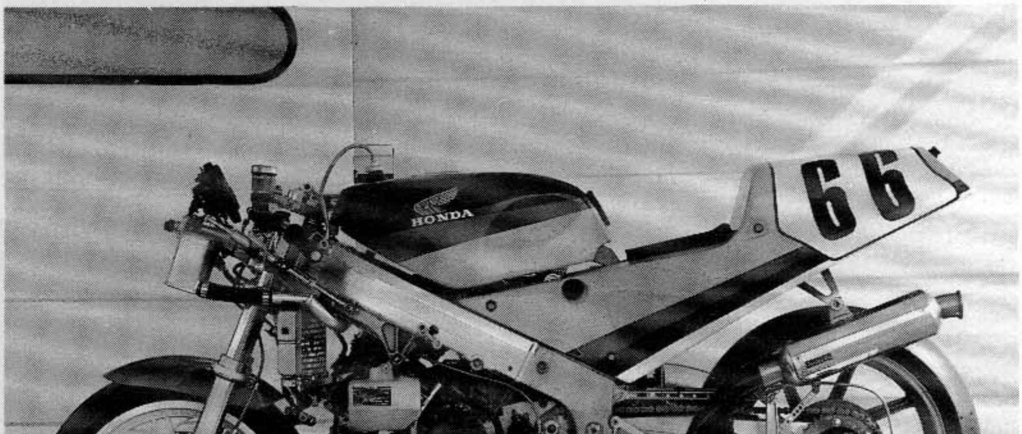
Ron Williams at Maxton set up the RC30's suspension with one of his rear Konis, some re-valved forks and this mechanical anti-dive.



Manonometers were fitted to the Yamahas to check the pressure changes near the carbs at various speeds. An air box designed to pick up the full pressure could be worth 10bhp.



The tank is jacked up to make more room above the intakes (and less room for the rider to get behind the screen . . .)



Charlie Corner's immaculately-prepared Honda shows just how compact the RC design is. With so many radiators and so little space, it is hard to get cool air anywhere near the carburettor intakes.

Steve Parrish was currently waiting for a trick, carbon fibre airbox to arrive from the factory. This encloses the carburettors and can presumably make full use of any ram induction available. Meanwhile, Steve Lindsell runs an ordinary FZ which is conventionally tuned to F1 spec. Steve has an air flow rig and makes good use of it but his motor was still some 10bhp down on the kitted OW01. He has, however, built his own air box, encasing the carburettors and picking up so much pressure that it blew the liquid right out of a 10-inch manometer. That was the machine which reached 172mph.

So after years of removing air boxes, can we predict a total reversal, a trend to even bigger air boxes? LEDAR are already working on a system to measure the pressure head at the track and then simulate it in the test house using a compressor and an intercooler.

HONDA RC30

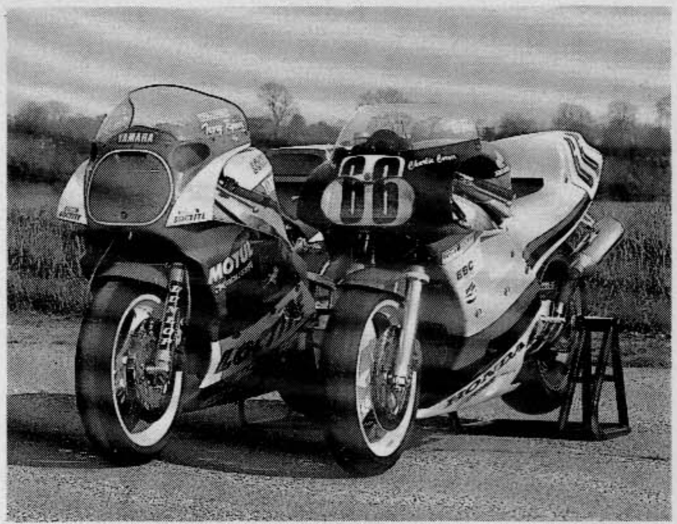
When we asked Honda UK where we could find a nice, factory kitted RC, the immediate reply was, "try Charlie Corner". His bike not only has all the recommended bits, he also runs one of the most professional teams we've ever seen.

Charlie managed to call in at the test track, practically on his way back from Mettet, and run the RC through the radar. His best run was 165mph, which was about peak revs on the same gearing he'd used at Mettet.

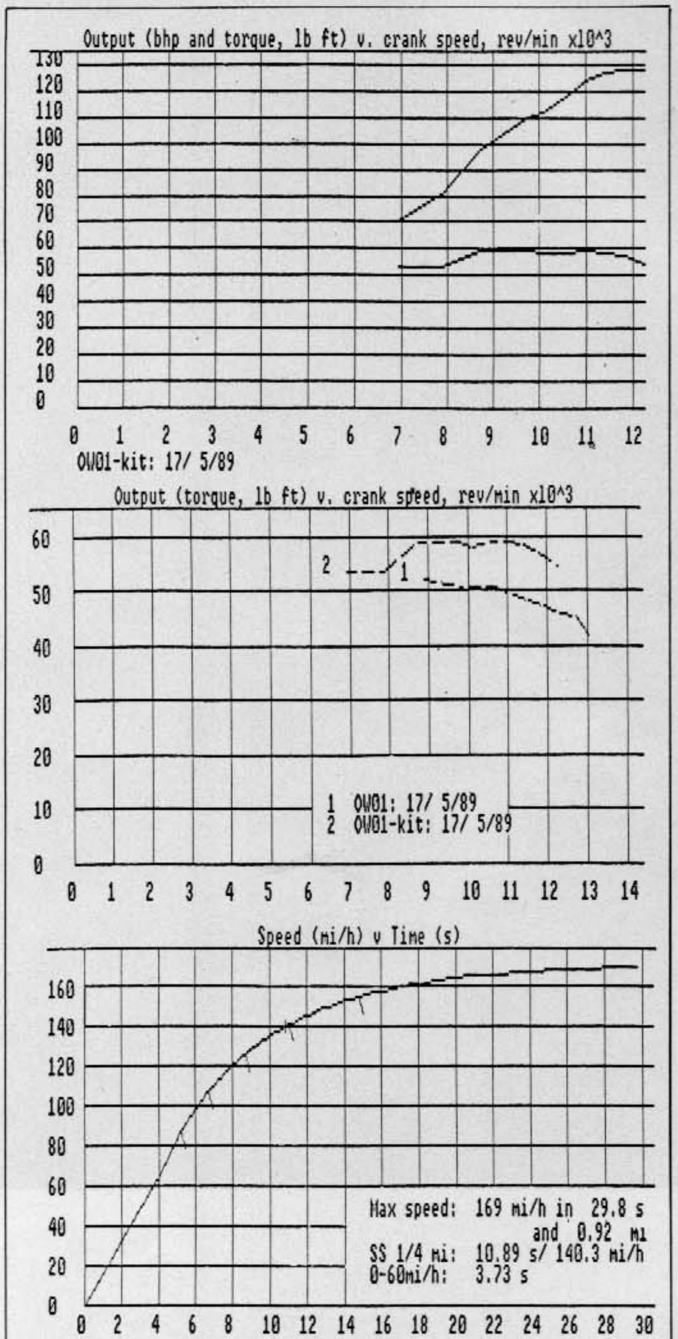
The 70 x 48.6 RC motor, based on the VFR and the racing RVF, has a much more extensive race kit than the Yamaha. Pistons, valves, cams, carburettors and exhaust form the bulk of the engine tuning — on an engine which is already a tuned version of the VFR, as the power curves for the standard models show.

The pistons — with a life of 5,000km — are available in a 70.4mm oversize. Honda's race cam has 20° more duration on the intake and exhaust than the VFR roadster and the valve clearances are opened right up to 0.2mm intake and 0.3mm exhaust. Honda recommend a certain amount of port reworking — mainly removing steps in the port and re-shaping the valve guide bosses. They warn that it is easier to lose power than to gain it if too much metal is removed, particularly near the valve seats.

From there on the engine build is the usual matching of pistons and rods (Honda also use titanium alloy rods with coated big end eyes; removal of the coating can lead to big end



The RC is smaller than the Yamaha but its front is full of holes and coolers and it makes more rider stick out into the breeze.



The OW01 gives a lot of power as stock, enough to reach 157mph but it is flexible, with peak torque at 9,000rpm. The race kit keeps this flexibility — see the flat torque curve — even though it shifts peak power up to 129bhp. The computer-predicted 169mph was what the bike actually managed.

seizure because the titanium will not stand any amount of rubbing) and the adjustment of piston clearances, deck height and squish band, all in the hands of the engine builder.

Charlie Corner uses Tony Scott engines with valves from Dave Parkinson. Non-Honda parts include the Micron exhaust, Dyna rev limiter and Ron Williams suspension — modified Koni rear strut and re-valved forks with, as an experiment, one of Ron's mechanical anti-dive linkages.

The carbs and jet kit are one matter. Getting air to flow to them on the RC is a different thing altogether. Hidden inside the compact V motor, a heat shield is essential and many racers, like Charlie, jack the tank up to leave more room. This makes it hard to get behind the screen, especially with the 24-litre tank modification.

This doesn't help aerodynamics, and neither does the front of the bike. The Honda is smaller in all directions than the Yamaha but its front is a mess of radiators and matching holes in the fairing which must have the same C_d as a combine harvester. Any air which gets through as far as the carbs will have been thoroughly heated by the various oil and water coolers.

Honda partly acknowledge this. They are producing a flat sheet to form a smooth underside to the bottom yoke (high tech note: the Honda Dominator trail bike already has one!) and suggest hammering a 10mm dent in the top of the upper radiator to allow a greater passage for air flow.

There is naturally a lot more work on cycle parts, suspension and wheels. Honda supply alternative gears for everything except third, and they can be fitted in virtually any combination, which certainly stimulates plenty of thought. By comparison the engine modifications are — almost — simple and understated. But what is remarkable is the amount of power necessary for a small increase in speed.

90bhp propelled the ordinary FZ to something approaching 150mph; it takes 109bhp for the OW01 to go 7mph faster and yet another 20bhp for the racer to add 12mph to that total. There isn't much that can be done — within the FIM regulations — about aerodynamics, but anything would be a help. Internal air flow — for cooling and to supply the engine — is another matter. Based on Steve Linsdell's work, it looks like there is another 10bhp for the asking. And either some very complicated jetting arrangements or a sudden boom in fuel injection.