RACE TECHNICALITIES

CLIFF PETERS

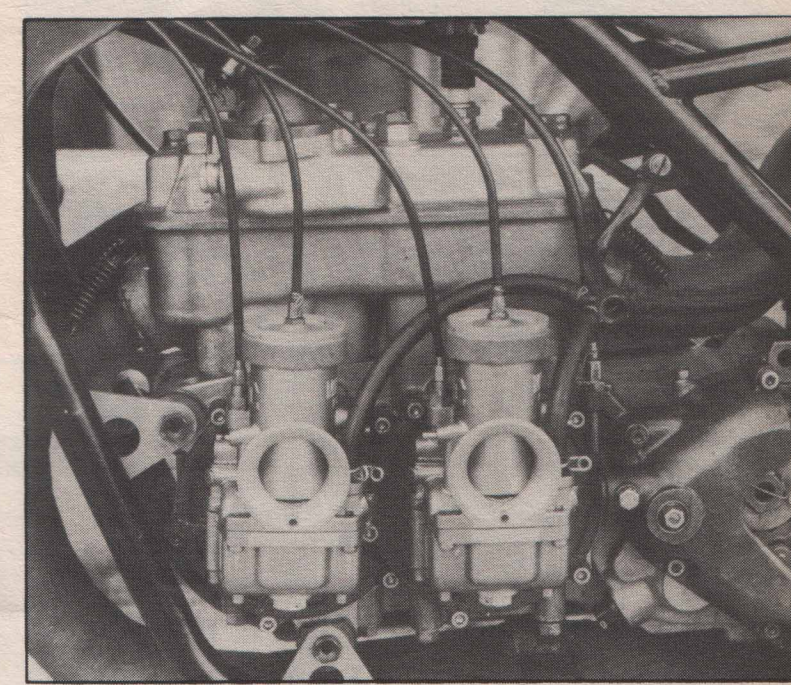
ONE OF the most obvious aspects of this year's World Championship season was the total domination of the 250 and 350 classes by Kork Ballington and the rest of the Kawasaki team. The little in-line twins are by no means new, they have been raced for some four years, gaining their first World Championship points last year when Mick Grant won the Dutch and Swedish 250 cc Grand Prix. The '77 250 cc World Championship was won by Mario Lega on the disc valved Morbidelli twin, and that win heralded the end of the Yamaha and Harley-Davidson domination of the middleweight classes with their piston ported engines. By bringing the superb riding skills of Kork Ballington into the team and adding a 350 cc twin to the stable, Kawasaki grabbed themselves two world crowns. Kork's ability to make use of the power advantage he had over non-Kawasaki riders (he was not to be hurried into any riding errors by having Greg Hansford breathing down his neck) was exactly what they needed.

The performance advantage that the Kawasaki has comes from advanced cylinder and cylinder head design, and most obviously from the disc valve induction system. The characteristic flat note is emitted by the cylinders firing together to make them sound like a single. Because the two cylinders have separate crankshafts, which are geared together, the engines could be built to fire two cylinders together, or opposed with one piston at TDC while the other is at BDC. When the little twins were originally designed they ran with the pistons opposed, but unreliability and vibration plagued them. When changed to the synchronised set-up, power and reliability improved and the results began to reflect the machine's potential. The layout of the 250 and 350 with the carburettors on the side indicates quite clearly the position of the disc valves that run on the end of the crankshafts.

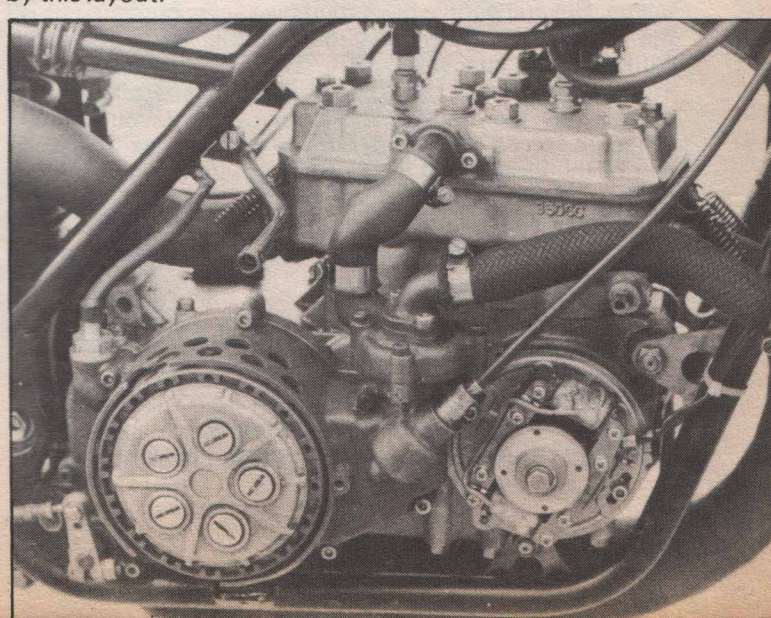
Disc valves

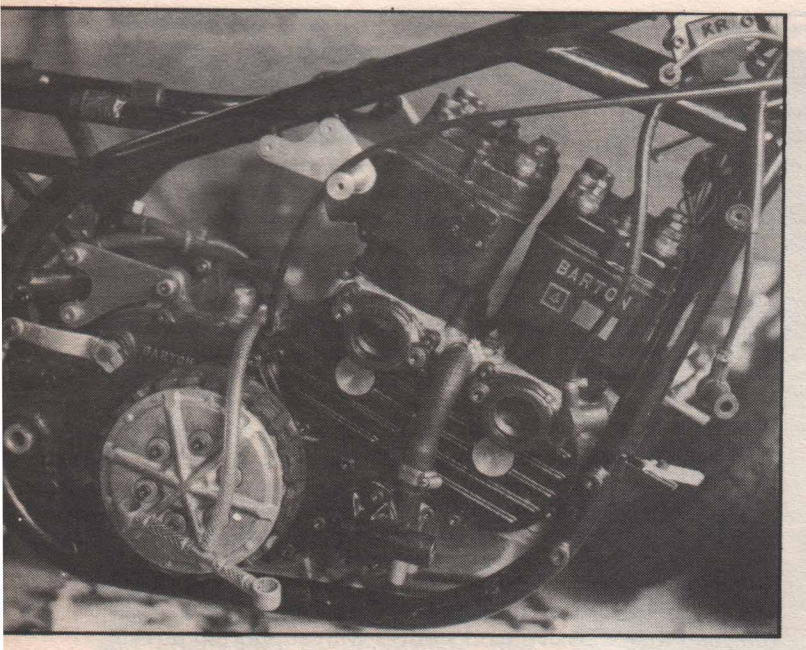
The advantage of a disc valve over a normally piston-ported induction system is the improvement in control over the inlet opening times. By the very nature of the two stroke principle, if no valving is added the induction time in which the crankcase is filled with fuel and air is limited. If the piston skirt is raised so that as the piston rises the induction tract from the carb is open longer, it will also be open longer as the piston falls and the longer it is open the more chance there is for the fresh charge to be forced back out through the carb. Yamaha use reed valves in their 750s to prevent this outflow through the carb, and while they work well on the 750s, they do restrict the gas flow at high rpm. Not so much a problem if you have ample engine capacity, but the smaller twins find themselves starved at high revs. By opening and closing the inlet tract mechanically without relying on the suction of the crankcase, the disc valve gives the designer complete freedom to use whatever port timing he deems fit. If required, the induction tract may be open for the entire upward stroke of the piston to allow fuel and air to be drawn into the crankcase, and then closed at TDC for the charge to be compressed as the piston falls. This compression is vital to force the charge up through the transfer parts to scavenge the cylinder and fill it with a fresh charge.

This apparently fundamental advantage that Kawasaki and Morbidelli have leads one to wonder at Yamaha's apparently outdated design. Yamaha had disc valve twins and fours of their own in the sixties, but abandoned them for the simplicity of the piston ported twins when they replaced their massive works effort with supported private

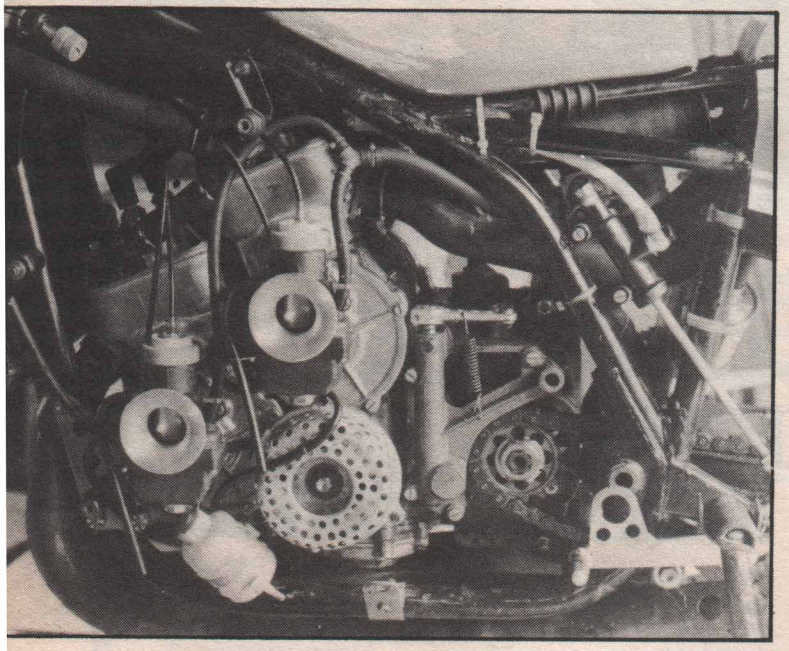


The watercooled, twin cylinder, disc valved engine raced so successfully by Kork Ballington for Kawasaki in both 250 and 350 cc guises. Very small frontal area presented by this layout.





Above: the Barton engine used in the British Phoenix is laid out in similar fashion to a same-as-you-can-buy RG Suzuki. Contrast this with Sheene's Works Suzuki below, where the four cylinders are staggered in two banks.



teams. Several people have tried disc valve conversions on the standard twins; Bruno Knoubula experimented without much success in 1976. The most successful non-works disc valver is Harold Bartol's 250cc special. Harold's engine has the traditional Yamaha style layout of two cylinders across the frame, but the exhausts exit from the rear of the barrels and the carbs are mounted on the front of the crankcases behind the front wheel. The discs are driven by a shaft running off the crankshafts between the two cylinders. While the machine hasn't won a Grand Prix yet, it does show promise.

Special heads

The Kawasaki's advantage comes from more than just the disc valves alone; the induction system gives more cylinder wall area for transfer ports, allowing further design flexibility. The cylinder heads are also rather special in that they have very deeply recessed combustion chambers with a squish area that covers more than half of the area of the piston crown. This deep chamber creates a high compression ratio and a very short distance for the flame front to burn. It also concentrates the heat of combustion over a small area of the piston crown, and hence reduces heat transfer and keeps piston temperature down. A fortunate by-product of the Kawasaki in-line layout is the low frontal area and ample ground clearance. The speed of the machines is balanced by good handling and braking. The rear suspension employs the rocker arm principle, used and discarded by Nico Bakker. Two pushrods run from the aluminium box section swing arm to the rocker that leans on the vertically mounted suspension unit. The main advantage of this system is the ease in which the spring to rear wheel travel ratio can be altered by adjusting the rocker. Not every detail of the machines are a result of a lengthy design and development programme.

The interesting grouped drilling pattern in the front disc of Grant's Kawasaki is not for reasons of stress relieving or dynamic balancing, but just because the hectic Grand Prix season didn't allow enough time for a complete drilling pattern and the four groups serve adequately to cut through the water film in wet weather! Kawasaki now have their name in the record books due not only to them having the best machine, but thanks to Kork Ballington's ability to ride as fast as anyone in the world — while looking ten miles an hour slower.

The five hundreds

While the smaller classes seem to be going the way of the disc valve, the 500cc class having been disc valve dominated for two years reverted in '78 to the piston ported engine! The similarity between the Kawasaki twins and the all powerful RG500 Suzuki are obvious when the engines are viewed from the side. The RG 500 Suzuki uses four separate cranks in square formation that are geared together. The Suzuki discs are spring steel as opposed to the Kawasaki's nylon, the nylon articles being marginally lighter. The fact is that while Suzuki powered most of the 500 class in '78, the championship was won by Kenny Roberts on his works Yamaha.

The Yamaha is a piston ported four, very similar in layout to the all-conquering 750s but unlike the 750 that anyone can buy. The 500s are limited-edition works specials, available only to the likes of Roberts, Cecotto and Katayama. The works teams did have specially valved engines available, but these had somewhat revolutionary *exhaust* not induction valves. These exhausts valves consisted of drums mounted in the exhaust ports that alter the exhaust port timing as they rotate. Controlled by the throttle cable, the drums rotate as the engine speed increases to give a wider spread of power. While still ostensibly an RG 500 Suzuki, the 1978 works machines are very different from the over-the-counter bikes. The four cylinders are staggered in two banks, and this makes the engine more compact; there are also differences in the porting and primary drive. One of the more obvious external changes being made this year to the works machines was the experimentation with a variety of different carburettor bellmouth shapes finally arriving at those in the photograph, which are quite different to the standard carbs.

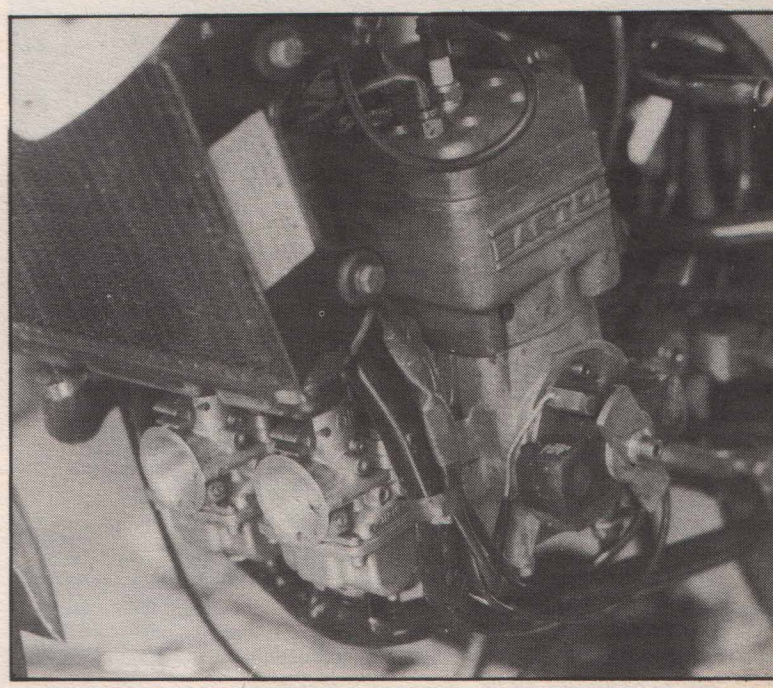
In comparison, the British 500cc Phoenix (a development of their 750) is laid out in similar fashion to the standard RG Suzuki in a conventional square-four arrangement. The interesting feature of the Phoenix is the

single suspension unit on the Spondon Engineering frame. The single De-Carbon suspension unit set up was developed for the three cylinder Sparton, where there is no room for a unit running over the top of the engine. It works so well that it was an obvious choice for the Phoenix. Whether or not we see the 54 x 54mm bore and stroke 500cc version of the Phoenix in production next year depends somewhat on increased financial backing, and demand — especially from the sidecar world who could quickly convert from 500cc to 750cc using the Barton Engineering motor.

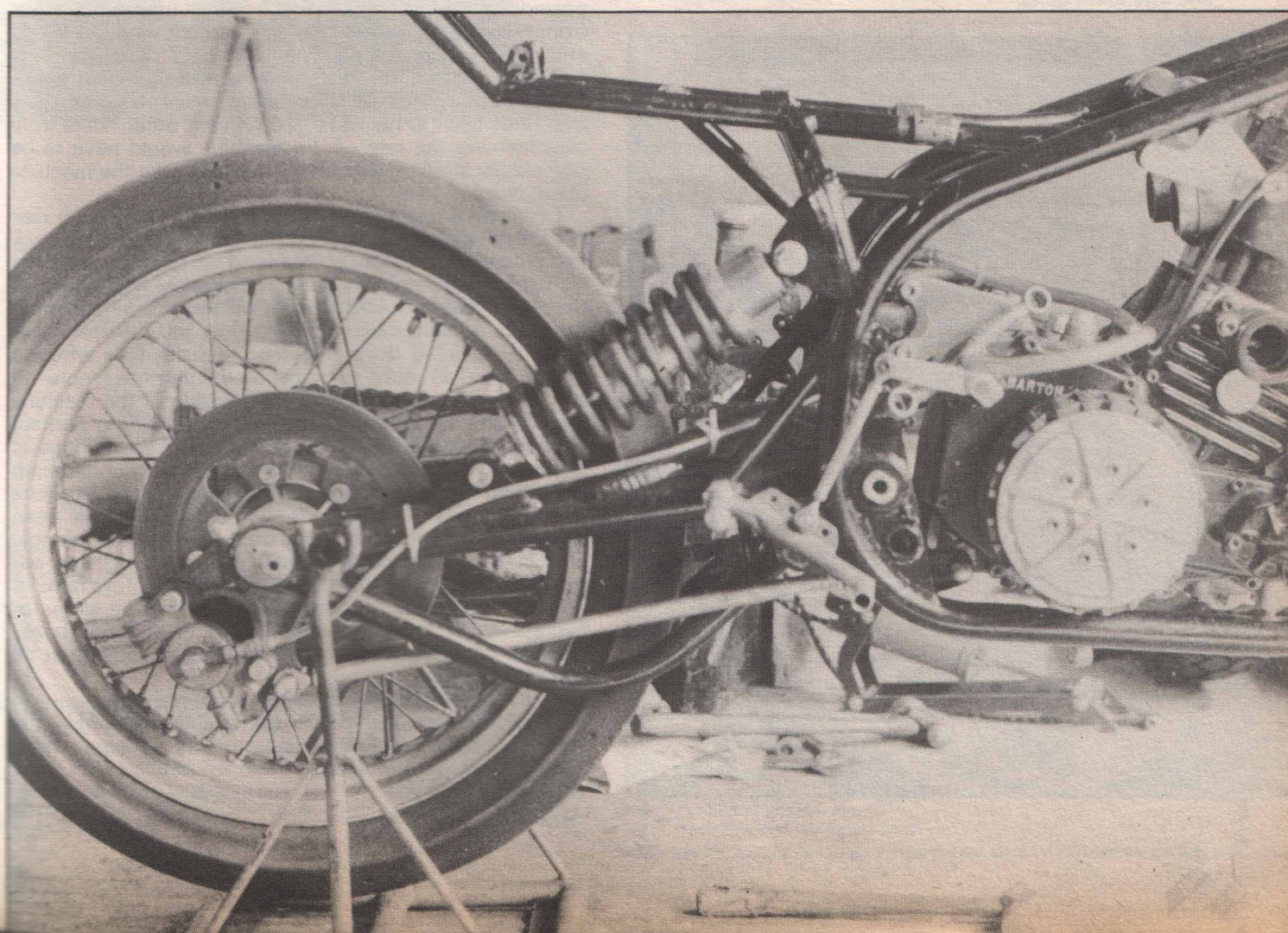
Attention to detail

While new and exciting engines and frames are the most obvious signs of factory involvement and developments, the fastest racing machines are created by gradual advancement and fanatical attention to detail. The ignition cover on Barry Sheene's Suzuki is drilled so full of holes that it becomes a work of art; a few grammes have been saved and the system runs cooler. The front wheel of Walter Villa's MBA is one of the new Campagnolas; the cast iron Brembo discs bolt straight onto the magnesium alloy wheel. There is no separate disc carrier, and hence the weight of the carrier and bolts is saved. If you ever want to see a superb example of attention to detail, then take the trouble to study Vic Souson's machines. Vic currently uses Bimoto frames, and these alone are beautifully crafted but he goes further. Every spacer or bracket is turned down and waisted paper thin where it needs little physical strength, and Titanium bolts abound. It is safe to assume that the same attention to detail is applied inside the engine, and the fact that Vic is one of the most successful privateers makes the effort worthwhile. One of the most unusual features of those immaculate Bimoto machines is the extra piece of instrumentation next to the rev counter and water temperature gauge: a pressure gauge. This is connected to the frame which is pressurised so that any crack appearing in the frame registers a drop in pressure on the gauge that can be immediately seen by the rider. The rate of loss of

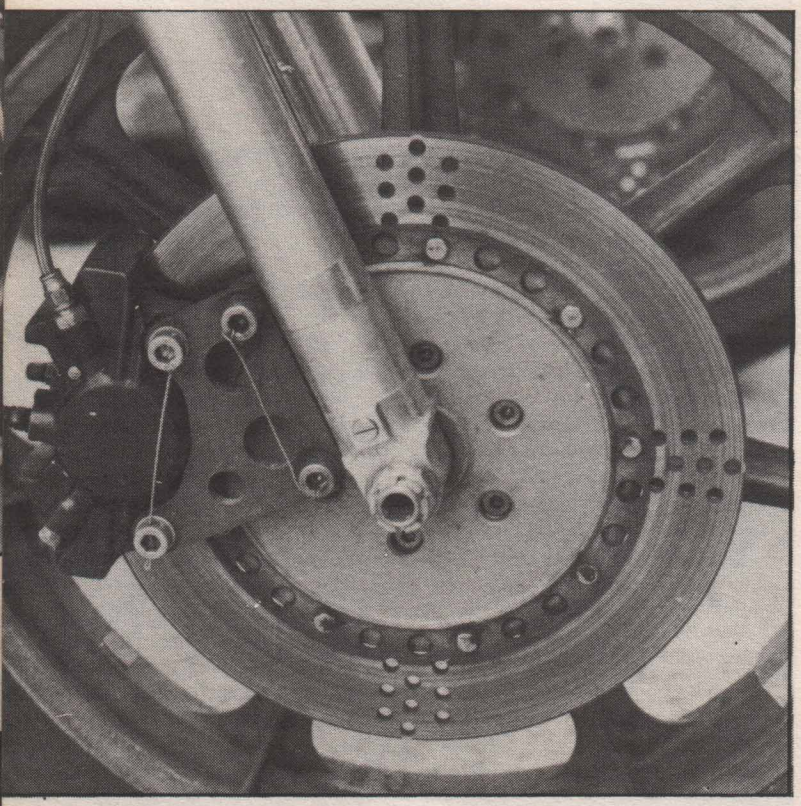
Harold Bartol's water-cooled 250 features disc valves with the carbs feeding into the front of the crankcases, exhausts facing rearwards.



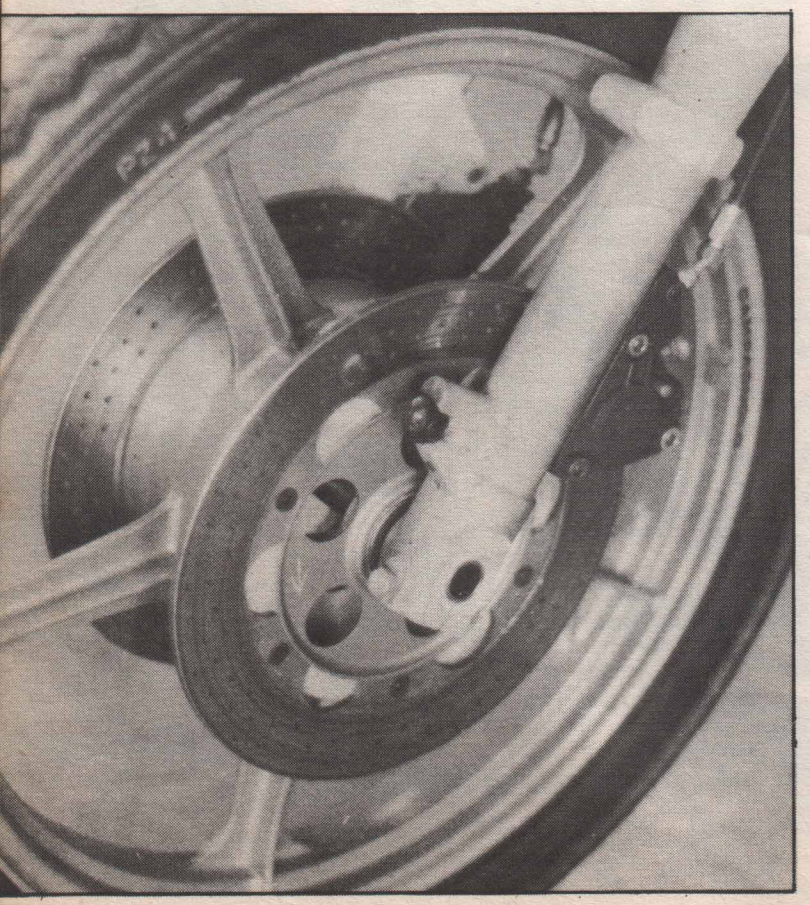
The Spondon Engineering frame used for the Phoenix manages to avoid mounting the single De Carbon suspension unit above the engine.



There's not always a scientific reason for everything on a racing bike. Mick Grant's disc brake would feature more holes to aid wet weather braking, if time permitted!



The latest magnesium alloy Campagnola wheel, as used by Walter Villa on his MBA. The cast iron discs bolt straight onto the hub, saving the weight of a separate disc carrier and attendant bolts.



pressure would give some indication of the size of the crack. Whether this is as much of an advantage as it first appears is open to question. If an exhaust pipe mounting bracket were to crack causing the pressure to disappear the rider might suspect that the rear wheel was about to fall out and stop unnecessarily.

Cheating the air

One of the slowest changing facets of the racing motorcycle is the fairing. They are not, as one might reasonably assume, just for the purpose of carrying advertisements and numbers. In theory, they offer some measure of streamlining to ease the machine's path through the air. The main factor resisting the development of truly efficient streamlining is the rule book. FIM regulations state that the front wheel and the rider with the exception of his forearms must be visible from the side. This obviously prevents the use of full streamlining, leaving designers little option but to cover the rest of the machine as smoothly as they can. There are several areas of severe speed-reducing air turbulence around the motorcycle, two of the most obvious are between the two wheels, and behind the rider's back. The little Kawasaki twins make use of their compact engines by using fairings with a small frontal area that are high off the ground, and little attempt has been made to smooth the flow of air between the two wheels.

Both the works Yamahas and Suzukis have fairings that come as close to the ground as cornering clearance will allow, and fit closely behind the front wheel. The principle behind this is that by preventing the air that has been parted by the front wheel from swirling back behind it, the rear wheel does not have to repeat the effort. There is little doubt that their fairings have the desired effect, as riders have found a slightly disturbing "straight on" tendency. At fast circuits like Spa, the smooth flow round the front wheel and fairing keeps the wheel on the straight-ahead position when peeling off for a corner until, with effort from the rider the wheel breaks alignment with the fairing and the flow is disturbed. The large 'hole' punched in the air by the rider and machine, and the effort to do so, keeps his speed down but will give a tow to a following machine that finds itself in his wake. To prevent other riders from slipstreaming the rear of the machine would have to be completely streamlined and this would make the machine about twice as long.

Takazumi Katayama produced his own offering for rear streamlining with a large soft block strapped to his back that smoothed the flow of air round his helmet and down his back. Takazumi used this 'hunchback' in practice at Spa, but it seems doubtful that it will become a permanent fixture as it might cause a falling rider to be flipped over instead of sliding down the road. As the four wheeled world have so ably demonstrated, there is more to streamlining than just easing the passage of the machine through the air. Keeping ultra fast machinery in contact with the ground is a problem in itself. The low fairings of the Suzuki and Yamahas prevent air getting underneath and lifting them from the road. To help keep pressure downwards on the wheels the works Suzuki have been experimenting with stub wings on the side of the fairings. Early in the season the wings had vertical anti-spill tips, but these were discarded and the simple plain aerofoils remain. To what extent we see aerodynamics alter the shape of fairings in the future depends largely on the rule book, because full scale wings are in fact illegal; they must be part of the fairing.

While we have been watching our heroes fight out the 78 World Championships on the circuits of Europe the research and development departments in Japan have been hard at work producing more wondrous examples of their art for next year.