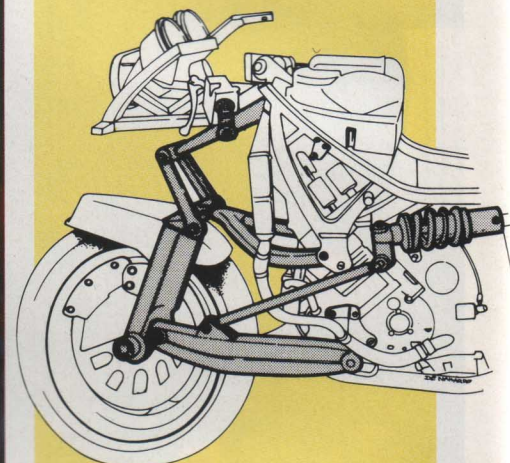
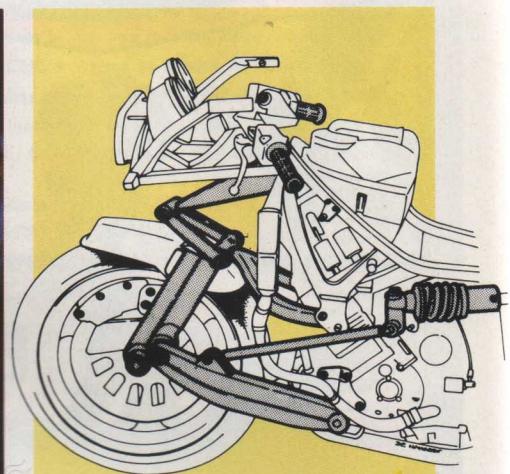
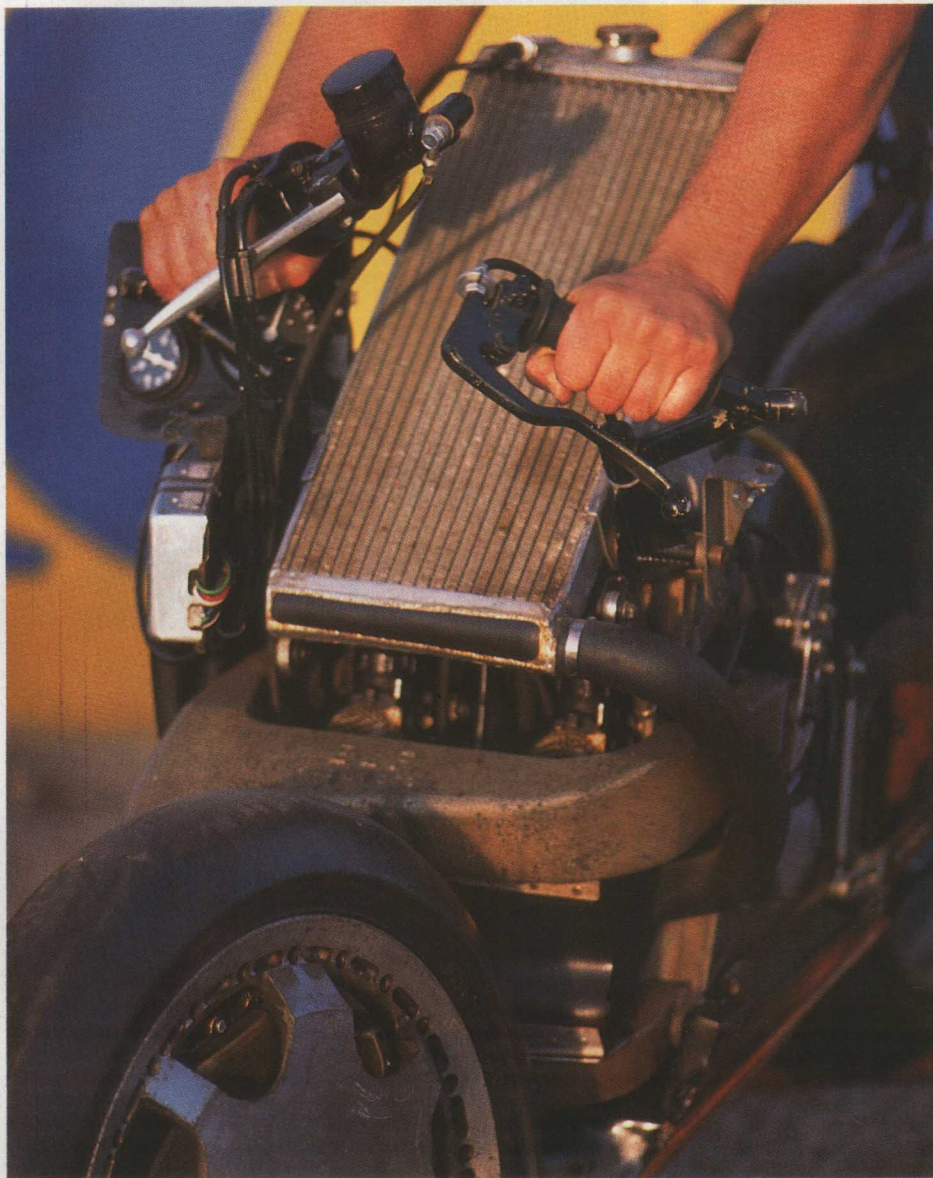


Hub of the



A Nico Bakker front end compressed (top) and extended (above). You will notice that the steering linkages have to move as well as the double decker swingarms. That's what it takes to separate steering and suspension.

Funny front ends: evolution or convolution?

Bikes with hub centre steering are nothing new. The observant visitor to the last Cologne show would have been able to admire the 1923 Ner-a-car. The Difazio front end goes back at least fifteen years. And for ten years Elf have raced a series of Grand Prix and Endurance machines.

Last year Honda acquired the Elf patents, in one of the occasional bouts of public interest which the manufacturers show in unconventional machinery. Suzuki had their Falcorustycy concept bike. Bimota had the Tesi. Various frame builders have built their own versions of the non telescopic front end, all sharing the same conviction that telescopic forks are no good.

What does the front suspension have to do? Locate the wheel, steer it, suspend it and transmit braking forces. The telescopic fork handles all these forces in what is basically two sliding components. This is the starting point for considering any new system.

Most alternative front ends carry the wheel in a swing-arm, with a steering knuckle fixed almost vertically. To allow for

suspension travel, a lever system is needed between the handlebar and the steering knuckle.

The brakes and the wheel pivot point should be positioned so that braking forces cannot upset the steering, which means that the wheel has to have dished spokes. Brake torque can be put into the suspension; by carefully applying lever laws it is possible to create an anti-dive effect during braking.

It is essential to have a direct connection between the handlebar and the steering — any deflection, play or lost motion has to be avoided, otherwise the steering loses its precision and its feel. The bearing which supports the steering knuckle has to be quite sophisticated. It has to follow the suspension travel and still allow steering movement, even under the very high loads caused by braking.

With present day designs, the front swing-arm pivot and the suspension mounts have to be carried in a subframe, which means additional weight and cost. Using the engine as a stressed member would save this; but not even Elf could get a suitable machine from Honda for their racing designs.

e Universe



Ten years' worth of Elfs, from Endurance racing days to Ron's last GP. Eventually engine shape stopped development.

Ten years of Elf

The eleventh hour of the French Revolution struck during the summer of 1976. Andre de Cortanze, a well-known automotive engineer who had worked for Renault, Alpine and Ferrari, and some enthusiastic executives of the oil company, Elf, had a discussion.

The basic idea of de Cortanze and his successor, Daniel Trema, was to design a motorcycle on which the centre of gravity was as low as possible and which behaved in an equally neutral way during acceleration and braking.

When the Elf X appeared in 1978 it was a technical sensation. Its tank was underneath the four-cylinder TZ engine, it had a swing arm at the front and a steering knuckle identical to that of a car.

From 1979 onwards, Honda supplied engines for endurance racing at first, later for 500 Grands Prix. The list of Elf riders is as long as it is prominent: Guilleux, de Radigues, Rougerie, le Liard, Villa, Espie, Aldana, Bolle, Fau and Haslam.

The 1986 season, under Serge Rosset, was promising; Haslam won at Macau and took a number of speed records at Nardo. In 1987 Honda supplied V4 works engines and, towards the end of the season, acquired just under 20 main patents and approximately 250 sub-patents.

This is where the story ends. To be at the very front it would be necessary to use a completely new engine design strong enough to carry the front and rear suspension without the need of additional subframes. But these means are only available to a factory like Honda.

The revolution has released its children. Honda will no doubt bring them up. Next year or the year after we shall know what production motorcycles with hub centre steering will look like. It is now five past eleven.

ELF 5

The greatest demands on motorcycle chassis continue to be made in 500cc world championship racing. In that sense, the Elf 5, ridden by Ron Haslam last season, should be the best solution for a steering knuckle concept — especially as Elf have already tried out all the possibilities of such a suspension system.

The result of this long development is initially surprising. The front suspension resembles the McPherson design used in passenger cars. The spring strut is positioned above the steering knuckle in the steering head and apart from its suspension function it guides the steering knuckle. So again a component has multiple functions.

An auxiliary frame carries the swing arm and cradles the engine. All the suspension parts are in cast magnesium, a luxury which can be justified on a Grand Prix machine.

On the face of it, putting the spring strut in the steering head has its disadvantages; the subframe which locates the steering also has to carry the suspension loads and has to be correspondingly strong. It is made from an immorally expensive aviation steel tube.

The logic of the system only becomes apparent after you have thought about the Elf 5 for a long time. We had the opportunity to study the chassis components in the development department of the French company ROC where the Elf machines were made. As time passed, the complicated relationships became more obvious.

Because of the force introduced by the brake calipers, the steering knuckle has to be strong. This means that it is also able to accommodate suspension forces without having to be made bigger. The forces in the lower swinging arm are less so that this and its subframes may be made lighter. Furthermore, the fairing, electronic components, etc. may be carried directly on the subframe, so the



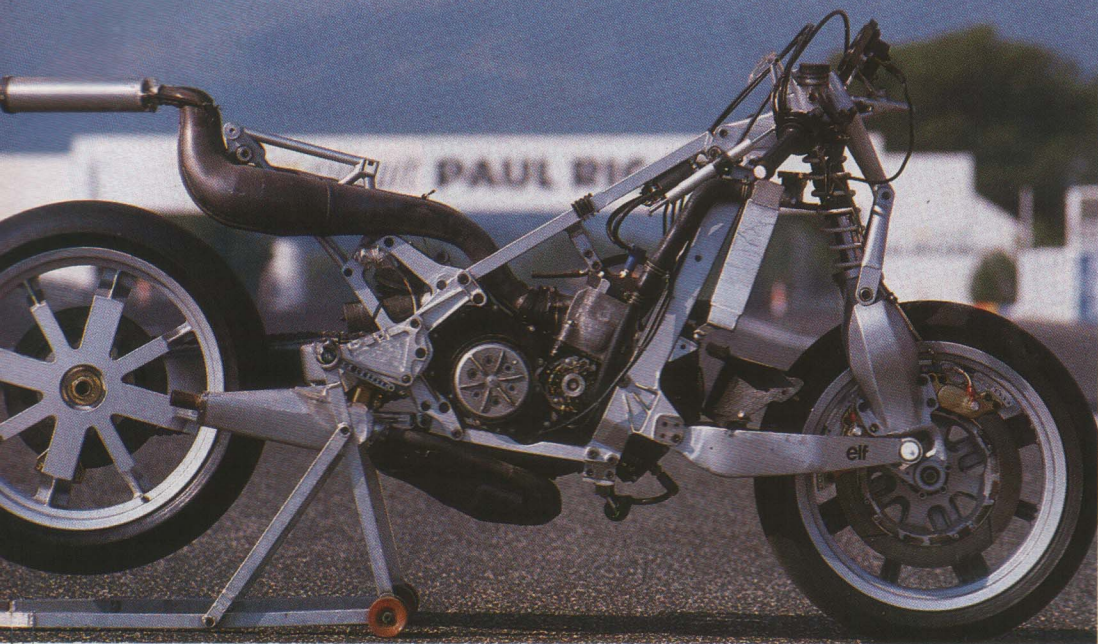
Ron's immorally expensive magnesium front end. Once you work out where the mudguard is, it all falls into place.

KAWASAKI RB2

At first sight the Kawasaki RB2 looks like a retrograde step because the steering head contains telescopic sliders. But the Dutch engineers Cor van Reeuwijk and Hans Bijl have good reasons for their design. By adjusting the angle of the sliding parts at the top end, the castor and trail may be adjusted to suit the rider.

Brake torque also gives a measure of anti-dive, which can be adjusted. Early track tests showed that the full adjustment was too much, and riders preferred it when the anti-dive was reduced.

The riding sensation was wonderful because of the RB2's precise steering. As with all front swing arms, the response of the suspension is soft — the telescopic part operates without any seals and with generous clearances, so there is no stickiness; most of the



The ideal was to bolt the suspension directly to the motor, but the NS500 triple wouldn't fit.

overall weight of the bike is low.

As the spring requirements at the front of the bike are different to those at the rear, the Elf engineers had to develop their own unit. Finding the best damping characteristic was the biggest problem and the development work took two years using an in-house test rig. Incidentally the spring strut contains several components from a telescopic fork . . .

The bearing which supports the steering knuckle is a self-aligning

ball bearing, used in aircraft construction. There are no suspension forces in this bearing. They are passed on in the steering knuckle, and so it can be quite small, with an advantage in that it has less friction and needs a lower break-away torque, avoiding any stickiness in the steering travel.

The brakes of the Elf 5 also surprise. No, we did not have one too many, it really does have a double disc brake at the front. The discs are attached to a joint carrier

and the calipers are mounted in an offset fashion — a masterly design achievement. It also works. Our testers were able to convince themselves at Paul Ricard.

Of all the models described here, the Elf 5 is the most mature design. It has impressively proved its use in this year's world championship. The question as to whether such a design will ever be available on a production basis must make a few heads smoke in Japan.

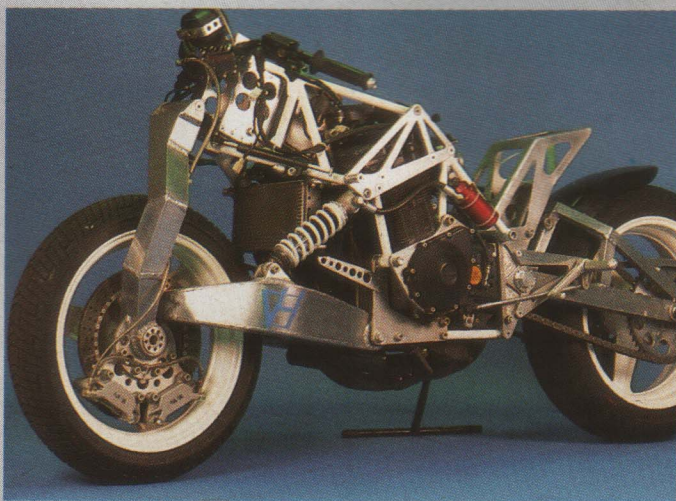
VH GSX-R1100

The first is the VH — built by Dip Ing Klaus Vosteen and Dieter Helms — and a GSX-R1100 Suzuki in a lattice tube frame with their own rear suspension and single-sided swing arm at the front.

The special characteristic of the VH is found in the steering head. The artistically bent, generously dimensioned steering knuckle is guided at its upper end by a sheet-metal steering arm. This is guided by a box which effectively forms the steering head. So, steering movements are transferred directly to the knuckle, while suspension loads are carried in the swing arm.

As the suspension compresses, the top steering arm swings up, so steering castor remains constant.

The short wheelbase (1370 mm, 53.9 inch) makes the handling very light it also makes the bike lift its front wheel under acceleration in the first three gears, but then an unrestricted 1100 (not is a German model) gives the VH a fair amount of thrust. The anti-dive effect can be felt during braking



but the suspension remains supple enough to soak up bumps at the same time. Stability is faultless, but because it is so light to handle, steering requires concentration.

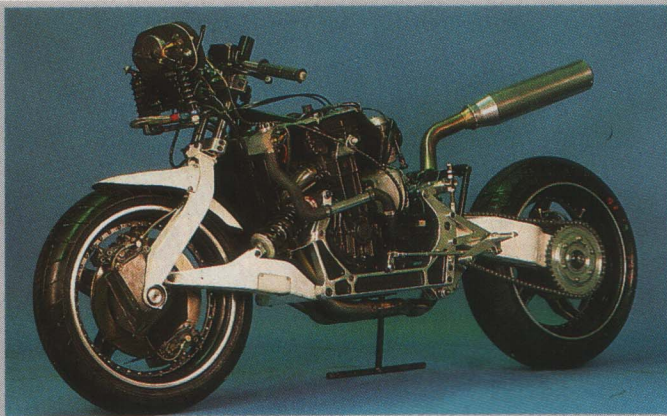
The track test at Nurburgring showed up the only fault, one which is an inherent disadvantage of this type of layout. After one and a half laps the Wiwo brake system failed through overheating. As the disc has to be mounted in the lee of the front wheel it needs an extra

supply of cooling air.

So while the front suspension itself works wonderfully well, the two gentlemen from Oldenburg still have to carry out some more development work.

Above and right: Would this, or would it not, be the business of a Sunday afternoon? Unfortunately the VH GSX-R cooks its brakes; the inboard disc can't catch enough cooling breeze.





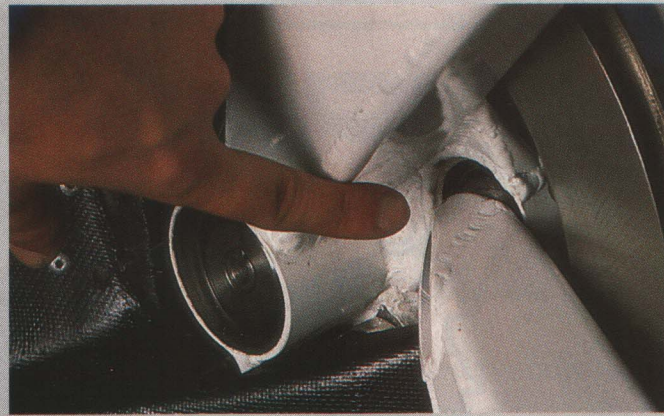
A GPX750 cradled in an overgrown footrest backplate.

load is carried in the swing arm and the sliding parts take only steering forces.

The spring strut is a Koni car unit which gives a very soft ride making the rear suspension seem surprisingly hard.

The swing arm and steering

knuckle car unit are fabricated from sheet steel, which permits a fairly small cross section and a neat external appearance. The frame is basically an engine cradle, skilfully milled from solid, to carry the swing arm suspension, front and rear. Wheels are three-



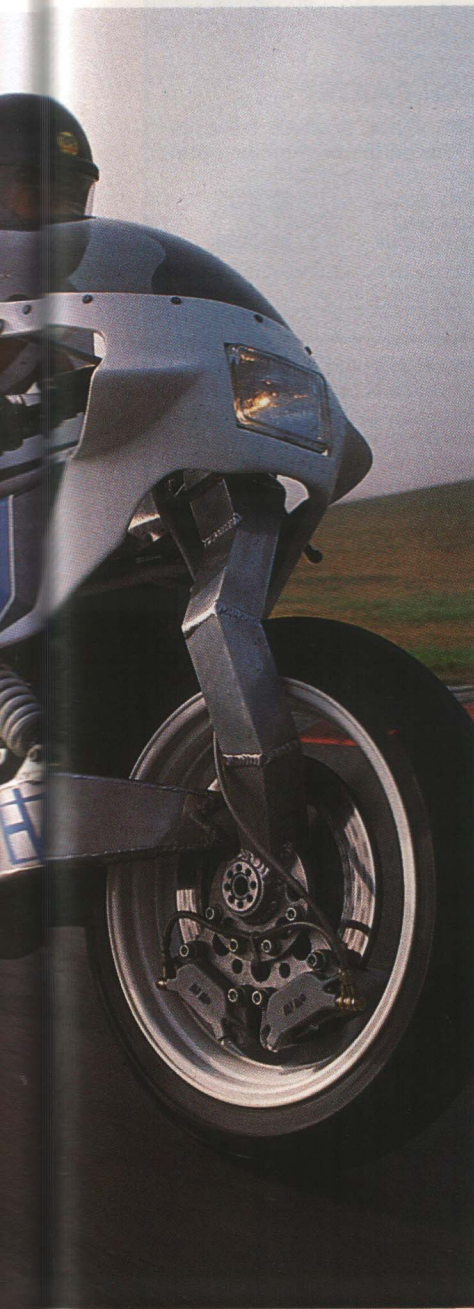
Steering waggles side to side; suspension goes up and down.

part components which the Dutch engineers designed themselves and, with careful attention to detail, the RB2 shows that hub-centre steering systems do not have to be ugly.

The bearing which supports the steering knuckle is actually a ball

joint, held in a friction bearing.

There were braking problems with this design. Brembo and Wiwo calipers gave bad results while the present four-piston Lockheed calipers are placed opposite one another which is not the most ideal solution either.



BoTT BOXER

Ulrich Volkel's BoTT racer has a double wishbone steering arm design, with the lower swing arm taking most of the suspension load.

The three drawings show a similar system introduced by Nico Barker at the Frankfurt International Motor Show. The VV device differs from the other designs by having the swing arm attached below the wheel spindle. A ball head bearing designed especially for Volkel ensures clearance-free support at the steering knuckle.

The VV-BMW has complete anti-dive control which at first makes the rider feel insecure. Michael Seeber, who raced the bike in the Battle of the Twins,

finished in fifth place in the German championship, so presumably he did not have any problems.

Response from the front suspension is excellent and the geometry is set up for high stability — in fact, for its 129kg (284lb) of wet weight, the BMW is almost unwieldy.

"No problem," says Ulrich Volkel, "I only need a few minutes to change the geometry considerably." Different possibilities for articulating the steering knuckle permit changes of castor and trail to suit the rider's tastes.

When set-up for good stability at high speed, even the Hatzen straight on the GP track lost its horrors. However, the rider had to get used to the low speed characteristics of the VV. It tended to tilt, just like a machine whose steering

head is adjusted too tightly. There is a suspicion that there is a great deal of friction at the steering axis.

The VV's brake, on the other hand, does not cause any problems. With a clearly defined pressure point and without let-up, the single, ventilated disc decelerates vehemently. A Wiwo disc and two Brembo four-piston calipers guarantee such an effect. The generous supply of air must also be beneficial. According to Volkel the cooling air is supplied to the brake disc from the inside and reaches the outside through spiral ribs in between the outer faces of the disc.

The double steering arm concept of the VV works but compared to the RB2 it appears to be rather expensive. The advantages of such expenditure were not clear to us.



Omit the steering head/fork assembly and road shocks go direct to a super strong cradle.