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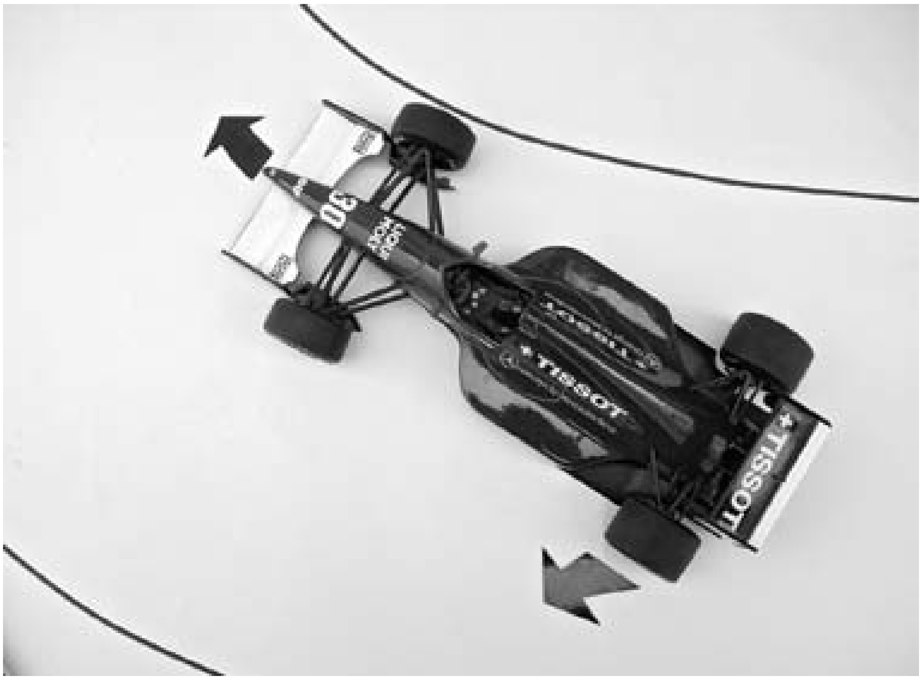
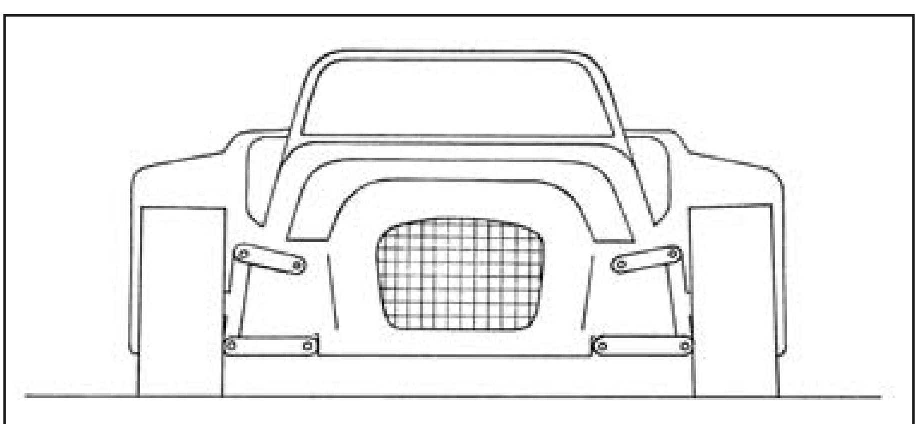


Corrective steering (opposite lock) has to be applied to prevent the car going completely out of control. Oversteer – the front wheels have been turned in to the corner and the front of the car responds as expected, but the back of the car starts to ‘come around’ or ‘go off line’ too much as it’s not ‘following’ the front of the car. When it goes too far the car becomes unstable; a little is acceptable and often advantageous; but a lot results in a spin.



Front wheels set with 2 degrees of negative camber.

The static negative camber of a sports car should ideally be adjustable over a range of zero to 2 degrees. If the static negative camber has to be fixed, set it at 1 degree, but make sure that the castor can be adjusted between 3 and 6 degrees by some means, such as moving the top or bottom wishbone, or both wishbones, longitudinally on the car. It would be unusual for a sports car to need more than 6 degrees of castor, but not impossible in the speed range under discussion in this book.

Note that the largest amount of castor ever likely to be able to be used on any car is about 15 degrees. While this may appear to be quite an outrageous amount, it should be remembered that, when negotiating high speed turns, the steering wheel is, in fact, turned only a very small amount, and this amount of castor is sometimes needed. The use of castor can be a useful tuning tool in certain racing applications.

The effective castor angle of a car is found by test, and is based on tyre contact with the road or track surface, the speed at which the car is negotiating the corners, and optimum grip; this requirement could vary track-to-track. Take it that the ideal starting point static negative camber setting of all wheels which have adjustable camber is about 1 degree. This is the amount to consider first for all sports cars being used within the speed range defined for this book (see ‘Using This Book’).

Although the car is set up with a specific amount of static camber, it doesn’t mean that during cornering, with some body roll, the settings will remain the same: there’s much more to it than this ...

Some static negative camber is usually a good thing, but too much is not. Think more in terms of how little static negative camber can be incorporated into the car, as opposed to how much.

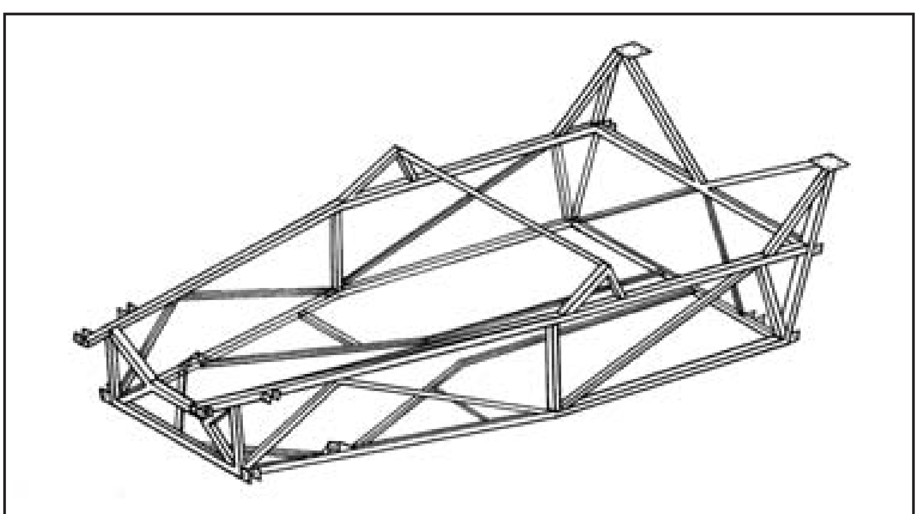
Dynamic camber

This term refers to the amount of wheel camber present when the car is in motion, and, more specifically, when the car is cornering. Three things can happen to the left-hand front wheel of a car whilst turning right, or the right-hand

Chapter 1
The 'chassis'

In the context of this book, the term 'chassis' can be taken to mean a true chassis in the sense that it's comprised of metal tubes, or the 'chassis' created by the rigid box sections of a monocoque body – both serve the same purpose.

The chassis or relevant structure of a monocoque body must be straight in the sense that all of the suspension pick-up points are in the correct positions relative to the car's structure and each other. If the chassis pick-up points are wrongly positioned through faulty manufacture or crash damage repair, etc., the suspension geometry will be wrong, and this cannot be worked around. All of the pick-up point centres for each pair of pick-up points on each side of the car have to be an equal height from a known datum, such as a perfectly flat floor. Even if the car is fully assembled, it can still be measured satisfactorily without too much trouble. Checking the alignment of the suspension pick-up points is the first step to improving a car's handling. If the pick-up points are all equal, then that's a start, but it doesn't actually mean that they're in the correct position, just that they are of equal height from the datum.



A tubular chassis with no protrusions below the lower rails can sit dead flat on a flat floor.

METHODS OF CHECKING CHASSIS INTEGRITY

Bare true chassis

If the car has been stripped for a rebuild it's relatively easy to check it for straightness. This is the ideal time to check a chassis as, if it's found to be incorrect, it can be repaired and then rechecked before being built up. The ideal accuracy on any chassis is to have all of the suspension pick-up point positions within a tolerance of about 1mm. Any chassis that is bent and proven to have more error than this,

Typical coil-over shock absorber.

feature coil-over shock absorbers or a coil and telescopic shock absorber arrangement of one sort or another. Some cars have the shock absorber mounted inside the spring, even though there is no direct physical connection between the two components. With this type of setup, even if the standard spring platform is not adjustable, there are usually ways around the problem of spring height adjustment to obtain equal side-to-side wheel weights (a steel spacer welded in place, for example) and invariably uprated shock absorbers/adjustable shock absorbers are available. So, even if not as easy as with a coil-over shock absorber featuring an adjustable spring platform, both spring/ride height and damping rates can still be modified.

Other cars will feature suspension systems with the spring and shock absorber completely separate. Even so, the principles of the suspension system are the same, as are modifications to the spring fitted heights to obtain equal wheel weights, spring tensions by changing springs for ones with a higher spring rate, and uprated shock absorbers or adjustable uprated shock absorbers.

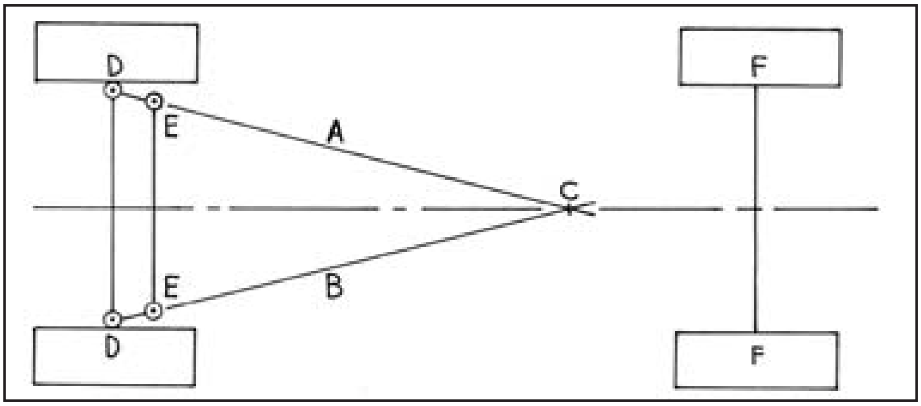
From the point of view of convenience, coil-over shocks featuring adjustable coil spring platforms are the easiest type to adjust and to substitute springs. It may be possible to substitute coil-over shock absorbers on some cars which are not equipped with them, and certainly kits exist to do this very thing. They are a good idea provided they are not difficult to fit, and most don't appear to be.

A spring is a spring irrespective of type. There are various types ranging from coil springs, torsion bars and leaf springs, etc. This book refers only to coil springs in the given examples as they're so common: all other forms of springing have been virtually superseded. However, the principles for other forms of springing are the same.

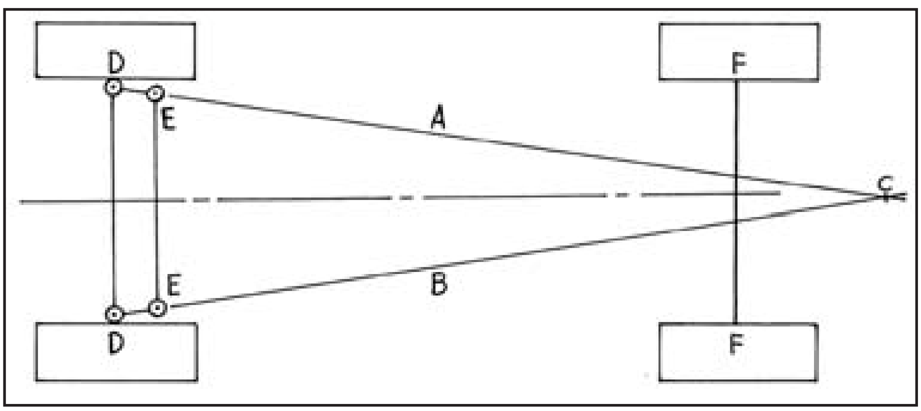
Essentially, the springs are what hold the car up at the required ride height and allow sufficient movement above and below this point without the springs coil binding (going solid) over undulations. A sports car that is used on long straight level roads wouldn't have to have very firm springs, and even if the springs were really a bit too soft it wouldn't be noticed until undulations were encountered which

Typical coil spring for a coil-over shock absorber unit. Poundage is always marked on the spring. If it isn't, get it checked for rate.

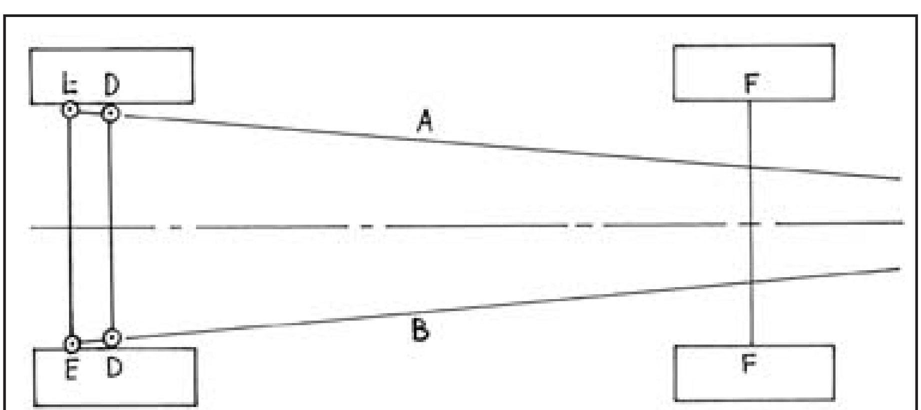
caused the coil springs to become coil bound. At the point of coil bind the car would effectively have no suspension and, besides making a crashing noise, the car would have a solid suspension which isn't any good at all. In such an instance, the coils need to be replaced with ones with a higher spring rate. If the coil springs of a sports car are far too hard, the occupants will feel every bump in the road, such cars are very uncomfortable to ride for anything more than a short distance. What this clearly illustrates is that the coil springs of any sports car need to be matched to the exact application. That means the



The Ackerman angle has been increased to promote increased turn-in of the front wheel on the inside of the turn. The lines 'A' and 'B' now intersect well before the centre line of the rear axle 'FF.'



The Ackerman angle has been decreased to reduce the amount of turn-in of the front wheel on the inside of the turn. The lines 'A' and 'B' now intersect behind the centre line of the rear axle 'FF.'



The steering rack is in front of the front axle centre 'DD.' The lines 'A' and 'B' extend well past the back of the car before they intersect. Not much Ackerman angle is possible, mainly because the tie rod ends, 'E' and 'E,' can only be so close to the disc rotors, but in most cases enough Ackerman is possible. The lines 'A' and 'B' carry forward in the manner shown, and the principles of Ackerman steering remain.

the outside of the turn. The steering arm of the wheel on the inside of the turn becomes more acute while the steering arm on the outside of the turn becomes less acute. The front wheel on the outside of the turn has its steering arm move in the opposite direction and effectively lengthen. This action is very easy to see on a go-kart.

The steering arms don't actually have to be behind the centre line of the front wheels, they can be in front, and in many instances they are. In such cases, the steering arms are angled outwards and towards the disc rotor or wheel. There's usually a limit to how much they can be angled before they would interfere with the disc rotor or wheel and, therefore, a limit to how much Ackerman steering can be incorporated into the steering. Sometimes there's enough, but usually there isn't. This is why people to used toe-out in an effort to gain better turning in.

The majority of stub axles these days are forged as one piece items. Older cars had removable steering arms, but this now is uncommon. If the arms are removable, new arms, which reposition the pick-up points of the steering system and alter the Ackerman angle, can be made from high tensile steel. Such arms can usually be government certified as fit for service, bolted onto the stub axle and legally used, but check local legislation before making this modification. **Warning!** In the past, steering arms have been cut and welded, or simply heated up and bent. However, this is a potentially dangerous practice, and, as a consequence, can't be recommended. It is also not legal to do this sort of thing on road going cars in most countries.

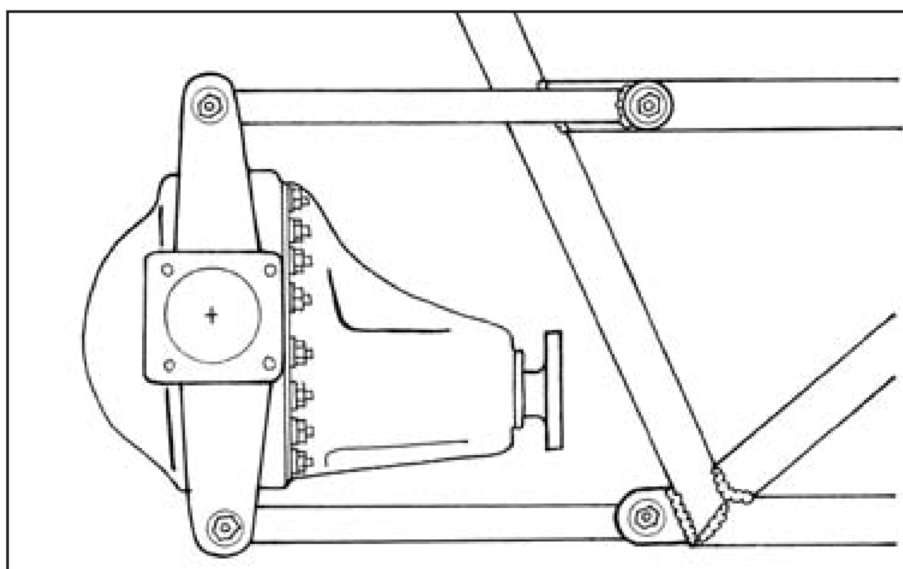
Chapter 7
Rear suspension

LIVE AXLES

A conventional 'live axle' is usually regarded as the cheap arrangement and is less favoured today. The reason that live axles are and have been used so much is because of their basic overall simplicity and adaptability. The live rear axle can give an excellent performance in a lightweight sports car or kit car, provided it is set up correctly. Nothing can alter the fact that there is a lot of unsprung weight in a live axle, or that the rear wheels are not independent in operation. With knowledge of this limitation, the live axle can be made to work very well and be very effective.

Live axle location

The most common method of live axle location used on production sports cars used to be by leaf spring. A problem associated with these was axle tramp, which was caused by deflection in the leaf spring. There were various solutions to this problem, including fitting 'anti-tramp bars' to prevent the springs from effectively shortening longitudinally. Another option was the fitting two 'traction bars' or a 'differential snubber' to harness the pinion torque under acceleration.



The trailing arms are the same length and parallel to the ground at the ride height. It is often less convenient to have the top arm fixed to the chassis as shown, which is why shorter top arms are sometimes used which connect to the back of the rear chassis.

The most common method of live axle location used these days has the axle constrained by four trailing links of equal length, and a Panhard rod for lateral location. The differential pinion angle change caused by the short top arms is rarely a problem. There are several variations on lateral location, such as an A-frame, or, more complicated, a Watts linkage. One