■ GIULIA AND 1750 MODELS ■

■ WHEEL AND SUSPENSION ■
■ FRONT END GEOMETRY ■

Alfa Romeo

SHOP MANUAL

PURPOSE OF THIS MANUAL IS TO DEAL WITH THE METHODS OF CHECKING AND ADJUSTING THE WHEEL ALIGNMENT SETTINGS TO ENSURE A SAFE AND COMFORTABLE RIDING. THE SAME SUBJECT IS ALSO COVERED BY THE MOTION PICTURE **CAR TRIM AND FRONT END GEOMETRY** WHICH SHOWS THE CORRECT SEQUENCE OF PERFORMING THE PROCEDURES HEREIN DESCRIBED IN DETAILS. THIS PICTURE IS AVAILABLE BY

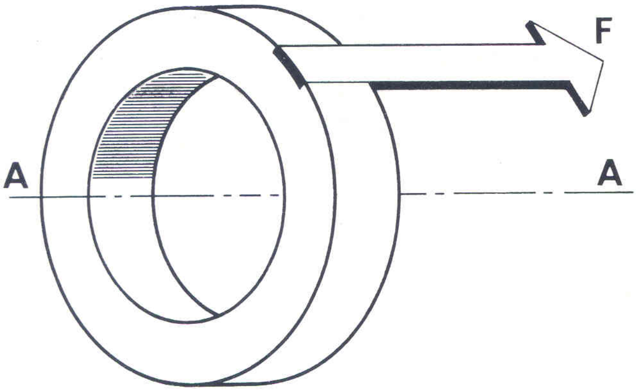
Direzione Assistenza *Alfa Romeo*

HISTORY OF WHEEL AND TYRE

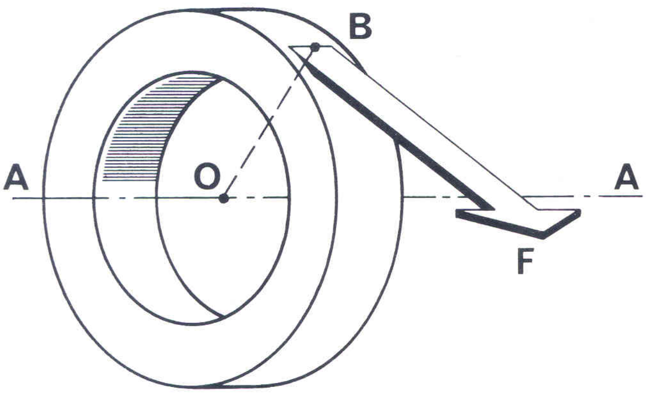
It is believed that the wheel originated from the usage of a bole as a roll to overcome the sliding friction by converting it into rolling friction. Soon after, men realized that a lighter wheel would have been a better thing and this brought to the spoke wheel. Then, a solid attire were used on the wheel rim and, in the nineteenth century, John Dunlop devised an air-filled high-pressure tyre. The vulcanizing process, introduced by Charles Goodyear in the 1920, gave the pneumatic tyre better characteristics; however the average life was just enough to cover about 4000 miles. In the 1923 appeared the low-pressure type of pneumatic tyre with a much longer life.

In the last decade, new types of tyres have been developed, especially in the U.S.A. Some of them, for example, have the inner surface coated with plastic material that, when the tyre is punctured, is forced by the internal air pressure to flow into and seal the hole left by puncture.

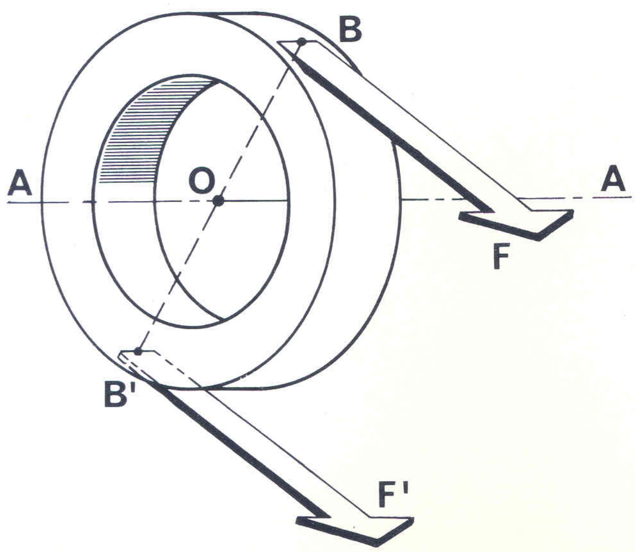
AN OUTLINE OF WHEEL KINETICS



Suppose a force F is acting on a wheel: if the direction of the force F is parallel to the wheel axis, the force has no effect on wheel rotation; if the direction of the force is not parallel to the wheel axis, the force tends to produce or change the motion of the wheel in direct proportion to its magnitude.

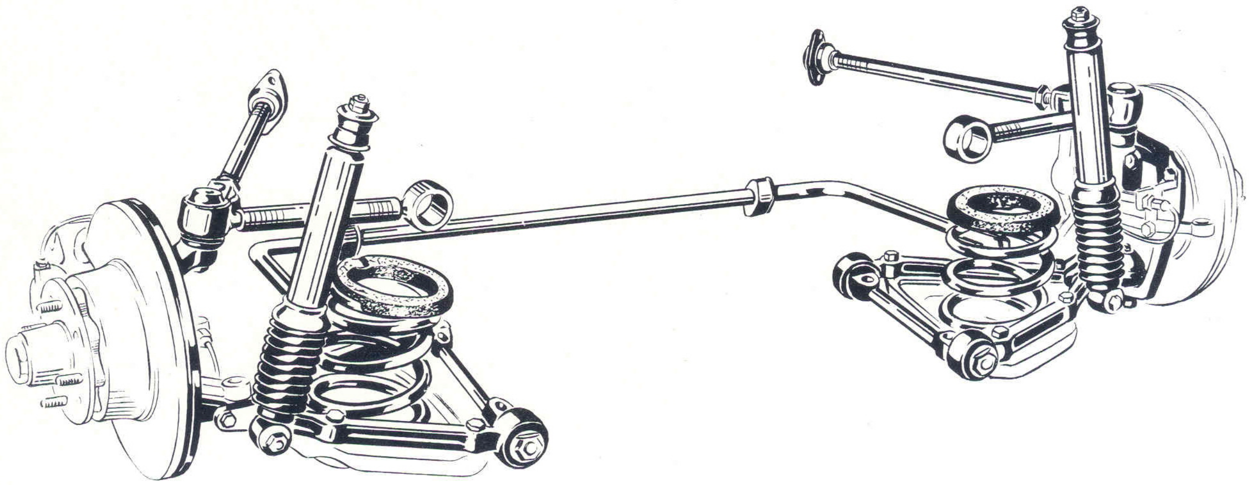


"Moment of a Force" is the product of the magnitude of the force F and the measure of its lever arm OB.
A moment applied to a wheel as outlined above tends to produce or change the wheel motion.



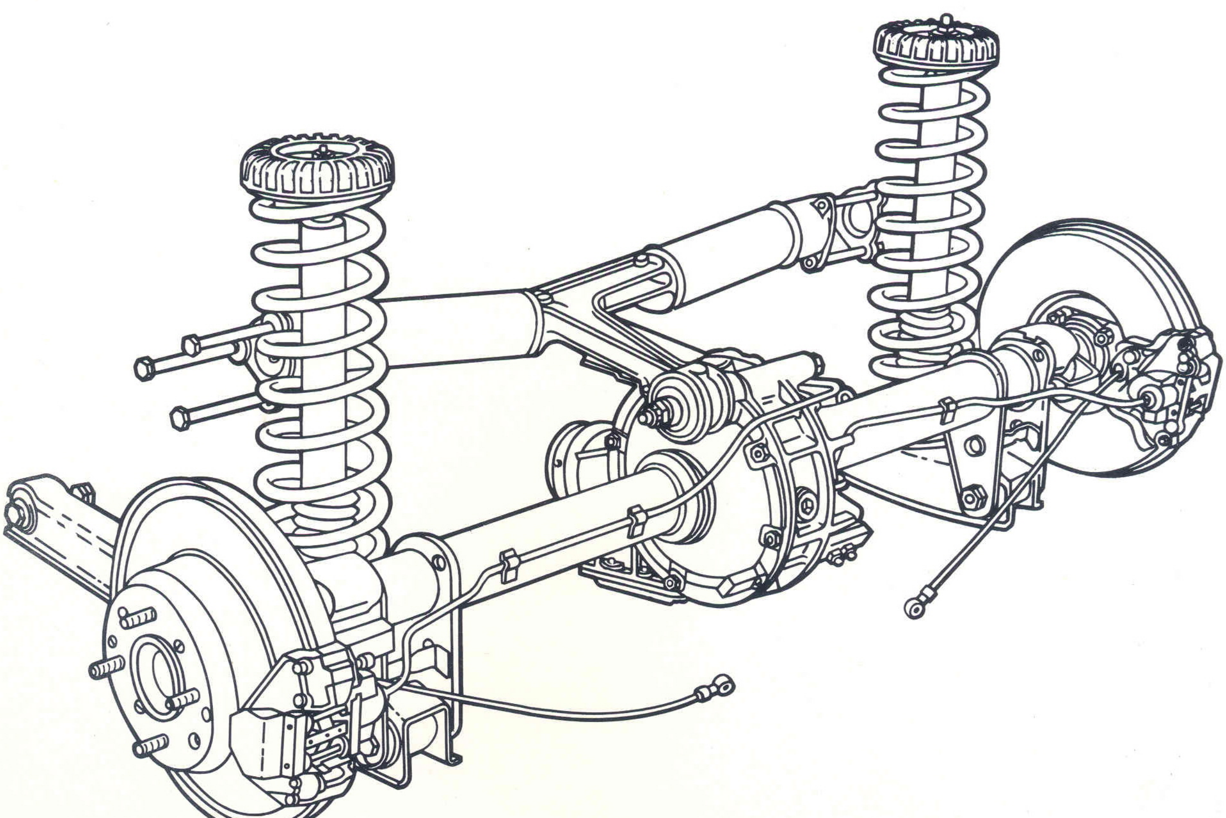
When a wheel is subjected to the action of two forces F and F1, whose moments about the axis are equal and opposite in direction, it remains in a state of balance. To distinguish between the directions of rotation the moments tend to produce, they are written with the sign "plus" when the direction is clockwise and "minus" when the direction is anti-clockwise.

SUSPENSION BEHAVIOUR

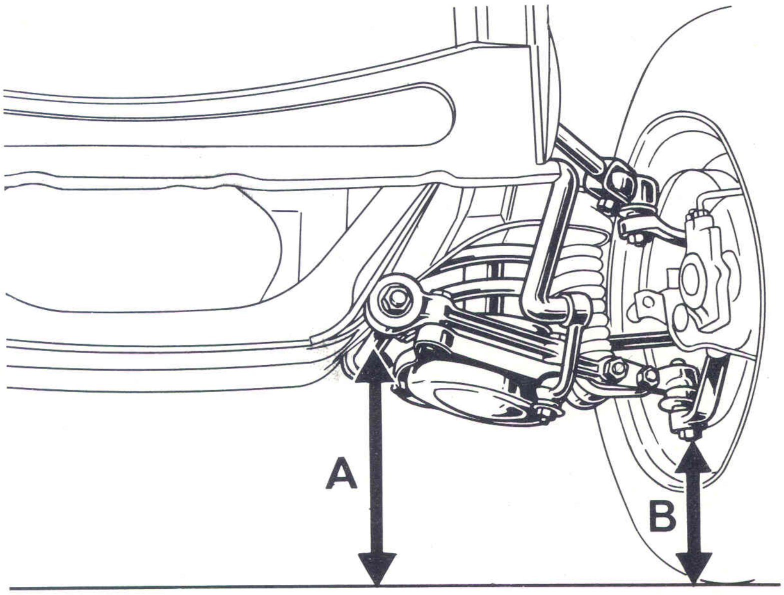


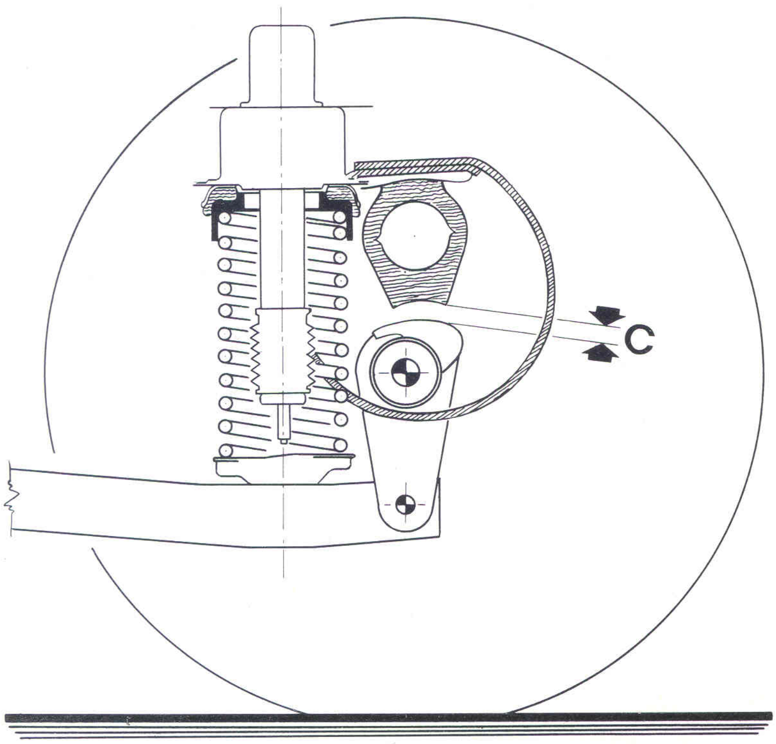
GENERAL

An essential feature of the suspensions dealt with in details in the following pages, is their direct attachments to the body.
Since the angular relationship between the suspension components and the frame varies as the car is moving, there is a number of position the suspension members can take. However, for the purpose of performing the necessary checks and adjustments a well definite position is chosen.



SUSPENSION BEHAVIOUR





CAR TRIM WITH THE ROAD

The car trim is the height of front suspension (dimensions A and B) from the ground or the spring sag (dimension C) at the rear suspension.

These dimensions should fall within the preset limits as checked under suitable loading conditions and with shock absorbers and stabiliser rods disconnected.

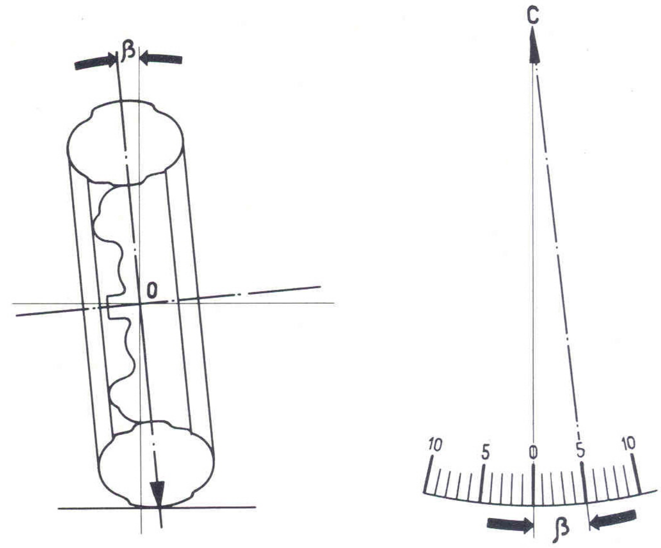
The position of the suspensions in these conditions is hereinafter referred to as "trim" under static load.

There is a close relationship between the car trim and the front wheel alignment; so, if the trim varies the wheel angles also vary.

Therefore, the wheel alignment checks and adjustments should not be performed unless the car trim is as specified.

The regular inspection and maintenance of the front end geometry and car trim will ensure the perfect operation of suspensions both as far as the road holding and riding comfort are concerned.

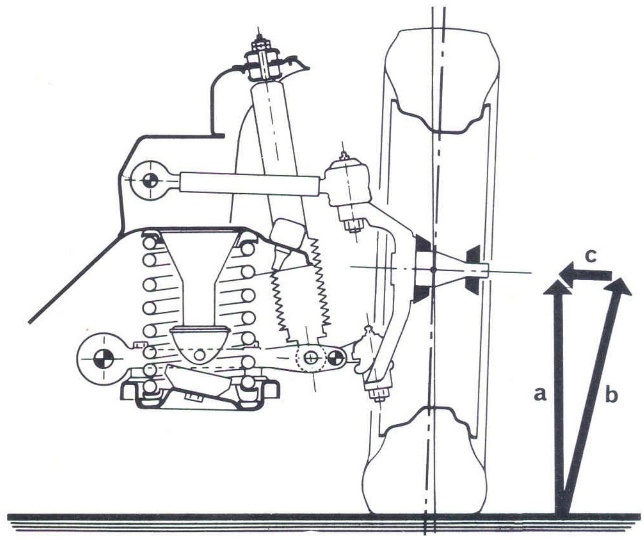
SUSPENSION BEHAVIOUR



CAMBER

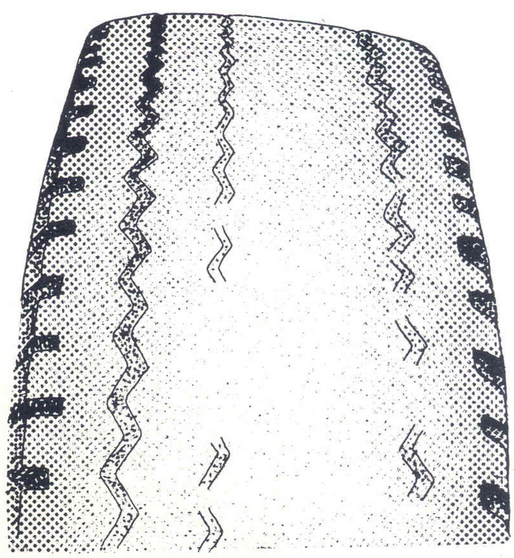
- Positive Camber (outward tilt of wheel top)

The camber angle is the angle β or the amount of wheel tilt measured in degrees from the vertical.



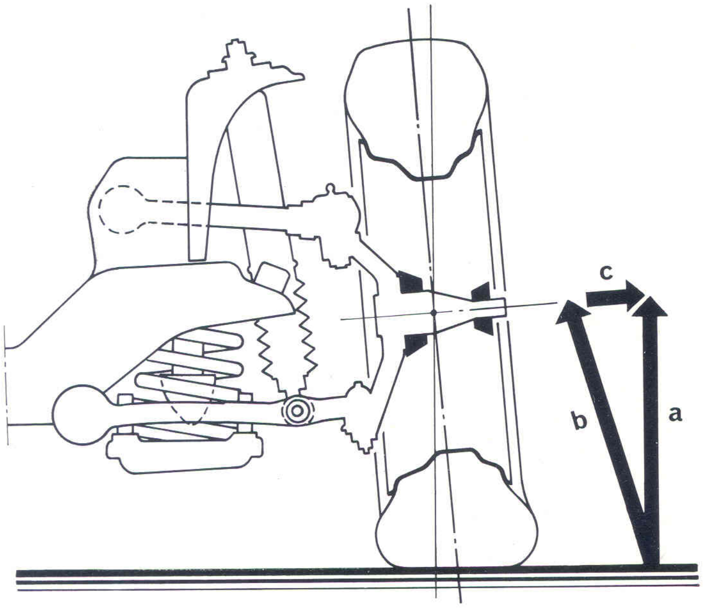
The wheel tilt does not remain constant but varies as the loading and springing conditions of front and rear suspension vary. One of the effects of camber is that of imposing the most of the wheel load on the hub bearing next to the steering axis.

a = load reaction
b = component force at right angle to wheel axis centreline
c = component force along the wheel axis centreline



An excessive camber angle could cause the outside of the tread to wear down especially in conjunction with an incorrect toe-in.

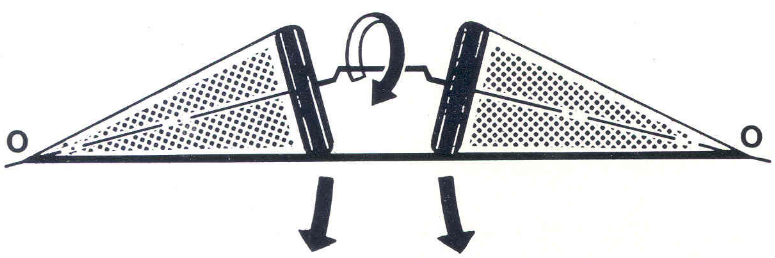
SUSPENSION BEHAVIOUR



- Negative camber (inward tilt of wheel top)

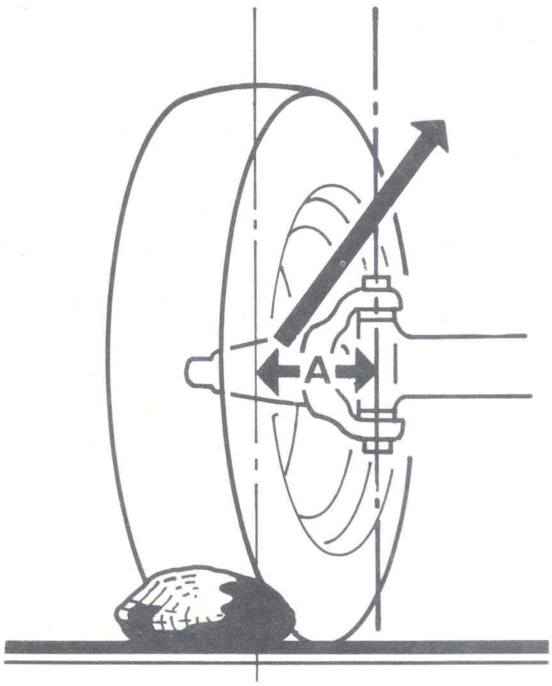
If the camber is negative the wheels have an inward tilt at the top, the majority of the load is supported by the hub bearing farther from the steering axis and the inside of the tread wears excessively.
A wheel with a negative camber tends to slip out of its hub.

a = load reaction
b = component force at right angle to wheel axis centreline
c = component force along the wheel axis centreline.



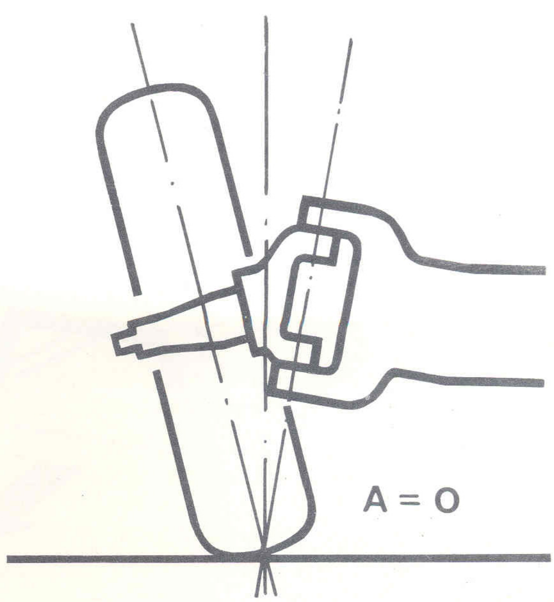
The front wheels when mounted with a camber angle behave like two cones tending to roll around their apex; thereby the wheels have a tendency toward moving apart.
This shows that too great a camber angle could cause the tyres to wear excessively. It is therefore essential that the camber angle be exactly that prescribed by design specifications.

SUSPENSION BEHAVIOUR



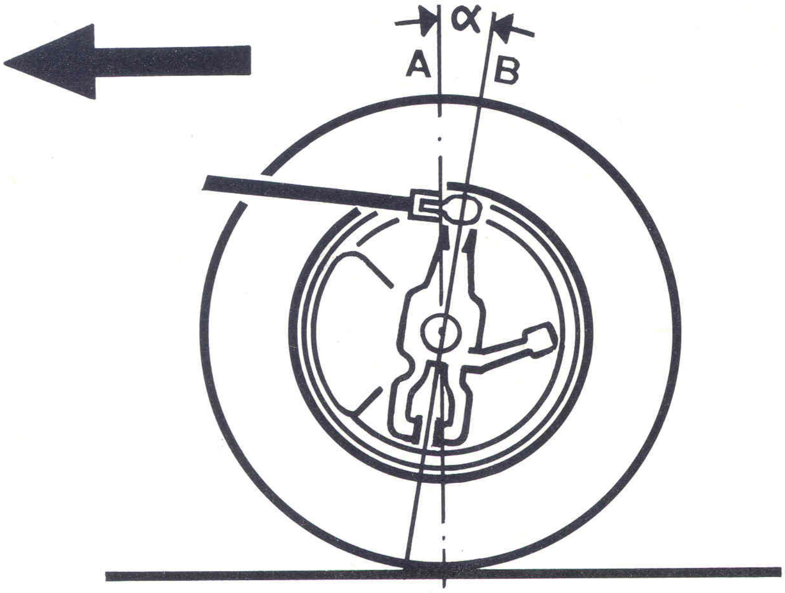
- How camber affects vehicle driving.

The figure shows a wheel with no camber angle.
As the wheel passes over a bump, the shock transfers to the steering gear greatly multiplied by the leverage A.



If the same wheel is so tilted that no more leverage A exists, it will transmit much less of the road shocks.
On Alfa Romeo cars the camber angle cannot be adjusted; however, it is a good rule to check whether the camber angle is as specified.
Actually, the point of intersection A is not at the road surface but slightly below; this means that in actual construction a certain amount of leverage A still exists.

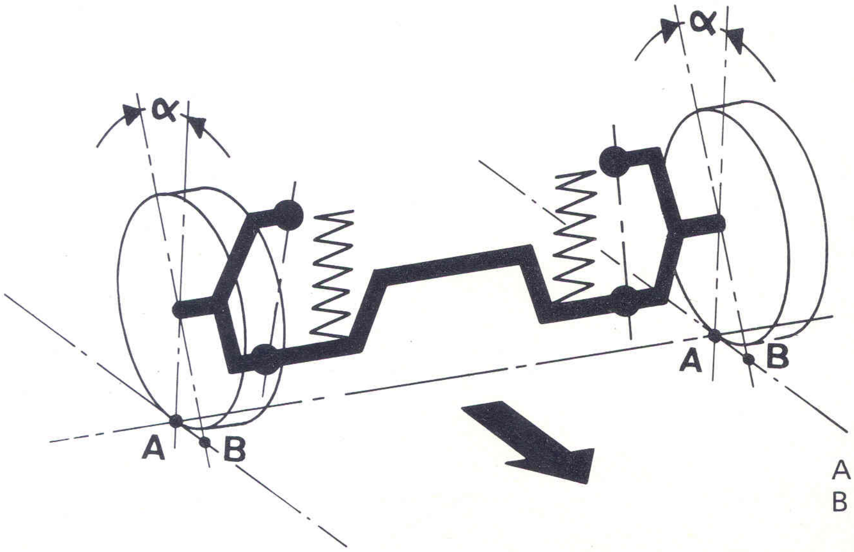
SUSPENSION BEHAVIOUR



CASTOR

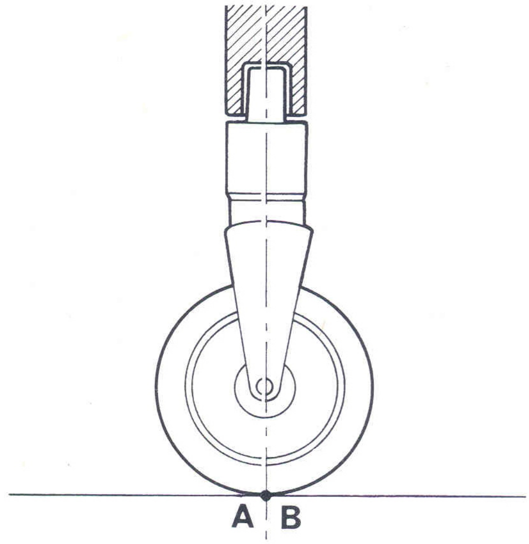
The castor angle α is the backward tilt of steering axis centreline B from the vertical A.
On Alfa Romeo cars the steering axis centreline is the centreline of stub axle ball joints passing through the road surface ahead of the wheel point of contact with the road.
Positive castor aids directional stability since it tries to keep the wheels straight ahead.

On Alfa Romeo cars the castor angle can be adjusted if checks performed with an optical aligner show such a need.
When castor angles are as specified, driving is easy and smooth. Any sideslip tendency can especially be prevented by making sure that the castor angle has the same value both at the near side and at the off side.



A = contact point with road surface
B = steering axis centreline intersection point

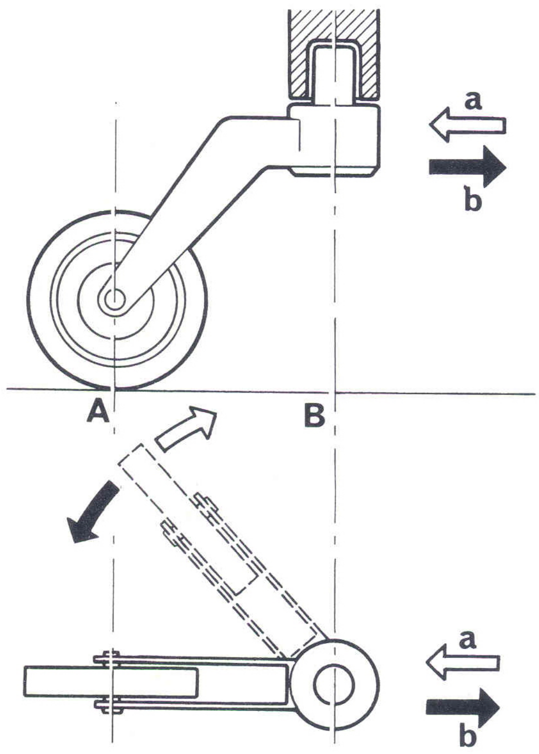
SUSPENSION BEHAVIOUR



For a better understanding of the effects of caster angle, let us consider a table leg wheel and discuss the following three cases:

- No caster angle (A coinciding with B).

  In this case there is no tendency toward recovery so that it is very difficult to keep the wheel straight ahead.

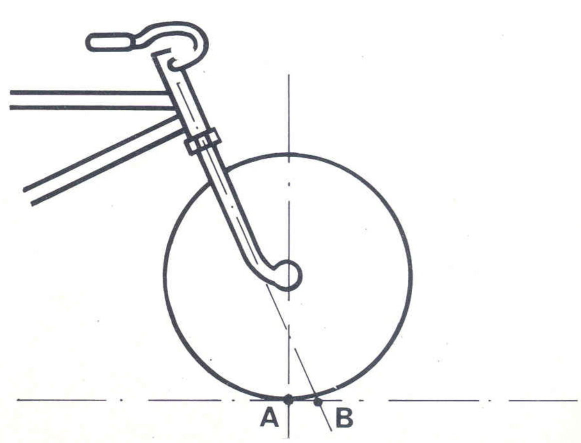


- Negative caster (A ahead of B in the direction "a").

  In this case not only there is no recovery but a reversing couple takes place just from the start.

- Positive camber (A behind B in the direction "b").

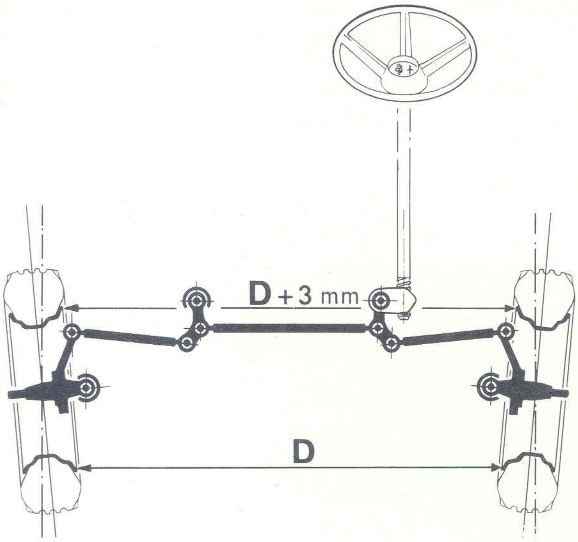
  In this case the wheel has the tendency toward recovery, that is, to "trail behind".



Such a behaviour is like that of the front wheel of a bicycle: the farther the intersection B of steering axis with road surface is ahead of wheel contact point A the more stable the wheel remains in straight forward direction.

The same considerations apply to a motor vehicle (see page 10).

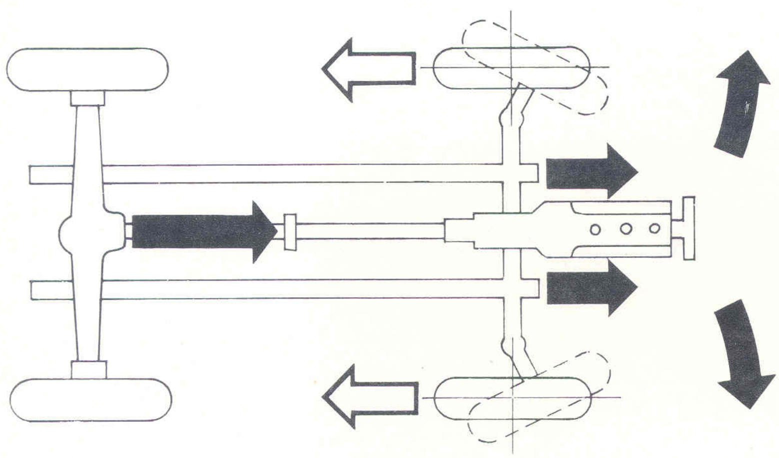
SUSPENSION BEHAVIOUR



TOE—IN

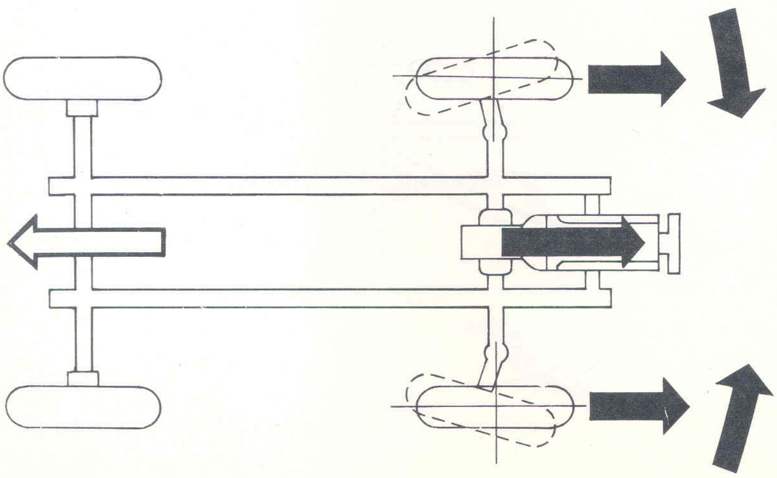
Toe-in is the pointing in of the front wheels which attempt to roll inward instead of straight ahead (rear wheel drive).
Toe-in measurements are also obtained by difference between the tracks as read at the front and at the rear of the wheel rim on a plane passing by the centreline of hubs.

Rear wheel drive:
the front wheels tend to toe aut.



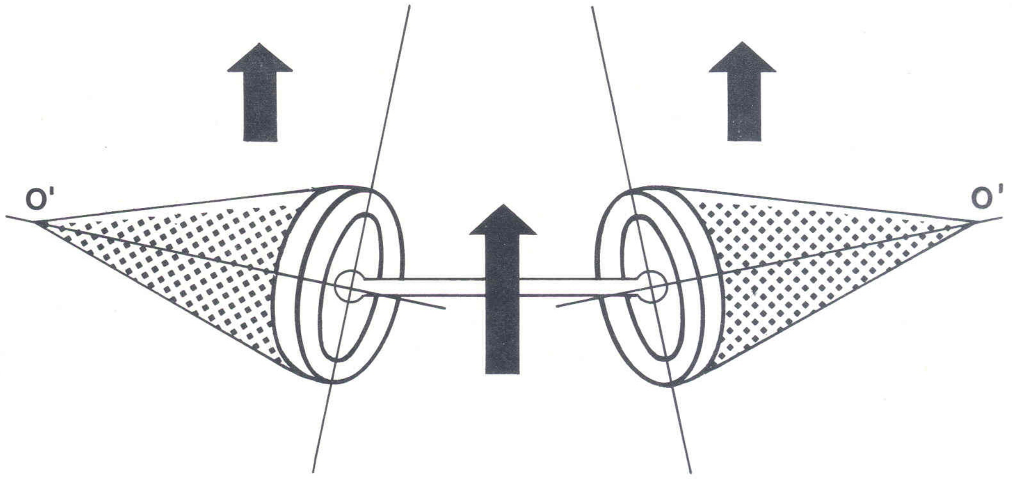
The purpose of toe-in is to ensure parallel rolling of front wheels, to stabilize steering as well as to prevent sideslipping and excessive wear of tyres. The toe in offsets the small deflections which come about when the car is moving forward. In fact, with rear wheel drive, due to the rolling resistance of the tyres on the road, the front wheels tend to roll parallel on the road, that is to toe-out.

Front wheel drive:
the front wheels tend to toe in.

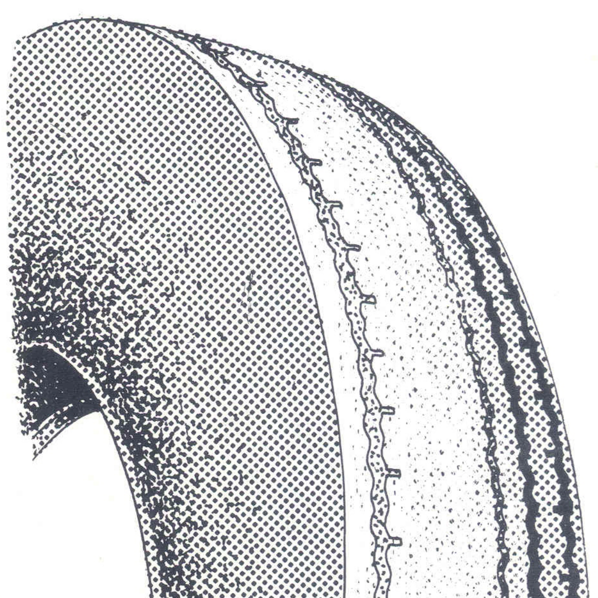


This is also the reason why the front wheels on a front drive vehicle are set to toe-out slightly when the car is standing still. On moving forward, the front wheels, being driving, tend to toe-in due to body resistance to motion.

SUSPENSION BEHAVIOUR

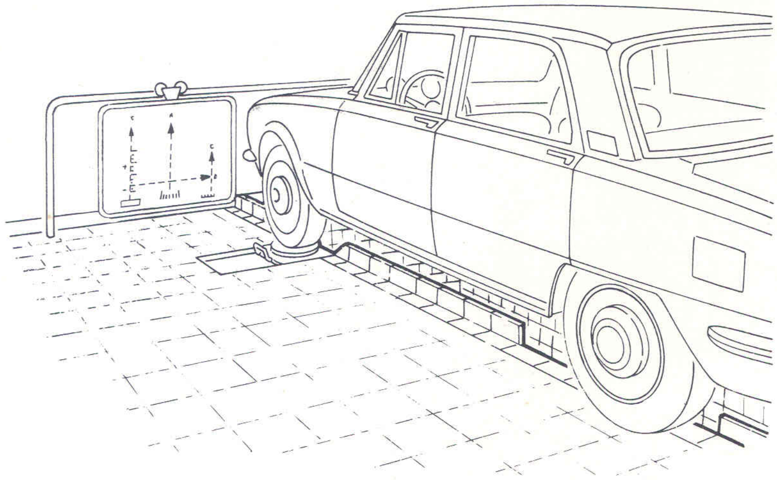


The toe-in allows to compensate for the sideslip tendency due to the camber angle (see page 8). Setting the wheels to toe-in, the two rolling centres O are shifted toward the front so that, in forward motion, the wheels roll parallel.



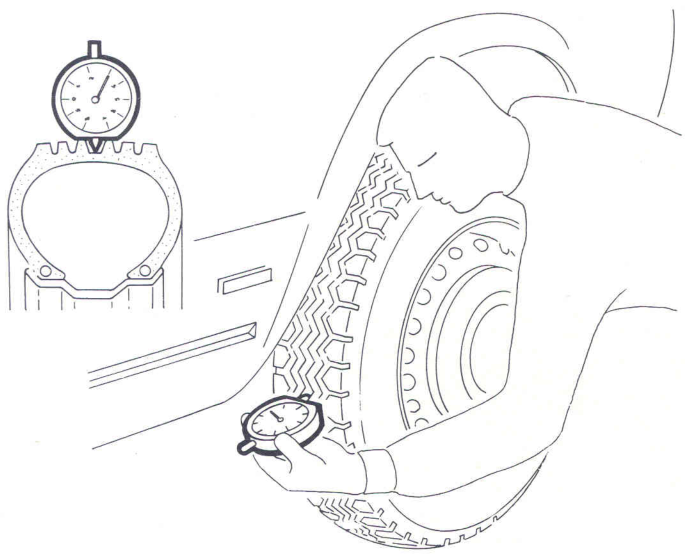
Improper toe-in greatly affects tyre wear.
Feather-edge wear from excessive toe-in.

CHECKING AND ADJUSTING THE CAR TRIM

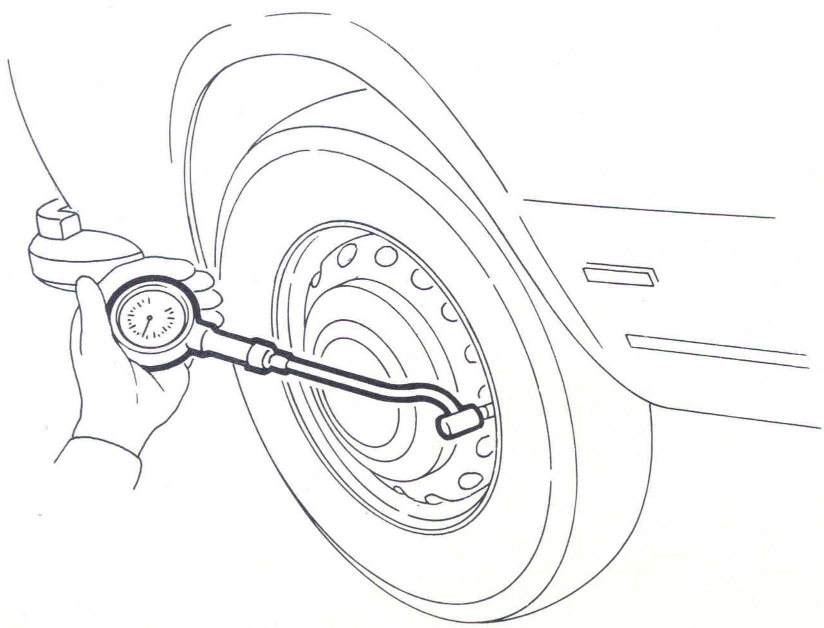


TRIM CHECK PRELIMINARY STEPS.

Carrying out the preliminary steps before performing the "Trim" and "Front end geometry" checking procedure is essential for best accuracy.
Place the car to be tested over a pit (or a four-post lift).



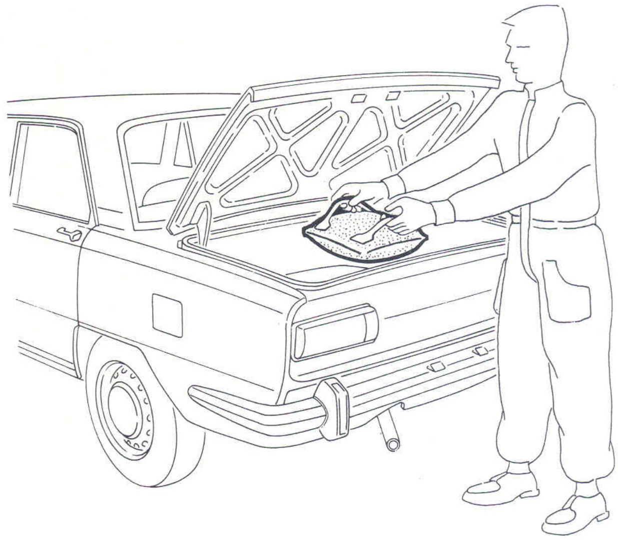
Check tyres for wear with a tread depth gauge. All four tyres should show the same amount of wear.



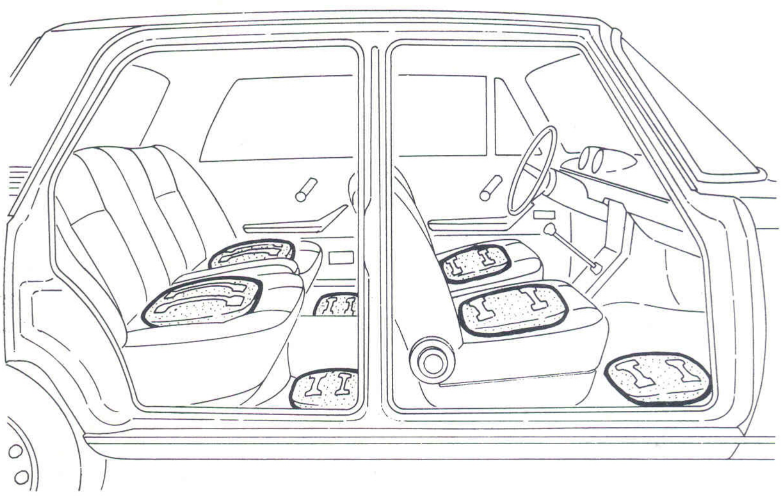
Check that tyre inflation pressure is as specified.

CHECKING AND ADJUSTING THE CAR TRIM

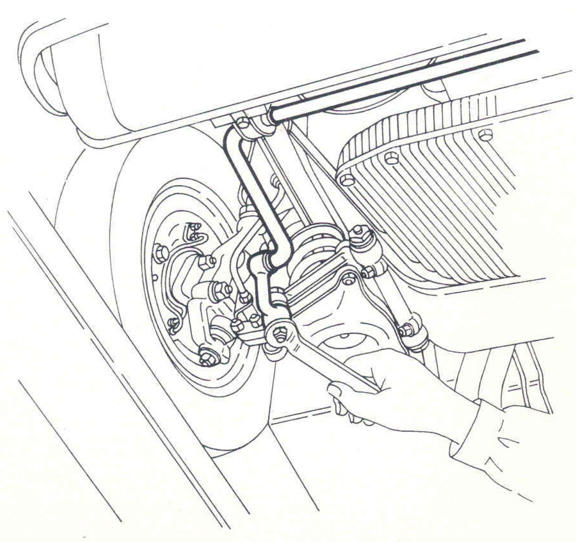
Make sure the spare wheel, the jack and the tool kit are in the boot and that the fuel tank is full; otherwise put a weight in the luggage boot to compensate for the difference in load.

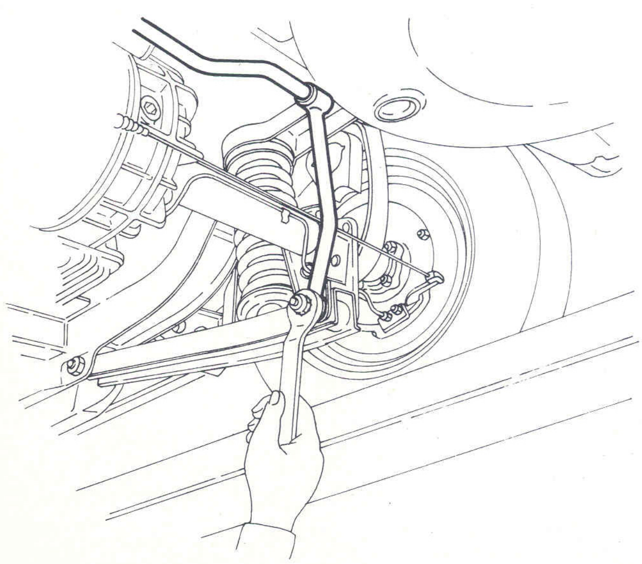


Put the car under static load by placing weights (sand bags or similar) as specified.

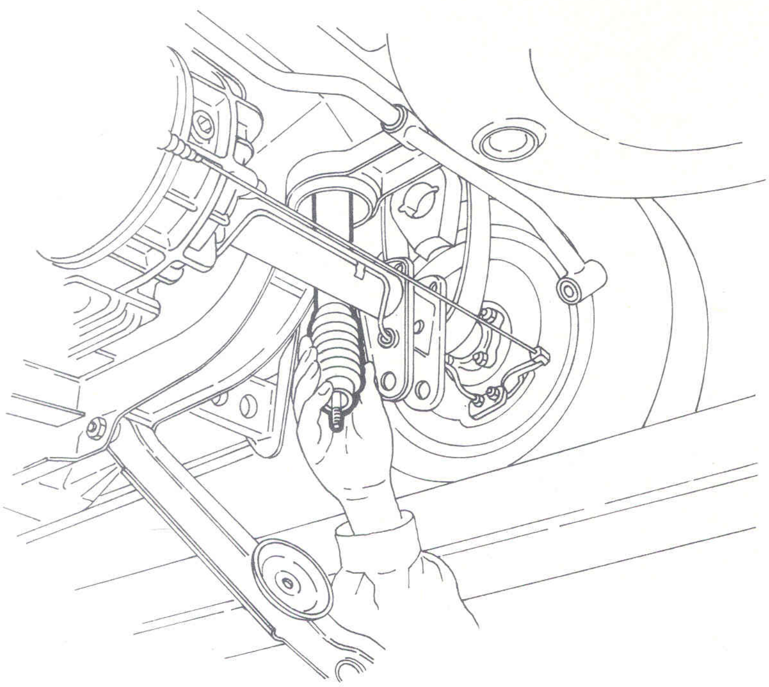


Disconnect the stabiliser rod of front and rear suspensions.

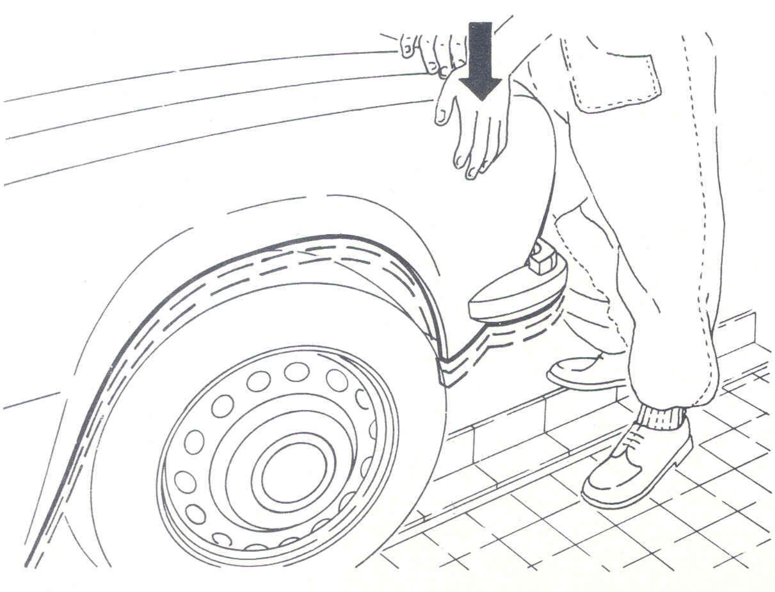




CHECKING AND ADJUSTING THE CAR TRIM

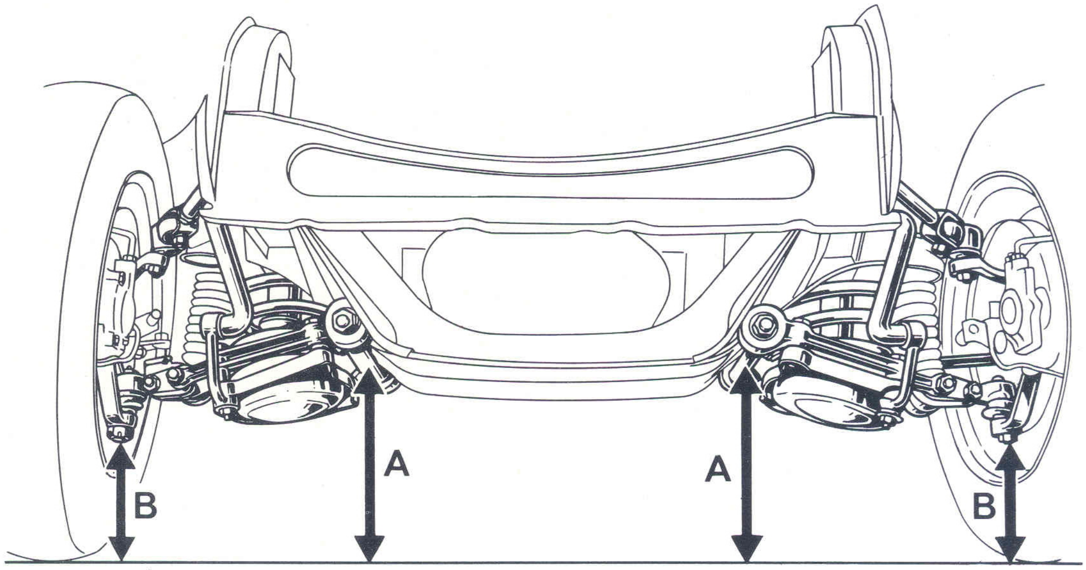


Disconnect the front and rear shock absorbers.



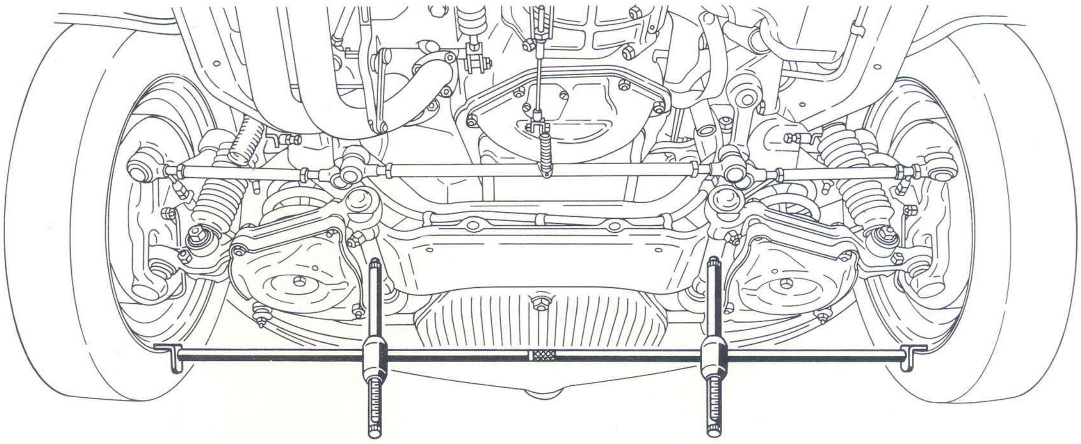
Rock the car up and down at the front first then at the rear to allow the suspensions to take up a static position.
This is a very important requirement if proper results have to be obtained.

CHECKING AND ADJUSTING THE CAR TRIM



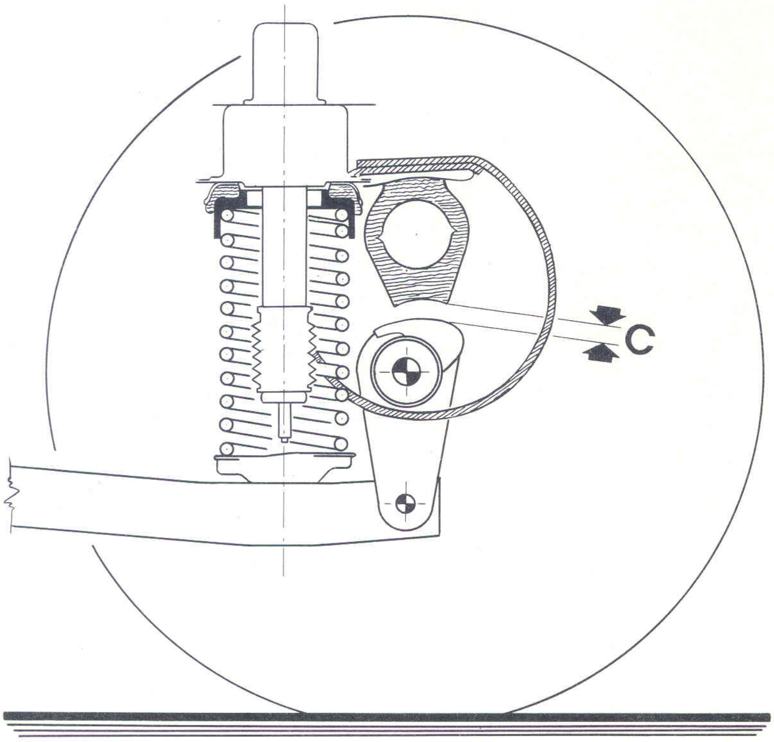
CHECKING THE FRONT END TRIM

The front suspension consists essentially of pivoted members which move up and down as the irregularities of the road are conveyed to them through the wheels.
With the car under static load, the suspension members settle to a well definite position and the suspension springs flex to a sag which can be checked by calculating the difference between the dimension A (distance from ground of lower wishbone shaft) and dimension B (distance from ground of bottom swivel pin).
Only if this requirement is met, the front wheel alignment can be checked and adjusted.



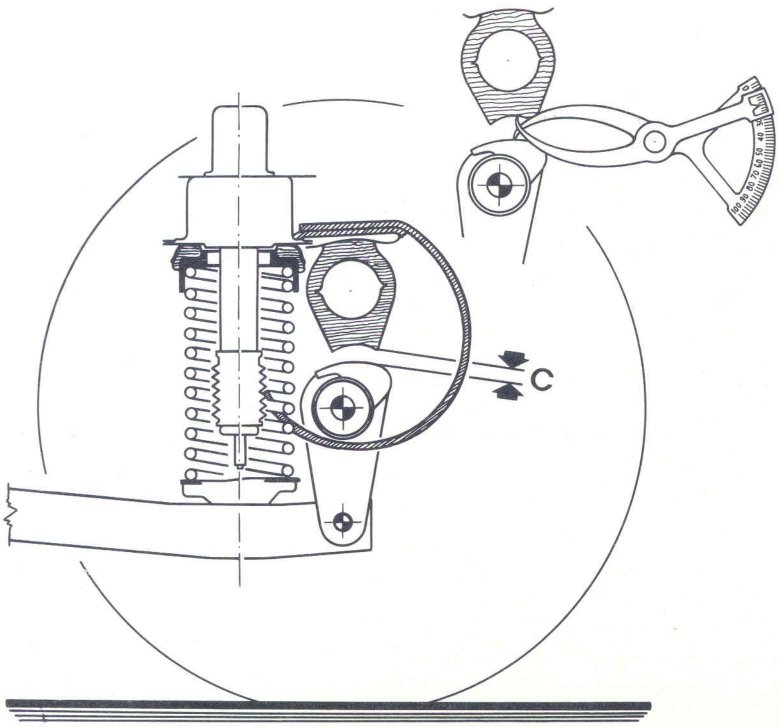
The front end trim can be easily checked with the special tool P.N. C.6.0125, which allows to take direct readings, by means of the suitable rules calibrated in millimetres, of the difference in value between A and B. The values of this difference should be as specified (according to the car model) in the table on page 46 et seq.

CHECKING AND ADJUSTING THE CAR TRIM



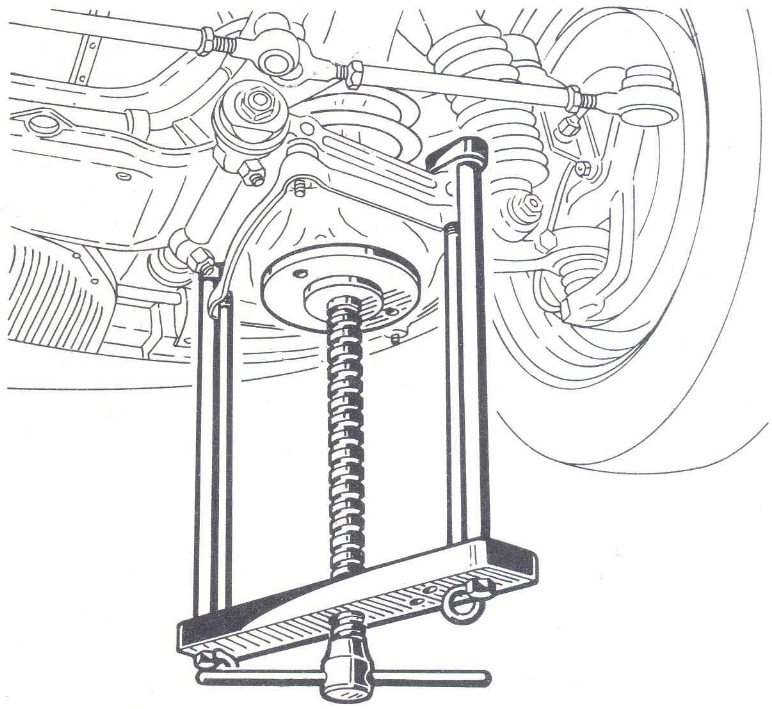
CHECKING THE REAR SUSPENSION SPRING SAG.

The rear suspension consists of a live axle controlled by two trailing arms and a T-arm.
The axle is elastically suspended by two coil springs, double acting telescopic shock absorbers and a stabiliser rod.
The rebound of rear axle is limited by straps and the upward movement by rubber pads.
The distance C between pad and axle housing serves as a reference for spring sag readings under static load condition.



Check with a caliper that the dimension C between rubber pad and axle housing is as specified in the tables on page 46 et seq. according to the car model being tested.

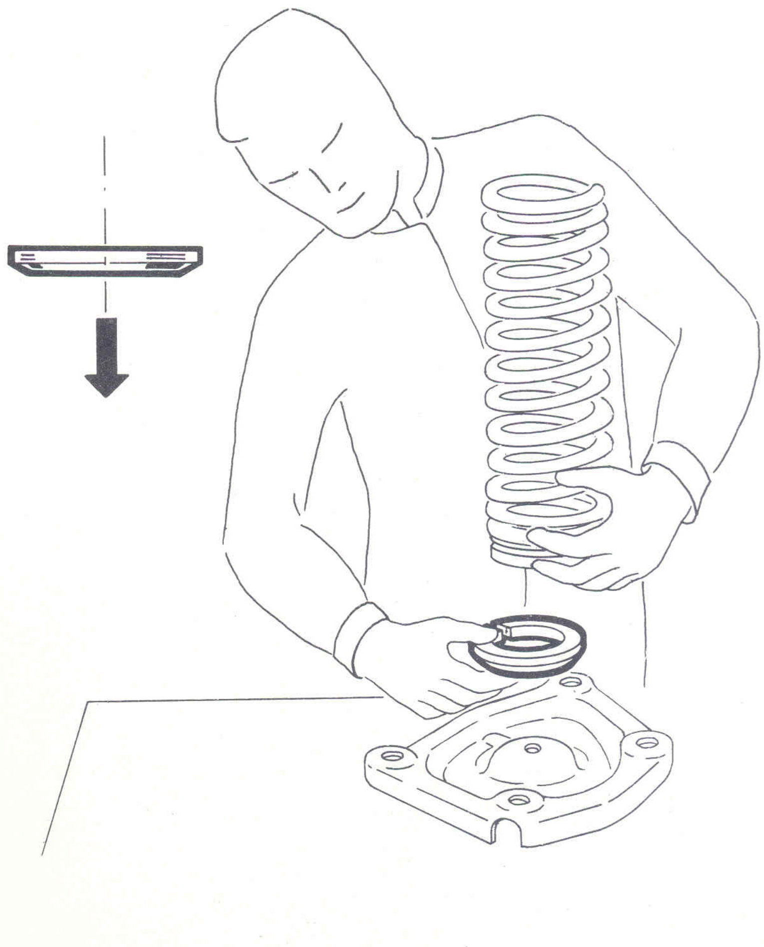
CHECKING AND ADJUSTING THE CAR TRIM



ADJUSTING THE FRONT SUSPENSION SPRING SAG.

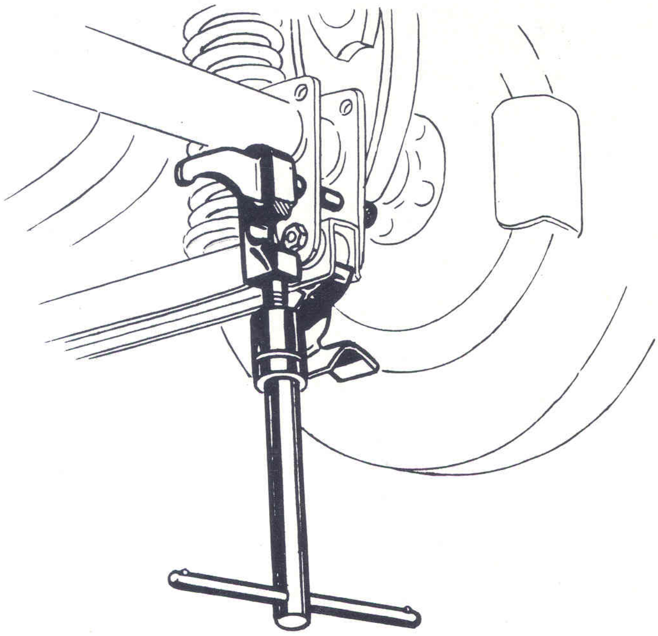
In the event the dimensions A and B (see page 17) are not as specified, bring them within design limits as follows:

- remove the spring with the aid of special tool P.N. A.2.0169;



- add the suitable spacer with the chamfered edge downward;
- refit all parts properly.

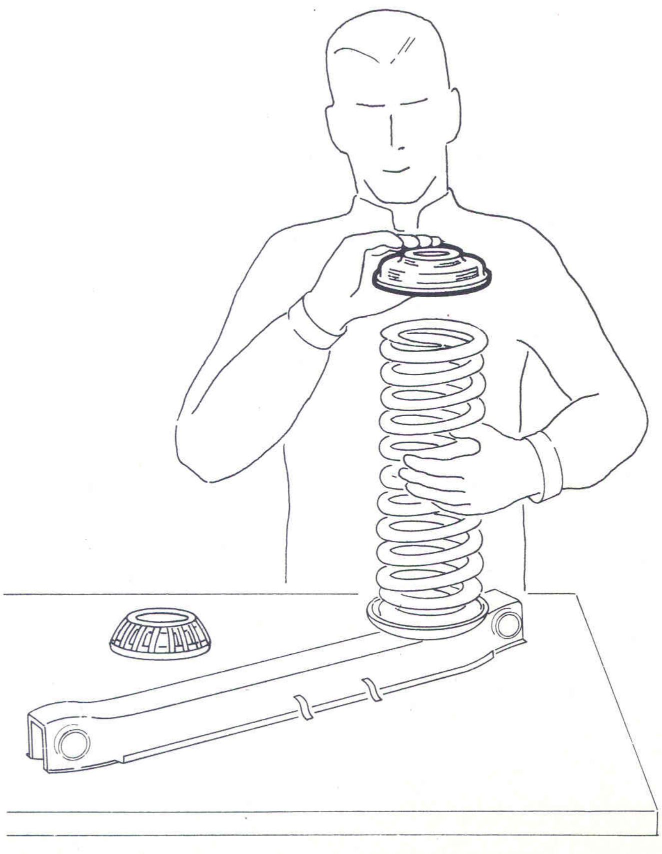
CHECKING AND ADJUSTING THE CAR TRIM



ADJUSTING THE REAR SUSPENSION SPRING SAG.

If the dimension C is not as specified, adjust it as follows:

– remove the spring with the aid of special tool P.N. A.2.0143;



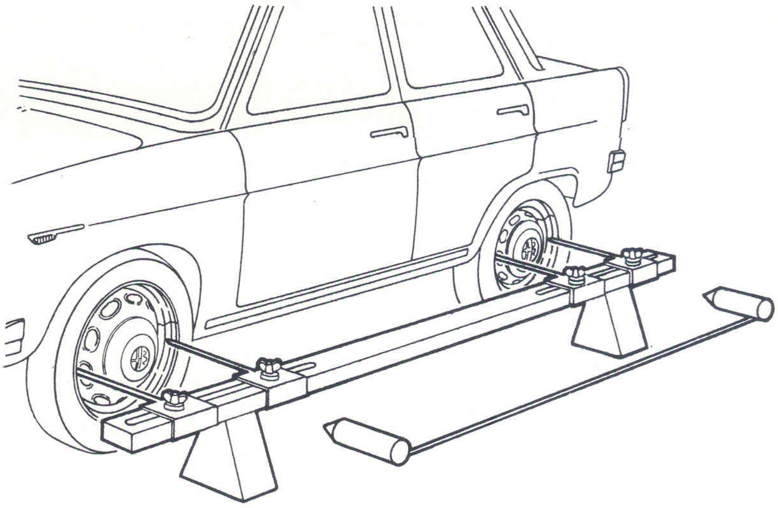
– insert a spacer of suitable thickness between the spring and its seat.

The thickness of spacer should be so selected as to obtain the correct dimension C as specified (see tables on page 46 et seq.) for the affected model.
Then, refit all parts properly.

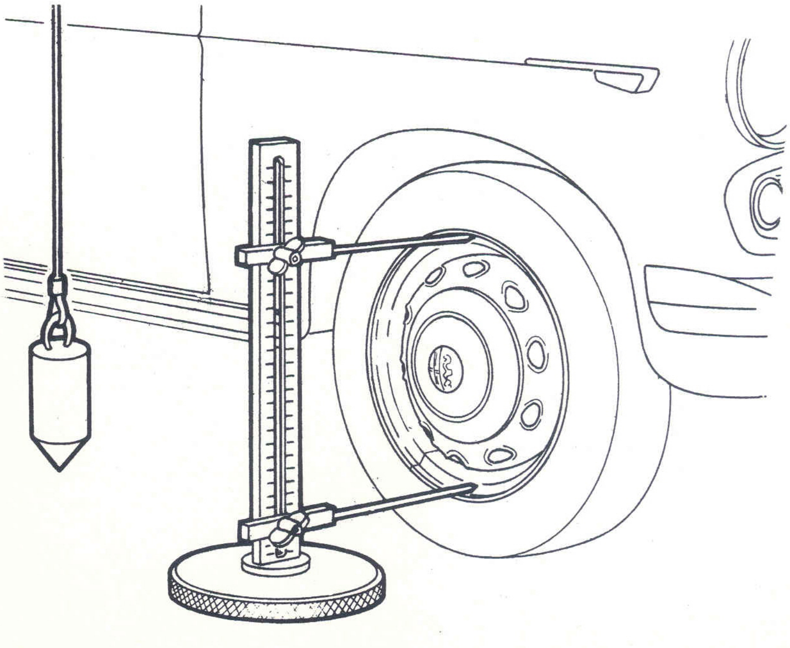
CHECKING THE FRONT END GEOMETRY

SELECTING THE WHEEL ALIGNMENT MACHINES.

The early means used to check the wheel angles were rules and plumb lines or squares. Of course, these procedures could not give accurate measurements, so there has been a constant endeavour to improve the wheel alignment machines and now the trend is toward optical aligners.

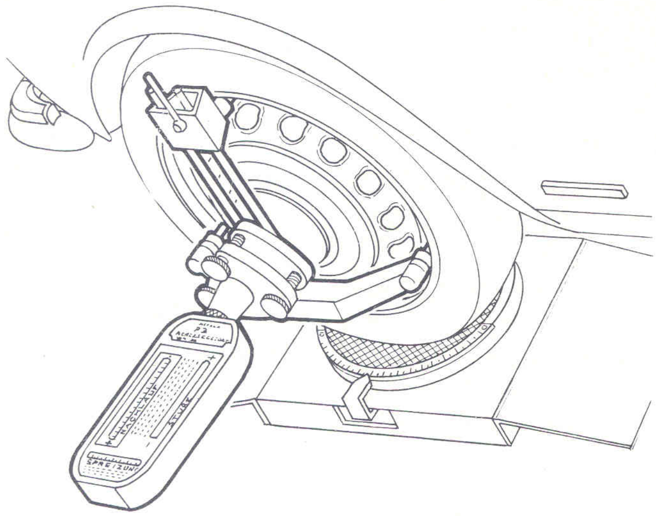


This figure shows how toe-in readings can be taken by means of a rule.
The rule, on suitable stands, is so aligned that the pointers just touch the rim of both front and rear wheels.
Approximate readings can then be taken of the wheel tracking and the front wheel toe-in.



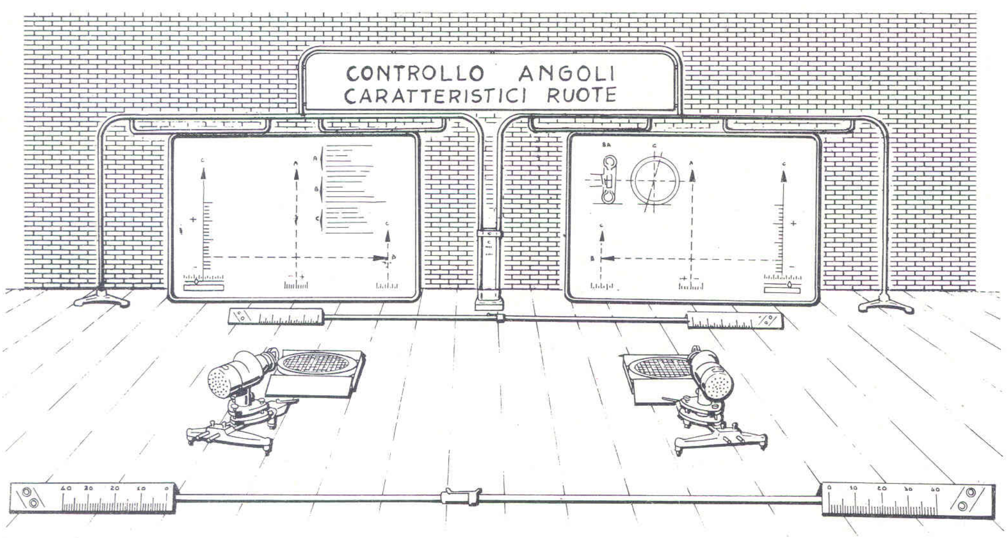
The figure shows a device for measuring the values of camber angle.

CHECKING THE FRONT END GEOMETRY

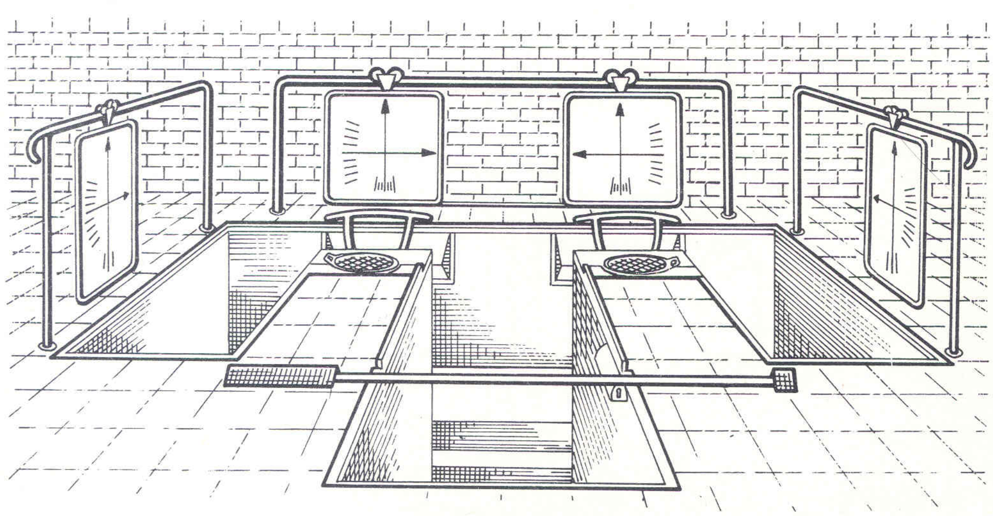


WHEEL ALIGNMENT TESTERS

These wheel aligners take measurements by means of level measuring devices such as spirit levels or similar. The position of the bubble in the spirit level shows the angle reading against a template calibrated according to the camber angle of wheels. The figure shows one of the many types of aligners used by workshops.



— a paneles colocados frontalmente



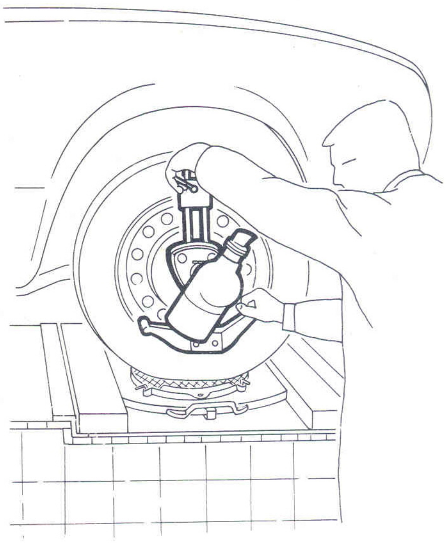
— a paneles colocados lateralmente

- Projection type aligner.

There are many types:
- target screen type to be placed at a given distance both at the front and at the sides of the car;
- reflection type with mirrors.

The alignment tester should be so selected as to comply with easy and fast handling requirements.
The directions given in the following pages covers a type of equipment commonly used by the repair shops of Alfa Romeo Dealers in these two versions:
- with screens at the car's front;
- with screens at the car's sides.

CHECKING THE FRONT END GEOMETRY

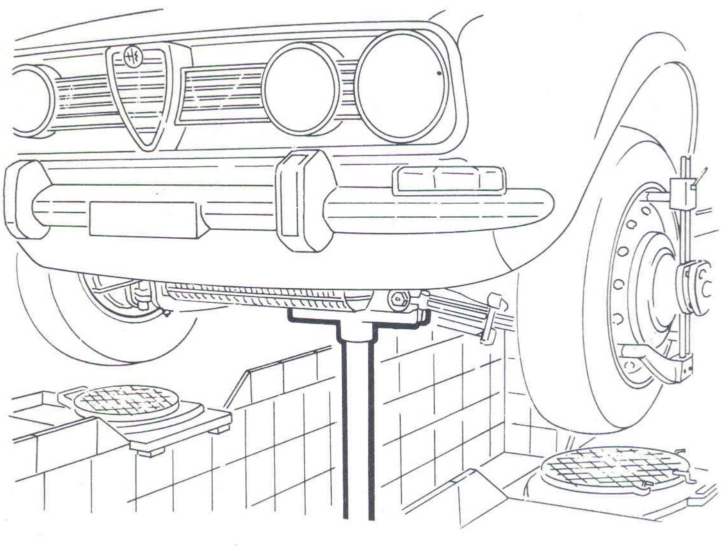


DETECTING BENT WHEELS.

- Preparatory steps.

It cannot be overemphasized the importance of carefully performing these preliminary checks; therefore, the directions given below must be strictly followed.

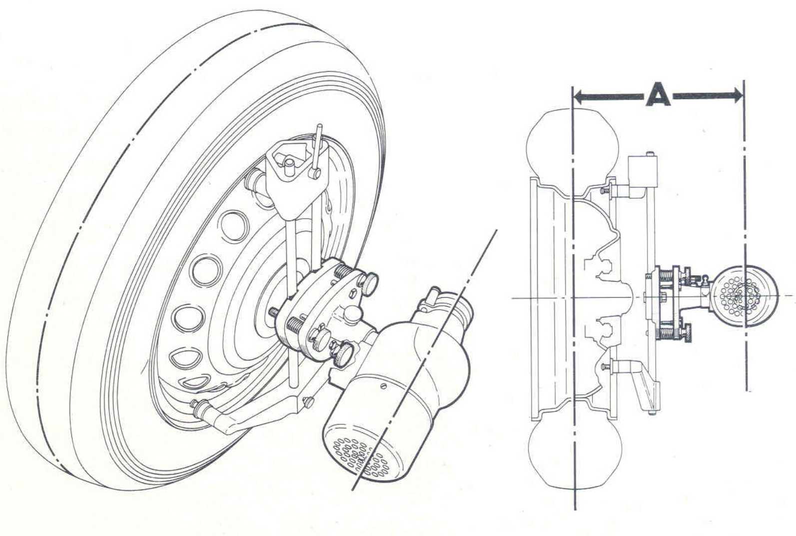
– Drive the car over the alignment rack (screens at the front) and position the front wheels straight ahead on turntables.
– Place one of the bars with scales at the prescribed distance, i.e. three times the diameter of wheel rim of car being tested; with this arrangement the readings as taken on the scale correspond to millimetres.
– Mount the projector onto the wheel as shown making sure the adapter fits securely the rim.
– Raise the front wheels until they can be revolved freely.



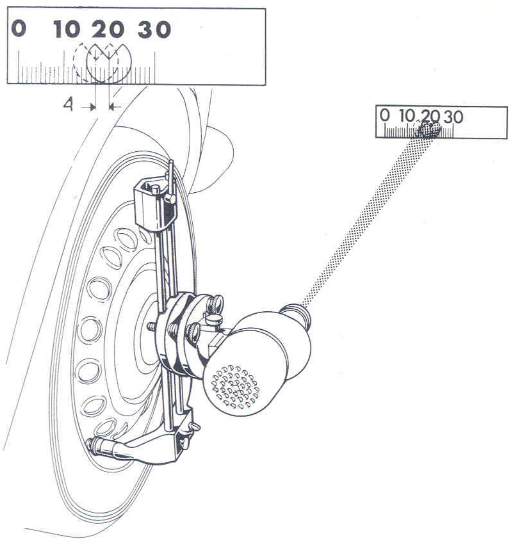
- Detecting rim buckle

The projector should be positioned in such a way that its centreline must lie in a plane parallel to that of wheel rotation. The illustration shows the projector as installed, parallel with wheel rotation plane and apart from it of the distance A.
Actually, this arrangement is obtained as follows:

– bring the projector to the centre of the wheel taking care to shift the mirror so that the projection is not prevented.
– Tighten in place the three thumb screws so as to set properly the mounting flanges.

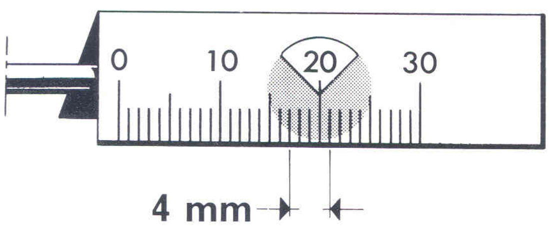


CHECKING THE FRONT END GEOMETRY



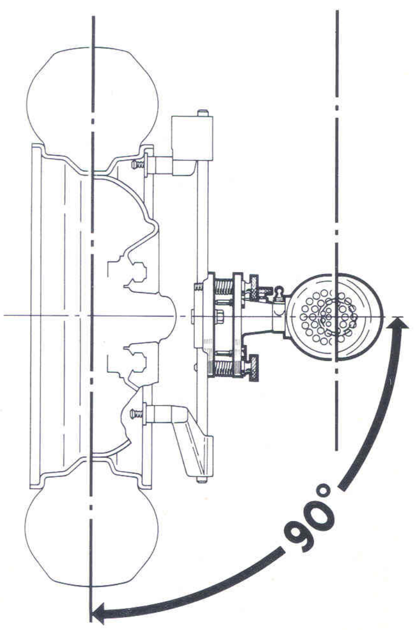
– project the light beam onto the scale.
– turn the wheel slowly taking care to keep the projector so directed as to aim the beam constantly at the scale.

The span covered by the pointer of the beam in its movement will indicate the maximum run out of wheel. When the pointer is at its maximum reach outward, the tyre should be chalk marked accordingly.



For example:

If the pointer is aimed at 20 and then it oscillates between 17 and 21, this means that the rim run out is 4 millimetres. Hence, the chalk mark on the tyre must be made in that position where the pointer is at its maximum reach outward, i.e. 21. Should the run out exceed the specified limits (3 to 4 mm), the rim must be changed before performing the subsequent checks.



- Calibration against errors from run out.

To neutralize the error that, introduced by run out even if falling within tolerances (3 to 4 mm), may impair the accuracy of subsequent readings, it is essential that the plane in which the beam lies be at right angle with the wheel axis centreline as if the wheel were running perfectly true.

This condition is obtained as follows:

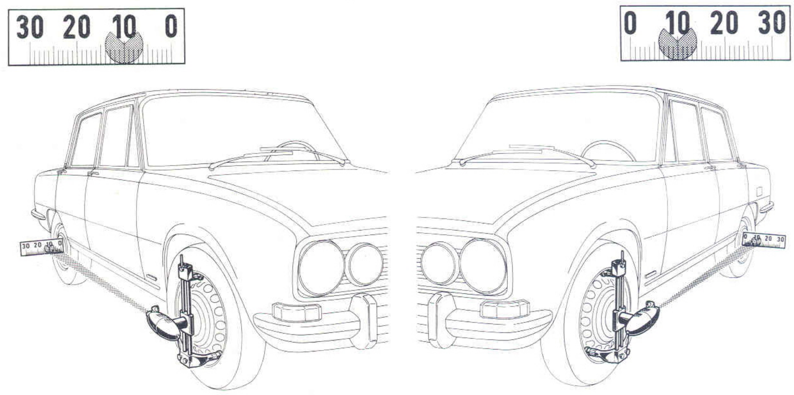
– direct the pointer at a figure on the scale (e.g. 10) and, holding the projector stationary, slowly rotate the wheel;
– the pointer will swing horizontally reaching out a maximum either side; keep a record of these limits and mark the tyre as outlined above;
– loosen the three thumb screws starting from which next to the mark until the projected pointer is aimed at the average value between the min. and max. readings previously recorded. If the outward reach was 13 and the inward 9, the average is 11. Repeat the procedure until the pointer remains steady on 11.

Doing so will bring the outer mounting flange and consequently the rotation plane of the projector at right angle with the wheel axis centreline. This calibration does away with the error introduced by the rim run out in the front wheel alignment tests.

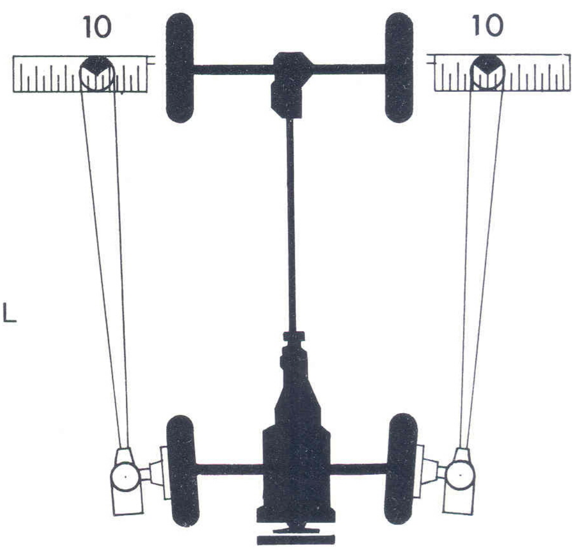
CHECKING THE FRONT END GEOMETRY

CHECKING AND ADJUSTING THE WHEEL "TRACKING".

Wheels properly "tracking" is an essential requirement if accurate results have to be obtained when checking the toe-in.
With the steering wheel spokes balanced for straight ahead direction, make sure the turntables are free, then proceed as follows:

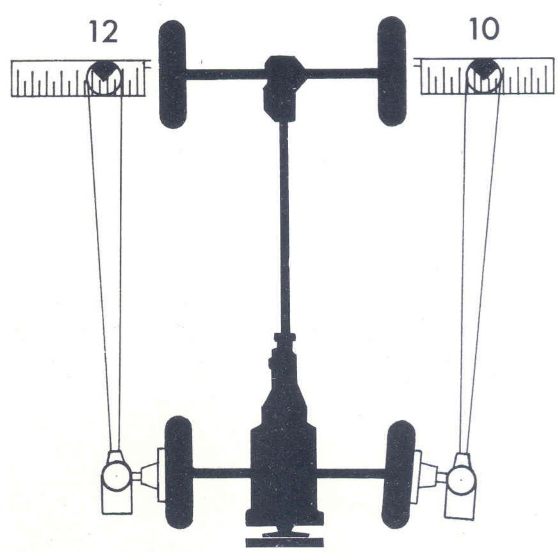


- place two scales at right angle with the rear wheels in correspondence of their centreline;
- bring the projectors to the centres of the front wheels;
- aim the beam from the projector on RH front wheel at the scale on the respective rear wheel and take the reading;



CORRECT WHEEL "TRACKING"

- Repeat the procedure for the wheels at the L.H. side.

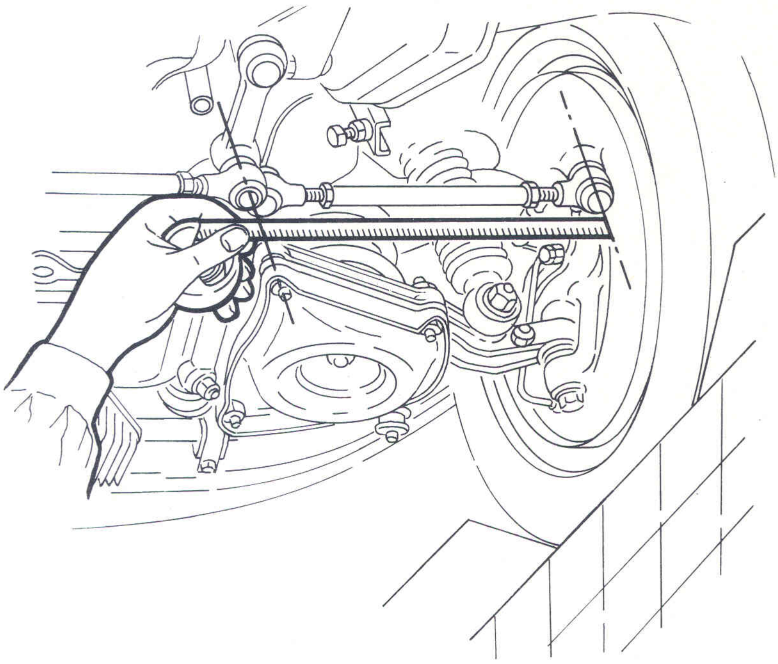


WRONG WHEEL "TRACKING"

If the wheel tracking is correct, the readings shall be the same on both scales.

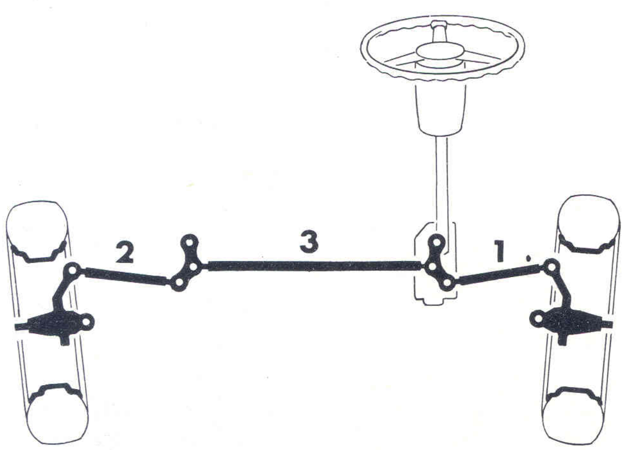
If the readings are unequal, the wheel tracking requires adjustment.

CHECKING THE FRONT END GEOMETRY



The procedure to restore the condition of wheel properly tracking is the following:

- measure the side tie rods 1 and 2 to check whether their lengths are in accordance with the specifications given in the tables on page 46 et seq. If not, adjust the side rods, then:
- act on the track rod 3 until the readings on the two scales are equal.



CHECKING THE FRONT END GEOMETRY

CHECKING AND ADJUSTING THE CASTOR ANGLE

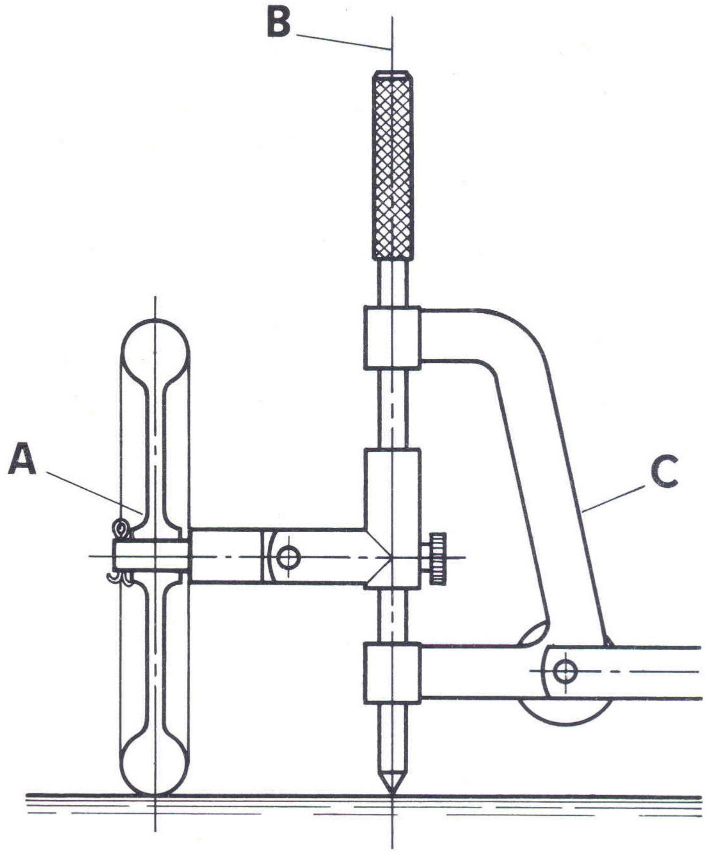
- Introduction

For a best understanding of the meaning of castor angle readings taken with wheel alignment testers, let us take a close look at some angular relationships between the positions of the wheel in its movements around the steering axis, which, in its actual installation on the suspensions, has the following setting:

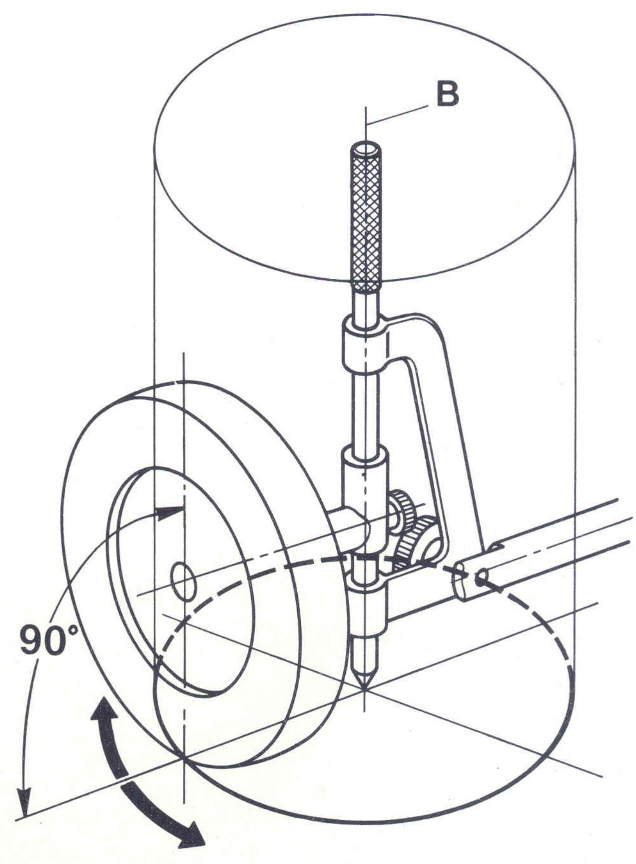
— castor angle (see page 31)
— camber angle (see page 36).

In this structural model of a suspension, let us consider three elements:

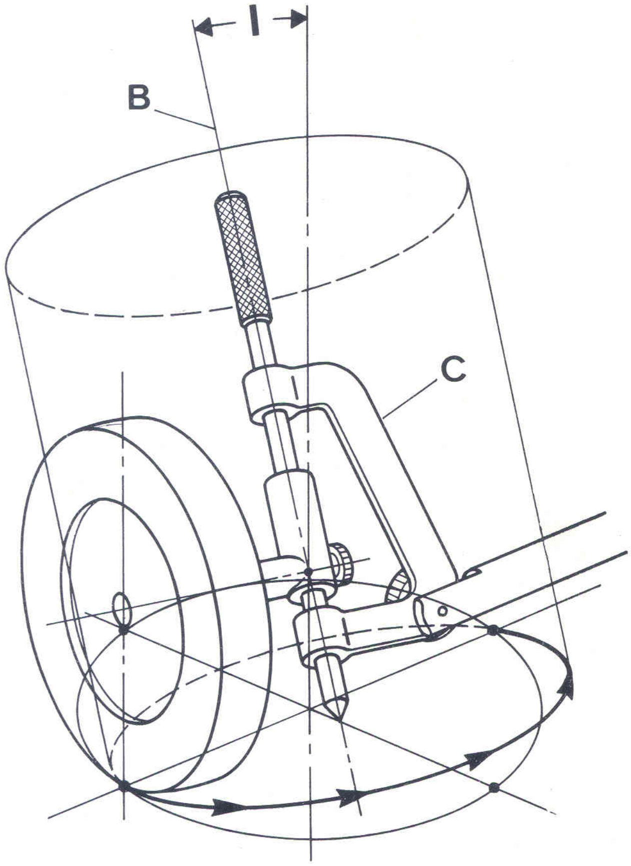
— A wheel and stub axle;
— B steering axis
— C jointed support of steering axis.



If these elements are so arranged as to render nil the castor and camber angles and the wheel is then steered in either direction around the axis B, the wheel will remain at right angle to the ground as it was initially, like if it were going round a cylinder whose axis is B.
Its track on the ground will be a circumference.



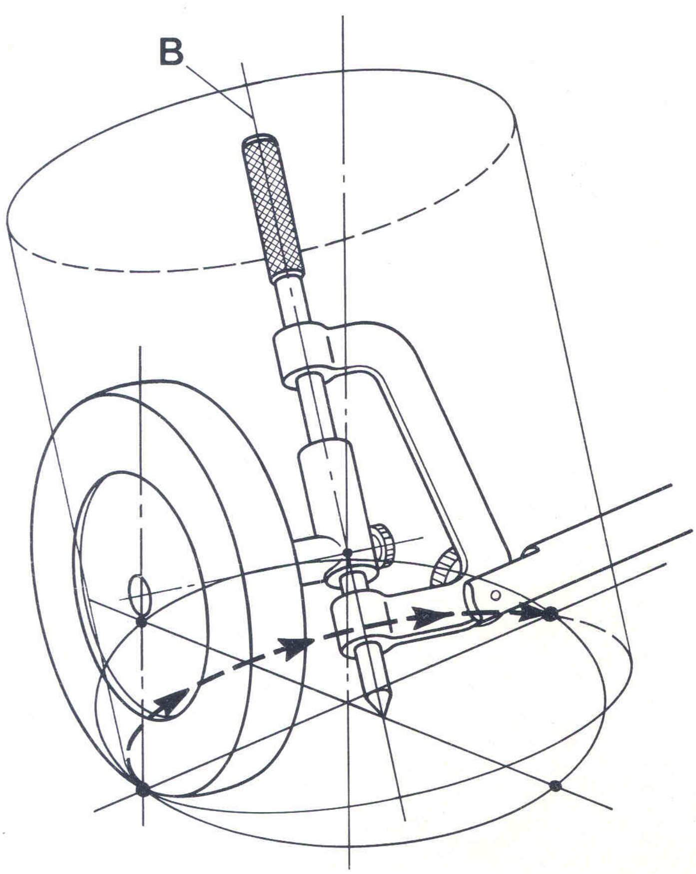
CHECKING THE FRONT END GEOMETRY



If the jointed support C is then tilted in such a way as to give the steering axis B a positive castor angle I in a plane parallel to the wheel, the behaviour of the wheel will be different. Again steering the wheel around the axis B, the following conditions will take place:

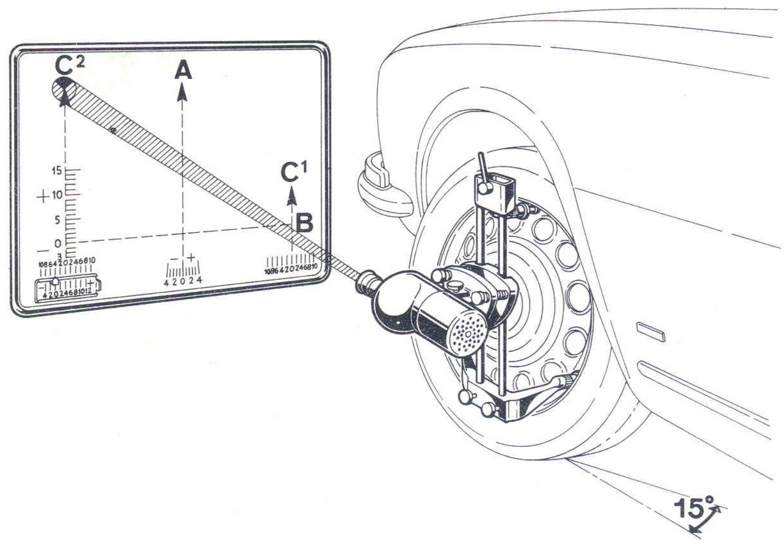
– At the starting point the wheel is parallel to the axis B, rests on the ground and lies in a vertical plane.
– As the wheel is rotated in the arrow direction it tends to lift from the ground and owing to the inclination of axis B deviates from the vertical.

Actually, in the car, the wheel cannot be lifted, prevented in that by the car's weight; instead, the side of the car drops. The wheel, however, as a consequence of its rotation around the steering axis, takes up a negative camber (see page 8).
On the model this angle, that with the axis B parallel to the wheel and the latter steered by 90 degrees, is equal to the castor angle I, varies, as the wheel is steered, from O degrees through all intermediate values up to the caster angle I. Actually on the vehicle however, even with the wheel brought in conctact with the ground, the camber angle will not vary since the angular relationship between wheel and frame remains unchanged.

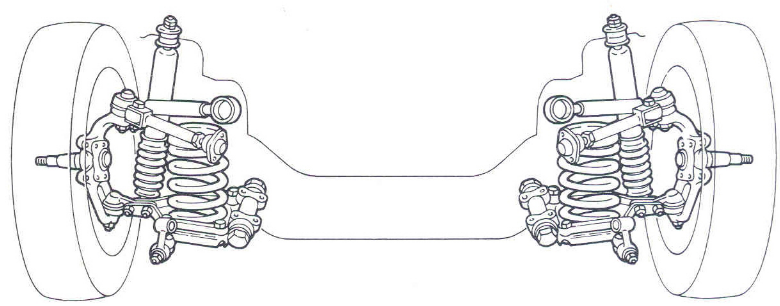


Rotating the wheel in the other direction around the axis "B", it tends to move down the road surface. When actually rolling on the road the wheel cannot move down, therefore the car body is actually lifted and the wheel tilted of an amount (positive camber) which reaches its maximum at 90 degrees to become again nil at 180 degrees.

CHECKING THE FRONT END GEOMETRY

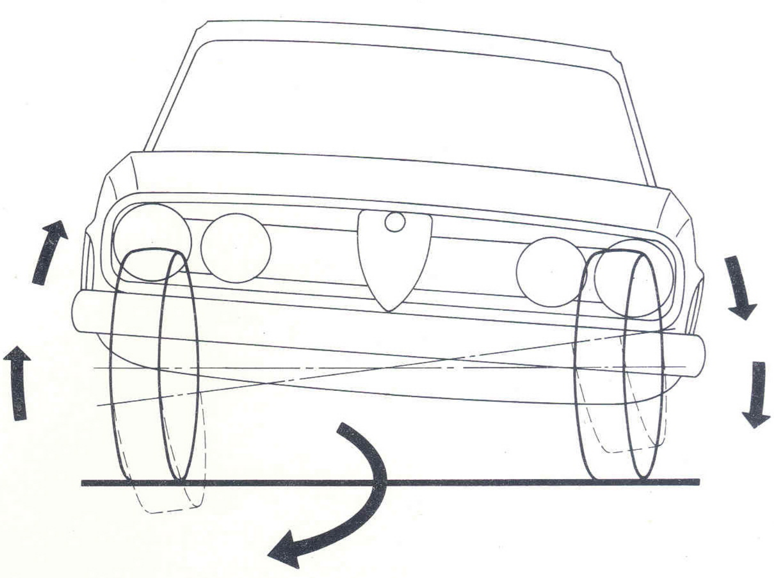


It is precisely on the basis of this relationship between the angle of axis B and the inclination of the wheel, that the value of the castor angle can be determined by wheel aligners of the projector type with screens at the front, even if in practice the readings taken relate rather to the camber angle of the wheel.



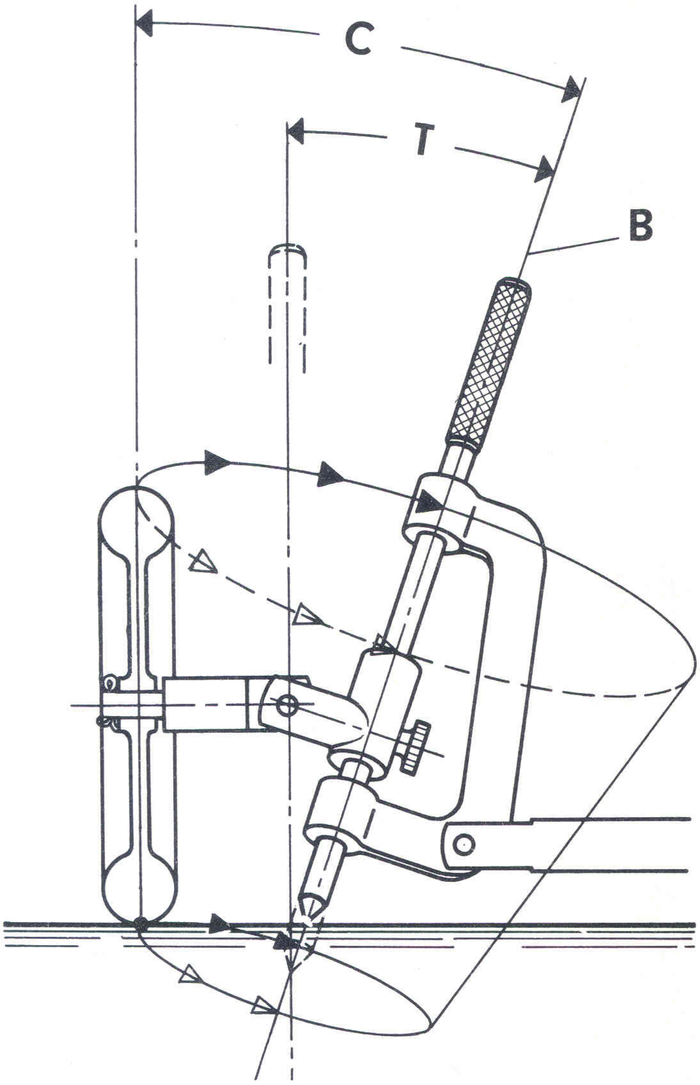
Further, notice that:

- On a straight course the position of the suspension and the two wheels is symmetrical as shown.
- On a turn, a condition like that previously outlined takes place.



On a turn, as the inner wheel is tilted in a positive direction, the car lifts partially while, as the outer wheel is tilted in a negative direction, the car drops partially (refer to page 28). This reaction, together with that exerted by the steering axis inclination, will enable the wheels to seek automatically the straight ahead direction as outlined further in the following page.

CHECKING THE FRONT END GEOMETRY



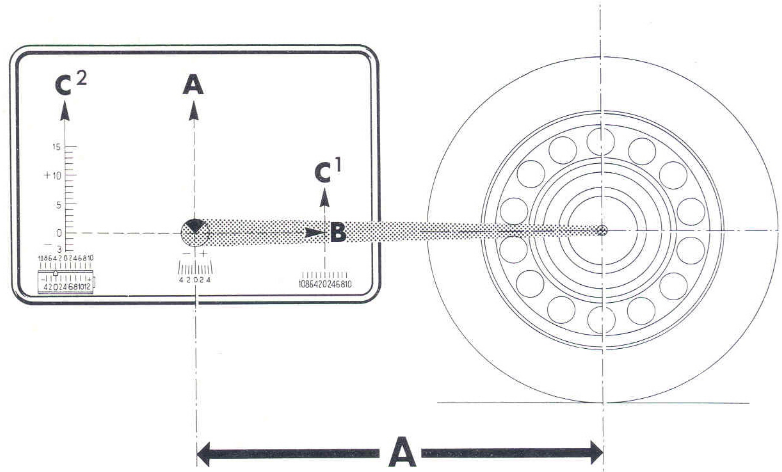
C = included angle
T = steering axis inclination
B = steering axis centreline

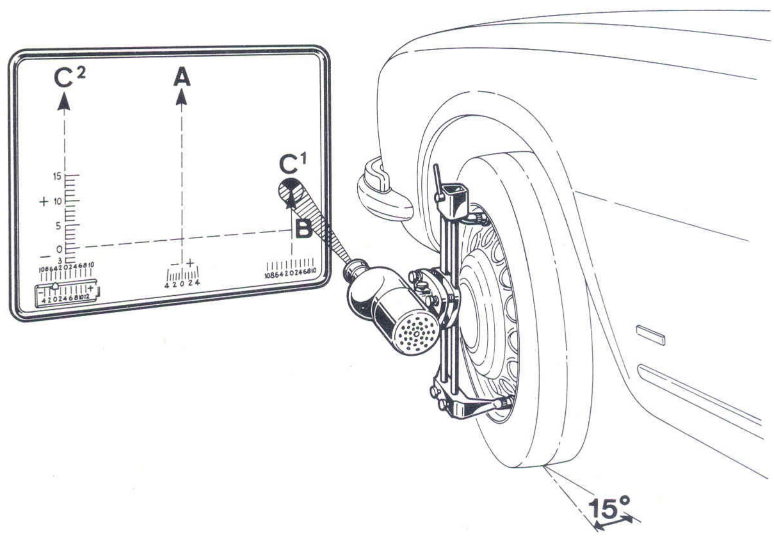
In the previous discussion no mention has intentionally been made of the steering axis inclination since this, being factory set in the Alfa Romeo type of construction, requires no check; further, taking measurements of the steering axis inclination through the position of the wheel is so remarkably affected by the plays in the joints that the readings would have little significance.
Owing to the steering axis inclination, the wheel, if rotated in either direction, would tend to move down the road surface.
This shows that the vehicle's load tends to bring the wheel back to the initial position.
As can be easily seen, steering axis inclination, together with caster angle, greatly aids recovery and directional stability.

CHECKING THE FRONT END GEOMETRY

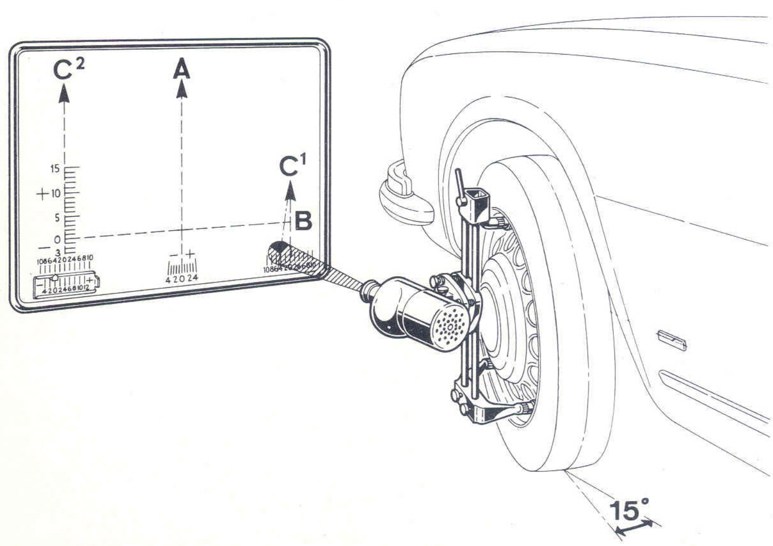
- Checking the castor angle with screens at the front.

Position the steering wheel spokes for a straight ahead direction of front wheels. Apply the pedal depressor to prevent the wheels from moving on the turntables when steered.
Place the scale screen at the distance A as specified and, with the projector at wheel centre, aim the pointer at the intersection of the reference lines on the screen.
The diagram shows how screen, projector and wheel are actually brought into alignment.



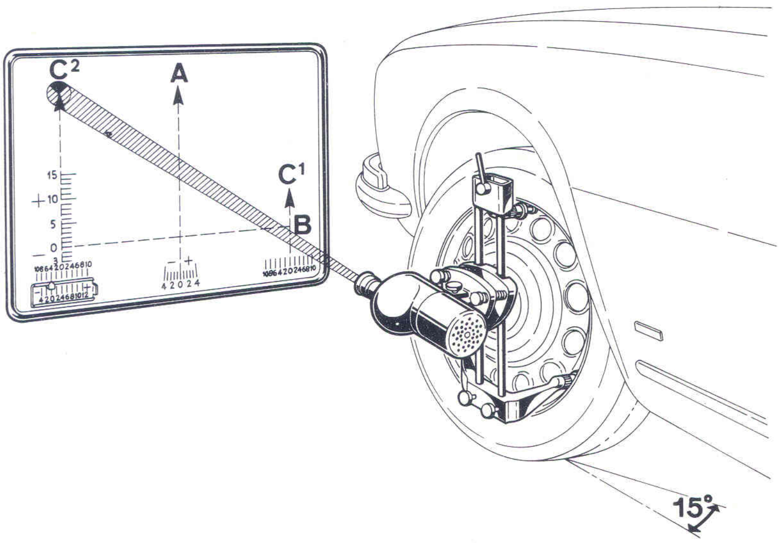


Steer the wheel by 15 degrees inward and properly move the screen until the mark C1 and the pointer are aligned.

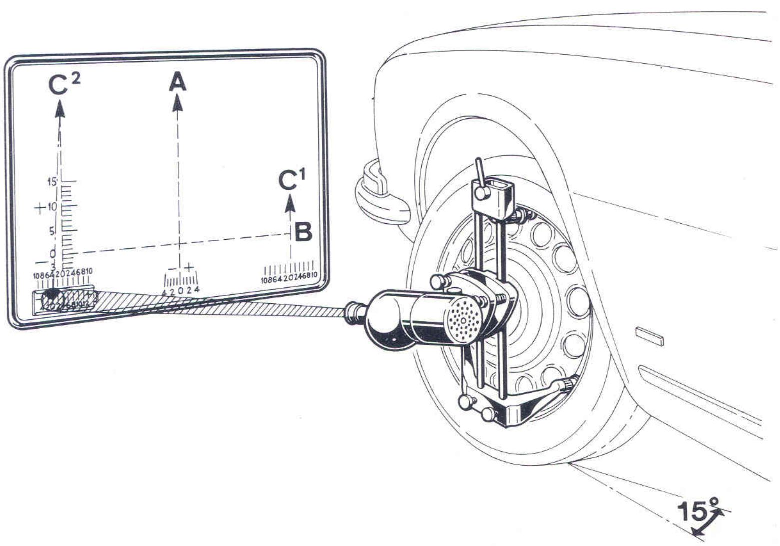


Rotate the projector downward and read the value on this scale.
The reading so taken must be brought over the outer scale of the screen with the suitable rule.

CHECKING THE FRONT END GEOMETRY

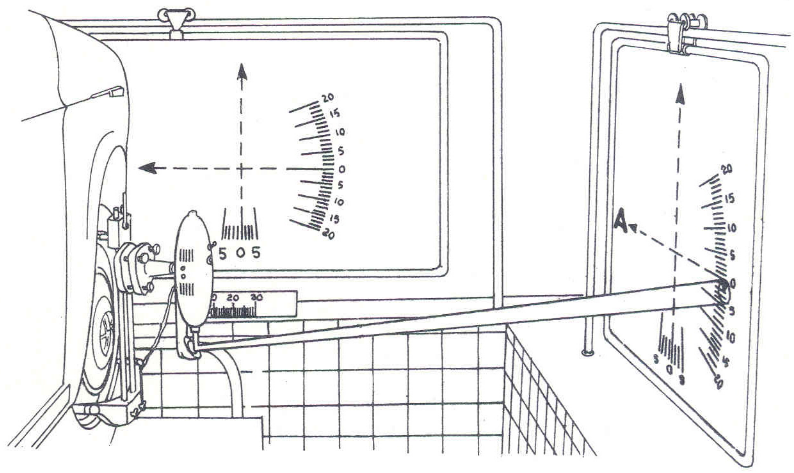


Steer the wheel by 15 degrees outward and move the screen until pointer and the mark C2 are aligned.



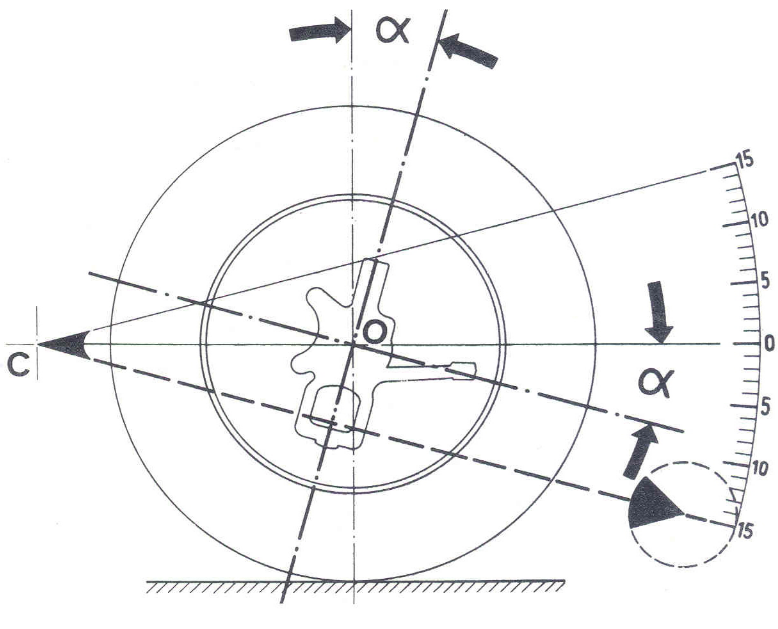
Rotate the projector downward and read the total value of castor angle with the rule.

CHECKING THE FRONT END GEOMETRY

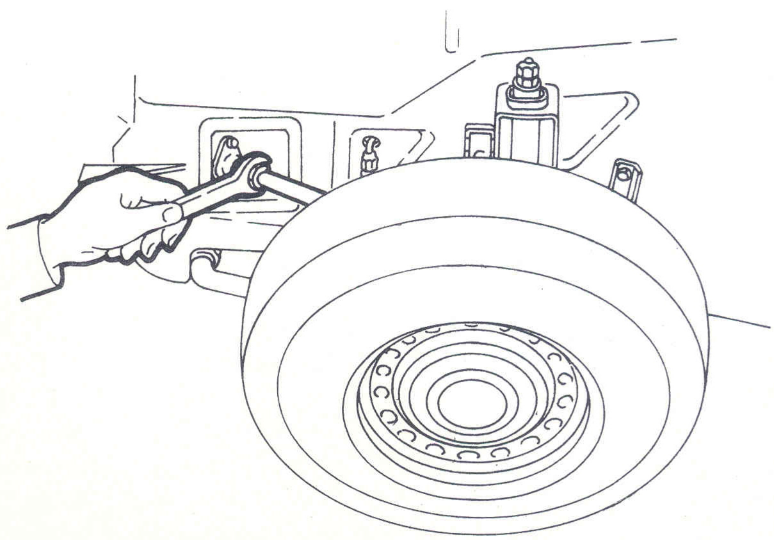


- Checking the castor angle with screens at the sides.

Adjust the mirror of projector so that the pointer is centred on the scale.
Steer the wheel to align the pointer with the arrow A on the panel.
Steer the wheel in the opposite direction until the pointer is on the scale and take the reading.



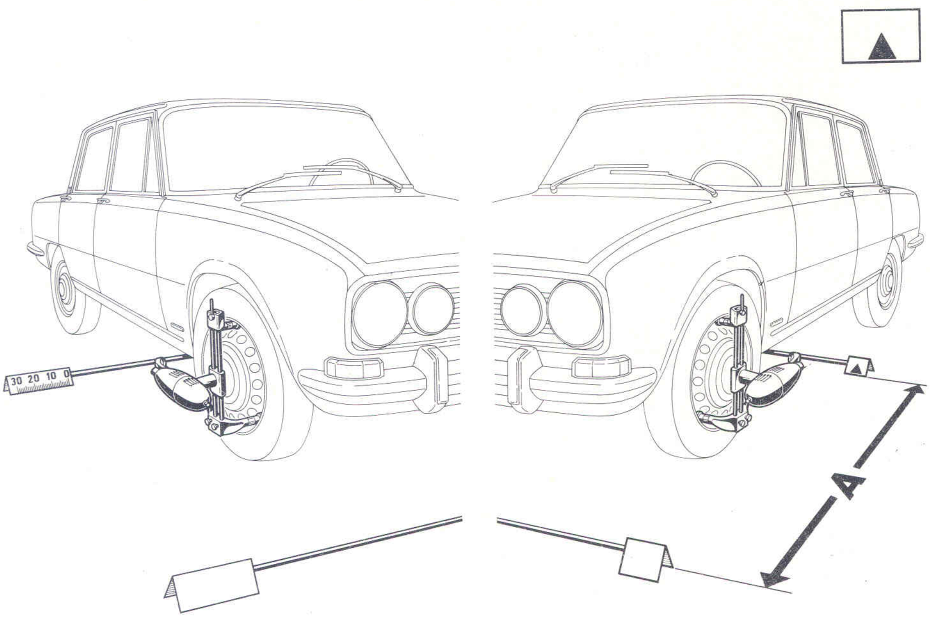
The trace followed by the pointer is at right angle with the steering axis centreline and forms with a level line the same angle as the castor angle.



- Adjusting the castor angle.

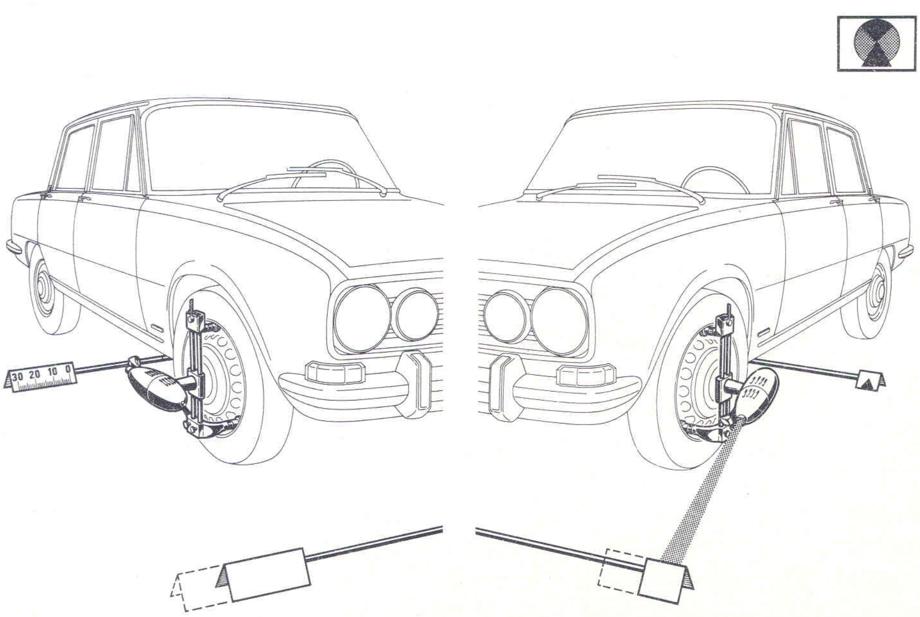
If the readings (taken in whatever manner) are not as specified, adjust the castor angle by acting on the adjuster of upper wishbone strut.

CHECKING THE FRONT END GEOMETRY

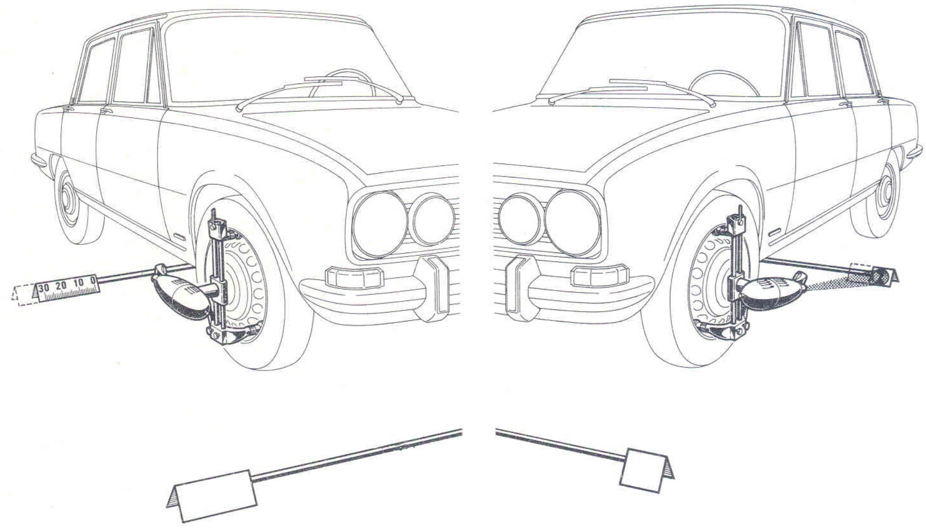


CHECKING AND ADJUSTING THE TOE–IN

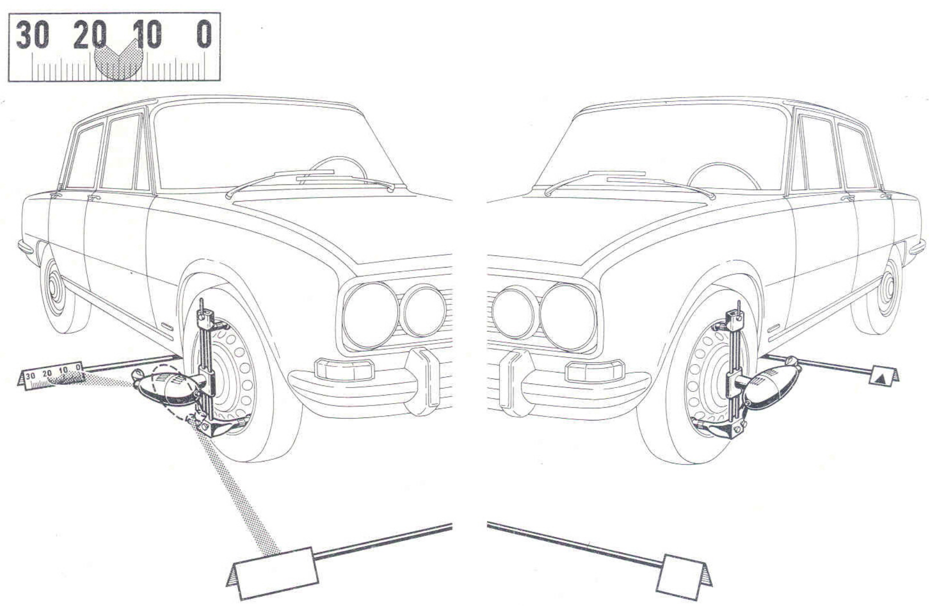
With the steering wheel spokes symmetrically disposed for straight ahead direction and the turning radius gauges on turntables set to zero, place the bars with the scales as shown one a distance A apart of the other as prescribed and equally spaced about the front wheel centreline. The distance A must be equal to seven times the diameter of the wheel rim of the car being tested. Place the bar in such a position that the points of the mark on the front bar and the pointer of the projector (either at the left or at the right indifferently) are exactly in line.



CHECKING THE FRONT END GEOMETRY



Turn the projector over and align pointer and mark on the bar at the rear of the wheel by positioning the bar itself properly.

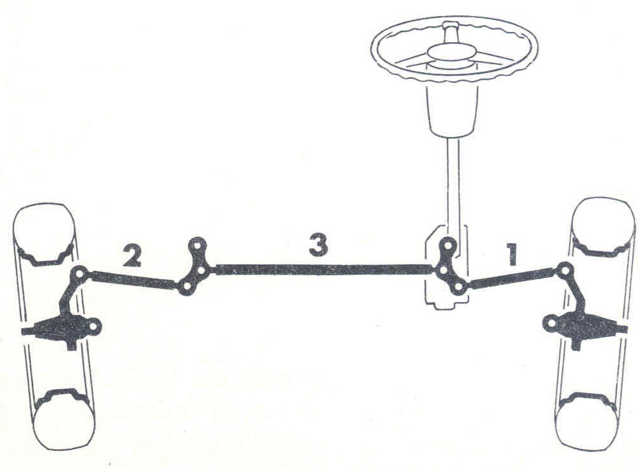


The alignment so obtained between the projector and the mark on front and rear bars acts as a reference for taking readings of total toe-in on the scales at the opposite side of the car.
To take the readings, direct the projector at the front scale first and then at the rear scale.

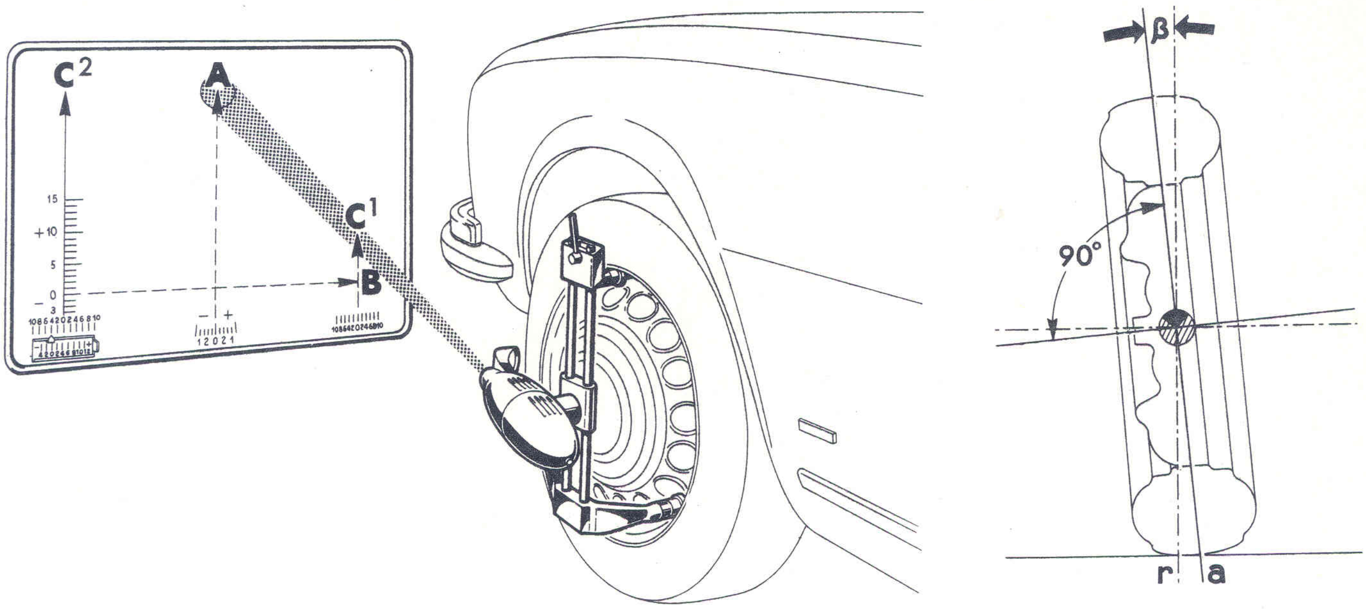
Calculate the value of toe-in or toe-out by difference between the readings taken. When the reading taken at the rear is greater than that at the front, the wheels are toeing in; conversely, they are toeing out. e.g.:

wheels toeing in:
front 16 mm rear 20 mm
wheels toeing out:
front 26 mm rear 24 mm

The values as read on the scales are to be referred to the tyre centreline when the steering wheel spokes are balanced for straight ahead direction. If the readings do not fall within the limits as specified in the tables on page 46 et seq. rectify the toe-in by properly adjusting the side rods 1 and 2 and the track rod 3.

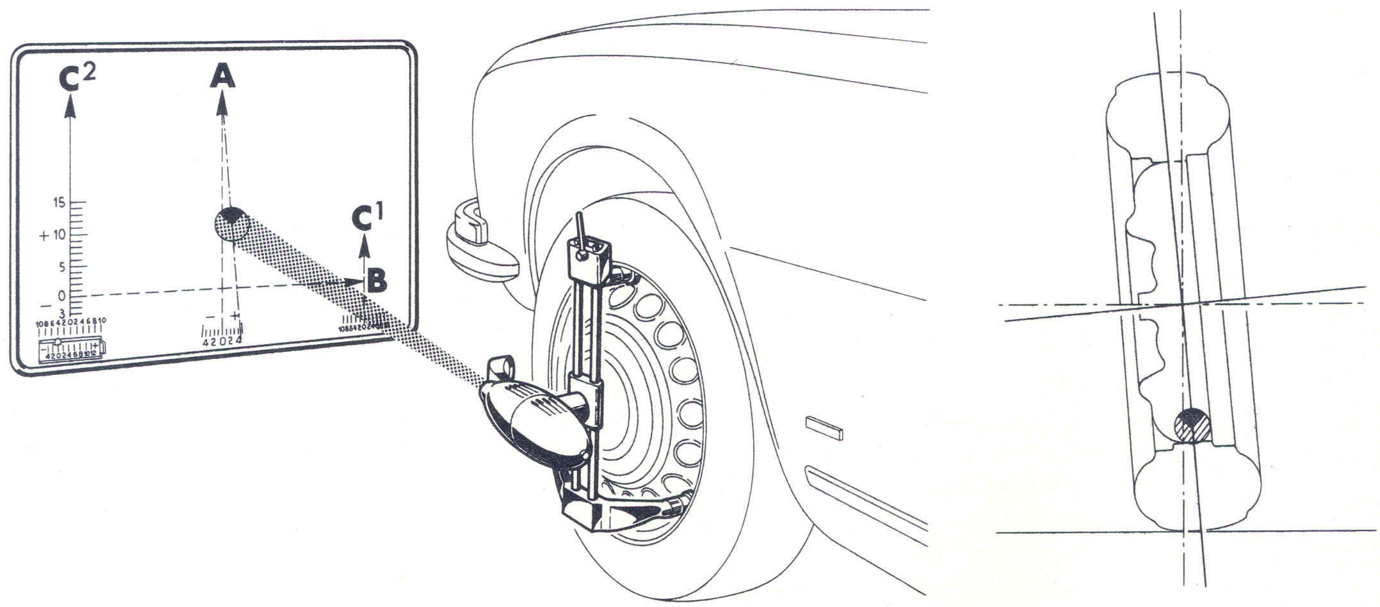


CHECKING THE FRONT END GEOMETRY



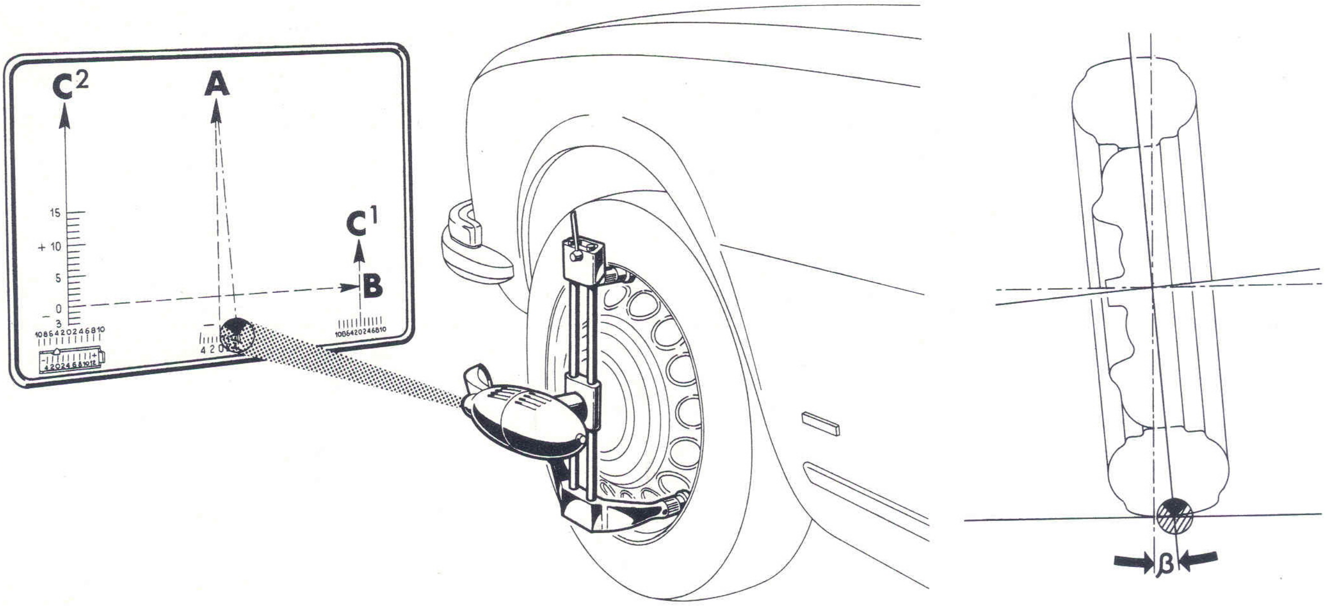
CHECKING THE WHEEL CAMBER

With the turning radius gauges set to zero for straight ahead direction of wheels, bring the projector to the wheel centre. Aim the projector at the screen so as to line up the pointer with the arrow A.



Rotate the projector toward the scale at the bottom of screen to take the camber angle reading. The pointer will follow a trace that will deviate from the vertical as a consequence of the tilt of the wheel, that is for the presence of the camber angle.

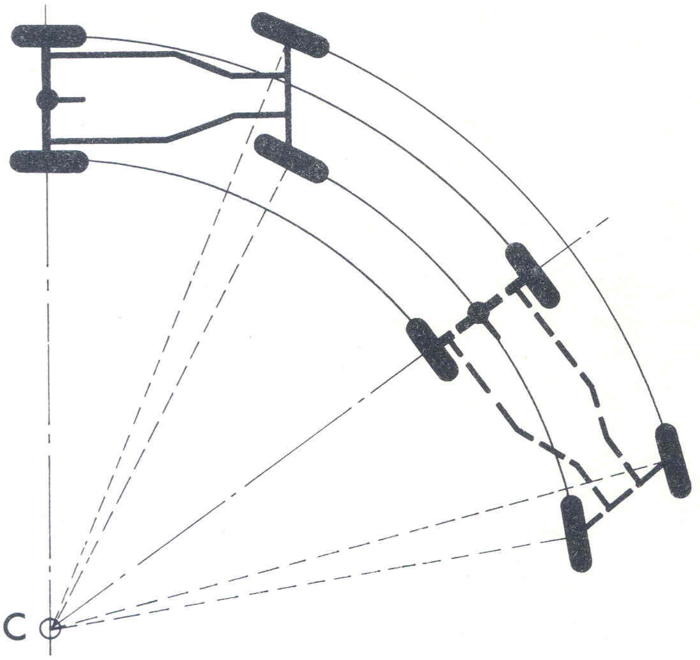
CHECKING THE FRONT END GEOMETRY



The reading taken on the scale is the wheel camber angle. Each wheel must be subject to test to check whether the camber angle is as specified. Furthermore, check that the difference in camber angle between the front wheels falls within the specified limits.

NOTE: The camber angle is not adjustable (except on Giulietta, 2000 and 2600 models). If adjustment is needed, check the suspension attachments to body and the suspension arms.

CHECKING THE FRONT END GEOMETRY

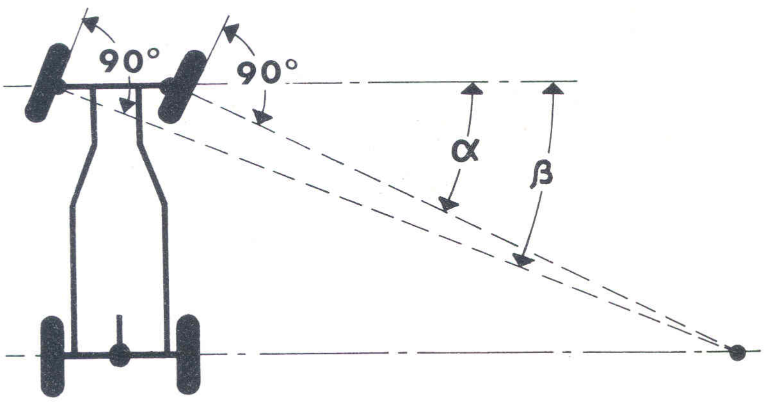


CHECKING AND ADJUSTING THE TOE–OUT ON TURNS

For best steering stability the parallelism between front axle and rear axle must be ensured to maintain the vehicle's base unchanged.

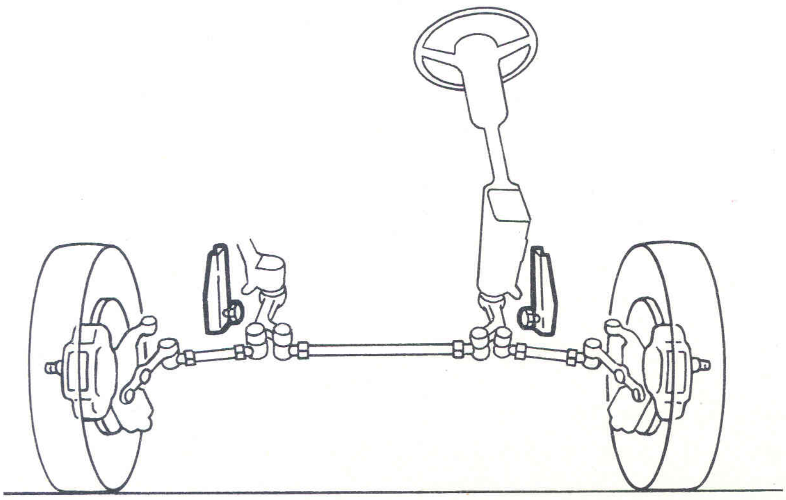
When steering, the vehicle's front and rear wheels turn on circles which are concentric; that is, their centres are at the same place C as shown.

To fulfill this condition, each front wheel must be kept continuously at right angle with the line connecting the wheel to the centre.



$\alpha > \beta$

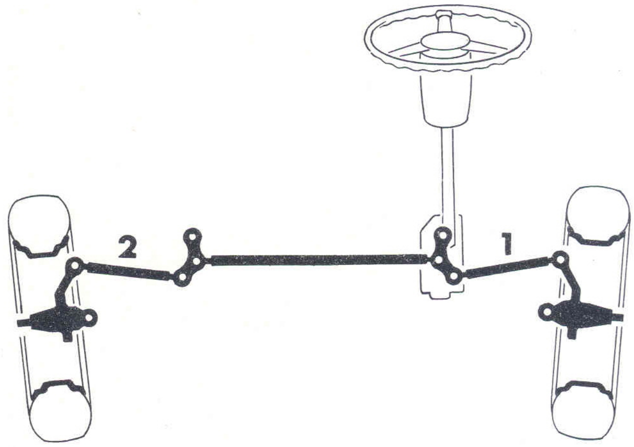
The condition shown in the diagram is actually obtained by turning the front wheels at different angles and specifically α greater than β, that is by toeing them out.



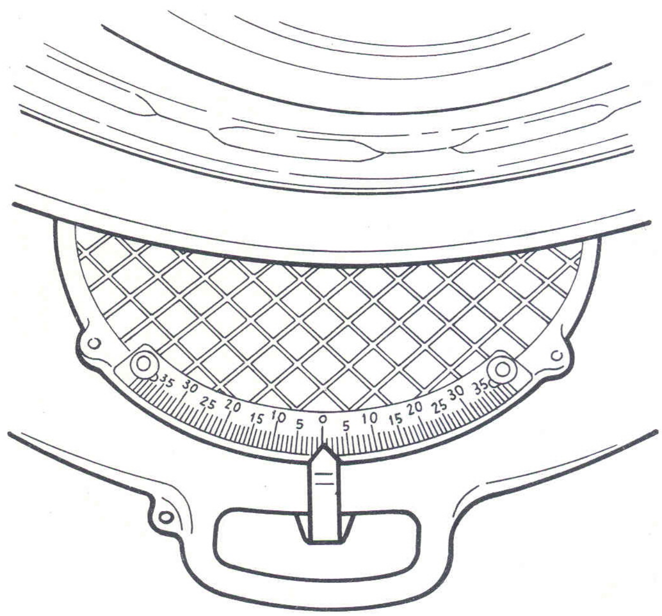
In actual construction, this relationship is secured by providing a steering linkage of the type shown in the illustration.

CHECKING THE FRONT END GEOMETRY

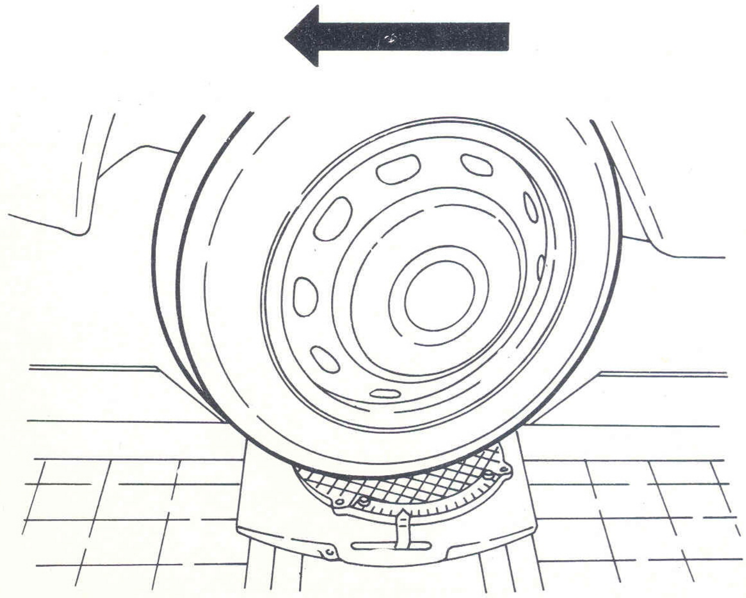
If during the testing procedure it is found that the wheel angles and the length of rods 1 and 2 meet exactly the specifications, the checking of the turning angle will not be necessary. Nevertheless, the steering locks might need adjustment. In this event, proceed as follows:



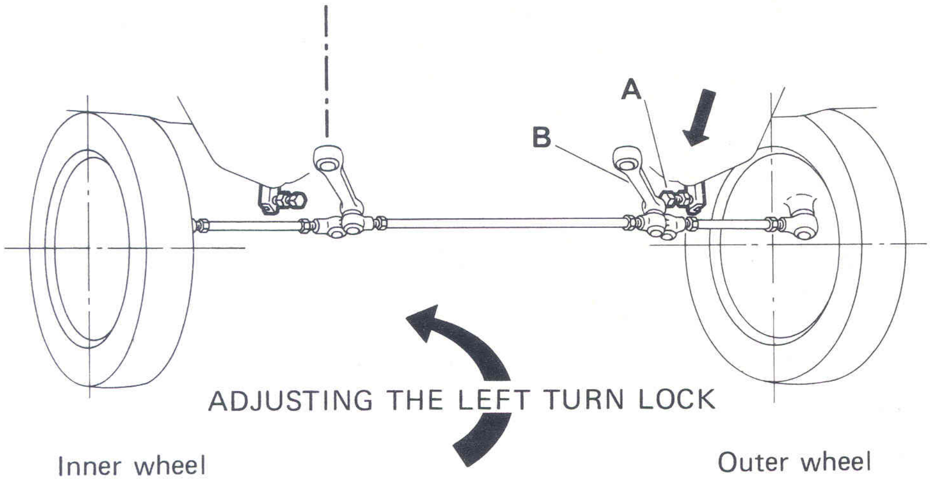
– Position the steering wheel spokes for straight ahead direction and apply the pedal depressor to prevent the wheels from moving on the turning radius gauges which should be set to zero.



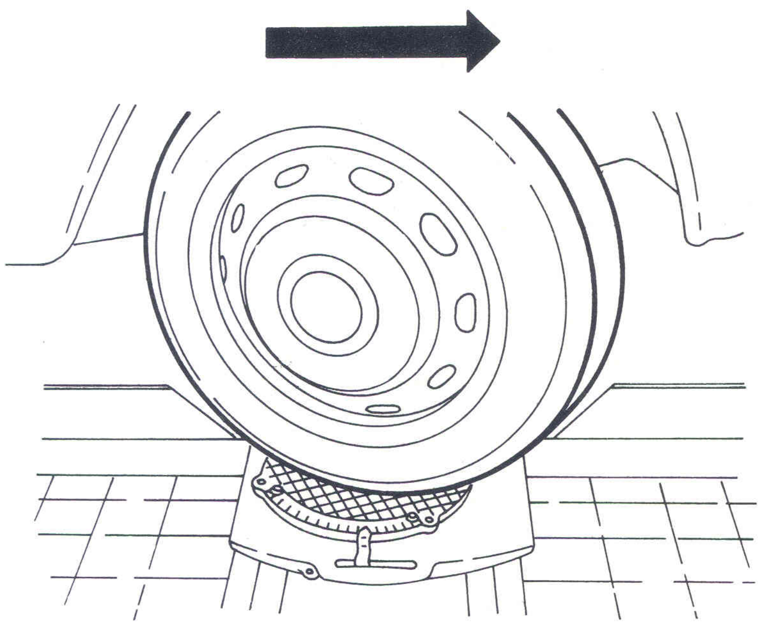
– Steer to the left until the outer wheel is turned at the specified angle (as read on the gauge).



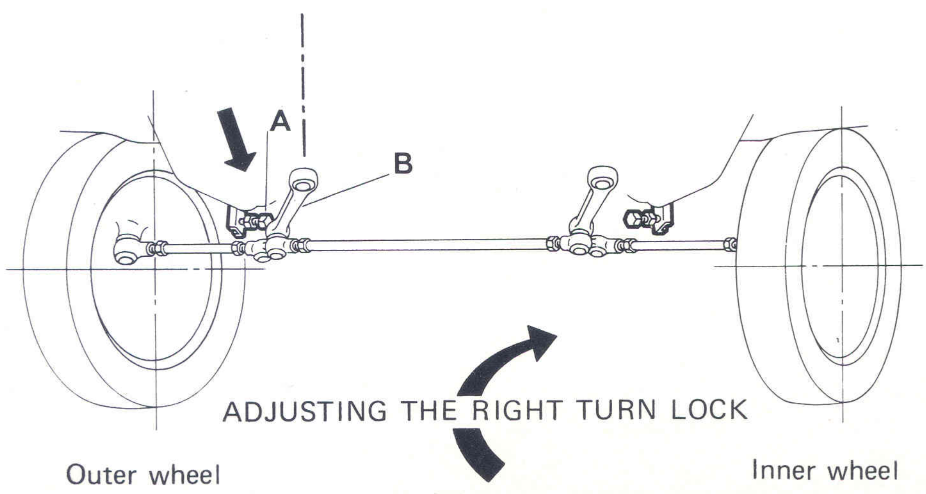
CHECKING THE FRONT END GEOMETRY



– Check that the relay B contacts the adjuster A of the steering lock; if necessary, set the adjuster accordingly.



– Steer to the right until the outer wheel is turned at the same angle as previously read.



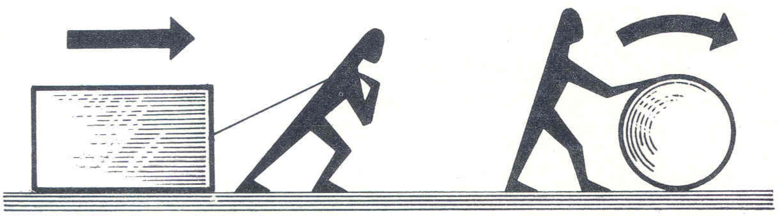
– Check that the arm B contacts the adjuster A of the steering lock and adjust if necessary.

During the above outlined procedure also the turning angles of the inner wheels can be checked for compliance with the values given in the tables.

NOTE: If unusual values are found while performing these checks, the steering linkage must be inspected for distortion.

TROUBLE	POSSIBLE CAUSE	REMEDY
Improper tyre wear	Camber incorrect	The camber (except on Giulietta, 2000, 2600 models) is not adjustable. If adjustment is needed, check the suspension attachments to body and the suspension arms.
	Toe in incorrect	Check and adjust as per specifications and directions given on page 34
	Tyre pressure uneven or incorrect	Inflate to correct pressure
	Wheel shimmy	Refer to the following item
Shimmy	Tyre pressure uneven or incorrect	Inflate to correct pressure
	Excessive wheel bearing play or wear	Carefully inspect and adjust the wheel hubs following strictly the specified pre-loads and directions
	Defective shock absorbers	Repair or replace, if necessary
	Wheels out of balance	Rebalance wheels as installed by means of the modern electronic wheel balancers
Car pulls to one side	Incorrect trim under static load	Check the sag of suspension springs as directed on page 14
	Tyre pressure uneven or incorrect	Inflate to correct pressure
	Front alignment off (wheel angles incorrect or uneven)	Check front wheel alignment and adjust as necessary
	Incorrect front wheel bearing play	Readjust the bearing play following strictly the directions given in the relevant Shop Manual
	Worn wheel bearings	Change bearings
	Defective shock absorbers	Repair or replace, if necessary
	Worn suspension joints	Renew suspension arm bushings
	Looseness at upper or lower ball joints	Renew worn ball joints
Wheel tramp	Tyre pressure uneven (possible air leakage)	Inflate to correct pressure and check the air valve for sound conditions
	Wheel ouf of balance	Rebalance wheels statically and dynamically
	Sagging springs	Change springs
	Defective shock absorbers	Change shock absorbers
	Bent wheel rim	Change wheel rim

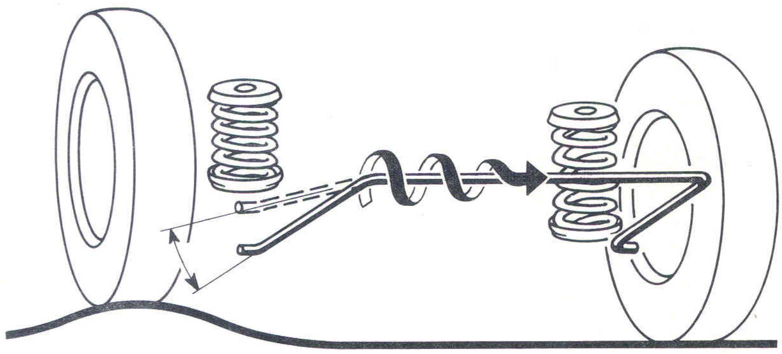
FRICTION - STABILISER ROD - DRIFT



SLIDING FRICTION ROLLING FRICTION

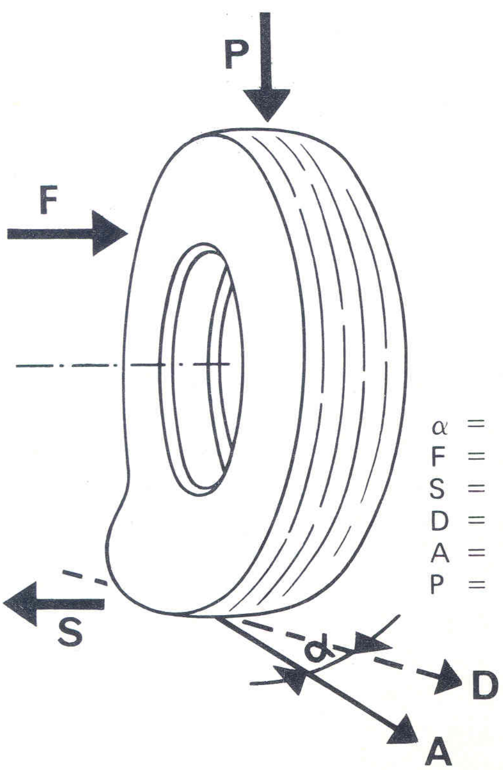
FRICTION

Friction is a force which acts to prevent an object to get started or to keep it moving. Such forces are named "sliding friction" when the surfaces of the objects in relative motion are sliding on each other and "rolling friction" when an object is rolling on a surface. Sliding friction is always greater than rolling friction. Friction vehicle's wheels must overcome depends on the density of the medium and is proportional to the square of vehicle's speed.



STABILISER ROD

It is an elastic component of the suspensions having usually a round cross section and attaching points to both the suspension and the body. It is designed to bear torsion stresses, thus providing a flexible interconnecting means between the two lower suspension arms to reduce body roll on turns. In fact, when one of the front wheels tends to rise or drop, the stabilizer rod twists in such a way as to cause the other wheel to follow the same motion. Sway is thus minimized.



α = slip angle
F = thrust
S = road reaction
D = actual wheel direction
A = apparent direction
P = load

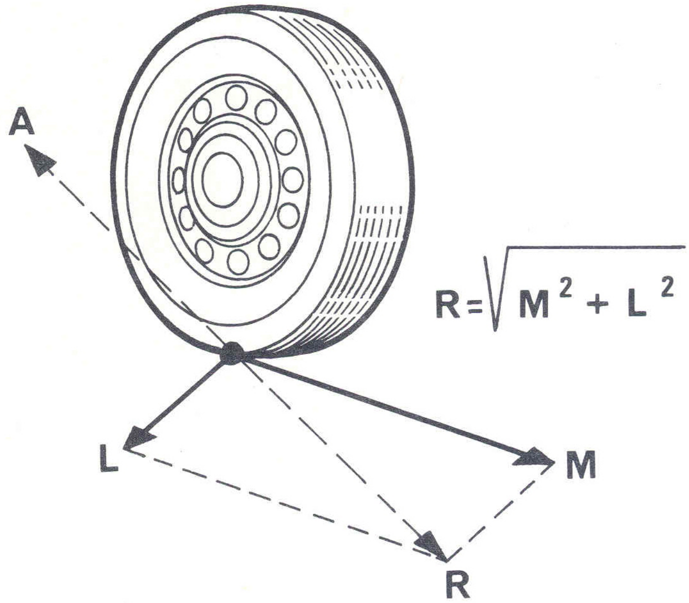
DRIFT

If a force F is applied to a tyre, the tyre flexes because of the tendency of that part of the tyre in contact with the road to adhere to the pavement while the wheel tends to follow the direction of the force F. This giving of the tyre causes it to deviate from the apparent direction A by an angle α. Such a "slip angle" forces the car to round a curve wider than guided.

ADHESION - SHOCK ABSORBER

GRIP

Grip or adhesion: a force which prevents a wheel from skidding or sideslipping. This force is equal to the load on the wheel multiplied by the friction coefficient. The latter depends upon the road surface (concrete, asphalt, gravel, etc.), the quality of the tyre and the tread design.
The illustration shows a wheel under the effect of a motive force M and A centrifugal force L.



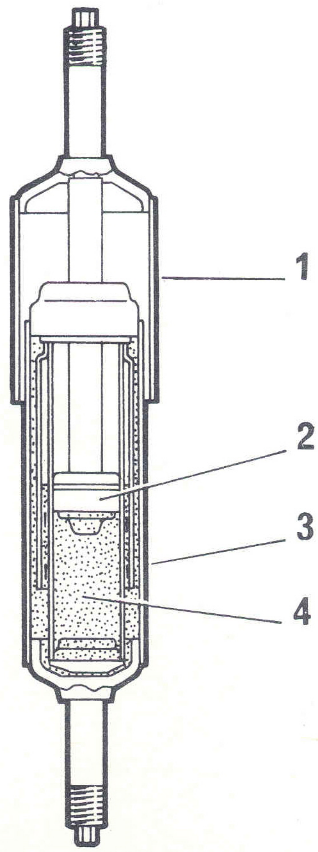
M = motive force R = resultant force
L = centrifugal force A = skid limit
The limit is attained when A equals R

SHOCK ABSORBER

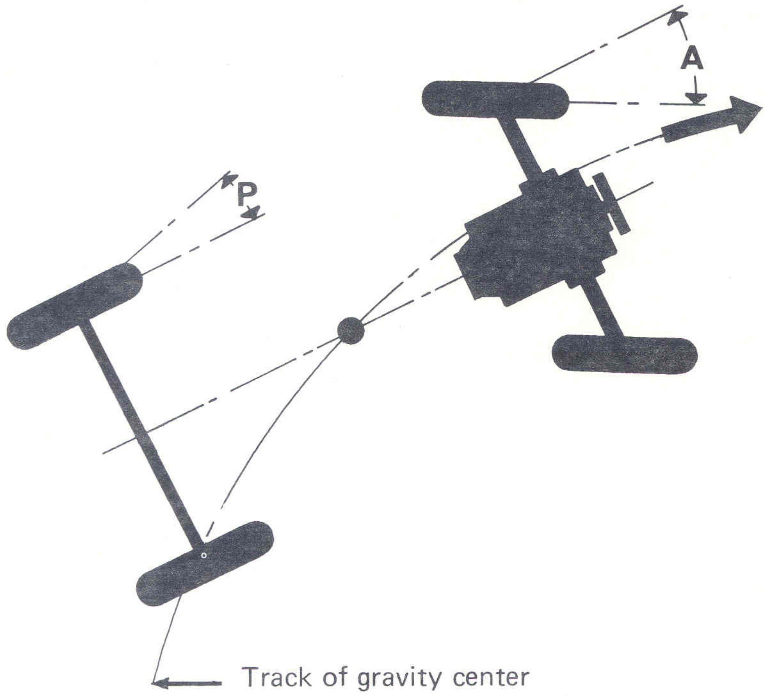
A device in the vehicle's suspensions that checks excessively rapid spring movement and oscillation.
The hydraulic shock absorbers commonly installed on today's cars consists of:

a dust shield 1, a piston 2 which moves in the cylinder 3 full of constant viscosity fluid 4.

The operating principle is based on the ability of fluid to resist flowing when forced to pass through small orifices.



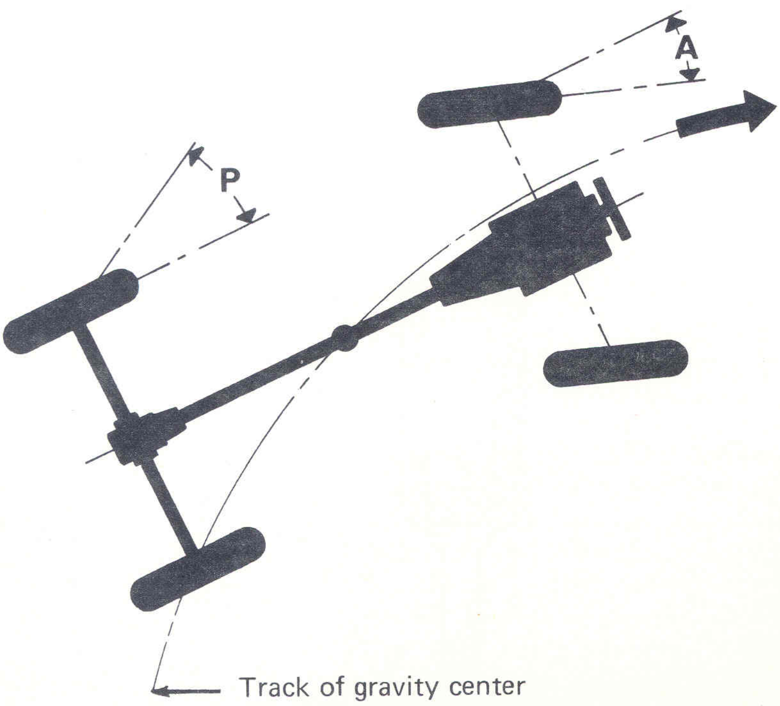
FRONT WHEEL DRIVE - REAR WHEEL DRIVE



FRONT WHEEL DRIVE

A feature of vehicles in which traction is exerted by the front wheels.
To guide a front wheel drive vehicle on a constant radius turn, it is necessary to steer the wheel a little more (that is to increase the steering angle, opening up the throttle at the same time) a little less on deceleration or overrunning.
The illustration shows a front drive vehicle: the slip angle A of front wheels is larger than that of rear wheels.

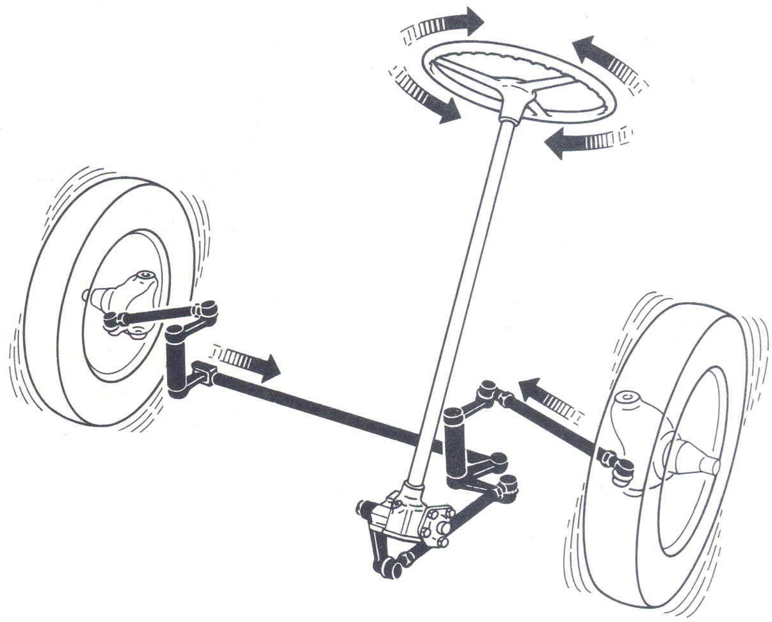
A = Slip angle of front wheel
B = Slip angle of rear wheel



REAR WHEEL DRIVE

A feature of vehicles in which traction is exerted by the rear wheels.
On a rear wheel drive vehicle, the variations in engine power output less noticeably affect the steering angle. On acceleration, the increase in steering angle is partially or completely neutralized by the increment in slip angle of rear wheels due to the motive torque.
The illustration shows a rear drive vehicle: the slip angle A of front wheels is smaller than the drift angle P of rear wheels.

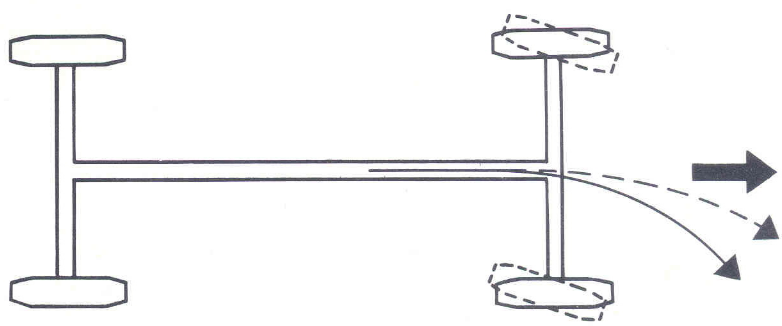
SHIMMY - OVERSTEER - UNDERSTEER



SHIMMY

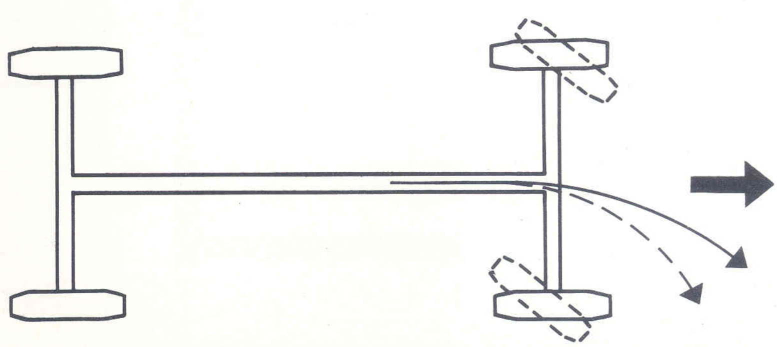
Shimmy is the rapid oscillation of the front wheels which try to turn in and out alternately causing the steering linkage to shake from side to side exhibiting a resonance phenomenon. This condition makes driving difficult and dangerous; the car should therefore undergo the following tests:

- dynamic balancing of wheels;
- steering linkage for proper play
- wheels for proper alignment and toe-in.



OVERSTEER

Condition for which a vehicle steers more than guided.



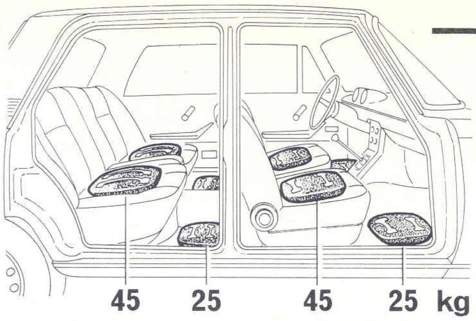
UNDERSTEER

Condition for which a vehicle steers less than guided.

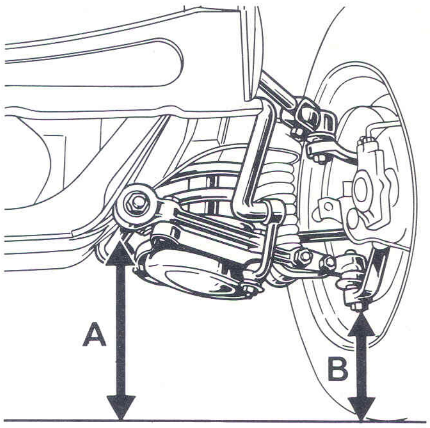
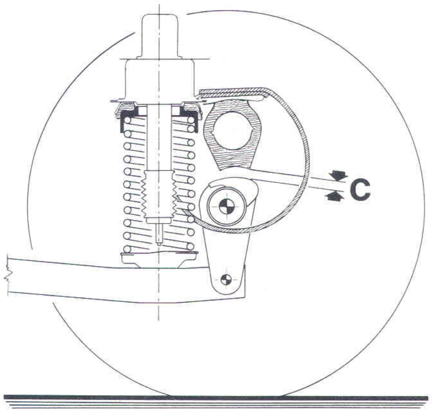
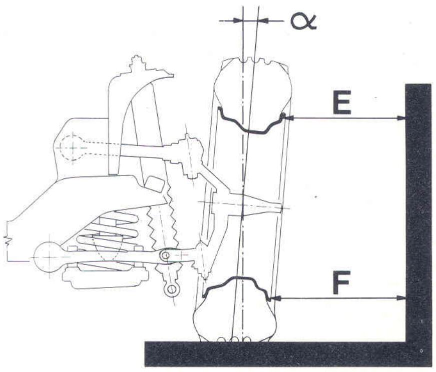
SPECIFIC

dimensions in millimetres

LOADS FOR CAR TRIM



- 4-door models:
  load as shown = 280 Kg total weight
- 2-door models:
  load the front only = 140 Kg total weight

			GIULIA 1300		GT 1300	
			former to chassis no. 645.000	from chassis no. 645.001	earlier than model year '68	model year '68
FRONT SPRING SAG		A minus B =	33 to 43 (1) 29 to 39 (2)	29 to 39	29 to 39 (2) 9 to 19 (3)	19 to 29
REAR SPRING SAG		C =	5 to 15	31 to 41	10 to 20	36 to 46
CAMBER		α = (4)	20′ to 1°20′	– 10′ to 50′	20′ to 1°20′	– 10′ to 50′
		F =	E + (2 to 9)	E + (–1 to 5)	E + (2 to 9)	E + (–1 to 5)

ATIONS

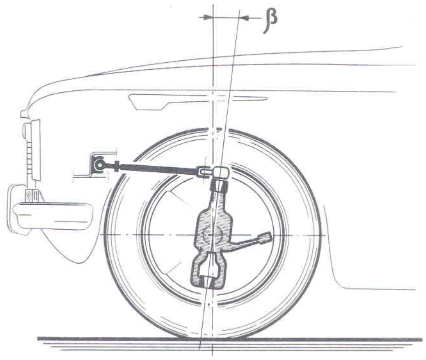
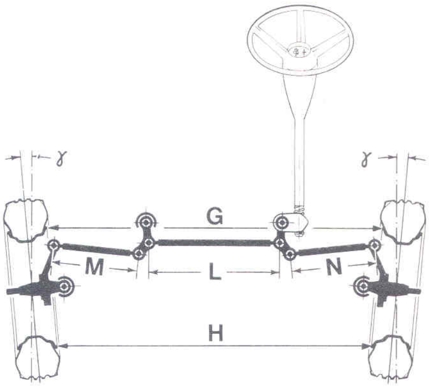
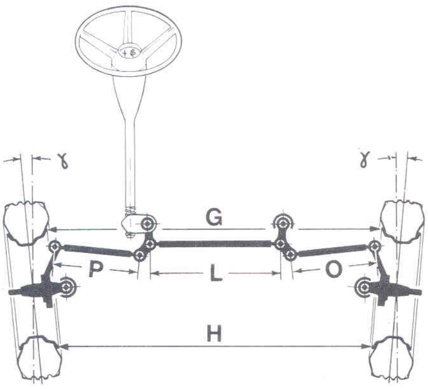
unless otherwise stated

(1) Wishbone shaft P.N. 105.00.21.301.02 (round cross-section)
(2) Wishbone shaft P.N. 105.14.21.301.00 (elongated cross-section)
(3) Wishbone shaft P.N. 105.41.21.301.00 (upper limiting buffer outside the spring)
(4) Maximum difference in castor angle between R.H. and L.H. wheel = 40′

JUNIOR	GIULIA 1300 TI			GTA 1300 JUNIOR	SPIDER 1300 JUNIOR		GIULIA SPRINT GT	SPIDER 1600
model year '69	earlier than model year '68	model year '68	model year '69		model year '68	model year '69		
19 to 29	29 to 39	29 to 39	29 to 39	29 to 39	19 to 29	19 to 29	33 to 43 (1) 29 to 39 2)	23 to 33
36 to 46	5 to 15	31 to 41	31 to 41	36 to 46	28 to 38	28 to 38	10 to 20	28 to 38
– 10′ to 50′	20′ to 1°20′	– 10′ to 50′	– 10′ to 50′	– 10′ to 50′	– 10′ to 50′	– 10′ to 50′	20′ to 1°20′	20′ to 1°20′
E + (–1 to 5)	E + (2 to 9)	E + (–1 to 5)	E + (–1 to 5)	E + (–1 to 5)	E + (–1 to 5)	E + (–1 to 5)	E + (2 to 9)	E + (2 to 9)

SPECIFIC

dimensions in millimetres

		GIULIA 1300		GT 1300	
		former to chassis no. 645.000	from chassis no. 645.001	earlier than model year '68	model year '68
CASTOR 	β = (5)	1° to 2°	1° to 2°	1° to 2°	1° to 2°
TOE-IN L.H.D. 	γ =	13′	13′	13′	13′
	G =	H + 3	H + 3	H + 3	H + 3
	M = (6)	N	N	N	N
TOE-IN R.H.D. 	γ =	13′	13′	13′	13′
	G =	H + 3	H + 3	H + 3	H + 3
	O = (7)	P	P	P	P

ATIONS

unless otherwise stated

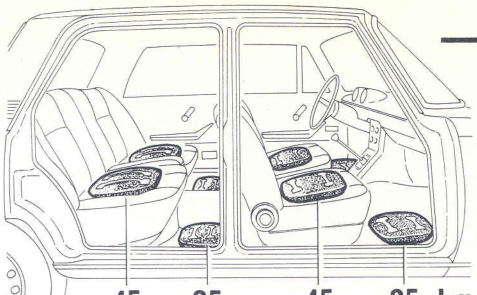
(1) Wheel: 4 1/2j x 15 (390 mm dia.)
(2) Wheel: 5j or 5 1/2j x 14 (365 mm dia.)
(3) Steering arm P.N. 105.04.24.201.00
(4) Steering arm P.N. 105.49.24.201.00 marked with a white dot
(5) Max. difference in castor between R.H. and L.H. wheel = 20′
(6) Rod length: L = 530 to 550 mm; N = 264 to 280 mm.
(7) Rod length: L = 530 to 550 mm; P = 259 to 275 mm.

JUNIOR	GIULIA 1300 TI			GTA 1300 JUNIOR	SPIDER 1300 JUNIOR		GIULIA SPRINT GT	SPIDER 1600
model year '69	earlier than model year '68	model year '68	model year '69		model year '68	model year '69		
1° to 2°	1° to 2°	1° to 2°	1° to 2°	1° to 2°	1° to 2°	1° to 2°	1° to 2°	1° to 2°
13′ (1) 14′ (2)	13′	13′	13′ (1) 14′ (2)	14′	13′	13′ (1) 14′ (2)	13′	13′
H + 3	H + 3	H + 3	H + 3	H + 3	H + 3	H + 3	H + 3	H + 3
N – 5	N	N	N – 5	N	N	N – 5	N	N
13′ (1) 14′ (2)	13′	13′	13′ (1) 14′ (2)		13′	13′ (1) 14′ (2)	13′	13′
H + 3	H + 3	H + 3	H + 3		H + 3	H + 3	H + 3	H + 3
P (3) P + 5 (4)	P	P	P (3) P + 5 (4)		P	P (3) P + 5 (4)	P	P

SPECIFIC A

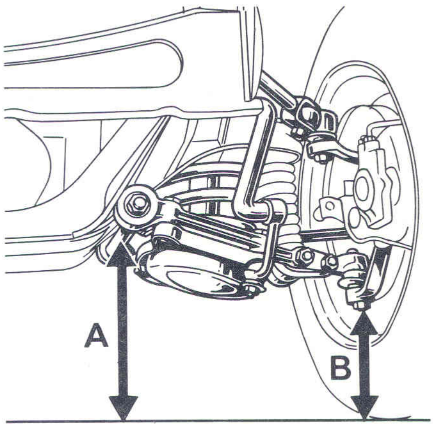
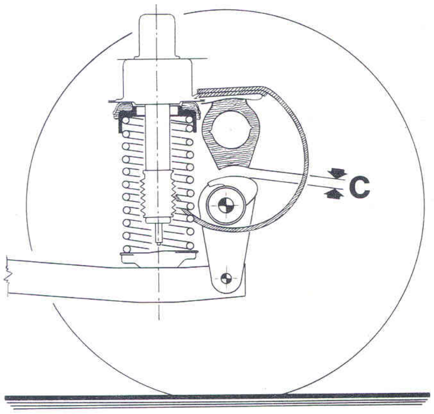
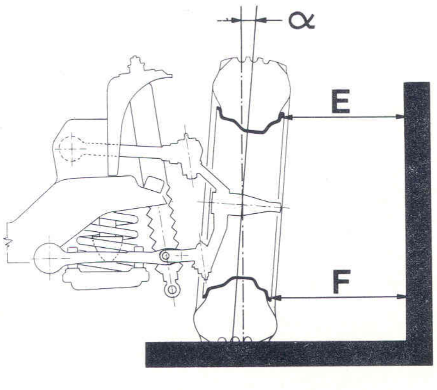
dimensions in millimetres un

LOADS FOR CAR TRIM



- 4-door models:
  load as shown = 280 kg total weight
- 2-door models:
  load the front only = 140 Kg total weight

* load the same as for 2-door models

		GIULIA TI	GIULIA TI SUPER *	GIULIA GTC	GIULIA SPRINT GTA	
FRONT SPRING SAG 	A minus B =	33 to 43 (1) 29 to 39 (2)	35 to 41	33 to 43 (1) 29 to 39 (2)	54 to 60	
REAR SPRING SAG 	C =	5 to 15	10 to 20	15 to 25	36 to 46	
CAMBER 	α = (4)	20′ to 1°20′	20′ to 1°20′	20′ to 1°20′	20′ to 1°20′	2
	F =	E + (2 to 9)	E + (2 to 9)	E + (2 to 9)	E + (2 to 9)	E

ATIONS

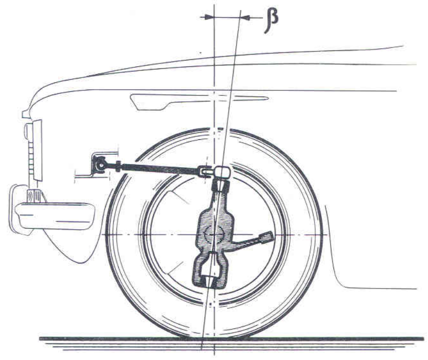
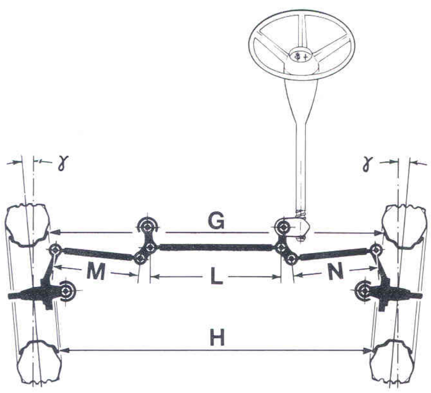
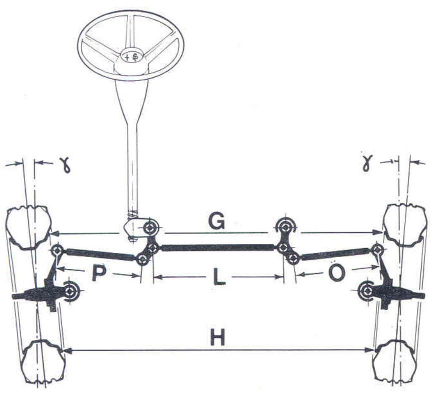
unless otherwise stated

(1) Wishbone shaft P.N. 105.00.21.301.02 (round cross-section)
(2) Wishbone shaft P.N. 105.14.21.301.00 (elongated cross-section)
(3) Wishbone shaft P.N. 105.41.21.301.00 (upper limiting buffer outside the spring)
(4) Maximum difference in camber angle between R.H. and L.H. wheel = 40′

GIULIA SPRINT GT VELOCE	GIULIA SUPER			GIULIA 1600 S	1750 GT VELOCE		1750 BERLINA	1750 SPIDER VELOCE
	earlier than model year '68	model year '68	model year '69		L.H.D.	R.H.D.		
29 to 39 (2) 9 to 19 (3)	33 to 43 (1) 29 to 39 (2)	29 to 39	29 to 39	29 to 39	19 to 29	29 to 39	29 to 39	19 to 29
10 to 20	5 to 15	31 to 41	31 to 41	31 to 41	36 to 46	36 to 46	31 to 41	28 to 38
20′ to 1°20′	20′ to 1°20′	– 10′ to 50′	– 10′ to 50′	– 10′ to 50′	– 10′ to 50′	– 10′ to 50′	– 10′ to 50′	– 10′ to 50′
E + (2 to 9)	E + (2 to 9)	E + (–1 to 5)	E + (–1 to 5)	E + (–1 to 5)	E + (–1 to 5)	E + (–1 to 5)	E + (–1 to 5)	E + (–1 to 5)

SPECIFIC

dimensions in millimetres

			GIULIA TI	GIULIA TI SUPER	GIULIA GTC	GIULIA SPRINT GTA
CASTOR		β = (5)	1° to 2°	30′ to 1°30′	1° to 2°	30′ to 1°30′
TOE-IN L.H.D.		γ =	13′	13′	13′	14′
		G =	H + 3	H + 3	H + 3	H + 3
		M = (6)	N	N	N	N
TOE-IN R.H.D.		γ =	13′		13′	14′
		G =	H + 3		H + 3	H + 3
		O = (7)	P		P	P

ATIONS

unless otherwise stated

(1) Wheel: 4 1/2j x 15 (390 mm dia.)
(2) Wheel: 5j or 5 1/2j x 14 (365 mm dia.)
(3) Steering arm P.N. 105.04.24.201.00
(4) Steering arm P.N. 105.49.24.201.00 marked with a white dot
(5) Maximum difference in castor between R.H. an L.H. wheel = 20′
(6) Rod length: L = 530 to 550 mm; N = 264 to 280 mm.
(7) Rod length: L = 530 to 550 mm; P = 259 to 275 mm.

GIULIA SPRINT GT VELOCE	GIULIA SUPER			GIULIA 1600 S	1750 GT VELOCE		1750 BERLINA	1750 SPIDER VELOCE
	earlier than model year '68	model year '68	model year '69		L.H.D.	R.H.D.		
1° to 2°	1° to 2°	1° to 2°	1° to 2°	1° to 2°	1° to 2°	1° to 2°	1° to 2°	1° to 2°
13′	13′	13′	13′ (1) 14′ (2)	13′ (1) 14′ (2)	14′		14′	14′
H + 3	H + 3	H + 3	H + 3	H + 3	H + 3		H + 3	H + 3
N	N	N	N – 5	N – 5	N – 5		N – 5	N.– 5
13′	13′	13′	13′ (1) 14′ (2)	13′ (1) 14′ (2)		14′	14′	14′
H + 3	H + 3	H + 3	H + 3	H + 3		H + 3	H + 3	H + 3
P	P	P	P (3) P + 5 (4)	P + 5		P (3) P + 5 (4)	P (3) P + 5 (4)	P (3) P + 5 (4)

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NOTES

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