FRONT AXLE
ALIGNMENT MANUAL

CADILLAC and LA SALLE

Service Department
CADILLAC MOTOR CAR COMPANY
DETROIT, MICHIGAN

CONTENTS

Reprinted 1977

Car Model	Caster Angle	Camber Angle		Inclination of Steering Knuckle Bolt		Toe-In	Toe-Out on Curves		Front Wheel Tire Pressure in Pounds		†Steering Pivot Position See "A" Fig. 7	*Spring Position See "B" Fig. 7
		With Car Weight off Wheels	With Car Weight on Wheels	With Car Weight off Wheels	With Car Weight on Wheels		Outside Wheel	Inside Wheel	Normal (Also Rr. Wheels)	High Speed Driving		
Before Frt. Ax. Unit 3-27619	1—2°	—	—	—	—	—	—	—	—	—	—	—
Begin. Frt. Ax. Unit 3-27619	2½—3°	—	—	—	—	—	—	—	—	—	—	—
353	2½°	1½°	¾—1°	10¼°	10¾–11°	$\frac{1}{16}$—$\frac{3}{16}$″	20°	22—23½°	40	45	1¼—1¾″	6⅞″
355-A	2—3½°	1½°	¾—1°	8½°	9–9¼°	$\frac{1}{16}$—$\frac{3}{16}$″	20°	22—23°	40	45	1⅛—1½″	5¼″
355-B	2—3½°	1½°	¾—1°	7¾°	8¼–8½°	$\frac{1}{16}$—$\frac{3}{16}$″	20°	22—23½°	35	40	3⅜—3⅝″	5¾″
355-C	2—3½°	1½°	¾—1°	7¾°	8¼–8½°	$\frac{1}{16}$—$\frac{3}{16}$″	20°	22—23½°	35	40	3⅜—3⅝″	5¾″
V-12 370-A	2—3½°	1½°	¾—1°	8½°	9–9¼°	$\frac{1}{16}$—$\frac{3}{16}$″	20°	22—23°	40	45	1⅛—1½″	5¼″
370-B	2—3½°	1½°	¾—1°	7¾°	8¼–8½°	$\frac{1}{16}$—$\frac{3}{16}$″	20°	22—23½°	35	40	3⅜—3⅝″	5¾″
370-C	2—3½°	1½°	¾—1°	7¾°	8¼–8½°	$\frac{1}{16}$—$\frac{3}{16}$″	20°	22—23½°	35	40	3⅜—3⅝″	5¾″
V-16 452-A	2—3°	1½°	¾—1°	—	—	$\frac{1}{16}$—$\frac{3}{16}$″	20°	22—23½°	40	45	3¼—3¾″	5⅞″
Before Frt. Ax. Unit 7-2634	—	—	—	10¼°	10¾–11°	—	—	—	—	—	—	—
Begin. Frt. Ax. Unit 7-2634	—	—	—	8½°	9–9¼°	—	—	—	—	—	—	—
452-B	2—3½°	1½°	¾—1°	7¾°	8¼–8½°	$\frac{1}{16}$—$\frac{3}{16}$″	20°	22—23½°	35	40	2⅞—3⅜″	5¼″
452-C	2—3½°	1½°	¾—1°	7¾°	8¼–8½°	$\frac{1}{16}$—$\frac{3}{16}$″	20°	22—23½°	35	40	2⅞—3⅜″	5¼″

†Distance from top of spring seat on axle I-beam to center of pivot on steering knuckle arm to which steering connecting rod is attached as indicated at "A" in Fig. 7.

*Distance from top of spring seat on axle I-beam to under side of frame is indicated at "B" in Fig. 7.

Front Axle Specifications

All elements of front wheel alignment should measure within 1/2 degree between the right and left sides of the car

Car Model	Caster Angle	Camber Angle		Inclination of Steering Knuckle Bolt		Toe-In	Toe-Out on Curves		Front Wheel Tire Pressure in Pounds		†Steering Pivot Position	*Spring Position
		With Car Weight off Wheels	With Car Weight on Wheels	With Car Weight off Wheels	With Car Weight on Wheels		Outside Wheel	Inside Wheel	Normal (Also Rr. Wheels)	High Speed Driving	See "A" Fig. 7	See "B" Fig. 7
LASALLE												
303	2½—3°	2½°	1¾—2°	7½°	8–8¼°	3/16—5/16″	20°	22—23½°	40	45	1—1½″	5¼″
328	—	2½°	1¾—2°	7½°	8–8¼°	3/16—5/16″	20°	22—23½°	40	45	1⅛—1½″	5¼″
Before Frt. Ax. Unit 4-8137	2½—3°	—	—	—	—	—	—	—	—	—	—	—
Begin. Frt. Ax. Unit 4-8137	1—2°	—	—	—	—	—	—	—	—	—	—	—
340	1½°	1½°	¾—1°	10¼°	10¾–11°	1/16—3/16″	20°	22—23½°	40	45	1⅛—1½″	5⅜″
345-A	2—3½°	1½°	¾—1°	8½°	9–9¼°	1/16—3/16″	20°	22—23°	40	45	1⅛—1½″	5⅜″
345-B	2—3½°	1½°	¾—1°	7¾°	8¼–8½°	1/16—3/16″	20°	22—23½°	35	40	3⅜—3⅝″	5¾″
345-C	2—3½°	1½°	¾—1°	7¾°	8¼–8½°	1/16—3/16″	20°	22—23½°	35	40	3⅜—3⅝″	5¾″
CADILLAC												
(V-8) 341-A	2½—3°	2½°	1¾—2°	5°	5½–5¾°	3/16—5/16″	20°	22—23°	40	45	3—3½″	6⅜″
341-B	—	2½°	1¾—2°	5°	5½–5¾°	3/16—5/16″	20°	22—23°	40	45	3—3½″	6½″

Front Wheel Alignment Manual

Note: This manual should be used in the service meeting to supplement Cadillac Service Guide No. 26 (June 1933) featuring "Front Wheel Alignment".

Front wheel and axle alignment is the mechanics of keeping all interrelated parts affecting steering in proper adjustment. Correct alignment is essential to keep the front wheels in their true running position for easy and efficient steering and the prevention of abnormal tire wear.

The elements involved in front wheel and axle alignment are caster, camber with the inclination of the steering knuckle bolts, toe-in and toe-out on turns. These elements are all related and dependent upon each other. In addition to these elements, there are several other factors that affect the alignment of the axle unit; namely, tire inflation, wheel wobble, wheel and tire balance, location of pivot on steering knuckle arm for steering connecting rod, tightness of springs on axle and shackles, straightness of axle parts and frame, alignment of axles with frame, adjustment of the wheel and steering knuckle bearings, the steering gear and connections, spring modulator and the shock absorbers, and proper lubrication of the shock absorbers.

Caster

Caster is the angle of backward inclination between the steering knuckle bolt and vertical. See Fig. 1. Its purpose is to stabilize steering. The caster angle is obtained by tilting the top of the axle back and is established by the design of the front axle and springs.

This setting of the steering knuckle bolts enables them to pull rather than to push the front wheels, thereby imparting a trailing action to the wheels, which has the effect of keeping the car in a straight ahead course and in straightening up wheels on a turn.

Only a slight amount of caster is necessary to stabilize steering. Excessive caster causes hard steering, due to the increasing tendency of the front wheels to toe-in and the necessity for the inner steering knuckle on a turn actually to raise the weight of the car on that side further off the ground. The reason for this is that when a wheel spindle is turned rearwards, either the outer end of the spindle must lower with respect to the axle or else the axle must rise, leaving the end of the spindle in the same position. Since the spindle is supported in the wheel and cannot change its position, it is obvious that the axle must rise slightly, carrying the weight of the car with it. This condition, however, is practically offset by the action of the other steering knuckle which when turned frontwards slightly lowers the axle and the weight of the car on that side.

Too much caster is also undesirable as the weight of the car on the front axle then has a tendency to turn the wheels in at the front around their respective steering knuckle bolts. Since the front wheel steering knuckles are connected together by a steering cross rod, it is obvious that through any inequality of this tendency of the front wheels to turn around the steering knuckle bolts, the wheel having the greatest turning effort will tend to pull the other wheel back, resulting in a wheel shimmy.

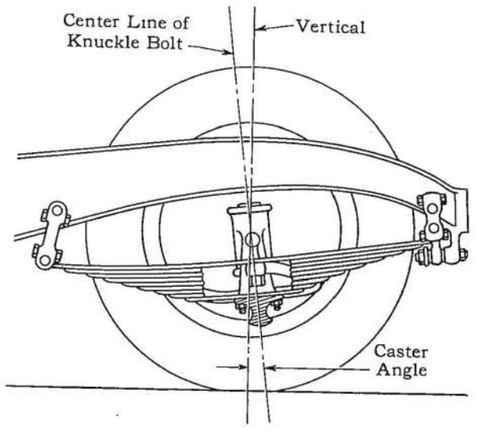


Fig. 1. Caster is the angle of backward inclination between the steering knuckle bolt and the vertical

Insufficient caster results in car wander which makes it difficult to keep a car traveling ahead in a straight course. The reason for this is that the plane of the wheel spindles and that of the axle remains practically the same in a turn as when straight ahead with little or no inherent force to keep the wheels in a straight ahead position.

Reverse caster results in erratic steering. A car under this condition will tend to go from one side of the road to the other, will turn curves easily but will be difficult to straighten out at the end of the curve.

A rapid fluctuation of caster from its normal setting results from the flexing of the springs. If there is any variation in the spring action, a condition is brought about that may develop a shimmy. From this it is evident that the springs should be alike on both sides and the shock absorbers properly adjusted.

Another factor that affects caster is the braking force on the front wheels. Since the front brakes are anchored to the axle, the braking action tends to rotate the axle in the direction of wheel rotation and cause reverse caster. If the brakes are unequally adjusted, therefore, uneven or reverse caster might result on heavy brake application, causing the car to pull to the side with the tightest brake.

Camber

Camber, as illustrated in Fig. 2, is the outward tilt of the front wheels at the top and results in the bottom of the wheels coming more nearly under the load. The purpose of camber is to support the greater part of the car weight on the inner wheel bearings, to reduce side thrust on the steering knuckle bolts, to compensate for looseness and wear in the steering knuckle and wheel bearings and to bring the point of pivot near the center of the tire tread in contact with the road for center point steering.

The many advantages of camber, however, are partially offset by the undesirable effect it has on tire contact with the road. With cambered wheels, the outer edge of the tire tread which is in contact with the road surface is closer to the wheel center than the inner edge and this condition increases with an increase in camber or a decrease in the tire inflation pressure. In other words, the outer edge of the tread rolls on a smaller circumference than the inner edge. Since the wheel moves straight ahead, a portion of the tire must slip, under this condition, causing excessive wear. This is one of the many reasons why the tires should be kept inflated to the recommended pressure.

Reverse camber also causes excessive tire wear due to the inner edge of the tread rolling on a smaller circumference.

Since too much camber is undesirable, some other means is necessary to give the effect of camber which is required for easy steering and minimum wear of parts. This

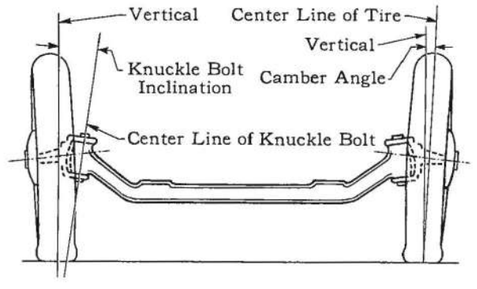


Fig. 2. Camber is the outward tilt of the front wheels at the top

Diagnosis Chart—Continued

Effect	Cause	Remedy
Car Wanders—Continued	Steering knuckle bent.	Replace with new knuckle.
	Front or rear axle shifted. (Spring clip bolts loose or center bolt sheared.)	Check spring clips for looseness. Also measure from front spring bolt to steering knuckle bolt and from rear spring bolt to rear axle housing. See Fig. 6. These distances should be uniform on both sides of car.
	Spring shackles loose, worn or incorrectly adjusted.	Adjust or install new parts as required. Shackle must not be adjusted tight enough to bind on spring.
	Better tread on rear tires than on front ones.	Change tires putting ones with best tread on front.
Road Shocks	Low air pressure.	Inflate tires to pressure given in the Specification Table, page 18.
	Steering gear or connections incorrectly adjusted.	Adjust steering gear and connections as outlined in the Shop Manual.
	Modulator incorrectly adjusted or springs damaged.	Adjust or replace springs as recommended on page 10.
	Excessive caster.	Check caster and adjust with wedge plates. Straighten or replace axle with new one, or install extra leaves in springs or rearch as necessary.
	Shock absorbers incorrectly or unevenly adjusted, improperly lubricated or inoperative.	Check adjustment and correct as necessary. Also make sure they are properly lubricated.
	Front springs weak or sagged.	Replace weak springs with new ones of correct type. Check distance from spring seat on axle to under side of frame against dimensions given in the Specification Table, page 18. Sagged springs should be replaced with new ones. Satisfactory adjustment can in some cases be made by installing extra leaves or rearching.
	Wrong type or size of tires used.	Install new tires of correct type and size.
	Steering knuckle arm pivot for steering connecting rod incorrectly located. (Arm bent).	Check location of pivot against dimensions given in Specification Table, page 18. Replace bent arm with new one.
	Steering knuckle bent.	Replace with new knuckle.

Diagnosis Chart—Continued

Effect	Cause	Remedy
Front Wheels Shimmy—(Continued)	Front axle bent or twisted.	Check axle alignment by testing the camber, knuckle bolt inclination and caster. If axle is out of car, check against specifications given in the Shop Manual. Straighten axle or replace as necessary.
	Steering knuckle bent.	Replace with new knuckle.
	Wheels, tires or back drums out of balance.	Balance wheels and tires as explained on page 8. Also check for out of balance brake drums and for eccentric or bulged tires and replace as necessary.
	Wheels or tires out of true.	Check for wheel and tire wobble. See that rim lugs are tightened uniformly on early cars. On later cars see that wheels and tires are properly mounted.
	Steering gear incorrectly adjusted.	Adjust steering gear as outlined in the Shop Manual.
	Insufficient or incorrect lubricant used.	Check lubricant in steering gear and lubricate steering system as recommended in the Shop Manual.
	Eccentric or bulged tires.	Replace with new ones.
	Excessive camber.	Check camber and correct by straightening axle or replacing parts as necessary.
	Springs too flexible.	Check springs for broken leaves and sagging. Replace springs, install extra leaves or rearch as necessary.
Front or Rear Wheels Tramp	Wheels, tires or brake drums out of balance.	Balance wheels and tires as explained on page 8. Also check for out of balance brake drums and for eccentric or bulged tires and replace as necessary.
	Front springs weak.	Replace with new ones of correct type, install extra leaves or rearch.
	Shock absorbers incorrectly or unevenly adjusted, improperly lubricated or inoperative.	Check adjustment and correct as necessary. Also make sure they are properly lubricated.
Car Wanders	Low or uneven tire pressure.	Inflate tires to pressure given in the Specification Table, page 18.
	Steering gear or connections adjusted too loose or worn.	Adjust as outlined in the Shop Manual or install new parts as necessary.
	Steering gear or connections adjusted too tight.	Test steering system for binding with front wheels off floor. Adjust as necessary and lubricate.
	Steering knuckle bearings incorrectly adjusted or worn.	Adjust according to instructions given on page 9 or replace parts as necessary.
	Wheels toe-out in straight ahead position.	Adjust steering cross rod to make front wheels toe-in to dimensions given in the Specification Table, page 18.
	Insufficient or uneven caster.	Check caster and adjust with wedge plates. Straighten or replace axle with new one, or install extra leaves in springs or rearch as necessary.

condition is obtained by **inclination of the steering knuckle bolts.** See Fig. 2. It is obvious, therefore, that the angle or inclination of the steering knuckle bolts is closely associated with wheel camber in its effect on steering. The angle of the steering knuckle bolts is determined by the design of the axle and varies in different car models.

Toe-in

The setting or adjustment of the front wheels, so that the distance between them is less at the front than at the rear, as shown in Fig. 3, is called toe-in. Toe-in is necessary as camber tend to cause the wheels to run out or separate at the front. Sufficient toe-in is necessary, therefore, to compensate for this tendency and make the wheels roll straight ahead.

As stated under "Camber," the outer edge of the tire tread on a cambered wheel is compressed more and consequently rolls on a smaller circumference than the inner edge. Cambered wheels, therefore, like segments of cones, have a tendency to roll outward in a circle. Toeing the wheels in at the front compensates for this tendency, thus reducing the road friction to a minimum.

The amount of toe-in is dependent upon the amount of camber and must be adjusted accordingly. In other words, high camber requires that the wheels toe-in more than low camber, and if the camber is changed the amount of toe-in must be changed also. Each degree of camber requires approximately $\frac{1}{8}$-inch of toe-in. Excessive toe-in or toe-out will cause abnormal tire wear. Too much toe-in will cause the tread sections to wear with a feathered edge at the inner side. Insufficient toe-in or toe-out of the wheels in the straight ahead position will cause the tread to wear with the feathered edges toward the outside.

Toe-out on Turns

In addition to the front wheel and axle settings previously described, there is another

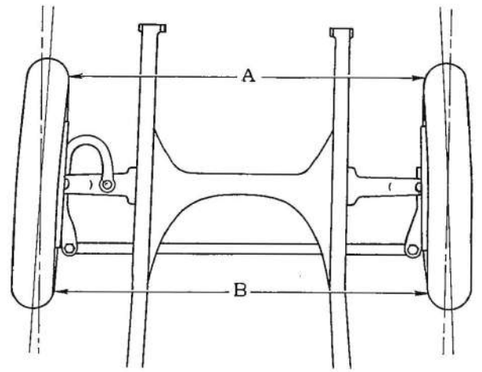


Fig. 3. Toe-in is the setting or adjustment of the front wheels so that the distance "A" between them at the front is less than the distance "B" at the rear.

very important action of the front wheels, which has a great effect on tire wear. This action is toe-out on turns. See Fig. 4. In other words, when the front wheels are turned to the right or left they separate slightly at the front, depending on the amount of deflection from the straight ahead course, instead of retaining their toed-in relation. The wheel making the inside or smaller circle makes a greater angle with the axle than the outside wheel, thus making toe-out necessary on curves. The amount of toe-out increases as the turn increases due to the increasing angle between the wheels.

Toe-out of the front wheels is a result of steering knuckle arm design and is dependent on the alignment of these arms. The setting of the arms is at an angle with one another and with the center line of the car instead of straight back in order to maintain the proper relation of the front wheels on turns. In other words, if these arms were extended back far enough toward the rear of the car they would intersect or cross at a point in front of the rear axle, varying with the wheelbase of the car. The angle of these arms depends upon their length, the wheel base of the car and the distance between the steering knuckle bolts.

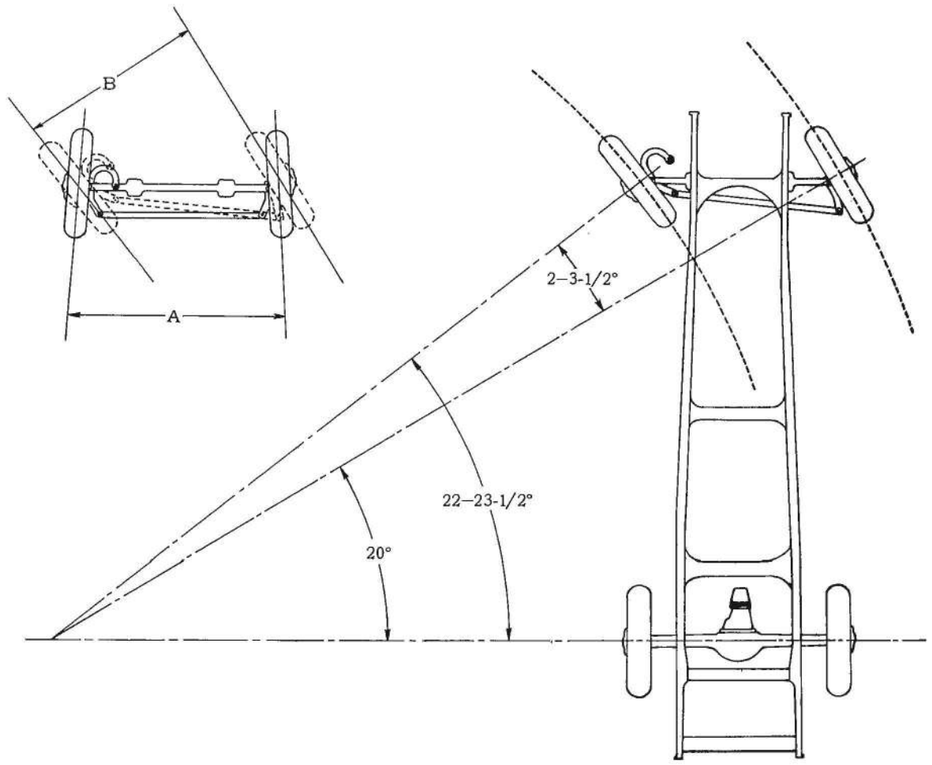


Fig. 4. The front wheels instead of retaining their toed-in relation as indicated by the angle "A" actually toe-out or separate slightly at the front as shown by the angle "B" when turned to the right or left

Checking Alignment

No set rule can be given for the sequence of operations in checking and correcting front wheel and axle alignment. Neither can the exact cause of any form of misalignment be given, as much depends upon the age of the car and consequently the condition of the parts. The factors affecting alignment and the elements of alignment should, however, be checked in the following order as closely as possible.

Diagnosis Chart—Continued

Effect	Cause	Remedy
Cupped Tires—(Continued)	Normal cupping of tires.	Explain to owner that such cupping is due to normal action of a non-skid tires on the road.
	Wheels, tires or brake drums out of balance.	Balance wheels and tires as explained on page 8. Also check for out of balance brake drums and for eccentric or bulged tires and replace as necessary.
	Dragging brakes. (Incorrectly adjusted.)	Adjust brakes as outlined in the Shop Manual.
	Loose steering knuckle or wheel bearings incorrectly adjusted or worn.	Adjust or replace as necessary.
	Uneven caster.	Check caster and adjust with wedge plates. Straighten or replace axle with new one, or install extra leaves in springs or rearch as necessary.
	Front axle bent or twisted.	Check axle alignment by testing camber, knuckle bolt inclination and caster. If axle is out of car, check against specifications given in the Shop Manual. Straighten axle or replace with new one.
	Steering knuckle bent.	Replace with new knuckle.
Front Wheels Shimmy	Low or uneven tire pressure.	Inflate tires to pressure given in the Specification Table, page 18.
	Steering connections incorrectly adjusted or worn.	Adjust or install new parts as necessary.
	Front wheel bearings incorrectly adjusted or worn.	Adjust as explained on page 9. Replace worn parts with new ones.
	Modulator incorrectly adjusted or springs damaged.	Adjust or replace springs as recommended on page 10.
	Shock absorbers incorrectly or unevenly adjusted, improperly lubricated or inoperative.	Check adjustment and correct as necessary. Also make sure they are lubricated.
	Spring shackles loose, worn or incorrectly adjusted.	Adjust or install new parts as required. Shackles must not be adjusted tight enough to bind on spring.
	Front axle shifted. (Spring clip bolts loose or center bolt sheared.)	Check spring clips for looseness. Also measure from front spring bolt to steering knuckle bolt. This distance should be uniform on both sides of car.
	Steering knuckle bearings incorrectly adjusted or worn.	Adjust according to instructions given on page 9, or replace parts as necessary.
	Toe-in incorrect.	Adjust steering cross rod to make front wheels toe-in to dimensions given in the Specification Table, page 18.
	Incorrect or uneven caster.	Check caster and adjust with wedge plates. Straighten or replace axle with new one, or install extra leaves in springs or rearch as necessary.

Diagnosis Chart—Continued

Effect	Cause	Remedy
Car Pulls to one Side (Continued)	Front springs sagged.	Check distance from spring seat on axle to under side of frame against dimensions given in the Specification Table, page 18. Sagged springs should be replaced with new ones. Satisfactory adjustment can in some cases be made by installing extra leaves or rearching.
	Spring eye straightened out.	Replace main or eye leaf or spring assembly
	Front or rear axle shifted. (Spring clip bolts loose or center bolt sheared.)	Check spring clips for looseness. Also measure from front spring bolt to steering knuckle bolt and from rear spring bolt to rear axle housing. See Fig. 6. These distances should be uniform on both sides of car.
	Frame bent or broken.	Check frame for proper alignment and breakage. Repair or replace frame as necessary.
	Steering knuckle bent.	Replace with new knuckle.
	Steering knuckle arm bent.	Check by testing toe-out. Replace with new arm.
Scuffed Tires	Tires improperly inflated.	Inflate tires to pressure given in the Specification Table, page 18.
	Wheels or tires out of true.	Check for wheel and tire wobble. See that rim lugs are tightened uniformly on early cars. On later cars see that wheels and tires are properly mounted.
	Steering knuckle bearings incorrectly adjusted or worn.	Adjust according to instructions given on page 9, or replace parts as necessary.
	Toe-in incorrect.	Adjust steering cross rod to make front wheels toe-in to dimensions given in the Specification Table, page 18.
	Incorrect or uneven camber.	Check camber and correct by straightening axle or replacing parts as necessary.
	Uneven caster.	Check caster and adjust with wedge plates. Straighten or replace axle with new one, or install extra leaves in springs or rearch as necessary.
	Incorrect toe-out on turns.	Replace steering knuckle arms with new ones.
	Front axle bent or twisted.	Check axle alignment by testing camber, knuckle bolt inclination and caster. If axle is out of car, check against specifications given in the Shop Manual. Straighten axle or replace with new one.
	Steering knuckle bent.	Replace with new knuckle.
	Excessive speeds on turns.	Caution driver.
Cupped Tires	Tires improperly inflated.	Inflate tires to pressure given in Specification Table, page 18.

Factory Affecting Alignment

1. Tire Inflation.

   Checking and inflating the tires to the proper pressure is the very first operation of any wheel alignment job.
2. Running of wheels such as out of true, out of balance and not tracking.
3. Location of steering arm pivot for steering connecting rod.
4. Adjustment of front wheel and steering knuckle bearings.
5. Condition of springs and shock absorbers.
6. Adjustment of steering gear and connections.

Elements of Alignment

7. Caster angle of front axle.
8. Camber angle and knuckle bolt inclination.
9. Toe-in of front wheels in straight ahead position.
10. Toe-out of front wheels on turns.

Note: **All alignment checks should be made with the weight of the car on the wheels.**

WHEELS AND TIRES

Tire Pressure—One of the most important factors in the maintenance of good steering and in the prevention of excessive tire wear is proper inflation of the tires. Low tire pressure not only causes hard steering and undue tire wear but it also aggravates any tendency of the front wheels to shimmy or tramp. The use of tires of different make, design or size, may also contribute to wheel misalignment.

When a tire is soft or under-inflated, a broad surface is formed at the bottom where it contacts with the ground, which results in excessive tire friction and hard steering. A condition of slight misalignment is also caused by under-inflation, which tends to result in erratic performance of the wheels and consequently the steering system.

Beginning with the 345-B, 355-B, 370-B and 452-B cars, all four tires should be inflated to 35 pounds pressure. For continuous high speed driving it is advisible to increase the pressure of the front tires to 40 pounds. Prior to these models all tires should be inflated to 40 pounds for average driving and the front tires to 45 pounds for continuous high speed driving.

Wheel Wobble—The wheels or tires should not wobble or run-out sideways more than $\frac{3}{32}$ inch measured on the side walls of the tire with it properly inflated. Such wobble is the result of a bent wheel, looseness in the wheel or steering knuckle bearings or in the steering connections or improper mounting of the wheels or rims.

Wheel wobble must be corrected or eliminated as much as possible before checking the elements of alignment. Any remaining wobble or high spot on the tire should be marked with chalk, as indicated in Fig. 5, to aid in locating the wheels in the proper position when checking the alignment angles.

A wobble in excess of the amount just given will cause spotty tire wear and prevent correct alignment of the axle assembly.

Wheel Eccentricity—The wheels and tires should also run as nearly concentric as possible with the steering knuckle spindle; that is, they should not run eccentric more than $\frac{1}{16}$ inch. Aside from causing unnecessary tire wear, eccentricity in the wheels and tires also tends to set up a vertical movement of the axle, which is closely associated with shimmy and tramp.

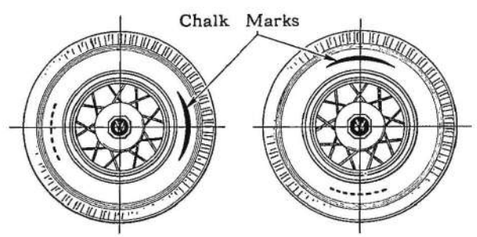


Fig. 5. The front wheels should be turned on their bearings to bring the high spot or that portion of the tire with the greatest run-out toward the front or rear as shown at the left when checking caster, camber, and knuckle bolt inclination and at the top or bottom as shown at the right when checking toe-in and toe-out

Run-out or eccentricity of the wheels and tires in excess of this amount can oftentimes be corrected by deflating the tire and changing its position on the rim.

Wheel and Tire Balance—Proper balance of the front wheels, tires and brake drums is another essential factor in the maintenance of good steering. Each wheel assembly should be balanced within one ounce at the tread in order to avoid the possibility of tramp or high speed shimmy. Tire balance also affects tire wear. Likewise, the rear wheels should be balanced, as an unbalanced condition will set up vibrations which will affect the performance of the front axle assembly as well as the riding quality of the car.

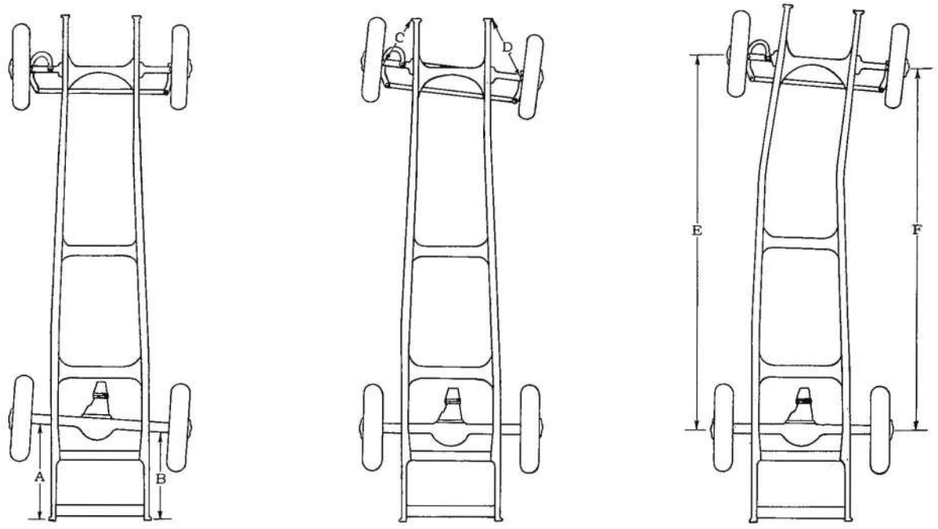
Tires are usually balanced to offset the weight of the valve stem and if removed they must be reinstalled in their original position with respect to the rim, otherwise the tire and wheel will be unbalanced. Such tires are generally branded on the side wall with some mark such as a small red square, which should be placed in line with the valve stem.

The wheel itself should also be in proper balance. This can be effected frequently by shifting the tire around in relation to the tube so that the valve stem will be at the lighter side of the tire. In other cases, it will be necessary to use detachable balancing weights, such as supplied by the Factory Parts Division, placing them on the light side of the wheel and as nearly under the center of the tire as possible. These weights are made in two styles, one for the rolled-edge drop-center rim, and one for the plain type of rim. The part numbers of these weights are as follows:

892498...Balancer for rolled-edge rim

1280290...Balancer for plain type rim

Tracking of Wheels—Another essential factor in the maintenance of good steering and in the prevention of excessive tire wear is the tracking of the rear wheels with the front ones. Failure of the wheels to track is usually quite obvious upon following the car on the highway.



Rear axle out of position — Front axle out of position — Bent frame

Fig. 6. To insure tracking of the rear wheels with the front ones the front and rear axles must be in the correct position and the frame straight. The dimensions "A" and "B" will be alike if the rear axle is straight and in the proper position. With the front axle straight and in the proper position the dimensions "C" and "D" will be alike. The dimensions "E" and "F" should also be alike; if they are not the same and both axles are straight and in the correct position with the front and rear of frame a bent frame is indicated

Diagnosis Chart—Continued

Effect	Cause	Remedy
Erratic Steering on Application of Brakes (Cont'd.)	Front axle shifted. (Spring clip bolts loose or center bolt sheared.)	Check spring clips for looseness. Also measure from front spring bolt to steering knuckle bolt. This distance should be uniform on both sides of car.
	Spring shackles loose, worn or incorrectly adjusted.	Adjust or install new parts as required. Shackles must not be adjusted tight enough to bind on spring.
	Front springs weak.	Replace with new springs of correct type, install extra leaves or rearch.
	Insufficient or uneven caster.	Check caster and adjust with wedge plates. Straighten or replace axle with new one, or install extra leaves in springs or rearch as necessary.
	Steering knuckle bent.	Replace with new knuckle.
	Steering knuckle arm pivot for steering connecting rod incorrectly located. (Arm bent)	Check location of pivot against dimensions given in Specification Table, page 18. Replace bent arm with new one.
Car Pulls to one Side	Low or uneven tire pressure.	Inflate tires to pressure given in the Specification Table, page 18.
	Rear wheels not tracking with front wheels.	Check alignment of rear axle with front axle and correct as necessary.
	Brakes incorrectly or unevenly adjusted.	Adjust brakes as outlined in the Shop Manual.
	Shock absorbers incorrectly or unevenly adjusted, improperly lubricated or inoperative.	Check adjustment and correct as necessary. Also make sure they are properly lubricated.
	Steering knuckle or wheel bearings adjusted too tight.	Check for binding with front wheels off floor. Adjust as explained on page 9 and lubricate.
	Toe-in incorrect.	Adjust steering cross rod to make front wheels toe-in to dimensions given in the Specification Table, page 18.
	Incorrect or uneven caster.	Check caster and adjust with wedge plates. Straighten or replace axle with new one, or install extra leaves in springs or rearch as necessary.
	Incorrect or uneven camber.	Check camber and correct by straightening axle or replacing parts as necessary.
	Steering knuckle arm pivot for steering connecting rod incorrectly located. (Arm bent)	Check location of pivot against dimensions given in Specification Table, page 18. Replace bent arm with new one.
	Front or rear axle bent or twisted.	Check axle alignment by testing camber, knuckle bolt inclination and caster. If axle is out of car, check against specifications given in the Shop Manual. Straighten axle or replace with new one.

Front Wheel Alignment
Diagnosis Chart

Effect	Cause	Remedy
Hard Steering (Indicated by tightness in steering system)	Low or uneven tire pressure.	Inflate tires to pressure given in the Specification Table, page 18.
	Steering gear or connections adjusted too tight.	Test steering system for binding with front wheels off floor. Adjust as necessary and lubricate.
	Steering cross rod adjusted too tight.	Check for binding with front wheels off floor. Adjust as required and lubricate.
	Insufficient or incorrect lubricant used.	Check lubricant in steering gear and lubricate steering system as recommended in the Shop Manual.
	Excessive caster.	Check caster and adjust with wedge plates. Straighten or replace axle with new one, or install extra leaves in springs or rearch as necessary.
	Front axle bent or twisted.	Check axle alignment by testing the camber and caster. If axle is out of car, check against specifications given in the Shop Manual. Straighten axle or replace with new one.
	Front springs sagged.	Check distance from spring seat on axle to under side of frame against dimensions given in the Specification Table, page 18. Sagged springs should be replaced with new ones. Satisfactory adjustment can in some cases be made by installing extra leaves or rearching.
	Frame bent or broken.	Check frame for proper alignment and breakage. Repair or replace frame as necessary.
	Steering knuckle bent.	Replace with new knuckle.
Excessive Play or Looseness in Steering System	Steering gear or connections adjusted too loose or worn.	Adjust as outlined in the Shop Manual or install new parts as necessary.
	Steering knuckle bearings incorrectly adjusted or worn.	Adjust according to instructions given on page 9 or replace parts as necessary.
	Front wheel bearings incorrectly adjusted or worn.	Adjust as explained on page 9. Replace worn parts as necessary.
Erratic Steering on Application of Brakes	Low or uneven tire pressure.	Inflate tires to pressure given in the Specification Table, page 18.
	Brakes incorrectly or unevenly adjusted.	Adjust brakes as outlined in the Shop Manual.
	Modulator incorrectly adjusted or springs damaged.	Adjust or replace springs as recommended on page 10.

It is very important to check the position of both the front and rear axles on the springs and to make sure that the spring center bolts are not sheared as these bolts serve to keep the axles in place. If the wheels do not track, and both axles are straight and in the proper position, the wrong type of spring may be in use, the spring eye may be partly straightened out or the frame may be bent. See Fig. 6.

STEERING ARM PIVOT

The correct position of the steering knuckle arm pivot to which the front end of the steering connecting rod is connected, is necessary to prevent road shocks at the steering wheel and erratic steering when the brakes are applied. The location of the pivot should be checked by measuring from the top of the spring seat on the axle I-beam to the center of the pivot as indicated at "A" in Fig. 7. The steering arm should be replaced if the pivot does not come within the dimensions given in the Specification Table, page 18.

WHEEL AND STEERING KNUCKLE BEARINGS

Correct adjustment of the front wheel and steering knuckle bearings is essential for proper performance of the front axle assembly and consequently efficient steering.

When adjusting the front wheel bearings, care should be taken not to mistake play in the steering knuckle connections for play in the wheel bearings. The adjustment of the steering knuckle bearings can be checked by lifting the wheel up and down with a bar. In case of looseness, the adjusting plug should be checked to make sure that it is free in the threads and screws all the way in against the bearing and then tightened as tight as possible by hand, using a 12 or 15-inch wrench.

To adjust the ball bearings in the front wheels, the adjusting nut is first drawn up as tight as possible by hand with a 12 or 15-inch wrench and then backed off to the second cotter pin slot. If the locking device cannot be placed in position without changing the adjustment, the adjusting nut should

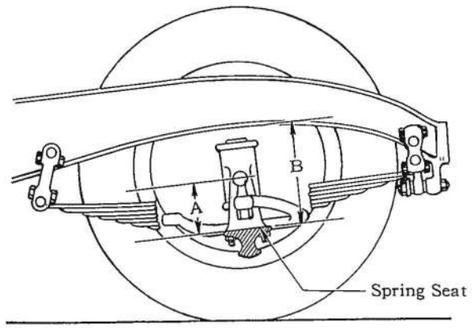


Fig. 7. The dimension "A" given in the Specification Table, page 18 is used for determining the location of the steering knuckle arm pivot. The dimension "B" also given on page 18 is used to determine whether the springs have sagged sufficiently to warrant replacement or rearching

be tightened instead of loosened until it can be secured with the locking device. It is preferable to have the adjustment on the tight side rather than the loose side provided it is not necessary to tighten the nut more than ½ notch.

It is also a good plan to turn the wheels toward the right side when adjusting the left wheel bearings, and toward the left side when adjusting the right wheel bearings to assure full release of the brakes.

SPRINGS AND SHOCK ABSORBERS

Spring Connections—Still another important factor in the maintenance of front wheel and axle alignment is proper adjustment of the spring connections. Any looseness in the spring shackles or clips is likely to affect the angle and action of the axle.

The spring clips should be kept tight in order to keep the axle in the proper plane and in the correct position on the springs. Looseness in the clips may cause the axle to tip or rock, affecting the caster and also the shearing of the center bolt which will allow the axle to shift or change its position on the springs and thus affect the alignment of the steering connecting rod and tracking of rear wheels.

Likewise, the spring shackles, should be properly adjusted. When adjusting them, care should be taken not to tighten the bolts

enough to bind the links on the spring leaf. All shackle connections should be free and properly lubricated.

Sagged or Weak Springs—Sagged or weak springs will cause unstable caster. The spring should be checked by measuring from the top of the spring seat or the axle I-beam to the under side of the frame as indicated at "B" in Fig. 7. If this distance does not come within the dimensions given in the Specification Table, page 18, the spring should be replaced or repaired by rearching or adding additional leaves. It is also extremely important that the springs be alike on both sides.

Shock Absorbers—Good steering is more or less dependent on proper performance of the shock absorbers. Front wheel shimmy and tramp are oftentimes traceable to shock absorbers that are incorrectly or unevenly adjusted, improperly lubricated or inoperative. It is imperative that the shock absorbers be checked and properly serviced as outlined in the Shop Manual when found to be out of order. They should also be checked for equal performance and proper lubrication.

Steering Modulator—Proper action of the steering modulator is essential to good steering. The modulator springs should be correctly adjusted and in good condition. Weak or defective springs may set up or aggravate front wheel shimmy or cause the car to pull to one side when the brakes are applied.

The modulator is adjusted by turning the nuts on the bolts supporting the small coil springs so that they are just flush with the ends of the bolts. If one or more of these coils springs is found broken or weak, a complete set of four new springs should be installed. These springs should have a free length of approximately 1½ inch and should show a pressure of 95 to 105 pounds, when compressed to $1\frac{3}{16}$ inch.

STEERING GEAR AND CONNECTIONS

Another very important factor in maintaining good steering is proper adjustment and lubrication of the steering gear and connections. An incorrectly adjusted steering system may cause any of the steering complaints, even though the front wheels and axle are in correct alignment.

Before any attempt is made to adjust the steering gear, the steering connections should be checked and readjusted or new parts installed if necessary. Binding or excessive looseness in the connections should be tested for by raising the front wheels off the floor and moving the connections by hand.

Both the steering connections and the steering gear should be adjusted as outlined in the Shop Manual. Strict adherence to these instructions is important.

Correct lubrication of the steering system is also necessary to good steering. The recommendations made in the Shop Manual and also in the Owner's Manual, which accompanies the car, should be followed.

CASTER ANGLE

Before checking the caster angle, it is important to remove all extras such as shimmy dampening devices, etc., from the front axle. The car is then lowered to bring all of the weight on the wheels as incorrect readings might otherwise be obtained due to spring in the axle and play in the steering knuckle and wheel bearings. The car should next be moved back and forth a full turn of the wheels after it is lowered on them to relieve the tire tension.

The caster angle should come within the limits given in the Specification Table, page 18. Equal caster or the same amount within ½ degree on both sides of the car is extremely important. Unbalanced caster will cause a car to pull to one side, usually towards the side with the least amount of caster, causing undue tire wear, hard steering and wheel shimmy.

The caster angle can be increased or decreased by means of wedge plates placed between the front springs and the spring seats on the axle I-beam. These wedge plates are available from the Factory Parts Division. Placing the thick edge of the plate towards the rear of the car increases the amount of caster and decreases it when placed toward the front. If it is necessary to change the caster between the two sides

of the car in excess of 1½ degrees, either the axle should be straightened or replaced with a new one. A bent axle can be straightened cold if out of true not more than 5 degrees.

CAMBER ANGLE

Camber is the next element of alignment to be checked. When checking the camber, the front wheels should be turned on their bearings to bring the high spot on the side of the tires in the horizontal plane toward the front or rear as shown in Fig. 5.

The camber angle should come within the limits specified in the Specification Table, page 18. It should also be the same on both sides within ½ degree. Unequal camber may cause a car to pull to one side usually the one having the greatest camber, thus contributing to wheel shimmy and spotty tire wear.

When the camber angle is found incorrect, the inclination of the steering knuckle bolt should also be checked, because the knuckle may be bent and not the axle I-beam. Incorrect inclination of the steering knuckle bolt indicates a bent axle while wrong camber may be due either to a bent axle or a bent steering knuckle.

An error in camber when due to a bent axle can be corrected by bending the axle back to its original position. The axle can be straightened cold if it is out of true only a small amount. If the axle is bent more than 5 degrees, it should be replaced with a new one.

A new steering knuckle should be installed whenever measurements disclose a bent steering knuckle yoke or spindle.

Changing the camber by bending the axle also affects slightly the turning angle of the wheels. Therefore, the toe-out of the wheels on turns should also be checked after making a camber correction.

It is also advisable after making a camber correction to change the tires putting the front ones on the rear wheels and the rear ones on front to provide a normal tire contact of the tires on the front wheels with the ground.

TOE-IN

Before the toe-in of the front wheels is checked, the wheels and tires should be made to run as nearly true as possible, regardless of the type of equipment used for measuring the toe-in. To check toe-in, the front wheels should be in the straight ahead position and when the measurements are taken from the side of the tire the wheels should be turned on their bearings to bring the high spot on the side of the tires in a vertical plane at the top or bottom as shown in Fig. 5. The toe-in dimensions should come within the limits given in the Specification Table, page 18.

Toe-in of the front wheels is adjusted by means of the steering cross rod and must be set to make the front tires run with a true rolling contact. Turning the cross rod in the same direction as the wheels revolve, when the car moves forward, increases the toe-in and turning it in the opposite direction decreases the toe-in. Large errors in toe-in indicate bent steering knuckle arms. The proper amount of toe-in can be determined by allowing ⅛ in. of toe-in to each degree of camber. **Toe-in must be corrected before checking toe-out on turns.**

TOE-OUT ON TURNS

Toe-out of the front wheels is checked by turning them to the right or left, locating the outside wheel in a definite position. With the outside wheel set to 20 degrees, the setting of the inside wheel should come within the limits given in the Specification Table, page 18.

Errors in the setting of the inside wheel are due to bent steering knuckle arms. When these arms are bent, the wheels will not turn in the proper relation on curves, which condition will affect the toe-out and result in excessive tire wear. Bent arms, however, will not necessarily affect the straight ahead driving.

When the steering knuckle arms are found bent or sprung out of line they should be replaced with new ones. Before discarding them, however, a careful check should be made to make sure that the axle I-beam is not bent, the camber and caster are correct and the same on both sides, the toe-in is correct and the front and rear wheels are parallel.