SECTION 3

STEERING, SUSPENSION, WHEELS AND TIRES

CONTENTS

SECTION 3A

FRONT END ALIGNMENT

CONTENTS

DESCRIPTION

Alignment is the proper positioning or state of adjustment of parts in relation to each other.

Proper alignment of front wheels must be maintained to ensure efficient steering and satisfactory tire life. The most important factors of front end alignment are wheel toe-in, wheel camber, and axle caster. Kingpin inclination is designed into the axle end. Front end alignment should be checked at regular intervals, and particularly after the front axle has been subjected to heavy impacts such as a collision or a hard curb impact. Before checking alignment, the wheel bearings must be properly adjusted, since loose wheel bearings will affect the instrument readings when checking the wheel toe in, wheel camber, and axle caster.

When checking the alignment, the instructions outlined in this section should be followed carefully, as well as instructions covering related units such as brakes, springs, steering gear, hubs and bearings, and wheels and tires, which are given in other sections of this manual. The front end alignment chart (figure 1) indicates the points at which the alignment dimensions are taken.

All alignment checking should be done with precision equipment and instruments. Refer to "Specifications" at the end of this section.

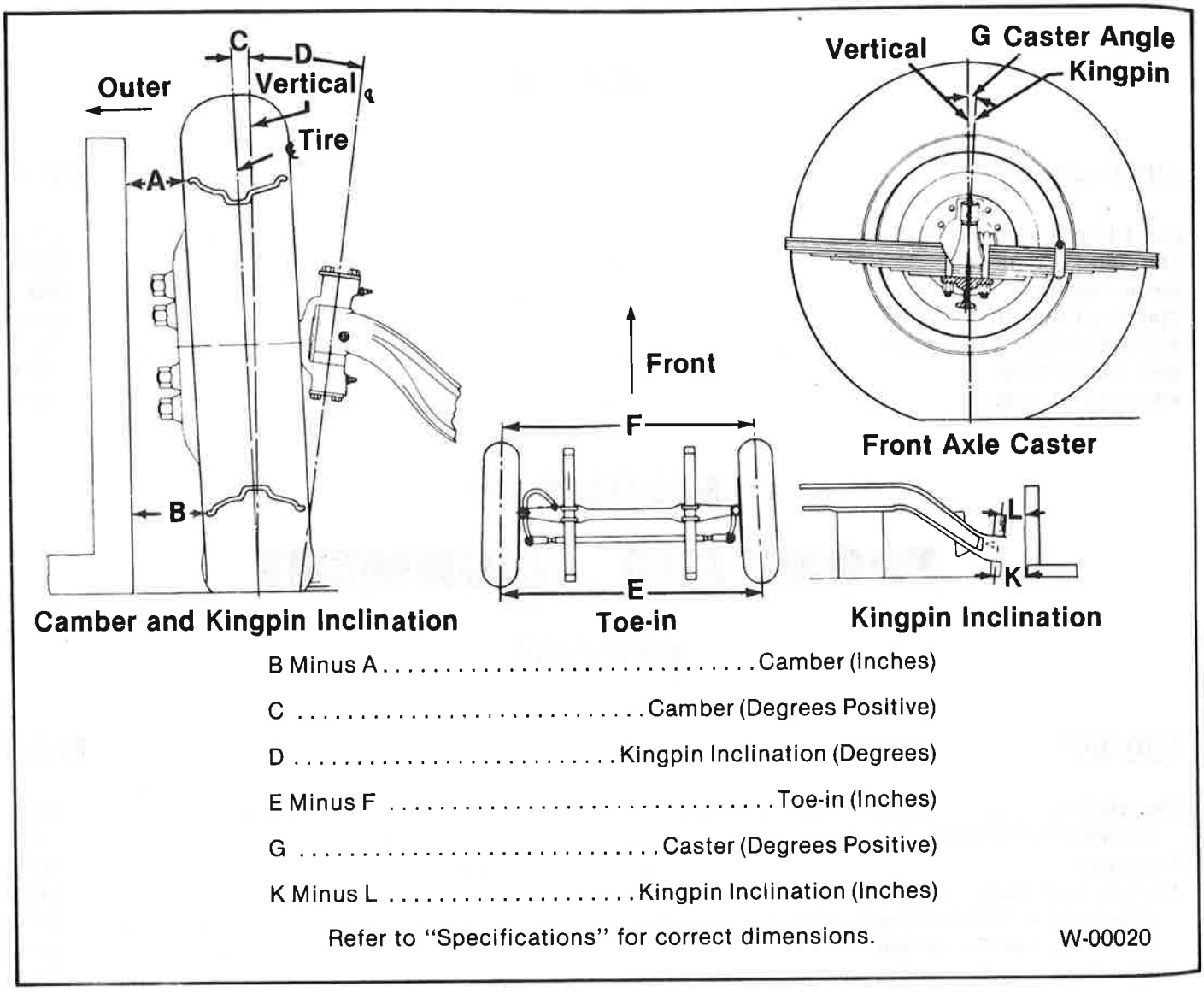


Figure 1. Front End Alignment Chart

DEFINITION OF TERMS

WHEEL TOE-IN

The distance between the front wheels is less at the front than at the rear of the axle (E and F, figure 1).

WHEEL CAMBER

Camber (A, figure 1) is the amount in inches or degrees the top of the front wheels are tilted outward or inward from the vertical position (C, figure 1). Camber offsets wheel deflection, due to wear of front axle parts, and prevents a reverse or negative camber condition. A reverse or negative camber is an inward inclination of wheels at the top.

If camber is extreme or unequal between the wheels, improper steering and excessive tire wear will result.

FRONT AXLE CASTER

The front axle caster is defined as the inclination of the kingpin from the vertical plane in the fore and aft direction of the vehicle (G, figure 1). Incorrect

caster may result from sagging springs, bent axle, twisted axle, or uneven tightening of spring U-bolt nuts. Tighten all U-bolt nuts equally. Refer to FRONT AXLE AND SUSPENSION (SEC. 3C) for U-bolt torque specifications. Generally, if the axle is twisted, the caster will be unequal for the right and left side.

KINGPIN INCLINATION

Kingpin inclination is designed into the axle end and is the amount that the top of the kingpin is inclined toward center of vehicle. Kingpin(s) are inclined (D, figure 1) to assist front wheel return to center after a turn is completed.

FRAME ANGLE

The caster, camber, and toe-in dimensions are for vehicle at design load (with frame level). If frame is not level on alignment equipment, the frame angle must be considered. This is especially important when making a caster angle check to obtain a true setting.

DIAGNOSIS

PROBLEM	POSSIBLE CAUSE	CORRECTION
NOISY FRONT END	1. Loose tie rod ends. 2. Lack of proper lubrication. 3. Loose shock absorber mounts. 4. Broken spring leaf. 5. Loose U-bolts or spring clips.	1. Replace ends. 2. Refer to MAINTENANCE AND LUBRICATION (SEC. 0B). 3. Refer to Diagnosis of Shock Absorbers (SEC. 3C). 4. Replace spring leaf. 5. Tighten.
WHEEL BOUNCE	1. Unbalanced wheels or tires. 2. Unequal tire pressure. 3. Weak or broken front spring. 4. Excessive wheel or tire runout. 5. Worn shock absorbers.	1. Refer to WHEELS AND TIRES (SEC. 3E). 2. Refer to WHEELS AND TIRES (SEC 3E). 3. Replace 4. Refer to WHEELS AND TIRES (SEC. 3E). 5. Refer to Diagnosis of Shock Absorbers (SEC. 3C).
EXCESSIVE TIRE WEAR	1. Incorrect wheel alignment. 2. Failure to rotate tires. 3. Improper tire inflation. 4. Overloaded or improperly loaded.	1. Align wheels. 2. Refer to WHEELS AND TIRES (SEC. 3E). 3. Refer to WHEELS AND TIRES (SEC. 3E). 4. Avoid overloading vehicle.

ON-VEHICLE SERVICE

For proper assembly torques of various components, refer to "Specifications" in STEERING LINKAGE (SEC. 3B1) or FRONT AXLE AND SUSPENSION (SEC. 3C) in this manual.

Before checking the front end alignment, the following front end inspection should always be made:

Inspect

1. Tires for proper inflation pressure. Note that the rim-to-floor height should be the same at each wheel.
2. Wheel installation and runout.
3. Wheel bearing alignment.
4. Steering tie rod and drag link ends for looseness.
5. Kingpins for looseness.

CHECKING AND CORRECTING TOE-IN

Incorrect toe-in results in excessive tire wear caused by side slippage and also unstable steering with a tendency to wander.

Toe-in may be measured from the center of the tire treads or from the inside of the tires. Measure at both the front and rear of the axle (E and F, figure 1). Note that the toe-in measurements must be made at the horizontal axis of the wheel.

When setting the toe-in adjustment, the front suspension must be neutralized; that is, all component parts must be in the same relative position when making the adjustment as they will be when in operation. To neutralize the suspension, the vehicle must be rolled forward 3.5 to 4.5 meters (12 to 15 feet). By rolling the vehicle forward, all tolerances in the front suspension are taken up and the suspension is then in normal operating position. Neutralizing the front suspension is extremely important, especially if the vehicle has been jacked up in order to mark the tires; otherwise, the front wheels will not return to the normal operating position due to the tires gripping the floor surface when the vehicle is lowered on the jack.

Toe-in is corrected by loosening the nut at the tie rod ends, then turning the tie rod with a wrench or tool that will not damage the tie rod, until wheels have proper toe-in (figure 2). Right- and left-hand threads are provided to facilitate toe-in adjustment.

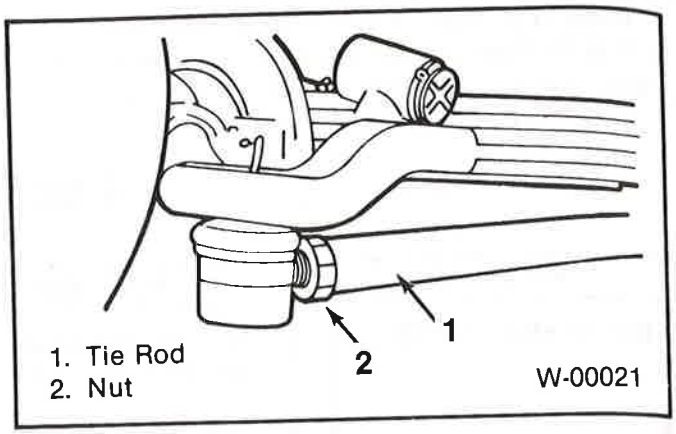


Figure 2. Toe-In Adjusting Location

CHECKING AND CORRECTING CAMBER

Camber variations may be caused by wear at wheel bearings and steering knuckle bushings, or by a bent steering knuckle or axle center. Camber specifications are listed at the end of this section.

1. Before checking the camber, inspect for kingpins as follows:
   a. Jack up the front of the vehicle, pull the bottom of the wheel outward, and take a camber reading. Then pull the top of the wheel outward and take a camber reading. If the readings vary more than 15 minutes, make the following adjustments:
   b. Adjust the wheel bearings as directed in FRONT AXLE AND SUSPENSION (SEC. 3C), then take the center readings as shown on "Front End Alignment Chart" (figure 1).
   c. Remove the front hub cap.
   Install camber, caster, and kingpin inclination gage on end of the knuckle spindle horizontally (figure 3).
   When removing the hub cap, take care so as not to cause damage to the gage fitting face at the end of the spindle.
   If end of the spindle has been scratched or damaged, correct before setting the gage.
   Reading of the camber scale directly indicates the camber angle.
   If the readings still vary over 15 minutes, replace the steering knuckle bushings and kingpins as instructed in FRONT AXLE AND SUSPENSION (SEC. 3C).
   d. Check the wheel runout as instructed in WHEELS AND TIRES (SEC. 3E). If the runout is excessive, straighten or replace the wheel.

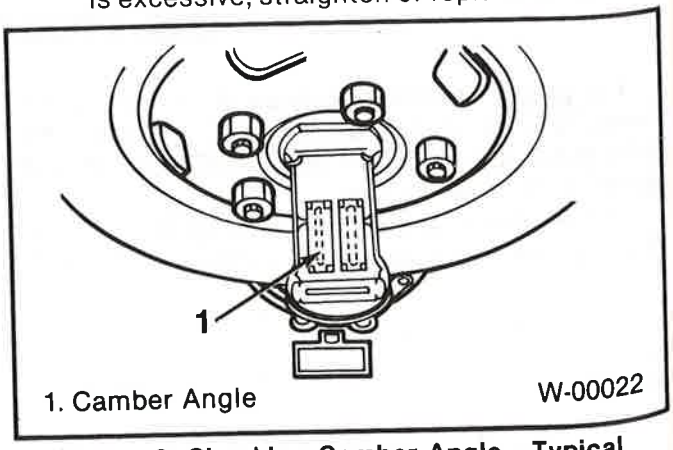


Figure 3. Checking Camber Angle—Typical

2. Place the vehicle on a level surface, with the normal weight of the vehicle on the wheels, then take the final camber reading. If a camber gage is not available, the readings can be taken as shown on the "Front End Alignment Chart" in figure 1. Place the square as shown and measure distances A and B. B SHOULD EXCEED A. Camber dimensions of the right wheel should not vary over 2.4 mm (3/32 inch) from camber dimensions of the left wheel. If the final camber reading is incorrect, either the steering knuckle or the axle is bent.
3. To determine which part is bent, check the kingpin inclination (D, figure 1). Camber plus kingpin inclination is the included angle of steering knuckle. If the kingpin inclination angle is to specification and the included angle or the camber angle is out of specification, then the knuckle (spindle) must be replaced. Excessive positive camber results in irregular wear of tires at the outer shoulder. Negative or reverse camber causes wear at the inner shoulder. Ease of steering is affected by any incorrect camber setting.

CHECKING AND CORRECTING CASTER

Models covered by this manual use shims for adjustment purposes.

Caster dimensions are for a vehicle carrying its design load. Design load is the load equal to the capacity of the vehicle's suspension, whereby the frame in most cases would be level. If an alignment check is to be made with the frame NOT LEVEL, the frame angle (figure 4) must be determined and added to the caster angle to obtain a true caster reading. To determine frame angle proceed as follows:

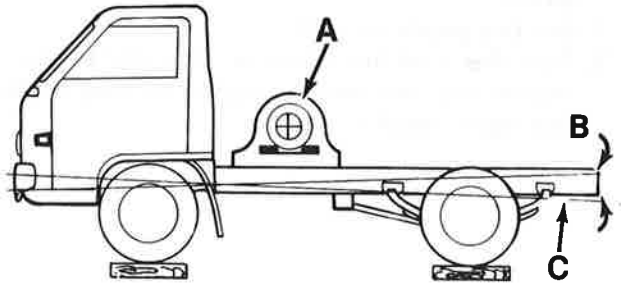
1. Position the vehicle on a smooth level surface.
2. Using inclinometer, measure the frame angle (FA) (figure 4). Frame angle is the degree of tilt in the frame from the level position. Negative frame angle means the frame is high (above level) in the rear. Positive frame angle is when the frame is low (below level) in the rear.
3. Determine the caster angle for the right wheel using the alignment equipment.
4. Calibrate the scale of the turning radius gage to zero and turn the steering wheel clockwise (counterclockwise for checking caster angle and kingpin inclination on the left side front wheel) until the front wheels are steered 20 degrees from the straight-ahead position (figure 5).

   Turning the steering wheel with the brake pedal depressed and using a brake pedal pusher will produce a more accurate reading.
5. When the front wheels are turned 20 degrees, calibrate the caster and kingpin scales to zero by turning the camber, caster, and kingpin gage adjuster.
6. Add the frame angle (FA) found in step 2 to the left wheel caster reading found in step 3 to determine the corrected caster for right wheel.

   To determine corrected caster with various frame and caster readings, the following rules apply:
   a. Negative frame angle must be added to positive caster reading.
   b. Positive frame angle must be subtracted from negative caster reading.
   c. Negative frame angle must be subtracted from negative caster reading.
   d. Positive frame angle must be added to negative caster reading.

   Example: The vehicle wheel caster reading of 30 minutes positive, and the frame angle is negative (high in the rear) 10 minutes. The positive caster reading is added to the negative frame angle, giving a 40 minute positive reading as the corrected caster for that wheel. Referring to "Specifications," we find that 40 minutes positive caster is within the specified setting.
7. Turn the steering wheel in the opposite direction until the front wheels are steered 20 degrees in the opposite direction for determining left wheel caster. Reading of the caster and kingpin scales directly indicates the caster and kingpin inclination angles being checked.

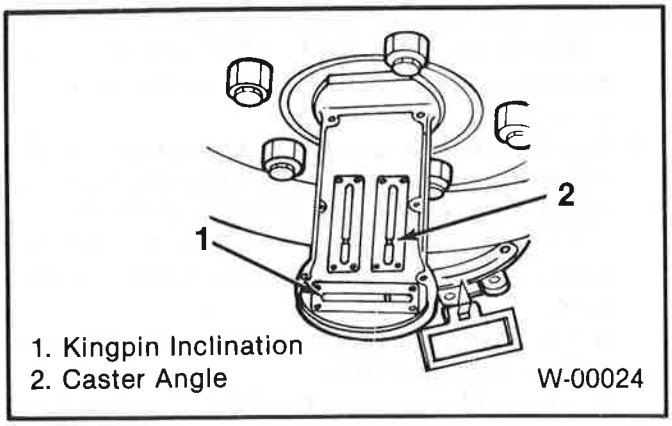
If the caster is not within specifications, caster can be corrected by installing proper caster shims between the axle and spring.



A. Inclinometer
B. Typical Negative Frame Angle "FA"
C. Level Line

W-00023

Figure 4. Checking the Frame Angle



1. Kingpin Inclination
2. Caster Angle W-00024

Figure 5. Caster Angle Measurement—Typical

CHECKING AND CORRECTING KINGPIN INCLINATION

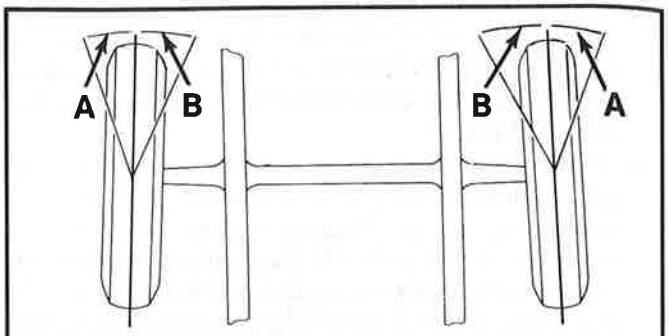
Precision instruments must be used to check kingpin inclination when axle is installed in the vehicle.

Kingpin inclination is built into the axle. Incorrect readings indicate a bent or damaged axle. If the axle is bent or twisted, refer to FRONT AXLE AND SUSPENSION (SEC. 3C) in this manual for corrective information. Straightening the axle to correct kingpin inclination will also change camber. Recheck camber after correcting kingpin inclination.

TURNING ANGLE MEASUREMENT AND ADJUSTMENT

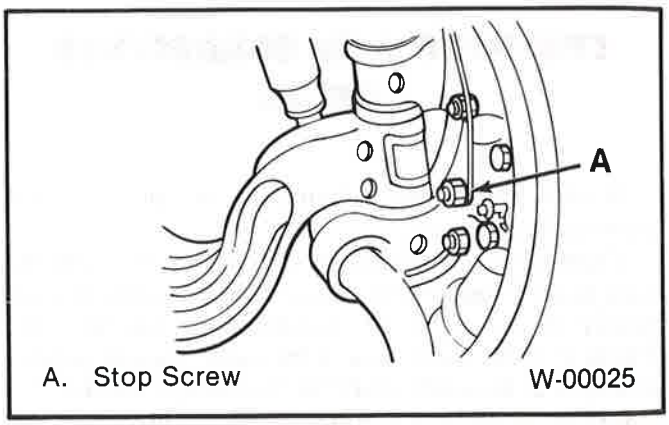
1. Place the front wheels on turning radius gages, with the front wheels in the straight-ahead position.
2. Set the gages to zero.
3. Turn the steering wheel all the way to lock in both directions, measuring the turning angle of the front wheels.
4. Refer to figure 6 for definition of terms. Refer to "Specifications" at the end of this section for proper readings.

If adjustment is needed, adjust the stop screws in or out as needed (figure 7). Then tighten the jam nut.



A. Inner Wheel Maximum Turn Angle
B. Outer Wheel Maximum Turn Angle B-04744

Figure 6. Stop Screw Adjustment—Definition of Terms



A. Stop Screw W-00025

Figure 7. Stop Screw

SPECIFICATIONS

FRONT END ALIGNMENT SETTINGS

Toe-in	4 to 6 mm (0.16 to 0.24″) (Bias-ply) 1 to 3 mm (0.04 to 0.12″) (Radial)
Camber	0°30′ to 2° (positive)
Caster	0°30′ to 2°30′ (positive)
Kingpin Inclination	6° to 8°30′ (positive)
Turning Angle (Maximum)	Inner Wheel 40° Outer Wheel 31°