SECTION A

FRONT SUSPENSION

4D-4F-4G-4H SERIES

CONTENTS

DIVISION I

TROUBLE DIAGNOSIS

30-1 FAULTY SPRINGS, SHOCK ABSORBERS, AND BALL JOINTS

A. Trim Height Checking Consideration

Optional equipment, undercoating, accumulated dirt, etc., change the car weight and must be considered when checking trim dimensions. Because of the many possible variations in loading due to optional equipment, it is not possible to give dimensions for all conditions; therefore, the spring trim dimensions following are for the standard car only, without optional equipment or undercoating and with car at curb weight. Curb weight includes full tank of gas, oil, water, and spare tire but no passengers or luggage.

Before measuring spring trim dimensions, bounce both ends of car up and down several times to make sure there is no bind in suspension members, and to let springs take a natural position.

B. Measuring Trim Height

1. On a new car, the front spring trim dimension "K" should be as shown in Figure 30-20. On a car having several miles the trim height will be less due to normal settling of bushings, dirt accumulation, etc.

2. On a new car, the rear spring trim dimension "L" should be as shown in Figure 30-20. On a car having several miles the trim height will be less due to normal settling of bushings, dirt accumulation, etc.

3. When checking *side to side* differences in trim height at the *front* take measurements at the front rocker panel as shown in Figure 40-3. If side- to-side variation is in excess of one inch, check suspension components for damage, excessive wear, or incorrect spring installation. See subparagraph c following for front shim installation.

4. When checking *side to side* differences in trim height at *rear* take measurements at rear rocker panel as shown in Figure 40-3. If shimming is required, see subparagraph c following.

5. Shimming of only one rear spring is not effective in correcting tilt. Side-to-side variation should be corrected by changing or shimming front springs.

C. Installation of Front Spring Shim

To correct variations in trim height, front spring shims may be ordered from the Parts Department under Group 7.425.

1. Remove front spring from car as described in paragraph 30-9.

2. Tape shim to top of spring as shown in Figure 30- 1.

3. Install shimmed spring in car per paragraph 30-9.

D. Weak and Non-Operative Shock Absorbers

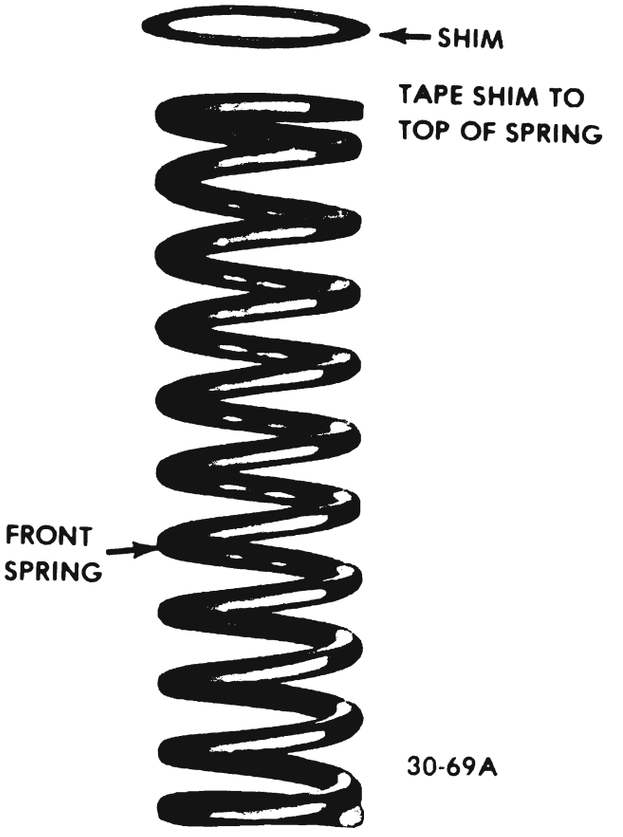


Figure 30-1 - Installing Shim on Spring

Many shock absorbers have been replaced and returned to the factory with the report that they were weak or leaking oil. When tested with special factory equipment very few of these replaced units have been found weak, leaking oil or otherwise below standard in operation. This indicates that these shock absorbers were needlessly replaced in an attempt to improve riding conditions which were actually standard, or that erroneous methods were used in judging the operating condition of the units. Leaking shocks are apparently diagnosed by observing a light oil film on or around the shock.

The shock absorber seal is designed to allow for lubrication of the piston rod, which under normal conditions, causes a light oil film to accumulate on the shock. This does not affect shock operation nor is replacement necessary as *all Delco shocks contain an added fluid reserve for this purpose.*

A leaking shock absorber is easily spotted as there will be evidence of fluid droplets on or around the shock. Before replacing any shock absorber, verify that the oil present on the shocks is not from some other chassis component.

Before attempting to test shock absorbers make sure that all attaching bolts and nuts are tight. Tires should be uniformly inflated to specified pressure (Group

100). The chassis should be well lubricated to make sure that suspension parts are free moving.

Test each front and rear shock absorber in turn by quickly pushing down and then lifting up on the end of the car bumper closest to the unit being checked. Use the same amount of force on each test, and note the amount of resistance provided by the shock absorber on compression and rebound. A little practice on another car of the same model which has satisfactory ride control will aid in judging the amount of resistance that should exist. Both front shock absorbers should provide the same feeling of resistance as should both rear shock absorbers. Any noticeable variation between right and left shock absorbers indicates that one unit is not operating normally. Little or no resistance on compression or rebound indicates air in shock absorbers, leakage due to wear, or that the valve is being held open by dirt. Excessive resistance indicates that bleeder hole in valve is plugged with dirt.

If there is any doubt about the action of a shock absorber after testing as described above, remove the unit from car. Mount it vertically in a vise with jaws gripping the lower mounting firmly, then move the piston rod up and down by hand. There should be no free movement in this test. Lack of resistance or jerky resistance to movement indicates air in the shock absorber, leakage due to wear, or that the valve is held open by dirt. Pumping the piston rod up and down through the full range of shock travel for approximately 12 strokes will remove air trapped in the inner cylinder. Shock *must* be upright when pumping out air. If air in the shock is the only problem, the resistance will smooth out as the shock is cycled. This test should be tried before judging the shock defective. A faulty shock absorber must be replaced as it cannot be disassembled for repairs. In the test given above, the amount of force that can be applied is not sufficient to open a valve against its spring pressure; therefore, this test only checks the flow of fluid through the valve bleeder hole as well as any leakage due to a valve being held open, or due to internal wear of piston and cylinder. Since it is unlikely that the valve springs will weaken in service, it may be assumed that the shock absorber action is normal if it operates satisfactorily in the test given above.

Condition	Possible Cause	Correction
Shock Leaking	1. Slight seepage.	1. None - normal condition.
	2. Chassis black paint.	2. None - normal condition, gives appearance of leak.
	3. Oil spray from other source.	3. Locate source and correct.
	4. Leaking.	4. Replace unit.
Shock Noisy	1. Loose mounting.	1. Tighten to proper torque.
	2. Worn or defective grommets.	2. Replace grommets, if possible.
	3. Interference.	3. Eliminate interference.
	4. Internal noise.	4. Disconnect bottom end and stroke shock. Replace if noisy.
Ride Sway or Body Lean In Corners	1. Improper tire inflation.	1. Check and adjust to vehicle specifications.
	2. Incorrect shocks.	2. Replace with correct part.
	3. Incorrect springs.	3. Replace with correct part.
	4. Stabilizer bar loose.	4. See Group 30 - "Front Suspension".

	5. Front alignment.	5. See Group 30 - "Front Suspension".
	6. Shock leaking.	6. Replace unit.
	7. Weak shock.	7. Bounce test - replace one (1) shock if noticeably weaker than mate.
	8. Steering system.	8. See Group 90 - "Steering".
Large Body Motions or Ride Too Soft	1. Secondary or rough roads.	1. Normal - recommend HD shocks at owner's expense.
	2. Incorrect shock.	2. Replace with correct part.
	3. Shock leaking.	3. Replace unit.
	4. Weak shock.	4. Bounce test - replace one (1) shock if noticeably weaker than mate.
Bottoming (Light Load - Driver and One Passenger)	1. Incorrect springs or low standing height.	1. See Groups 30 and 40 - "Front and Rear Suspension".
	2. Incorrect shock.	2. Replace with correct part.
	3. Leaking shock.	3. Replace unit.
	4. Weak shock.	4. Bounce test - replace one (1) shock if noticeably weaker than mate.
	5. Bump stop missing.	5. Inspect and replace.
	6. Secondary or rough roads.	6. Recommend superlifts at owner's expense.
Bottoming (Heavy Load - More Than Above)	1. Exceeding maximum rated load for vehicle.	1. Inform owner and recommend superlifts at owner's expense.
	2. Incorrect springs or low standing height.	2. See Groups 30 and 40 - "Front and Rear Suspension".
	3. Incorrect shock.	3. Replace with correct part.
	4. Secondary or rough roads.	4. Recommend superlifts at owner's expense.
Low or Uneven Trim Height	1. Shock cannot correct.	1. See Groups 30 and 40 - "Front and Rear Suspension".
Abnormal Tire Wear	1. System variations.	1. Almost always due to variations in the system other than shock absorbers. Only a totally inoperative shock can contribute to abnormal tire wear.

Hard Ride	1. Overinflated tires.	1. Check and adjust to vehicle specifications.
	2. Incorrect springs or low standing height.	2. See Groups 30 and 40 - "Front and Rear Suspension".
	3. Incorrect shocks.	3. Replace with correct part.
	4. Heavy duty suspension.	4. Normal.
	5. Bump stop missing.	5. Inspect and replace.
	6. Shock binding.	6. Disconnect bottom end and stroke shock. Replace if binding.
	7. Weak shock.	7. Bounce test - replace one (1) shock if noticeably weaker than mate.

E. Loose Ball Joints

The upper ball stud is spring loaded in its socket. This minimizes looseness at this point and compensates for normal wear. If the upper stud has any perceptible lateral shake, or if it can be twisted in its socket with the fingers, the upper ball joint should be replaced.

The lower ball joint is not spring loaded but firmly seated by the weight of the car. With the chassis spring load removed from the ball joint, this ball joint may show looseness. Such looseness is probably due to normal operating clearance and does not necessarily indicate a defective joint assembly.

1. Place jack under lower control arm as far outboard as possible while still providing access to the lower ball joint grease fitting. *Be sure the upper control arm does not contact the rebound bumper when the car is raised.* Raise car until front wheel clears the floor.

2. Remove lower ball joint grease fitting and install Gauge J-21240.

3. Place a pry bar between floor and tire and raise tire by hand. This puts a load on the ball joint.

4. Repeat procedure several times and take maximum and minimum gauge readings under load and no load conditions of the pry bar.

5. Subtract minimum reading from maximum reading. If difference is more than .070", replace ball joint.

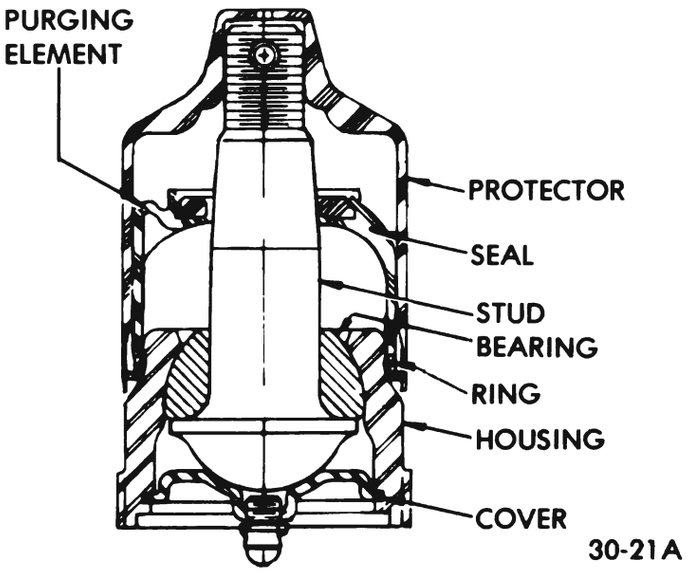


Figure 30-2 - Lower Ball Joint Construction

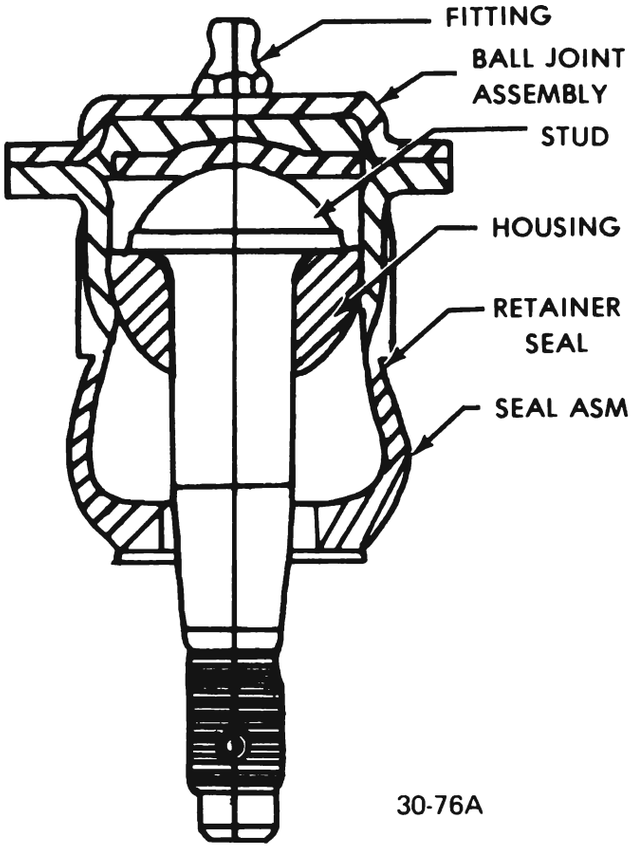


Figure 30-3 - Upper Ball Joint Construction

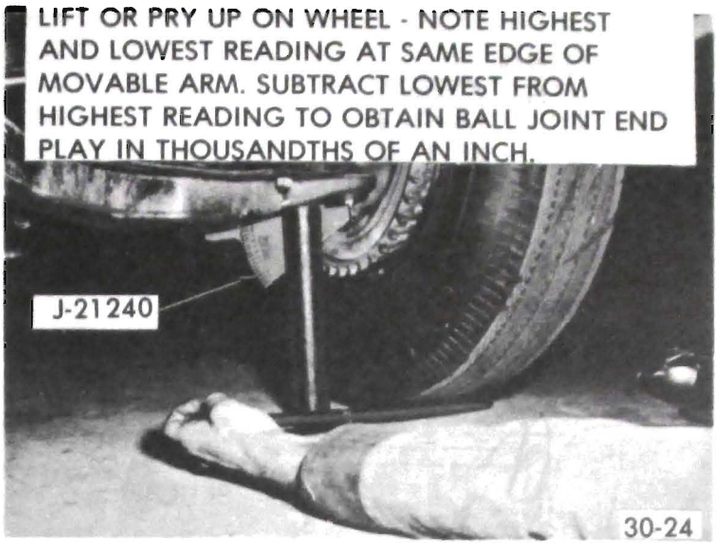


Figure 30-5 - Ball Joint Checking Gauge Installed

F. Upper Control Arm Bushing Retaining Nuts

If loose upper control arm bushing retaining bolts are encountered, it is necessary to torque bolts to 55 lb.ft. On some cars equipped with air conditioning, power brakes, etc., it will be necessary to remove the upper control arm per paragraph 30-7 to torque the nuts.

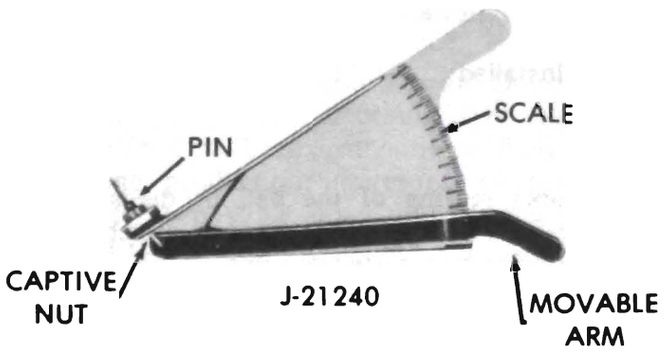


Figure 30-4 - Ball Joint Checking Gauge J-21240

DIVISION II

DESCRIPTION AND OPERATION

30-2 SUSPENSION DESCRIPTION

The front suspension is designed to allow each wheel to compensate for changes in the road surface level without appreciably affecting the opposite wheel. Each wheel is independently connected to the frame by a steering knuckle, ball joint assemblies, and upper and lower control arms. The control arms are specifically designed and positioned to allow the steering knuckles to move in a prescribed three dimensional arc. The front wheels are held in proper relationship to each other by two tie rods which are connected to steering arms on the knuckles and to an intermediate rod. See Figure 30-7.

Coil chassis springs are mounted between the spring housings on the frame and the lower control arms. Ride control is provided by double, direct acting shock absorbers mounted inside the coil springs and attached to the lower control arms by bolts and nuts. The upper portion of each shock absorber extends through the spring housing and is secured with two grommets, two grommet retainers, and a nut.

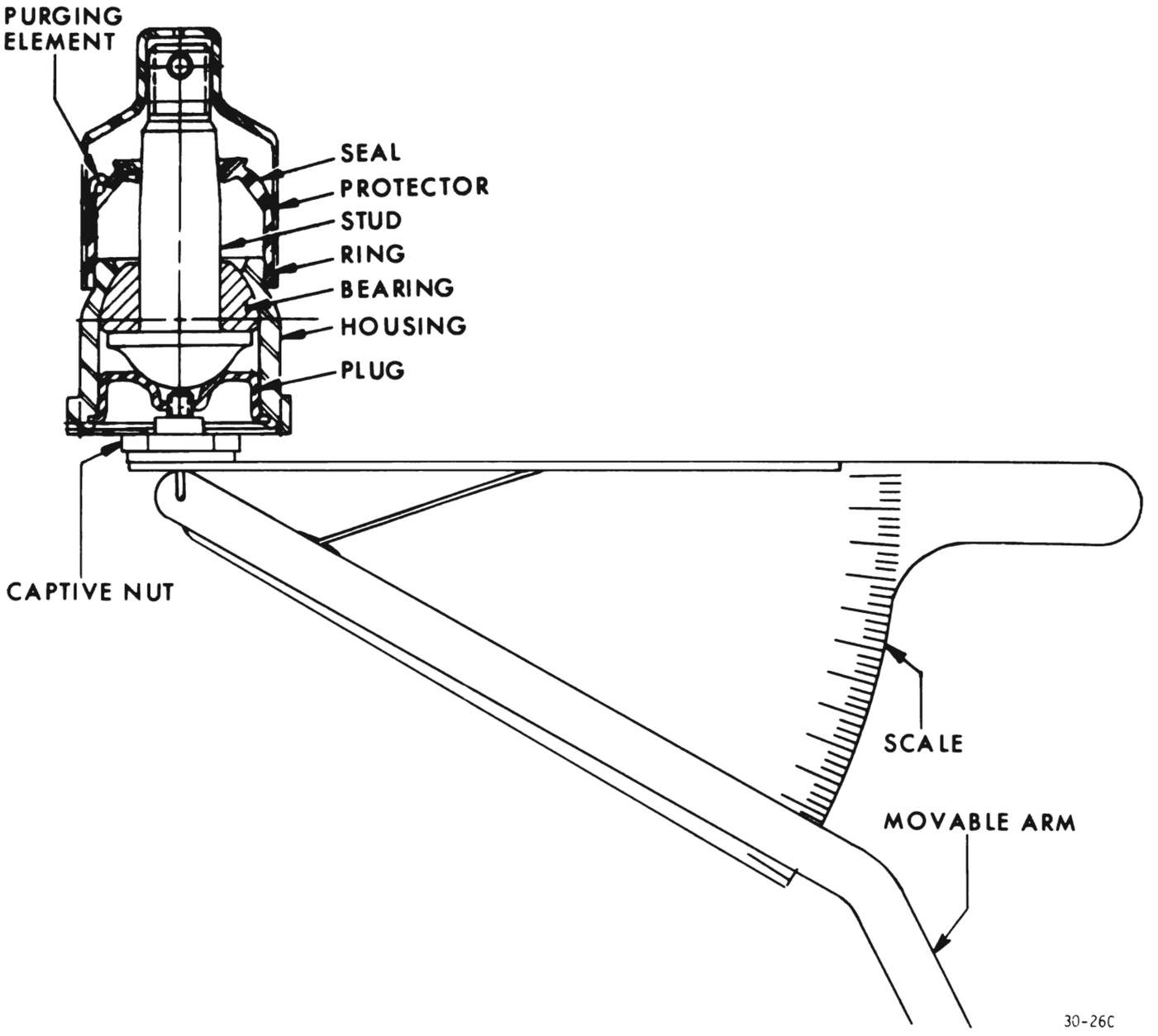


Figure 30-6 Ball Joint Check Gauge Installed

Side roll of the front suspension is controlled by a spring steel stabilizer shaft. It is mounted in rubber bushings which are held to the frame side rails by brackets. The ends of the stabilizer are connected to the lower control arms. Rubber grommets at these connections provide flexibility and ride features.

The upper control arm is attached to a cross shaft through isolating rubber bushings. The cross shaft, in turn, is bolted to frame brackets.

A ball joint assembly is riveted to the outer end of the upper arm. It is pre-loaded by a rubber spring to insure proper seating of the ball in the socket (see Figure 30-7). The upper ball joint is attached to the steering knuckle by a castellated nut.

The inner ends of the lower control arm have pressed-in bushings. Bolts, passing through the bushings, attach the arm to the frame. The lower ball joint assembly is a press fit in the arm and attaches to the steering knuckle with a castellated nut that is retained with a cotter pin (see Figure 30-18).

Rubber grease seals are provided at ball socket assemblies to keep dirt and moisture from entering the joint and damaging bearing surfaces.

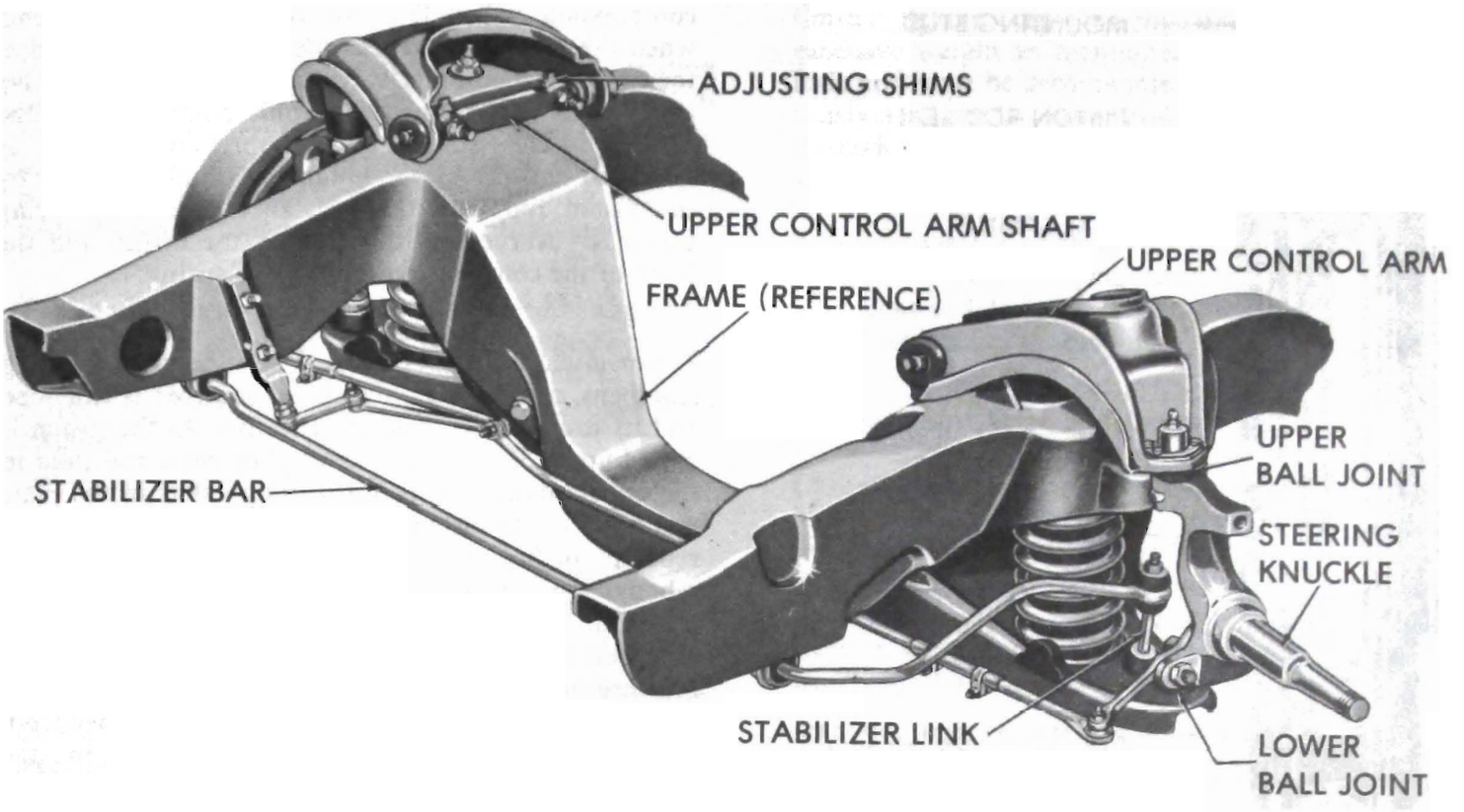


Figure 30-7 - Front Suspension

30-3 OPERATION OF SHOCK ABSORBERS

A. Shock Absorber Type and Location

Both front and rear shock absorbers are Delco, double, direct-action (telescoping), hydraulic type. All shocks are filled with a calibrated amount of fluid and are sealed during production; therefore, no refilling or other service is possible other than replacement of deteriorated rubber bushings.

Each *front* shock absorber is vertically mounted inside the front spring. The upper stem is attached to the frame by means of grommets and grommet retainers held in place by a nut. The lower insulated bracket is bolted to the lower control arm.

The shock absorbers are basically the same for all models but vary as to calibration. *Front* shock absorbers are interchangeable with respect to right and left, as are the *rear* . However, front and rear are not interchangeable with each other.

B. Shock Absorber Construction and Operation

The shock absorber consists of two concentric tubes, a piston and rod, and valves for controlling hydraulic fluid flow. The pressure (inner) tube provides a cylinder in which the piston and rod operate. The upper end is sealed by a piston rod seal, and the lower end is closed by the compression valve assembly. This tube is completely filled with fluid at all times. The reservoir tube provides space for reserve fluid and for overflow from the pressure tube during operation.

The piston and piston rod are attached to the car frame, while the pressure and reservoir tubes are attached as a unit to the chassis suspension through the

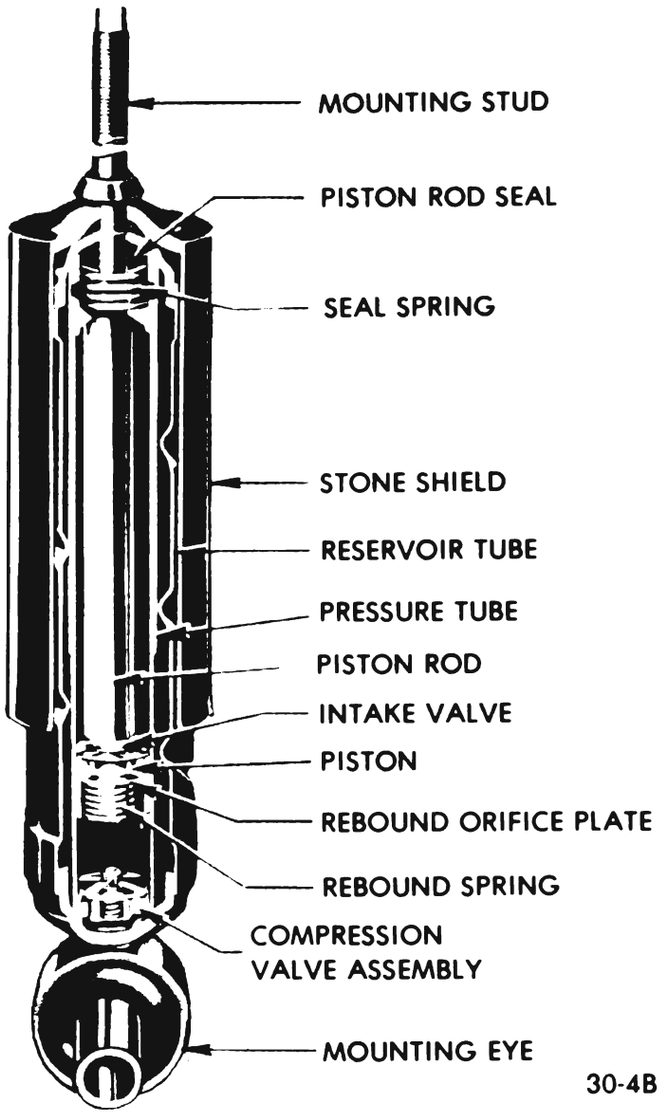


Figure 30-8 - Typical Shock Absorber

lower mounting. As the wheel moves up and down with respect to the frame, the chassis spring compresses or expands and the shock absorber is telescoped or extended. This action forces the fluid to move between the pressure and reservoir tubes through small restricting orifices in the valves. The restriction of fluid flowing through the orifices imposes restraint on the telescoping or extension of the shock absorber, thus providing the required dampening effect on wheel motions.

1. *Compression Stroke Operation.* When the chassis spring is being compressed, the shock absorber is telescoped causing the piston to move down in the pressure tube forcing fluid through holes in the piston. The pressure lifts the intake valve plate, allowing fluid in the lower chamber to pass into the upper chamber. As the piston rod moves downward into the pressure tube, it occupies space previously filled with fluid and this displaced fluid is forced out of the lower chamber into the reservoir through the restricting orifice in the compression valve. On fast or extreme movements when the fluid flow exceeds the capacity of the orifice, the spring loaded relief valve in the compression valve assembly is forced open to permit more rapid escape of fluid. The amount of compression control is governed entirely by the volume of fluid displaced by the piston rod, and the resistance to chassis spring travel is governed by the area of the orifice and the force of the compression relief valve spring.

2. *Rebound Stroke Operation.* When the chassis spring lengthens, or rebounds, the shock absorber is extended and its resistance is instantly effective. As the piston is pulled upward, the intake valve plate seats and fluid in the upper chamber is forced through slots in the plate and holes in the piston to build up pressure against the rebound orifice plate. As the pressure increases, the rebound spring is compressed and the orifice plate leaves its seat to permit fluid to pass into the lower chamber. As the piston rod moves upward out of the pressure tube, the space previously occupied by the rod is filled with fluid drawn into the lower chamber from the reservoir. A separate intake valve in the compression valve assembly opens to permit return of this fluid.

DIVISION III

ADJUSTMENTS AND MINOR SERVICE

30-4 FRONT WHEEL ALIGNMENT

Wheel alignment is the process of adjusting the position of the front wheels in order to attain proper vehicle handling characteristics and the least steering effort with a minimal amount of tire wear.

Wheel and tire balance has an important effect on steering and tire wear. If wheels and tires are out of balance, "shimmy" or "tramp" may develop causing tires to wear unevenly and give the erroneous impression that the wheels are not in proper alignment. For this reason, the wheel and tire assemblies should be known to be in proper balance before assuming that the front suspension is out of alignment.

Close limits on front wheel caster, camber, and theoretical king pin inclination are necessary for

proper car handling, but require only reasonable accuracy to provide normal tire life. With the type of front suspension used, the toe-in adjustment is usually more important than caster and camber as far as tire wear is concerned.

In the majority of cases, services consisting of inflating tires to specified pressure and interchanging tires at recommended intervals, balancing all wheels and tires, adjusting steering gear and setting toe- in correctly will provide more improvement in car handling and tire wear than will front end alignment adjustments.

The correct use of accurate front end alignment equipment is essential to determine whether front suspension parts have been damaged, and to obtain correct alignment settings after new parts have been installed.

A. Inspection Before Checking Front Wheel Alignment

Before making any adjustment affecting caster, camber, toe-in, theoretical king pin inclination, or steering geometry, the following checks and inspections should be made to insure correctness of alignment equipment readings and alignment adjustments.

1. The front tires should have approximately the same wear and all tires must be inflated to specified pressures (Refer to Group 100).

2. Check front wheel bearings for looseness and adjust if necessary (par. 30-5). Do not overtighten.

3. Check for run-out of wheels and tires.

4. Check wheels and tires for balance and correct if out-of-balance (Refer to Group 100).

5. Check for looseness at ball joints tie rod ends and steering relay rod. If found excessive, it must be corrected before alignment readings will have any value.

6. Check trim heights at all four wheels; if out of limits, correct with shims or replace spring. See Alignment Chart.

Consideration must be given the optional equipment on the car, undercoating, dirt, etc.

Vehicle should be at curb or free height when an alignment operation is performed. (All excess equipment, such as tool boxes, fishing or golfing equipment, should be removed from the vehicle. Vehicle should have a full tank of fuel.)

Good judgment should be exercised before replacing a spring when car trim height is only slightly out of limits. Spring replacement under conditions of excessive weight as mentioned above will accomplish little and must be accompanied by shimming to obtain satisfactory results. Front and rear shims are available through the Parts Department. Refer to paragraph 30-1 for front springs and Group 40 for rear springs.

7. It is advisable to check the condition and accuracy of any equipment being used to check front end alignment and to make certain that instructions of the manufacturer are thoroughly understood and followed.

B. Checking Caster and Camber Settings

Caster is the forward or rearward tilt of the steering knuckle pivot centerline from true vertical as viewed from the side of the vehicle. If the top of the steering knuckle pivot centerline is tilted forward of true vertical, it is called "negative caster." If the top of the steering knuckle pivot centerline is tilted rearward of true vertical, it is called "positive caster."

Camber is the inward or outward tilt of the top of a wheel from true vertical as viewed from the front of the vehicle. If the top of a wheel is tilted outward from true verticle it has "positive camber." If the top of a wheel is tilted inward from true vertical it has "negative camber."

Since caster and camber settings are both adjusted by shimming the upper control arms laterally relative to the frame, both of these settings must be checked before changing shims.

Regardless of equipment used to check caster and camber, car must be on level surface both transversely and fore and aft.

When alignment equipment is used which bears against the tire or wheel rim to obtain readings, it is very essential that the tires or wheels be checked for lateral run-out.

Caster and camber readings must be taken at points on the wheels which have no run-out or which lie in the same plane. Caster and camber should be within the limits shown in Figure 30-19. Note that the caster angles at both front wheels need not be exactly the same but must be within 1 degree of each other. Likewise, the camber angles on both sides must be within 1 degree of each other. If caster and camber are not within the specified limits, adjust in the following manner.

C. Caster and Camber Adjustment

For caster and camber adjustment purposes, use the following guide:

1. To increase camber only - (More positive) Remove an equal amount of shims from front and rear bolts.

2. To decrease camber only - (Less positive) Add an equal amount of shims to front and rear bolt.

3. To increase caster only - (More positive) Remove an amount of shims from front bolt and add an equal amount of shims at rear bolt.

4. To decrease caster only - (Less positive) Add an amount of shims at the front bolt and remove an equal amount of shims from the rear bolt.

5. To increase caster and camber at the same time - remove an amount of shims *at front bolt only.*

6. To decrease caster and camber at the same time - add an amount of shims *at front bolt only.*

The following guide lines will help you select and correctly shim with minimum effort. Shim thickness limit for any one stack for 4D-4F-4G-4H Series is .750 of an inch.

Shims are available in .030", .060" and .100" thicknesses.

By adding a pack of shims .090" thick at both sides, camber will be decreased by approximately 1/2 degree.

By adding a .030" shim on one bolt and removing a .030" shim from the other, caster will change approximately 1/2 degree.

To help you determine the shim thickness change required to return caster and camber to design dimension, a chart has been developed to enable you to do quicker and more accurate work. See Figure 30- 21.

This chart indicates in thousandths of an inch, the change required at (F) front and (R) rear shim position in order to return the initial reading to factory specifications. For example: Assume the initial readings for one wheel were, camber plus 1-1/4 degrees and caster plus 1/4 degrees. This chart indicates that an addition of plus 0.140 shim thickness to the (F) front shim position and an addition of plus 0.060 shim thickness to the (R) shim position would be required to adjust this wheel to factory specifications. See Figure 30-21.

Torque control arm shaft nuts to 50 lb.ft.

CAUTION: *This front upper control arm to frame fastener is an important attaching part in that it could affect the performance of vital components and systems, and/or could result in major repair expense. It must be replaced with one of the same part number or with an equivalent part, if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of this part.*

D. Checking Ball Joint Inclination

This check is necessary only when the front suspension components are suspected of being bent or damaged. Also perform check if proper front end alignment cannot be obtained with the prescribed maximum and minimum amounts of shims.

When checking ball joint inclination, car must be on a level surface both transversely and fore and aft, must have trim heights within limits, and must be at curb load.

Set camber and caster to the desired specifications as shown in Figure 30-19. Measure ball joint inclination relative to a vertical plane. Add to the measured king pin axis angle the value of the positive camber angle (subtract if the camber is negative) and compare this resulting angle to the value given in Figure 30-20.

There is no adjustment for ball joint inclination as this factor depends on the accuracy of the front suspension (steering knuckles). Distorted knuckles should be replaced with new parts.

Any heating, welding, or bending of front suspension parts to correct errors, or repair damage must be avoided as this may produce soft spots in the metal in which fatigue and breakage may develop in service.

E. Checking and Adjusting Toe-In

Toe-in is the distance in fractions of an inch that the front of the wheels are turned inward from a straight ahead position.

Car must be at curb weight and front and rear suspension trim should be within specified limits. Bounce front end and allow it to settle to operating height. Steering gear and front wheel bearings must be properly adjusted with no looseness in the steering linkage. The car should be moved forward one complete revolution of the wheels before the toe-in check and adjustment are started and the car should never be moved backward while making the check and adjustment. This presets the front suspension and removes lash from the joints.

1. Turn steering wheel to straight ahead position, with front wheels in same position. See Figure 30- 9 for checking steering gear straight ahead position.

2. Using a suitable toe-in gauge, measure the distance

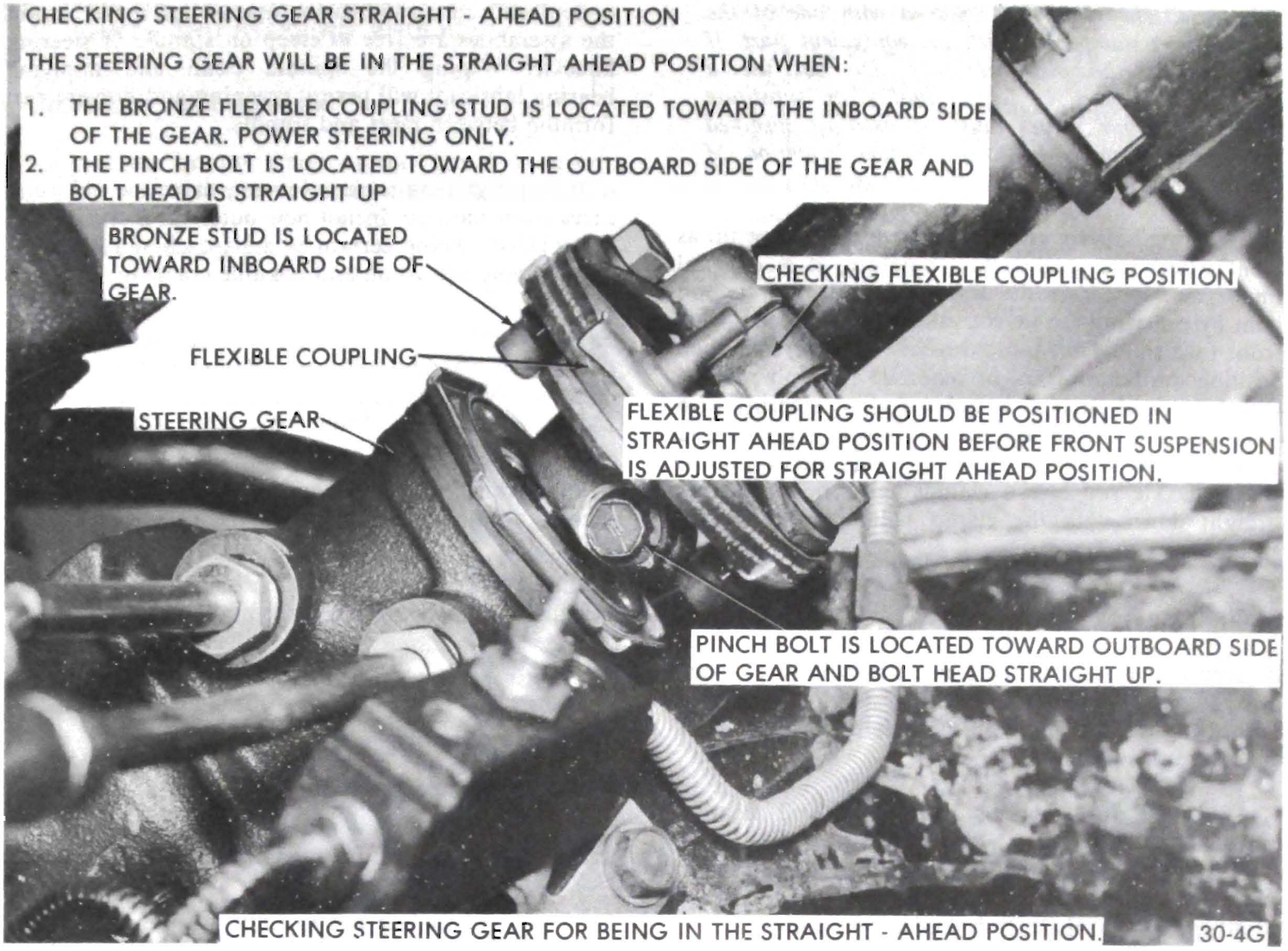


Figure 30-9 Checking Steering Gear for being in the Straight-Ahead Position

between outside walls of tires at the front at a height approximately horizontal to floor and through the centerline of the wheel assembly. See Figure 30-4. An accurate check also can be made by raising and rotating front wheels to scribe a fine line near the center of each tire, then, with tires on the floor and front end at running height, measure between scribed lines with a suitable trammel.

3. Roll the car forward until measuring points on tires are approximately 180 degrees from points used in Step 2 above.

The measurement at the front should be 1/16" to 5/16" less than the measurement at the rear.

4. If toe-in is not within specified limits, loosen clamp bolts and turn adjusting sleeves at tie rod ends as required. Decrease toe-in by turning left sleeve in same direction as wheel rotates moving forward and turn right sleeve in opposite direction. Increase toe-in by turning both sleeves in opposite direction.

Left and right adjusting sleeves must be turned exactly the same amount but in opposite directions when changing toe-in, in order to maintain front wheels in straight ahead position when steering wheel is in straight ahead position. Approximately the same amount of thread engagement in the adjuster sleeve should be noted for the inner and outer tie rod ends. The distance between the inner and outer tie rod ends in the adjuster sleeve should be approximately equal for both right and left wheels.

Never lengthen the tie rods to the point where the inner and outer threaded tie rod ends are outboard of the inner edge of the adjusting sleeve "U" clamps. If proper dimensions cannot be obtained within this amount of adjustment, inspect suspension and steering linkage for bent parts.

5. After correct toe-in is obtained, tighten clamp bolts to 15-25 lb.ft. See Group 90, Section D.

CAUTION: *The tie rod adjusting sleeve clamp fasteners are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair*

expense. They must be replaced with one of the same part number or with an equivalent part, if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.

The steering knuckle and steering arm "rock" or tilt as front wheel rises and falls. Therefore, it is of vital importance to center the travel of the inner tie rod joint by centering the tie rod stud in the socket (socket front face should be approximately vertical) and then position the bottom face of outer tie rod end parallel with machined surface at outer end of steering arm when the rod length is adjusted. Severe damage and possible failure can result unless this precaution is observed. Tie rod sleeve clamps must be positioned straight down with the clamp bolts parallel to the ground.

F. Checking Toe-Out-On-Turns

Be sure that caster, camber, and toe-in have all been properly corrected before checking steering geometry. Toe-out-on-turns must be checked with the weight of the car on the wheels.

1. With the front wheels resting on full floating turntables, turn wheels to the right until the outside (left) wheel is set at 20 degrees. The inside (right) wheel should then be at the angle specified in Figure 30-20.

2. Repeat this test by turning front wheels to the left until the outside (right) wheel is at 20 degrees; the inside (left) wheel should then be at the angle specified in Figure 30-20.

3. Errors in toe-out-on-turns generally indicate bent steering arms, but may also be caused by other incorrect front end factors. If the error is caused by a bent steering arm, the arm must be replaced. Replacement of such parts must be followed by a complete front end alignment check, as described above.

30-5 REPLACEMENT AND ADJUSTMENT OF FRONT WHEEL BEARINGS

A. Replacement of Bearings

1. Raise front of car and remove wheel with hub and drum assembly.

2. Remove outer race and outer bearing assembly from hub. Remove oil seal from hub so that inner race and bearing assembly can be removed from hub.

3. Clean and inspect all bearing parts. When inspecting or replacing race and bearing assemblies, make certain the assemblies are free to creep on spindle of steering knuckle. Wiping the spindle clean and applying bearing lubricant will permit creeping and prevent rust forming between races and spindle.

4. If bearings require replacement, drive the old outer races from the hub. Install new outer races with a soft (brass) drift, being certain to start each squarely into hub to avoid distortion and possible cracking.

5. Thoroughly pack both roller bearing assemblies with new wheel bearing lubricant. Remove surplus lubricant. Apply light coating of lubricant to spindle and inside surface of wheel hub.

6. Place inner race and bearing assembly in cup and install new oil seal.

7. Install wheel on spindle; then install outer race and bearing assembly, washer, and spindle nut.

8. Adjust bearings, as described in subparagraph b following.

B. Adjustment of Front Wheel Bearings - All Series

1. Hand spin wheel in forward direction.

2. "Snug-up" spindle nut to fully seat bearings, while wheel is spinning. This will overcome any burrs on threads.

3. Back off spindle nut until just loose (1/4 to 1/2 turn).

4. Hand "snug-up" spindle nut.

5. Do not install cotter pin if hole in spindle lines up with a slot in spindle nut. Loosen spindle nut a minimum of 1/12 turn, or a maximum of 1/6 turn. Then insert new cotter pin. Under no circumstances is the spindle nut to be even finger tight.

6. When the bearing is properly adjusted, there will be from .002 to .006 inches end play (looseness).

7. Remove support at front lower control arm and lower car.

DIVISION IV

REMOVAL AND INSTALLATION

30-6 REMOVAL AND INSTALLATION OF BALL JOINTS AND STEERING KNUCKLE

A. Upper Ball Joint Removal

1. Support car on car stand at the frame so front suspension is in full rebound position.

2. Remove front wheel.

3. Remove upper ball stud cotter key.

4. Loosen, but do not remove ball stud nut. Nut should be loosened not more than 1/8 inch. If ball stud nut is removed, injury could result since heavily compressed chassis spring will be completely released.

5. Install Tool J-23742-1 between the ball studs. Turn the threaded end of J-23742-1 until ball stud is free of steering knuckle.

6. Place jack under lower control arm at spring seat. Raise jack until compression is relieved on upper control arm rubber rebound bumper.

7. Remove the stud nut and lift upper control arm from knuckle.

8. Place a wood block between the upper control arm and the frame to act as a support during the following operations.

9. Center punch the four rivets as close to the center as possible.

10. Drill a 1/8" hole through the center of the rivets about 1/2 to 3/4 the length of the rivet.

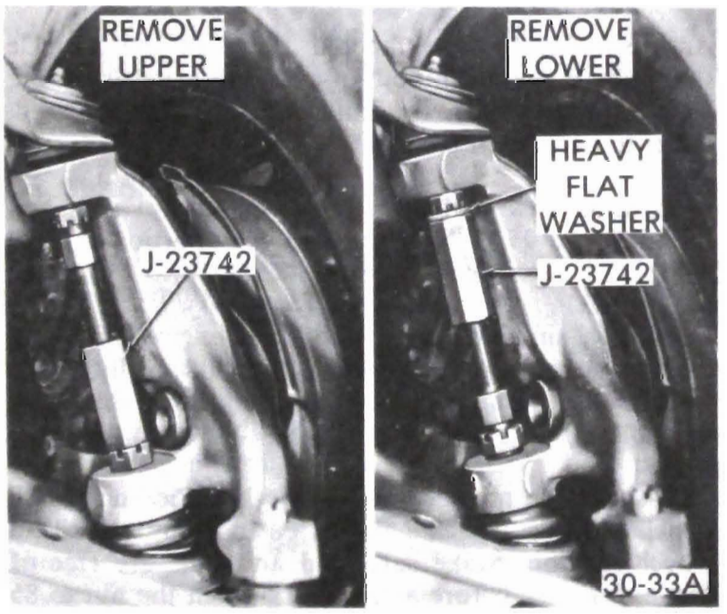


Figure 30-10 - Separating Steering Knuckle from Upper Ball Joint

CASTER AND CAMBER ADJUSTMENT

FOR INCREASED OR POSITIVE CASTER, DECREASE SHIMS AT BOLT A AND INCREASE SHIMS AT BOLT B AN EQUAL AMOUNT.

FOR DECREASED OR NEGATIVE CASTER, INCREASE SHIMS AT BOLT A AND DECREASE SHIMS AT BOLT B AN EQUAL AMOUNT

FOR INCREASED CAMBER, DECREASE SHIMS AT BOTH A & B BOLTS.

NOTE: SHIMMING GREATER THAN .750 NOT PERMISSIBLE. NO MORE THAN 5 SHIMS SHOULD BE USED AT EACH LOCATION.

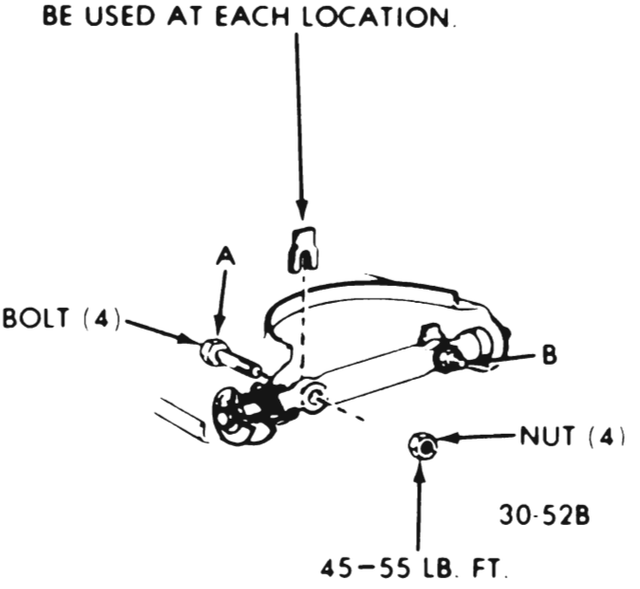


Figure 30-11 - Upper Control Arm Shimming Locations

11. Using a 7/32" drill, enlarge the hole, drilling again about 1/2 the length of the rivet.

12. With a chisel, remove the rivet heads.

13. Using a 3/4" punch and hammer, remove the rivets. Remove ball joint. Care must be used not to hit and damage the ball joint seat and rivet holes in the control arm.

B. Upper Ball Joint Installation

An inspection of the tapered holes in the knuckle should be made. If any out-of-roundness, deformation, or damage is noted, the knuckle should be replaced. Refer to paragraph e.

1. Install the new ball joint in the upper control arm and attach with the bolt and nut assemblies provided.

Insert the bolts from the bottom with the nut on top. Torque to 8 lb.ft.

2. Turn tapered stud so cotter pin hole is fore and aft. Remove the wood block from between the arm and the frame, move the knuckle up by jacking under outer edge of spring seat. Knuckle and brake drum assembly should be in a straight-ahead position.

3. Wipe tapered hole in knuckle and tapered stud free of dirt and grease and assemble stud to knuckle with castellated nut. Torque to 50 lb.ft. Warning: Never back off nut to align cotter pin holes. *Always tighten nut to next slot that lines up with hole in ball joint stud.* Install new cotter pin.

CAUTION: *This front upper control arm ball joint to steering knuckle fastener is an important attaching part in that it could affect the performance of vital components and systems, and/or could result in major repair expense. It must be replaced with one of the same part number or with an equivalent part, if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of this part.*

4. Install wheel and tire.

C. Lower Ball Joint Removal

1. Raise front of car and place jack stands under frame side rails. Remove wheel with hub and drum assembly attached.

2. Disengage lock plate from brake anchor bolt and remove bolt. Remove two bolts attaching brake backing plate and steering arm to knuckle. Remove the brake backing plate assembly from the steering knuckle. If the backing plate is wired carefully out of the way there will be no need to disconnect the brake hose.

3. Remove the ball stud cotter pin. Loosen, but do not remove the ball stud nut. Nut should be loosened not more than 1/8 inch. If ball stud nut is removed, injury could result since heavily compressed chassis spring will be completely released.

4. Install Tool J-23742-1 between the ball studs. Turn threaded end of J-23742-1 until the ball stud is free of the steering knuckle.

5. Place a jack under the lower control arm at the spring seat. Raise the jack until compression is relieved on the upper control arm rubber rebound bumper. Remove the stud nut. Move the steering knuckle out of the way.

6. Install Lower Ball Joint Remover and Installer as shown in Figure 30-07. The larger O.D. portion of Detail J-9519-17 is positioned in J-9519- 10.

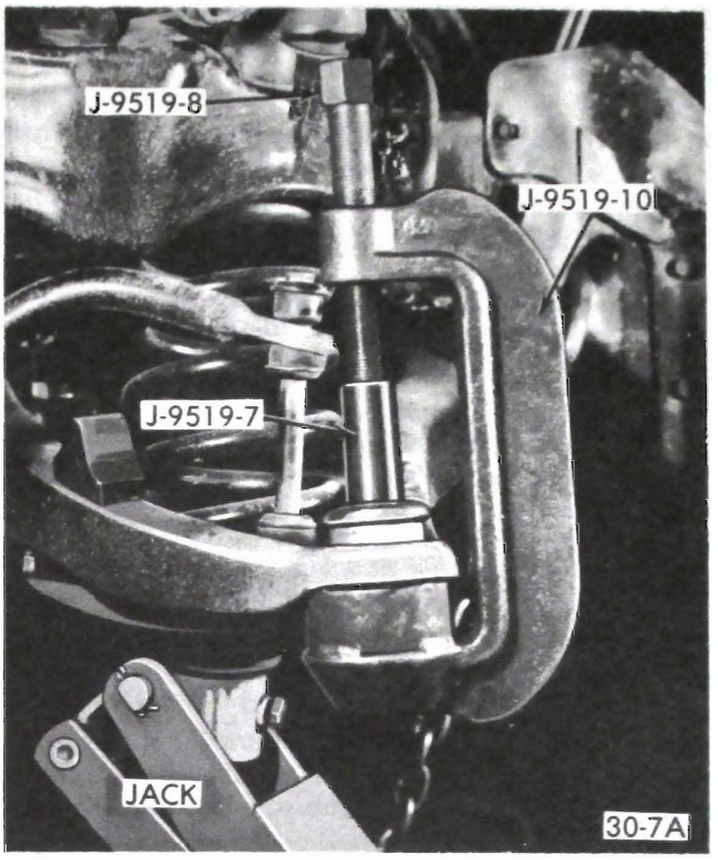


Figure 30-12 - Lower Ball Joint Remover Installation

7. Tighten Detail J-9519-8 with a socket and handle until ball joint is pressed out of the lower control arm. Ball joint may pop out suddenly.

D. Lower Ball Joint Installation

An inspection of the tapered holes in the knuckle should be made. If any out-of-roundness, deformation, or damage is noted, the knuckle should be replaced. Refer to paragraph e.

1. Position new ball joint in lower control arm and install Tool J-9519. Note that the O.D. portion of Tool J-9519-2 is positioned in detail J-9519-10.

2. With a suitable socket and handle, press the ball joint into the lower control arm until it is fully seated as shown in Figure 30-13. Turn the stud so the cotter key hole is fore and aft.

3. Position the tapered stud in the knuckle and install castellated nut. Knuckle should be in a straight-ahead wheel position. Make sure stud and hole are free of dirt and grease before assembly. Tighten the nut to 85 lb.ft. Never loosen nut to align cotter pin holes. *Always tighten nut to next slot that lines up with hole in ball joint stud.* Install cotter pin.

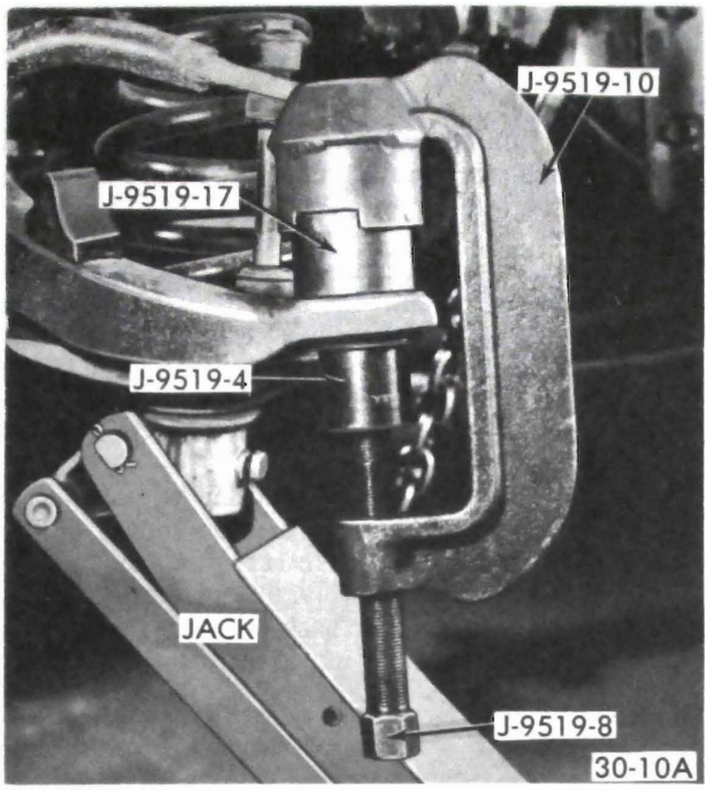


Figure 30-13 - Installing Lower Ball Joint

CAUTION: *This front lower control arm ball joint to steering knuckle fastener is an important attaching part in that it could affect the performance of vital components and systems, and/or could result in major repair expense. It must be replaced with one of the same part number or with an equivalent part, if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of this part.*

4. Install backing plate and wheel with hub and drum assembly. Adjust wheel bearing. Remove car stand and lower car.

E. Steering Knuckle Removal

1. Raise front of car. Remove wheel with hub and drum assembly attached.

2. Disengage lock plate from brake anchor bolt and remove bolt. Remove two bolts attaching brake backing plate and steering arm to knuckle. Remove the brake backing plate assembly from the steering knuckle. If the backing plate is wired carefully out of the way there will be no need to disconnect the brake hose.

3. Remove cotter pins from nuts on both ball joint tapered studs. Loosen, but do not remove nuts. If either ball stud nut is removed, injury could result since heavily compressed chassis spring will be completely released.

4. Force of chassis spring will tend to disengage ball joint tapered studs from steering knuckle. Rap knuckle sharply in area of ball studs to loosen studs from knuckle.

5. Support lower control arm and remove nuts from ball joint tapered studs. Raise upper control arm and remove tapered studs from knuckle. Remove steering knuckle. See Figure 30-14.

F. Steering Knuckle Installation

CAUTION: *Fasteners in steps 2 and 3 are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with one of the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part or lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.*

1. Clean the tapered studs of the ball joints and insert into steering knuckle. Steering knuckle should be positioned as though the wheel was in a straight-ahead position.

2. Align the cotter pin holes fore and aft and install the castellated nuts. Torque to 50 lb.ft. on the upper nut and 85 lb.ft. on the lower nut. Never back off nut to align cotter pin holes. *Always tighten nut to next slot*

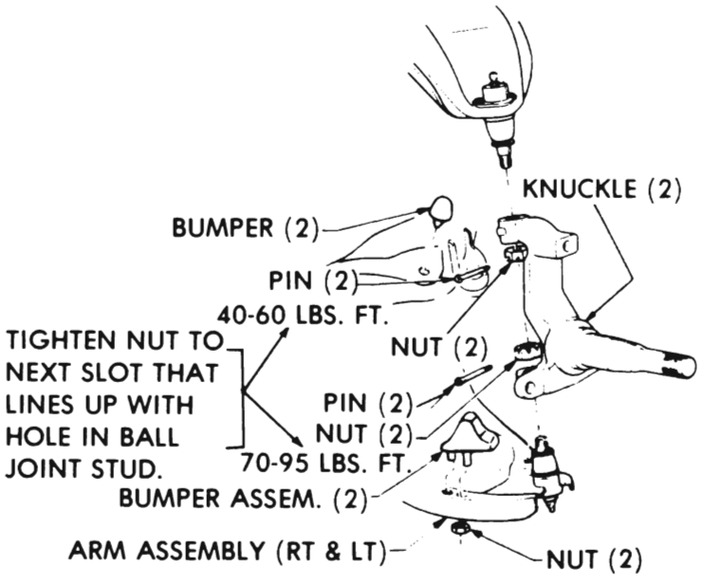


Figure 30-14 - Steering Knuckle Detail

that lines up with hole in ball joint stud. Install new cotter pin.

3. Position steering arm and brake backing plate to steering knuckle, being certain that the brake anchor pin engages properly in steering knuckle. Install backing plate retaining bolts and nuts. Torque to 75 lb.ft. Install anchor pin bolt and torque to 92 lb.ft. Bend lock plate to engage flats on brake anchor bolt head.

4. Install wheels, lubricate and adjust wheel bearings (par. 30-5).

30-7 REMOVAL AND INSTALLATION OF UPPER CONTROL ARM ASSEMBLY

A. Removal

1. Support car on car stand by frame, allowing front suspension to be in full rebound position.

2. Remove front wheel.

3. Remove upper ball joint stud cotter pin.

4. Loosen, but do not remove ball stud nut. If ball stud nut is removed, injury could result since heavily compressed chassis spring will be completely released.

5. Install Tool J-23742-1 between ball stud and turn threaded end until the ball stud is free of steering knuckle.

6. Place jack under lower control arm at spring seat. Raise jack until compression on upper rebound bumper is relieved.

7. Remove ball stud nut and lift upper control arm from knuckle.

8. Remove upper control arm shaft to frame nuts, noting the number, thickness and location of the adjusting shims.

9. Upper control arms are serviced only as complete assemblies. Therefore, the arm must be replaced if it is bent, or distorted, bushings are excessively worn, or the control arm shaft is damaged.

B. Installation

CAUTION: *Fasteners in steps 1, 2, and 3 are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with one of the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part or lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.*

1. Make sure that shaft and control are in proper relative position before tightening. Torque bushings to control arm shaft retaining nuts to 55 lb.ft. using vise to hold shaft.

2. Assemble upper control arm and shaft assembly to frame, making certain the number, thickness, and location of adjusting shims between shaft and bracket are correct. Torque shaft to frame nuts to 50 lb.ft. with a standard drive socket and J-1313 Torque Wrench or its equivalent.

3. Assemble tapered stud to knuckle with cotter pin holes fore and aft. Steering knuckle should be in a straight-ahead position. Make sure stud and hole are wiped clean before assembly. Install castellated nut. Torque to 50 lb.ft. Never back nut off to align cotter pin holes. Always tighten nut to next slot that lines up with hole. Install new cotter pin.

4. Install wheel.

5. Check and adjust front end alignment.

30-8 REMOVAL AND INSTALLATION OF LOWER CONTROL ARM

A. REMOVAL

1. Remove coil spring according to outline in paragraph 30-9.

2. Remove the two nuts and bolts attaching the control arm to the frame. See Figure 30-15.

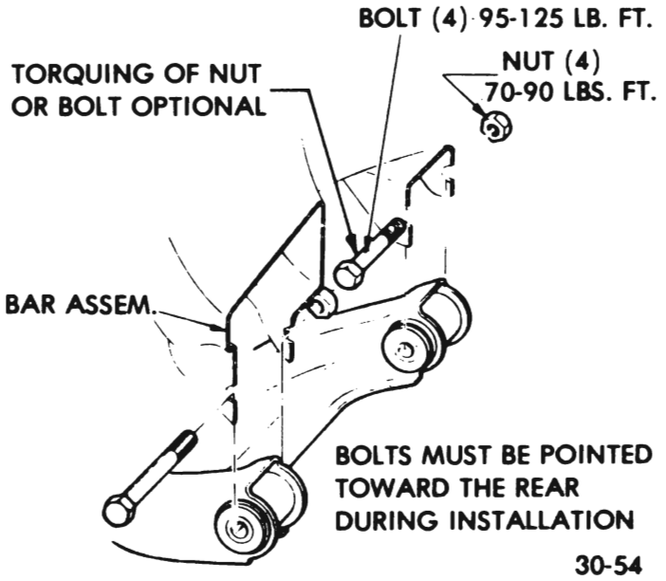


Figure 30-15 - Lower Control Arm Attachment

3. If lower control arm is to be replaced, remove the rubber bumper and attaching nut.

B. Installation

1. Install rubber bumper and attaching nut on new arm assembly. Torque to 20 lb.ft.

2. Install arm with the bolt heads to the front (bolt must be pointing to rear) of the car. See Figure 30- 15.

3. Reinstall coil spring according to instructions in paragraph 30-9.

4. Torque bushing retaining bolt nuts to 80 lb.ft.

CAUTION: *This front lower control arm to frame fastener is an important attaching part in that it could affect the performance of vital components and systems, and/or could result in major repair expense. It must be replaced with one of the same part number or with an equivalent part, if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of this part.*

5. Check and adjust front end alignment. This should be done when suspension is completely reassembled, car is at curb load, and front end of car has been "bounced out".

30-9 REMOVAL AND INSTALLATION OF FRONT SPRINGS

1. Raise front of car. Remove tire, wheel, and hub and drum assembly.

2. Disconnect stabilizer link from lower control arm. See Figure 30-16.

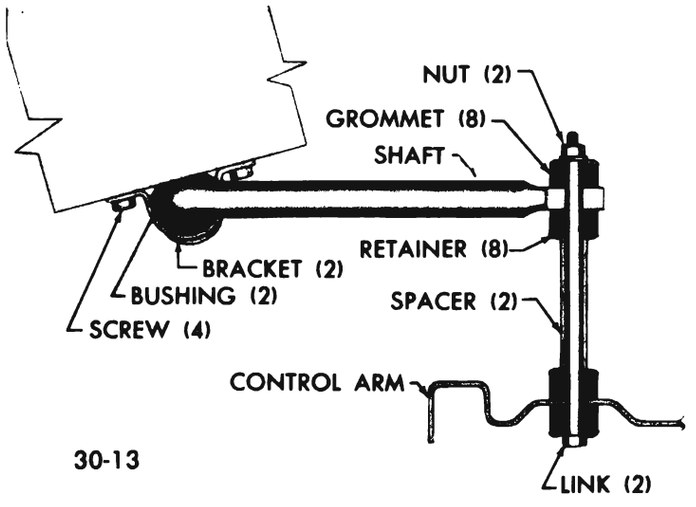


Figure 30-16 - Stabilizer Link Installation

3. Disconnect and remove shock absorber. Refer to Figure 30-16 for detail.

4. Disconnect lower control arm ball joint stud from steering knuckle as outlined in paragraph 30-6.

5. Install spring compressor J-9552.

6. Lower jack beneath control arm until spring is off its seat. Carefully disengage spring compressor and remove chassis spring.

7. Position new spring in frame tower and install compressor. Refer to Figure 30-18 for correct spring orientation.

8. Raise lower control arm with jack until just enough clearance is attained to permit installation of knuckle. Connect ball to knuckle as outlined in paragraph 30-6.

9. Lower jack from beneath lower control arm. Connect shock absorber. See Figure 30-17.

10. Connect stabilizer link as shown in Figure 30-16. Reinstall wheel with hub and drum assembly. Adjust bearing.

30-10 REMOVAL AND INSTALLATION OF SHOCK ABSORBERS

A. Removal

1. Remove upper shock absorber attaching nut, grommet retainers, and grommets. See Figure 30-17.

2. Raise front of car.

3. Remove the two lower attaching screws and remove shock absorber through hole in lower control arm.

B. Inspection

Check shock absorber for visible damage and oil leaks. Place shock absorber in upright position. Push and pull shock absorber noting resistance. If smooth hydraulic resistance is not present in both directions, replace absorber.

Do not operate shock absorber in a horizontal position. This will cause air to be trapped and shock will "lag" (appear defective).

C. Installation

1. Select the correct shock absorber for particular car model. Refer to Master Chassis Parts Catalog for correct absorber. Substitution of an incorrectly calibrated shock absorber will adversely affect car performance. With shock absorber in upright position and with rod pointed upward, manually push and pull

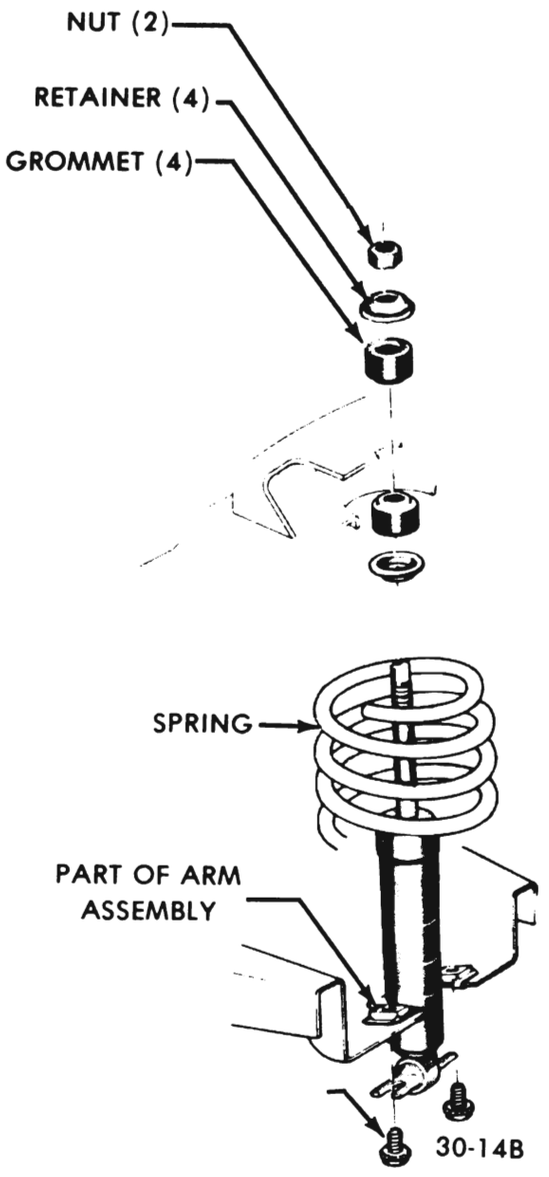


Figure 30-17 - Shock Absorber Installation

rod through the full stroke until a smooth resistance to motion is obtained. This procedure will remove air trapped in the shock absorber inner chamber. Keep shock in an upright position until it is installed in the car.

2. Extend shock, install one grommet retainer, and one grommet on absorber and slide through hole in lower spring seat. Attach with two screws torqued to 18 lb.ft. See Figure 30-17.

3. Install one grommet, grommet retainer, and nut on shock absorber shaft protruding through frame mounting hole. Torque nut to 8 lb.ft. Lower car and remove jack.

30-11 REMOVAL AND INSTALLATION OF STABILIZER SHAFT ASSEMBLY

CAUTION: *Fasteners in subparagraph A, B, and C are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with one of the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part or lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.*

A. Stabilizer Shaft, Removal and Replacement

1. Disconnect stabilizer links (subpar. c following) and disconnect the two frame-to-shaft insulator rubber mounts and brackets.

2. Remove stabilizer shaft.

3. To install, position insulator mounts and brackets over shaft and connect brackets to frame. Car should be at curb weight and should be "bounced out" before bolts are tightened. Torque bracket bolts to 20 lb.ft. Do *not* lubricate insulator mounts.

4. Connect stabilizer links subparagraph c below.

B. Stabilizer Bracket and Insulator, Removal and Replacement

Stabilizer brackets should be replaced if damaged, and rubber insulator mounts replaced if deteriorated.

Replace by supporting stabilizer shaft in position and replacing brackets and mounts one at a time. Torque bracket bolts 20 lb.ft.

C. Stabilizer Link Removal and Replacement

1. Remove nut from upper end of link. Remove link, spacer, retainers and grommets. See Figure 30- 16.

2. Inspect all parts for signs of damage or wear.

3. Install grommets dry (do not lubricate) and use care to center the grommets in the seats on stabilizer shaft and bracket on lower control arm. Also, center the retainers on grommets before tightening rod nut.

4. Tighten link nut to 12 lb.ft.

DIVISION VI

SPECIFICATIONS

30-12 BOLT TORQUE SPECIFICATIONS

A. Tightening Parts

Use a reliable torque wrench to tighten the parts listed in subparagraph B. The specifications are for clean and lightly-lubricated threads. Dry or dirty threads increase the amount of effective friction, preventing accurate measurement of torque.

B. Fastener Torques

Parts	Location	Torque Lb.Ft.
Nut and Bolt	Upper Control Arm Shaft to Frame	Nut 50
Nut and Bolt	Lower Control Arm to Frame	Nut 80, Bolt 110
Screw	Stabilizer Support to Frame	24
Nut	Upper Shock Absorber to Frame	8
Screw (2)	Lower Shock Absorber to Lower Control Arm	20
Nut	Lower Ball Joint Stud to Steering Knuckle	85
Nut	Upper Ball Joint Stud to Steering Knuckle	50
Nut	Lower Rubber Bumper to Lower Control Arm	17
Nut and Bolt	Stabilizer Bar Link	13
Nut, Bolt and Washer	Idler Arm to Frame	40
Bolt	Upper Control Arm Bushing to Shaft	Nut 35, Bolt 45
Nut	Steering Arm to Knuckle	Nut 85

30-13 DIMENSIONAL SPECIFICATIONS

Part Dimensions

Stabilizer Bar	
Sedans, Coupes, Convertibles	7/8" Dia.
G.S.	15/16" Dia.
Station Wagon	15/16" Dia.
Heavy Duty	
Sedans, Coupes, Convertibles	15/16" Dia.

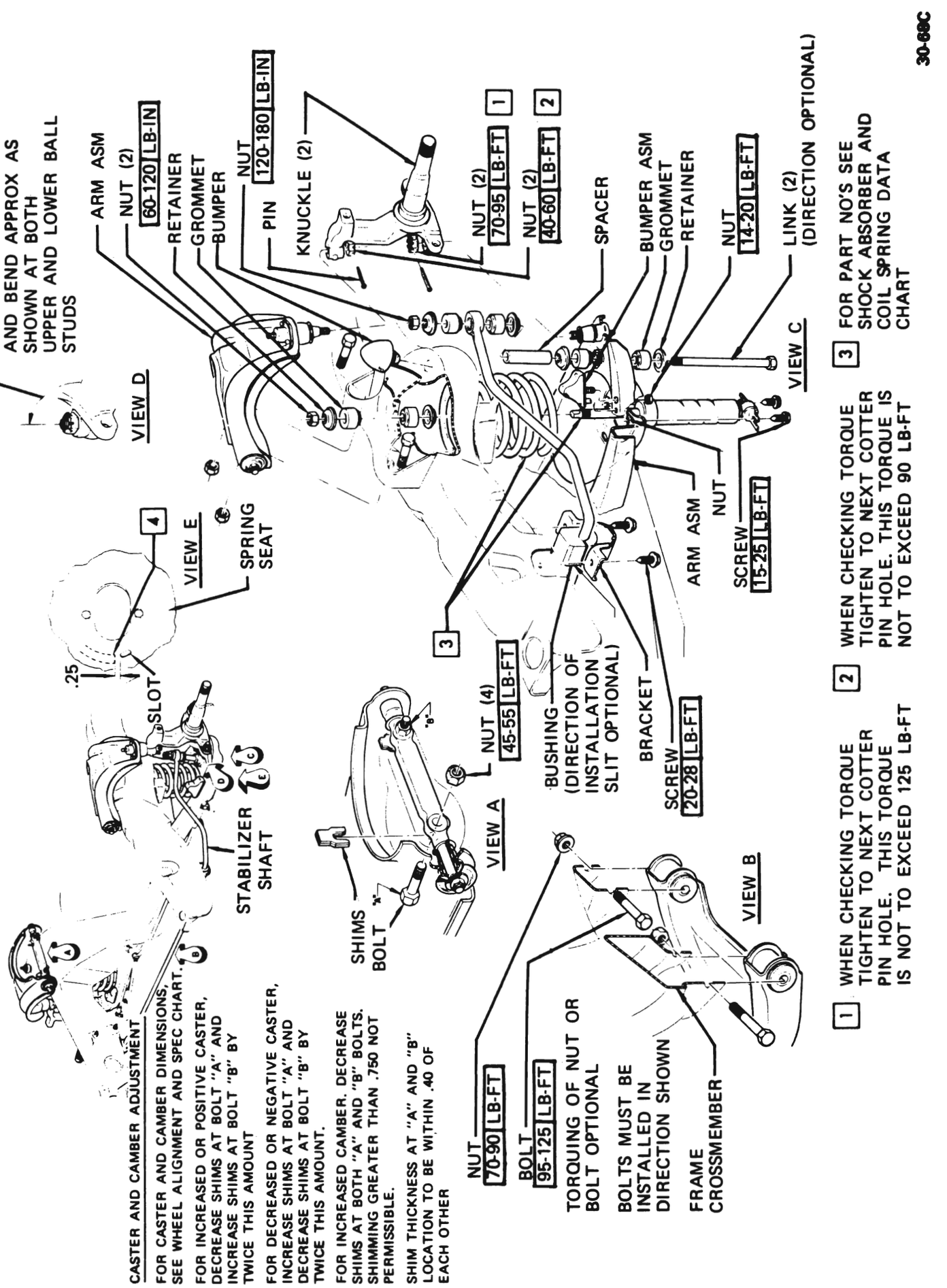


Figure 30-18 Front Suspension Details

FRONT END ALIGNMENT

Satisfactory vehicle operation may occur over a wide range of front end (wheel) alignment settings. Nevertheless, should settings vary beyond certain tolerances, readjustment of alignment is advisable. The specifications stated in Chart "A" of this manual should be used by owners, dealers, and repairmen as guidelines in vehicle diagnosis, either for repairs under the new vehicle warranty or for maintenance service at customers' requests. These specifications provide an acceptable all-around operating range in that they prevent abnormal tire wear caused by wheel alignment.

WHEEL ALIGNMENT SPECIFICATIONS

	CHART A Specifications for Diagnosis for Warranty Repairs Or Customer Paid Service		CHART B Specifications for Resetting Alignment	
	4D-4F-4G-4H SERIES	4L-4N-4R-4P-4U-4V-4Y SERIES	4D-4F-4G-4H SERIES	4L-4N-4R-4P-4U-4V-4Y SERIES
Caster	-1 1/2° to +1/2°	+2° to 0°	-1/2° (±1/2°)	+1° (±1/2°)
Camber	+1 1/4° to -1/4°	+1° to -1/2°	+1/2° (±1/2°)	+1/2° (±1/2°)
Toe-In	1/16" toe-in to 5/16" toe-in		3/16" toe-in (±1/16")	
Cross Caster	No More Than 1° Side to Side Variation		No More Than 1/2° Side to Side Variation	
Cross Camber	No More Than 1° Side to Side Variation		No More Than 1/2° Side to Side Variation	

Governmental Periodic Motor Vehicle Inspection programs usually include wheel alignment among items that are inspected. To provide useful information for such inspections, the tolerances shown in Chart "C" are applicable and well within the range of safe vehicle operation.

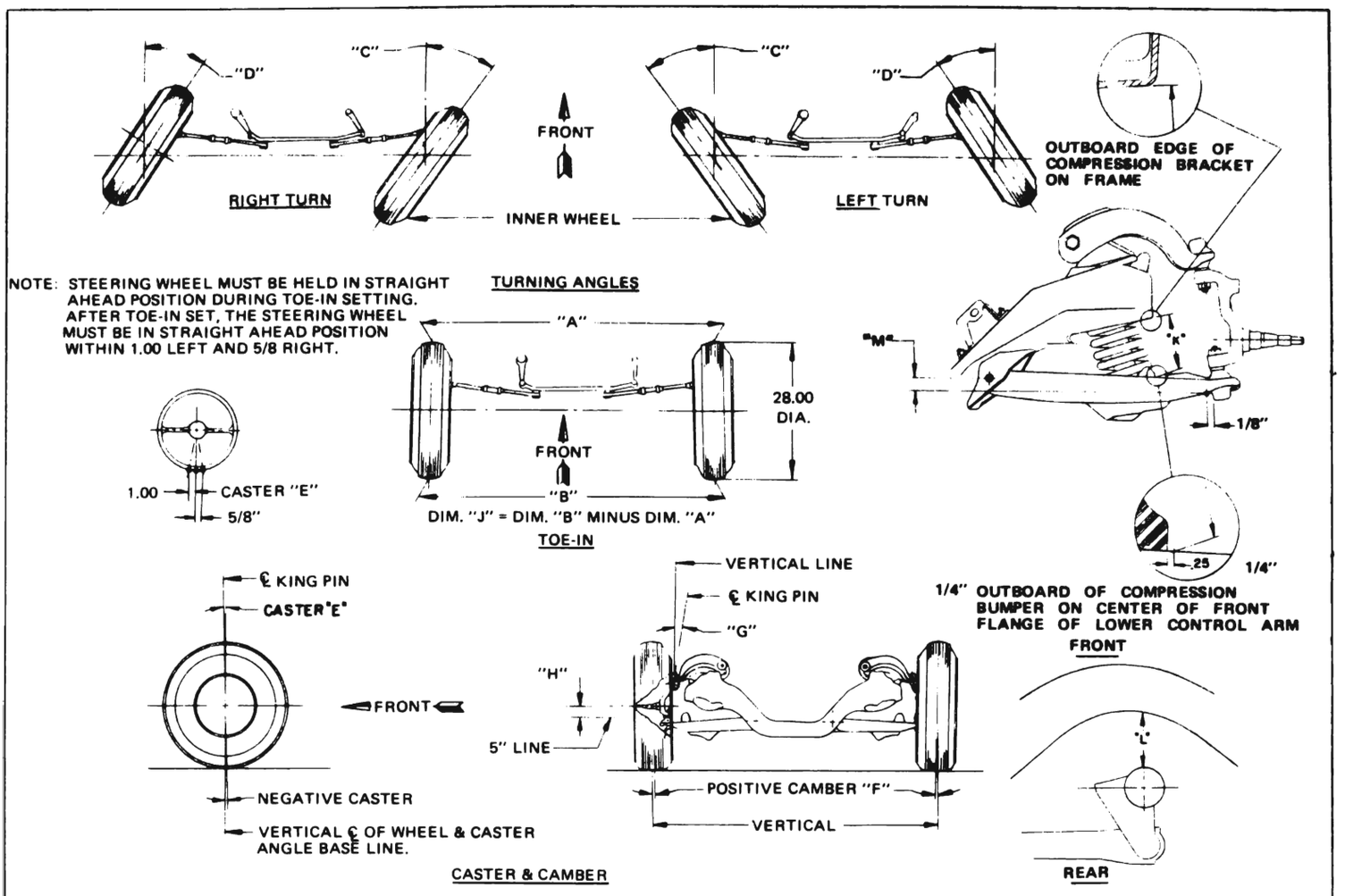
MOTOR VEHICLE INSPECTION STATION TOLERANCES

	CHART C	
	4D-4F-4G-4H SERIES	4L-4N-4R-4P-4U-4V-4Y SERIES
Caster	+1 1/2° to -2 1/2°	+3 to -1
Camber	+2° to -1°	+1 3/4° to -1 1/4°
Toe-In	3/16" toe-out to 9/16" toe-in	

In the event the actual settings are beyond the specifications set forth in Chart "A" or "C" (whichever is applicable), or whenever for other reasons the alignment is being reset, Buick recommends that the specifications given in Chart "B" ot the atoresaid applicable chart be used.

30-63B

Figure 30-19 Front Wheel Alignment and Chassis Trim Chart 4D-4F-4G-4H Series



MODEL	CHASSIS TRIM DIM. CURB WEIGHT		FULL TURN INNER WHEEL "C"	FULL TURN OUTER WHEEL "D"	OUTER WHEEL ANGLE WITH INNER WHEEL AT 20°	STEERING AXIS ANGLE "G" AT 0° CAMBER
	FRONT "K" ± 3/16	REAR "L" ± 1/4				
43337 43369 43337	3 15/16	5 5/16	36°	33 1/2°	18 1/2°	9°
43436	4 11/16	6 5/8				
43437 43467	3 11/16	4 1/2				
44437 44467 44439 44469	3 15/16	5 5/16				

30-20A

Fig. 30-20 Front Wheel Alignment and Chasis Trim Chart 4D-4F-4G-4H- Series

FRONT SUSPENSION ALIGNMENT CHART

1972 4D-4F-4G-4H SERIES

CURB LOAD

MEASURED CAMBER		MEASURED CASTER										
		¾°	½°	¼°	0°	−¼°	−½°	−¾°	−1°	−1¼°	−1½°	−1¾°
1¾°	F	+0.23	+0.23	+0.22	+0.21	+0.21	+0.20	+0.19	+0.19	+0.18	+0.18	+0.17
	R	+0.10	+0.12	+0.14	+0.16	+0.18	+0.20	+0.22	+0.25	+0.27	+0.29	+0.31
1½°	F	+0.19	+0.19	+0.18	+0.17	+0.17	+0.16	+0.15	+0.15	+0.14	0.14	−0.13
	R	+0.06	+0.03	+0.10	+0.12	+0.14	+0.16	+0.18	+0.20	+0.23	0.25	+0.27
1¼°	F	+0.15	+0.15	+0.14	+0.13	+0.13	+0.12	+0.11	+0.11	+0.10	+0.10	+0.09
	R	+0.02	+0.04	+0.06	+0.08	+0.10	+0.12	+0.14	+0.16	+0.18	+0.21	+0.23
1°	F	+0.11	+0.11	+0.10	+0.09	+0.09	+0.08	+0.07	+0.07	+0.06	+0.06	+0.05
	R	−0.02	0	+0.02	+0.04	+0.06	+0.08	+0.10	+0.12	+0.14	+0.17	+0.19
¾°	F	+0.07	+0.07	+0.06	+0.05	+0.05	+0.04	+0.03	+0.03	+0.02	+0.02	+0.01
	R	−0.06	−0.04	−0.02	0	+0.02	+0.04	+0.06	+0.08	+0.10	+0.13	+0.15
½°	F	+0.03	+0.03	+0.02	+0.01	+0.01	0	−0.01	−0.01	−0.02	−0.02	−0.03
	R	−0.10	−0.08	−0.06	−0.04	−0.02	0	+0.02	+0.04	+0.06	+0.08	+0.11
¼°	F	−0.01	−0.01	−0.02	−0.03	−0.03	−0.04	−0.05	−0.05	−0.06	−0.06	−0.07
	R	−0.14	−0.12	−0.10	−0.08	−0.06	−0.04	−0.02	0	+0.02	+0.04	+0.07
0°	F	−0.05	−0.05	−0.06	−0.07	−0.07	−0.08	−0.09	−0.09	−0.10	−0.10	−0.11
	R	−0.18	−0.16	−0.14	−0.12	−0.10	−0.08	−0.06	−0.04	−0.02	0	+0.02
−¼°	F	−0.09	−0.09	−0.10	−0.11	−0.11	−0.12	−0.13	−0.13	−0.14	−0.14	−0.15
	R	−0.22	−0.20	−0.18	−0.16	−0.14	−0.12	−0.10	−0.08	−0.06	−0.04	−0.02
−½°	F	−0.13	−0.13	−0.14	−0.15	−0.15	−0.16	−0.17	−0.17	−0.18	−0.18	−0.19
	R	−0.26	−0.24	−0.22	−0.20	−0.18	−0.16	−0.14	−0.12	−0.10	−0.08	−0.06
−¾°	F	−0.17	−0.17	−0.18	−0.19	−0.19	−0.20	−0.21	−0.21	−0.22	−0.22	−0.23
	R	−0.30	−0.28	−0.26	−0.24	−0.22	−0.20	−0.18	−0.16	−0.14	−0.12	−0.10

F — Shim pack thickness change required at front bolt (Inches)

R — Shim pack thickness change required at rear bolt (Inches)

\+ Means shim addition

− Means shim removal

Figure 30-21 Alignment Instructions 4D-4F-4G-4H Series