

## SECTION 18

# STEERING SYSTEM

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**NOTE:**

All steering system fasteners are important parts in that they could affect the performance of vital parts 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 this part.

## 18-1. GENERAL DESCRIPTION

The rotary motion of the steering handwheel is carried to the steering shaft upper, steering shaft lower, steering gear box and pitman arm. Then as the pitman arm moves, the drag rod is caused to move linearly, actuating the tie rod to turn the wheels, right and left, through their knuckle arms. The turning force exerted by the tie rod experiences a damping action due to the presence of the oil seal at the sphere-like joint between the knuckle case and the inner case (integral with the dead axle sleeve). Another damping action is available, which will be mentioned below.

The steering system formed by the components named above is designed for easy steering, high durability and excellent steering reaction as well as reliable self-restoring action. Articulated joints in the steering lever is equipped with a damping device for ensuring the greater steering stability.

Linkage are of wear-resistant ball-and-socket type. Pitman arm is equipped with a damping device for ensuring the greater steering stability.

[Right-hand steering vehicle]

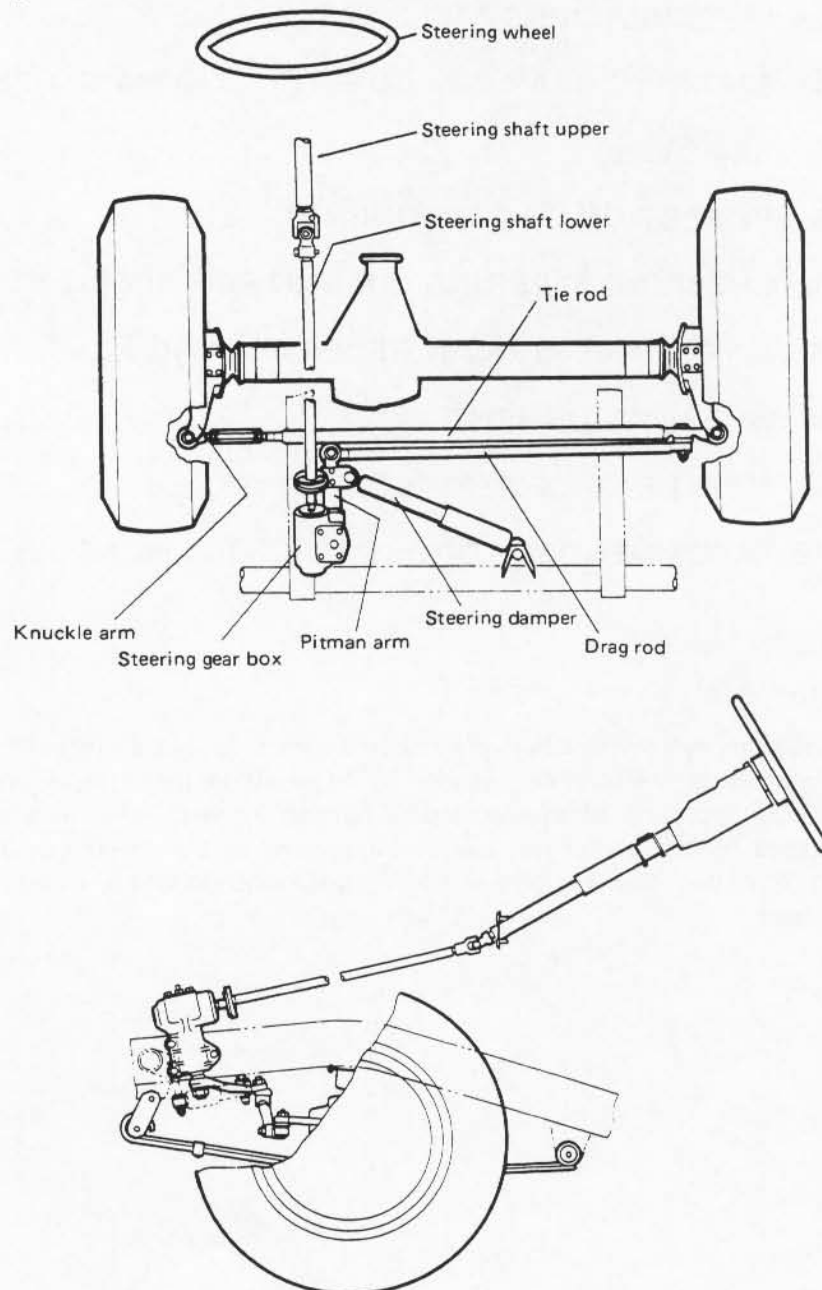


Fig. 18-1

[Left-hand steering vehicle]

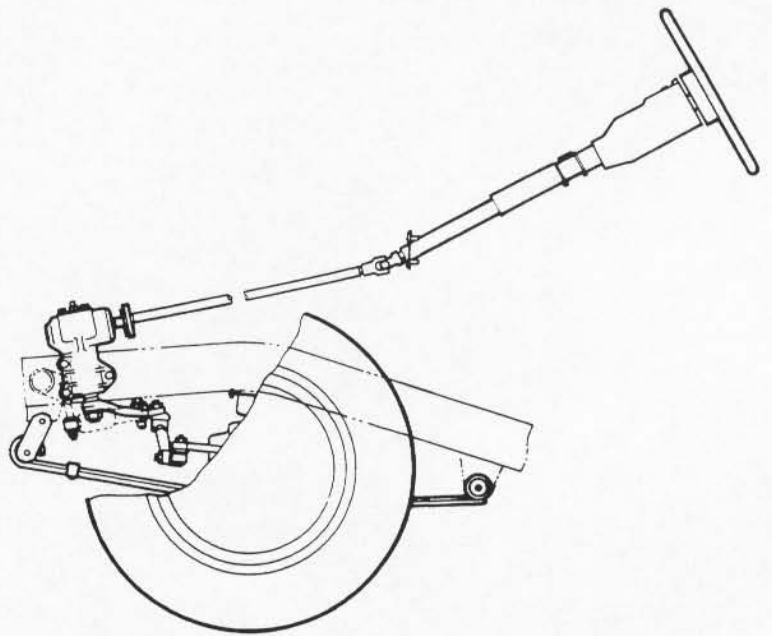
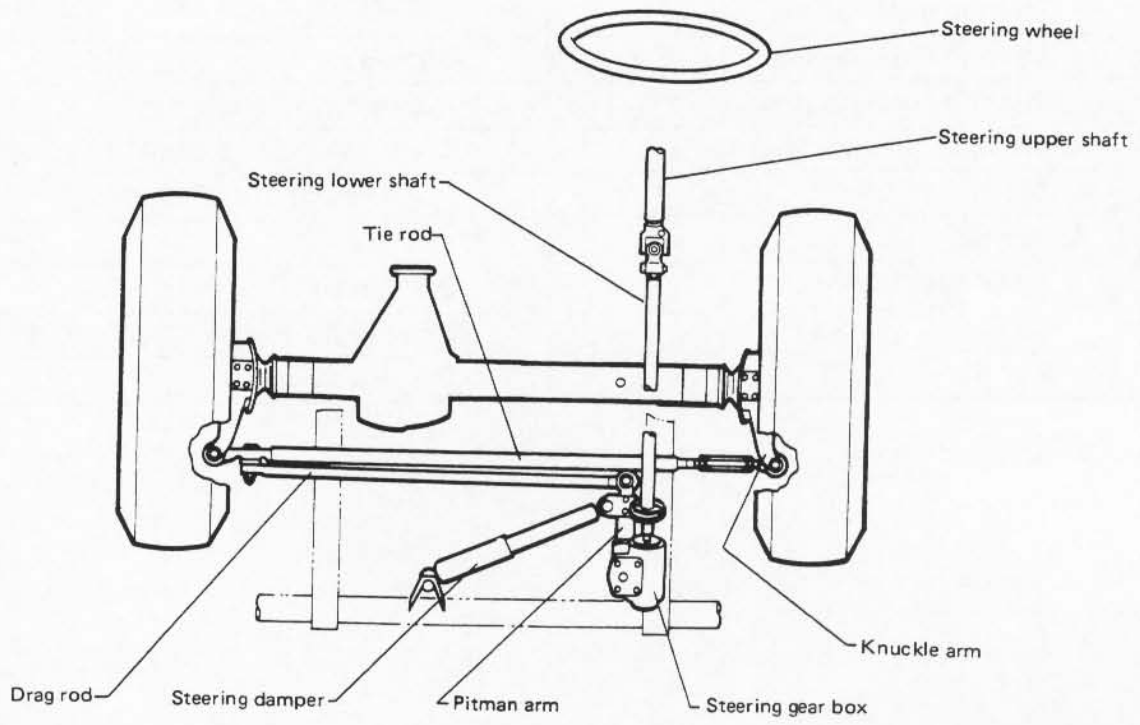


Fig. 18-1-1

## 18-2. SPECIFICATIONS AND DATA

	Steering gear box	Recirculating ball-and-nut type
	Gear ratio	15.6 – 18.1
	Steering angle, inside	$29^{\circ} \pm 3^{\circ}$
	Steering angle, outside	$26^{\circ} \pm 3^{\circ}$
	Steering wheel diameter	400 mm (15.74 in.)
	Minimum turning radius	5.1 m (16.1 ft.) *6.0 m (19.7 ft.)
WHEEL ALIGNMENT	Toe-in	2 – 6 mm (0.079 – 0.236 in.)
	Camber	1 degree ( $1^{\circ}$ )
	Kingpin inclination	9 degree ( $9^{\circ}$ )
	Caster	3 degree 30 minutes ( $3^{\circ} 30'$ ), 14.5mm (0.57 in)
	Side slip	0 – in 3 m/km

\* For long body type vehicle

### 18-3. STEERING GEAR BOX CONSTRUCTION AND OPERATION

The pitman arm is rigidly connected to the outer end of the shaft integral with the sector gear, which is inside the gear box and meshed with the teeth of the nut capable of sliding along the worm. Between the nut and the worm is a row of steel balls, which serves two purposes: to provide rolling contact between nut and worm and to keep the nut engaged with the worm as if the two were threadedly engaged. With the nut prevented from turning, the rotation of the worm causes the nut to move up or down the worm.

The worm is an extension of the steering shaft. As the handwheel is turned, the steel balls roll along in the groove and the nut moves up or down. The steel ball that has reached the end of the groove in the nut enters the return guide. The guide sends the ball back to the other end of the same groove. In this way, the row of balls recirculates.

By so moving, the nut turns the sector gear and hence the pitman arm. It should be noted here that it is through the steel balls that a rotary motion of the worm is converted into a linear motion of the nut, which is then converted into another rotary motion of the section gear.

The steering gear box is a precision-machined device, each part of it being machined to a closer tolerance for smooth conversion of motion, and is build sturdy for long service life. Special tools and instruments are needed in addition to specialized skill if the gear box is to be overhauled. For this reason, a gear box found to be in defective condition should be replaced with a new one; replacement is more economical and what is perhaps more important, safer.

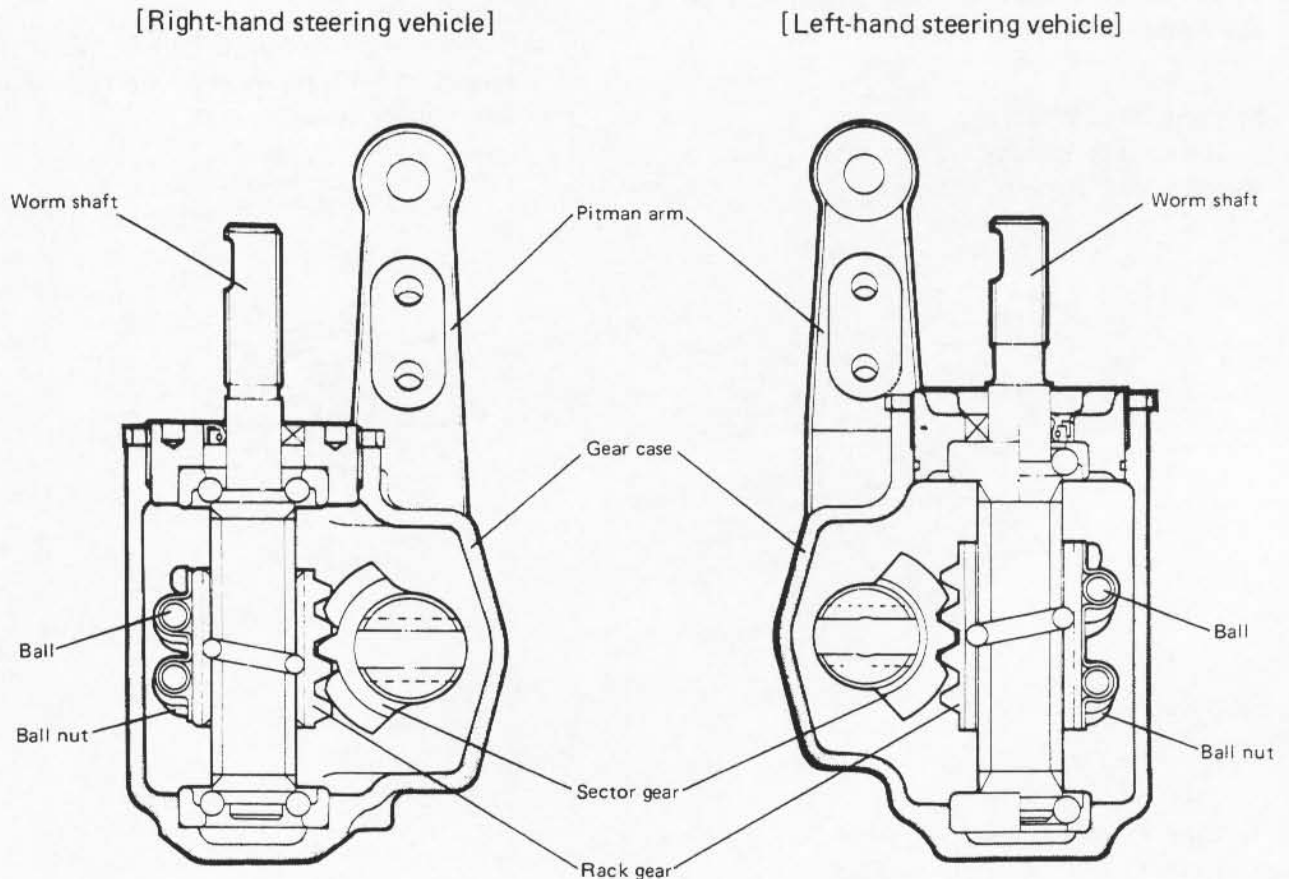


Fig. 18-2

## 18-4. REMOVAL

### NOTE:

There are two types of steering column for this vehicle. They are double tube type and single tube type. Which type to be used varies with countries.

Illustrations show double tube type only, but the same removal and installation procedures are used for single tube type.

Both types of column may be easily removed and installed. For installation, it is important that only the specified screws, bolts, and nuts be used as designated and that they are tightened to the specified torque.

When removing the column assembly from the car, special care must be taken in handling it. Use of a steering wheel puller other than the steering wheel remover recommended in this manual or a sharp blow on the end of the steering shaft, leaning on the assembly, or dropping the assembly is prohibited. Any of such actions could shear the plastic shear pins which maintain column length especially with the double tube type column.

### Steering Hand Wheel

- 1) Disconnect negative battery cable.
- 2) Pull horn button to remove.

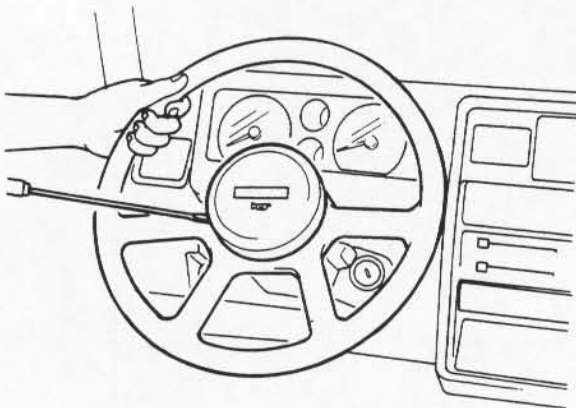


Fig. 18-3

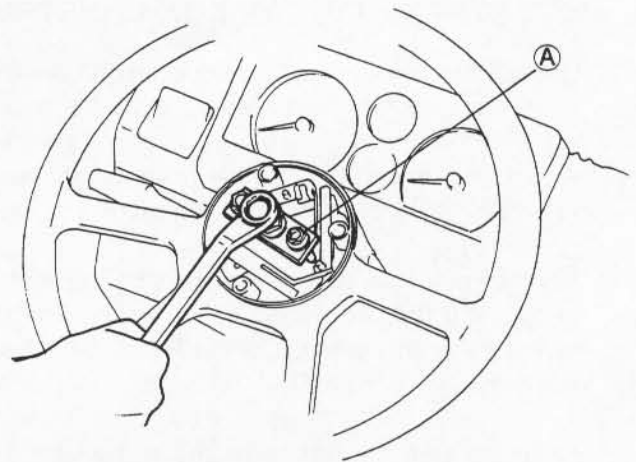


Fig. 18-4 (A) Special tool (Steering wheel remover 09944-36010)

### Steering Column

- 1) After removing steering handwheel according to the foregoing step, remove steering covers (lower & upper).

### NOTE:

After removing instrument lower panel, loosen 2 screws and 4 nuts securing steering column to remove upper cover.

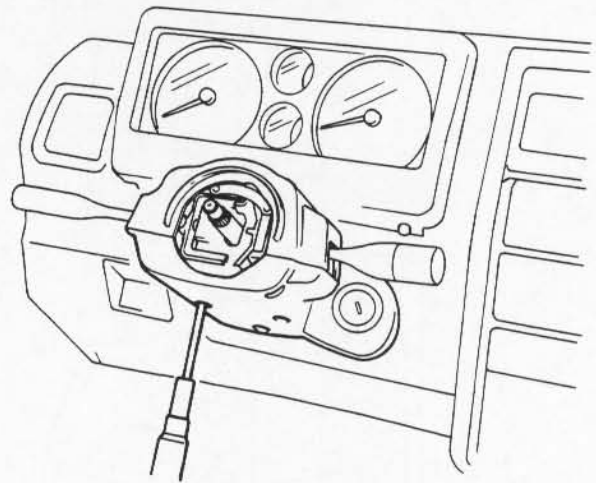


Fig. 18-5

- 3) After loosening steering shaft nut, remove steering wheel by using special tool.



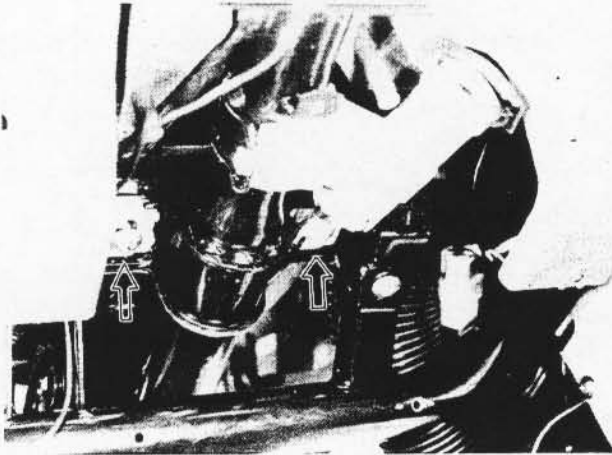


Fig. 18-6

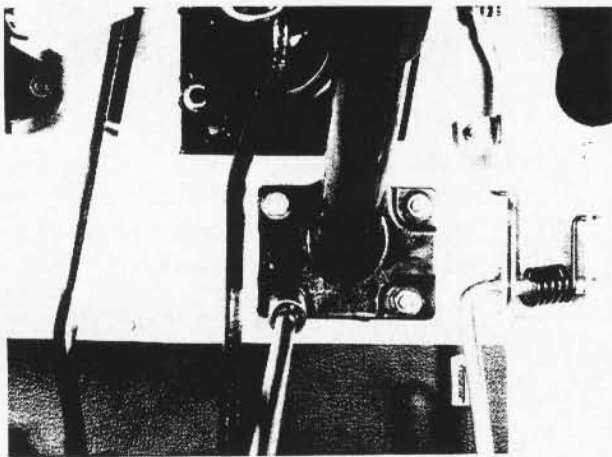


Fig. 18-7

2) Disconnect combination switch couplers and remove combination switch.

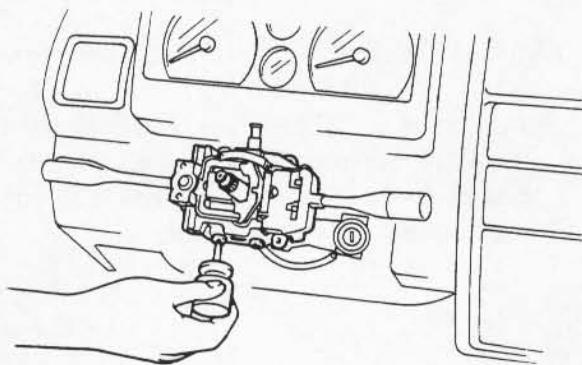


Fig. 18-8

3) Remove the bolt joining steering shafts in engine room.

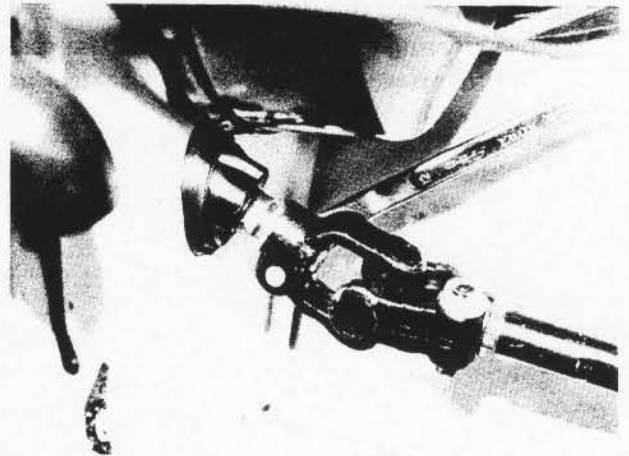


Fig. 18-9

4) Remove steering column ass'y.

**NOTE:**

- Don't separate double tube type steering column assembly into steering column and shaft. If column or shaft is defective, replace as an assembly.
- Single tube type steering column assembly can be separated into steering column and shaft. If either part is found defective, disassemble the assembly and replace defective part.

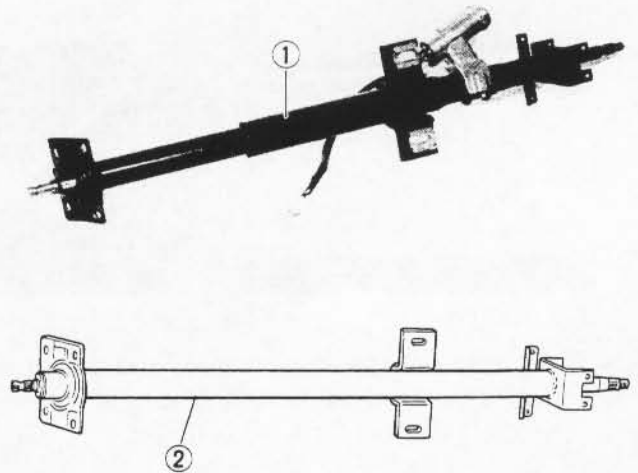


Fig. 18-10 ① Double tube type (Can't be disassembled)  
② Single tube type (Can be disassembled into shaft and column)

### Steering Lock (Applicable to Vehicle Equipped with Steering Lock)

- 1) After removing steering column, loosen and remove steering lock mounting bolts. Use care not to damage aluminum part of steering lock body with center punch.

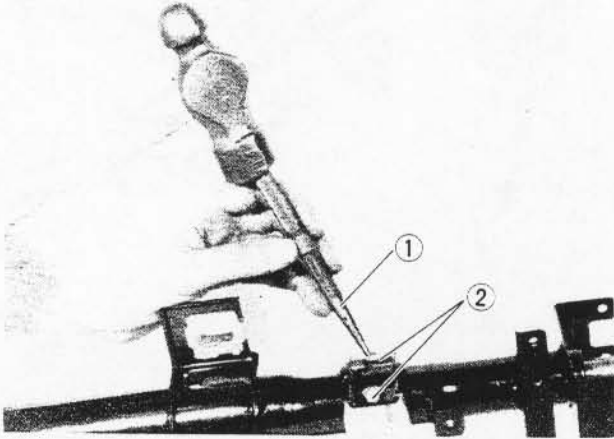


Fig. 18-11 1. Center punch (with sharp point)  
2. Steering lock mounting bolts

- 2) Remove steering lock assembly from steering column.

### Gear Box

- 1) Remove joint bolt.

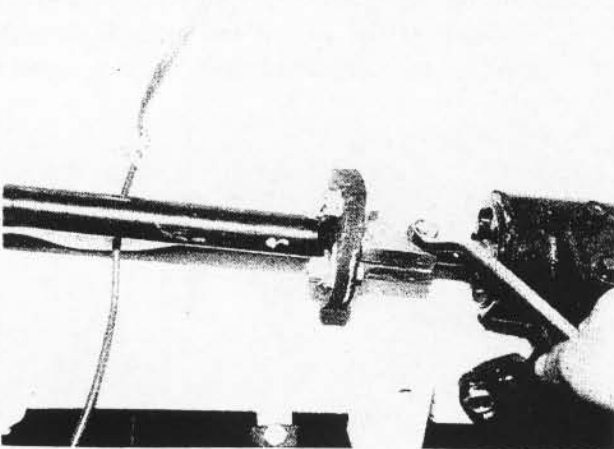


Fig. 18-12

- 2) Remove radiator under cover, and disconnect ball stud of drag rod using special tool and steering damper from pitman arm.

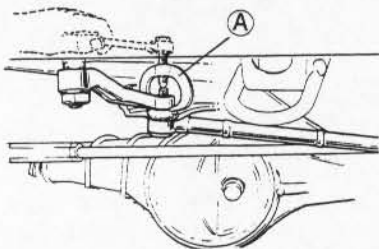


Fig. 18-13 (A) Special tool (Tie-rod end remover 09913-65210)

- 3) Steering gear box is secured in place by mounting bolts. Remove these bolts and take down gear box.

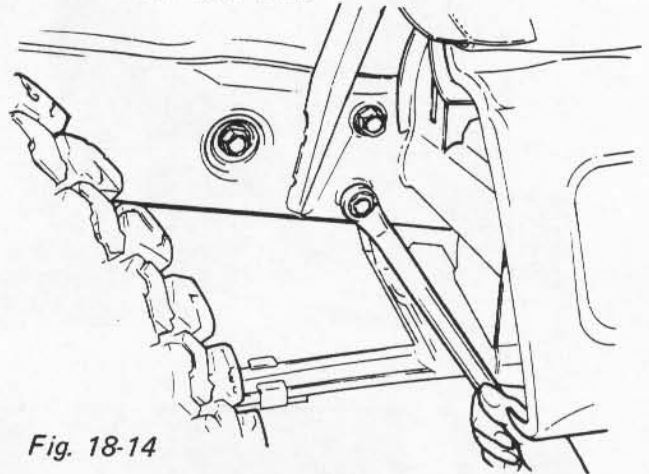


Fig. 18-14

### Tie Rod and Tie Rod End

- 1) Hoist car and remove wheels.
- 2) Remove drag rod castle nut, and then remove tie rod and tie rod end using special tool.

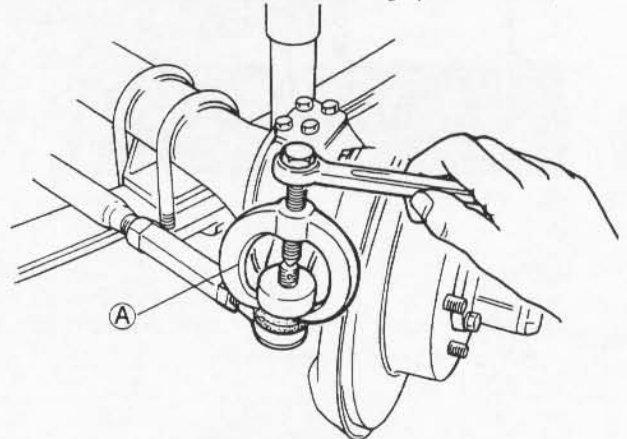
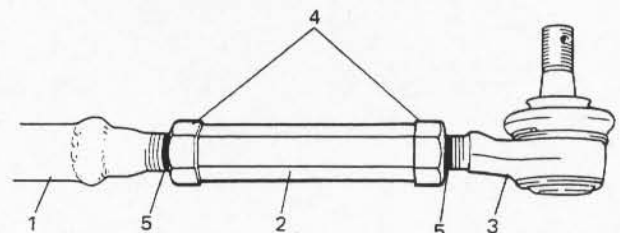


Fig. 18-15 (A) Special tool (Tie-rod end remover 09913-65210)

- 3) For ease of adjustment after installation, mark tie rod and tie rod end to indicate lock nut positions. Then loosen each lock nut and separate tie rod and tie rod end.



1. Tie rod
2. Turnbuckle
3. Tie rod end
4. Lock nut
5. Marking to be made

Fig. 18-16



## 18-5. INSPECTION OF COMPONENTS

### Steering Gear Box

[Oil level]

Oil surface should be up to the level as shown in below figures. If not, add prescribed gear oil, SAE 90.

Right hand steering vehicle

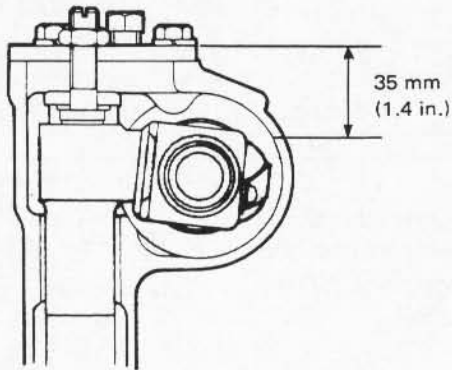


Fig. 18-17

Left hand steering vehicle

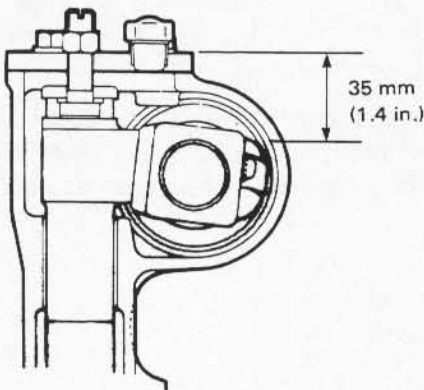


Fig. 18-18

[Adjustment of worm shaft starting torque]

The steering gear box is provided with adjusting bolt ① which gives preload to sector shaft.

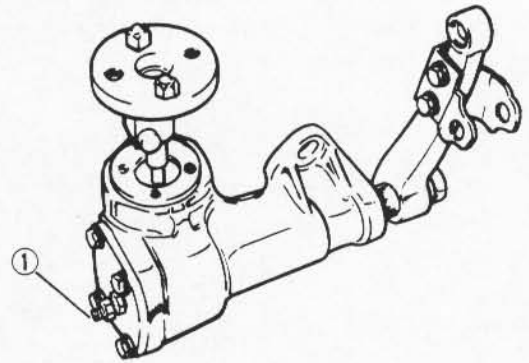


Fig. 18-19 ① Adjusting bolt

Make an adjustment according to the following procedure.

- 1) Check worm shaft to ensure that it is free from thrust play.
- 2) Position pitman arm in parallel with worm shaft as shown below.  
(With pitman arm in this position, front wheel is in straightforward state.)

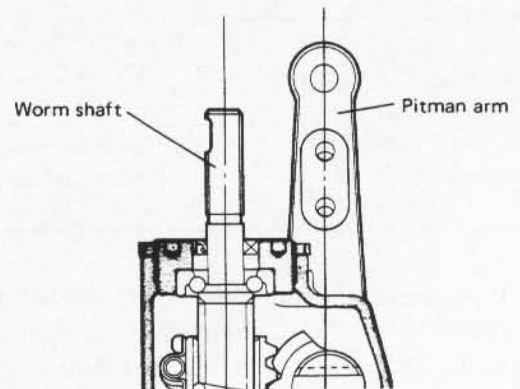
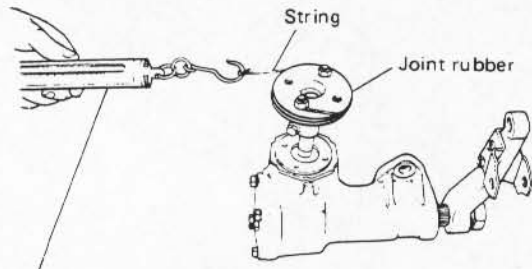


Fig. 18-20

3) Measure worm shaft starting torque from its position in the straightforward state in 2), using a spring balance and string as shown in below figure.



Spring balance (Use one with a maximum measurement of around 5 kg (11 lb.))

Fig. 18-21

Worm shaft (including sector shaft) starting torque (with torque wrench)	Right-hand steering vehicle 7.5 – 13.0 kg-cm (0.54 – 0.94 lb-ft)
	Left-hand steering vehicle 6.0 – 10.0 kg-cm (0.43 – 0.72 lb-ft)

Worm shaft (including sector shaft) starting torque (with spring balance)	Right-hand steering vehicle 1.97 – 3.42 kg (4.34 – 7.53 lb)
	Left-hand steering vehicle 1.58 – 2.63 kg (3.48 – 5.80 lb)

If measured torque is not within the specification, carry out adjustment with adjusting bolt ① to meet specification and check to confirm it again.

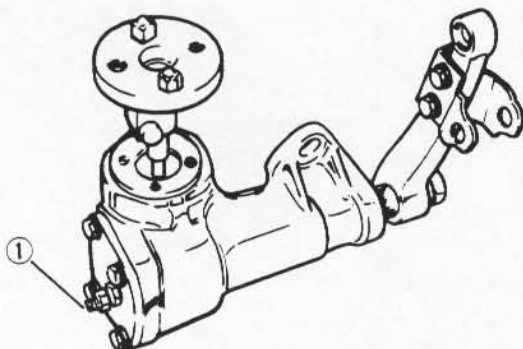


Fig. 18-22

4) If worm shaft starting torque is checked all right, another check should be carried out on worm shaft operating torque in its entire operating range (turning the worm shaft all the way to the right and left) as shown in Fig. 18-21.

Worm shaft (including sector shaft) operating torque (with torque wrench)	Right-hand steering vehicle Under 13.0 kg-cm (Under 0.94 lb-ft)
	Left-hand steering vehicle Under 12.0 kg-cm (Under 0.86 lb-ft)

Worm shaft (including sector shaft) operating torque (with spring balance)	Right-hand steering vehicle Under 3.42 kg (Under 7.53 lb)
	Left-hand steering vehicle Under 3.15 kg (Under 6.96 lb)

If measured torque does not conform to specification, readjust worm shaft starting torque in straightforward state by means of adjusting bolt ①, and then recheck worm shaft operating torque.

If the specified value is not attained even after readjustment, it is advisable to replace the gear box with a new gear box ass'y.

## 18-6. CHECKING STEERING COLUMN FOR ACCIDENT DAMAGE

Cars involved in accidents resulting in body damage or where the steering column has been impacted may also have a damaged or misaligned steering column.

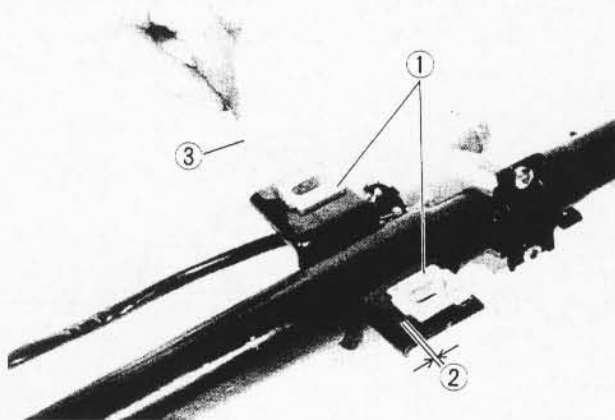
In such a case, following steps 1) through 5) should be performed for double tube type steering column and 4) through 6) for single tube type steering column.

### Checking Procedure

1) Check capsules on steering column bracket; all should be within 1.0 mm (0.039 in) from the bottom of slots. If not, steering column assembly should be replaced. Use thickness gauge for convenience.

### NOTE:

This inspection is required only for double tube type steering column which has capsules mounted on column bracket with 4 pins.



1. Capsules

Each capsule should be within 0 – 1.0 mm (0 – 0.039 in.) from the bottom of slot. If not, replace column assembly.

2. Within 0 – 1.0 mm

(0 – 0.039 in)

3. Thickness gauge

Fig. 18-23

2) Take measurement "A" as shown. If it is shorter than specified length, replace column assembly with new one.

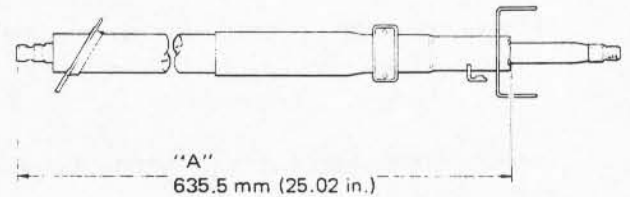


Fig. 18-24

3) Take measurement "B" of steering lower shaft as shown. If it is shorter than specified length, replace it with new one.

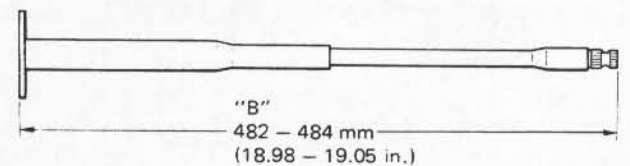


Fig. 18-25

4) Check steering shaft joints and shaft for any damages such as crack, breakage, malfunction or excessive play. If anything is found faulty, replace.

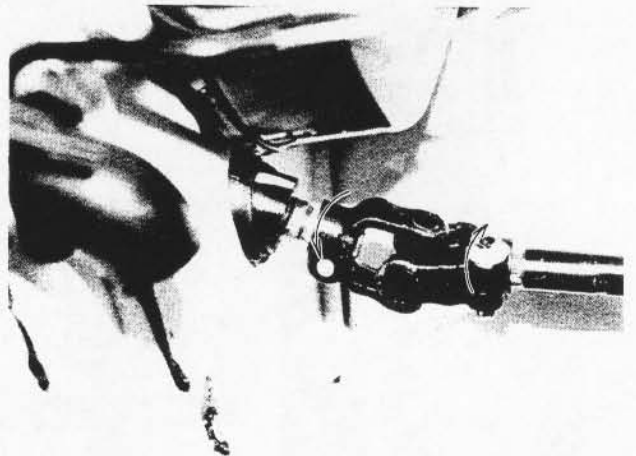


Fig. 18-26

5) Check steering shaft for smooth rotation. If found defective, replace as column assembly.  
6) Check steering shaft and column for bend, cracks or deformation. If found defective, replace.

## 18-7. IMPORTANT STEPS IN REINSTALLATION

Reverse removal procedure for installation, noting the following.

### Steering Lock (Applicable to Vehicle Equipped with Steering Lock)

- 1) Position groove of steering shaft in the center of hole in column.

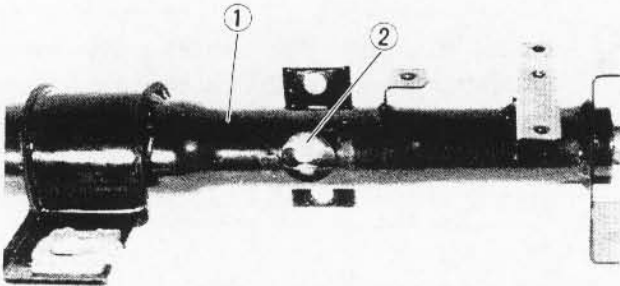


Fig. 18-27 1. Steering column  
2. Steering shaft

- 2) Align hub on steering lock with groove of steering shaft and rotate shaft to assure that steering shaft is locked.

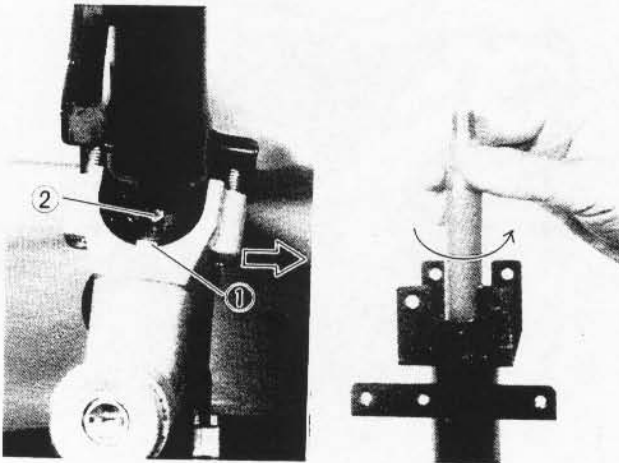


Fig. 18-28 1. Hub  
2. Groove

- 3) Tighten 2 new bolts until head of each bolt is broken off.

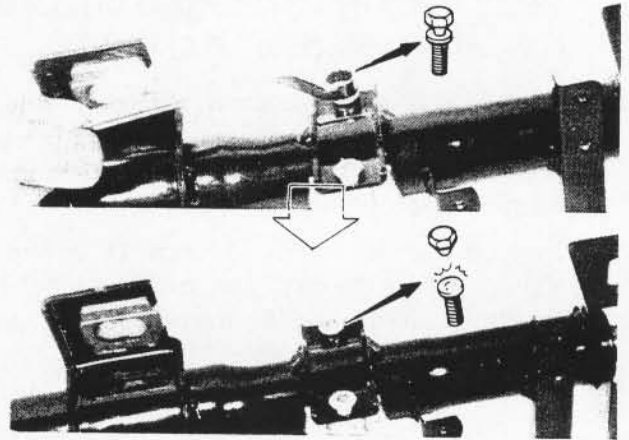


Fig. 18-29

- 4) Turn ignition key to "ACC" or "ON" position and check to be sure that steering shaft rotates smoothly. Also check for lock operation.
- 5) Install steering column. Refer to the following page.

### Steering Gear Box

Put steering gear box bolts through from inside of car and tighten nuts to specified torque.

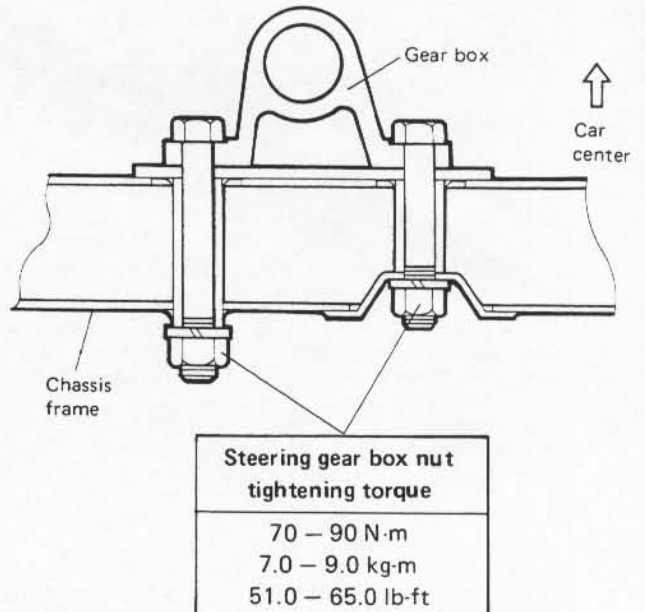


Fig. 18-29-1

## Steering Damper

- Install steering damper with larger diameter hole end directed toward pitman arm and hole in outer shell downward.
- Install steering damper stay, directing its circular boss side upward.
- Mount steering damper and steering damper stay bolts from the top.
- Torque steering damper pin nut and damper nut to specification while directing steering to straightforward state (with pitman arm in parallel with center line of car).

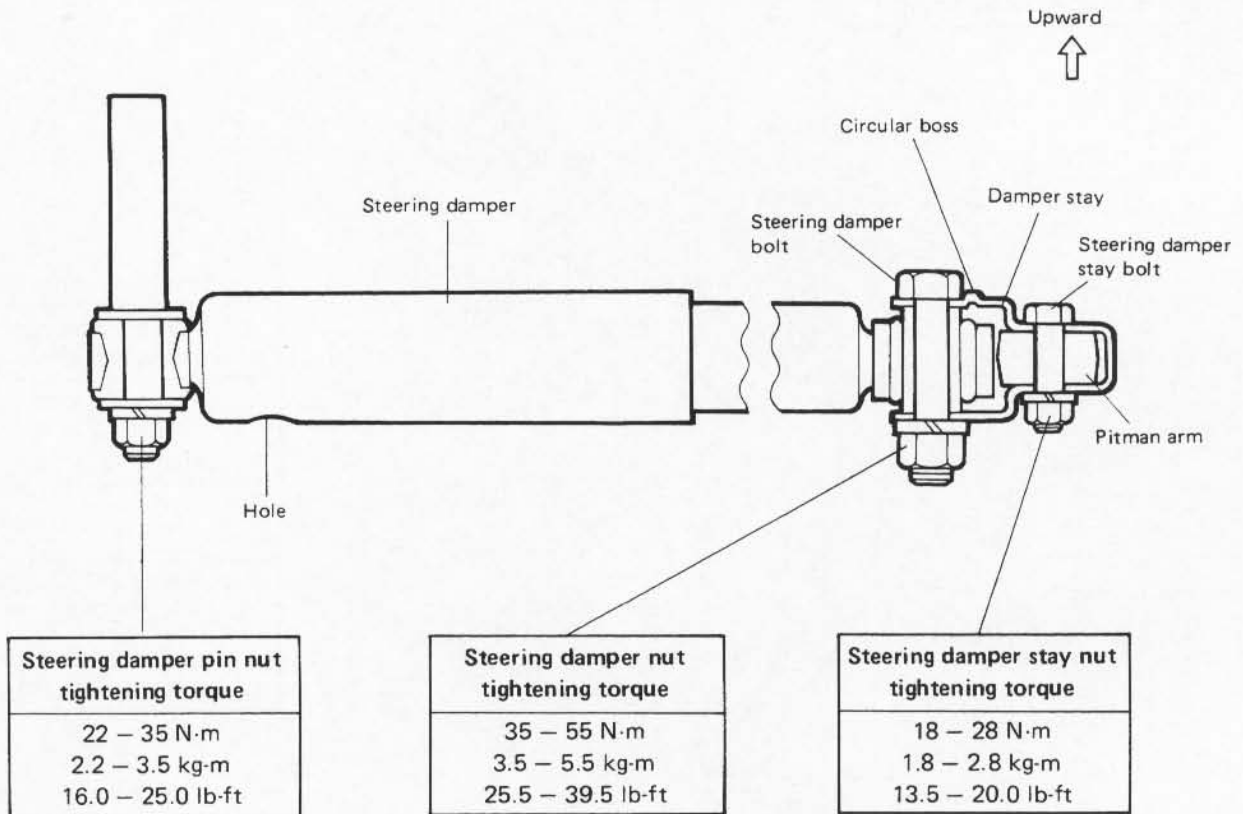


Fig. 18-29-2

## Single Tube Type Steering Column

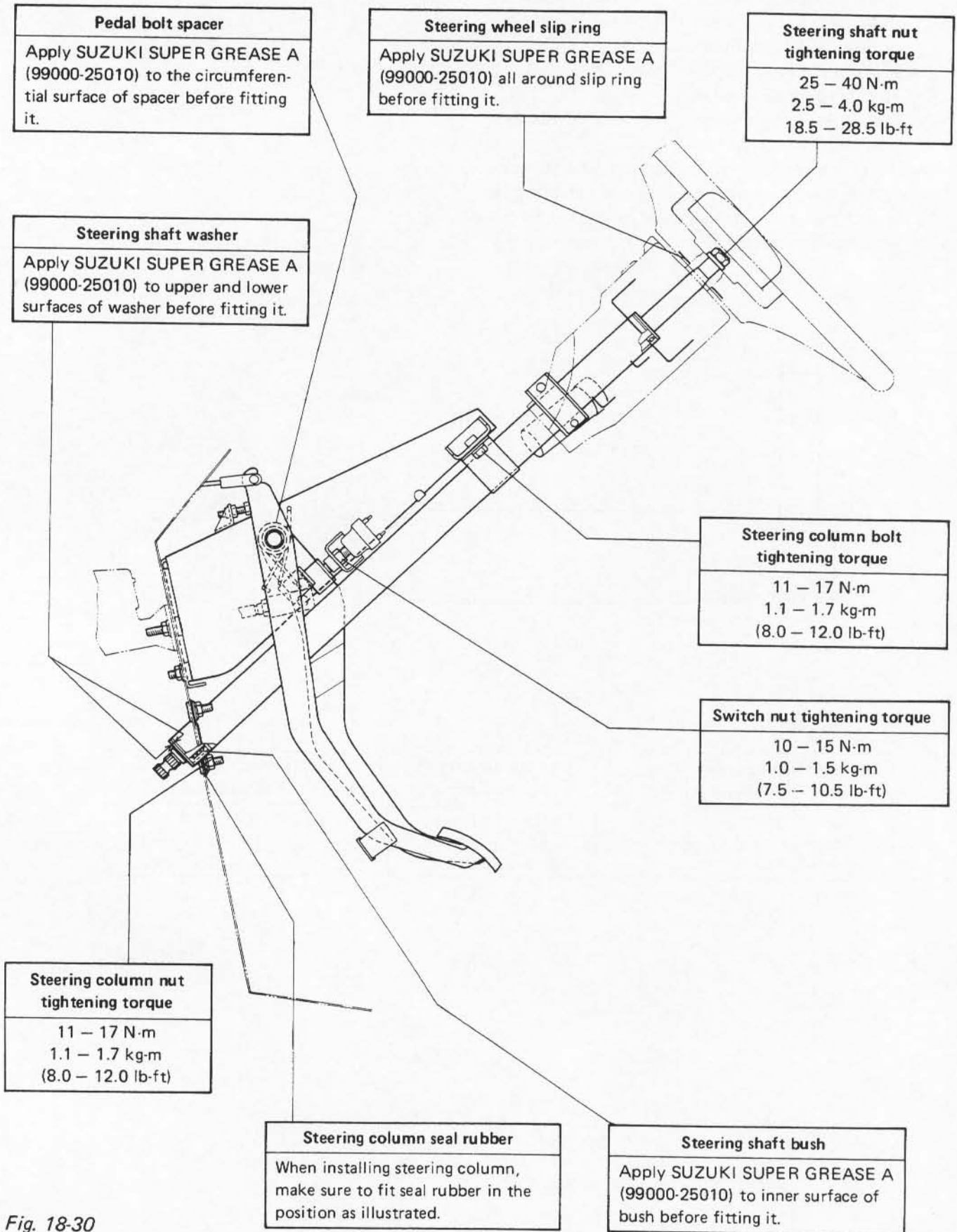


Fig. 18-30



## Double Tube Type Steering Column

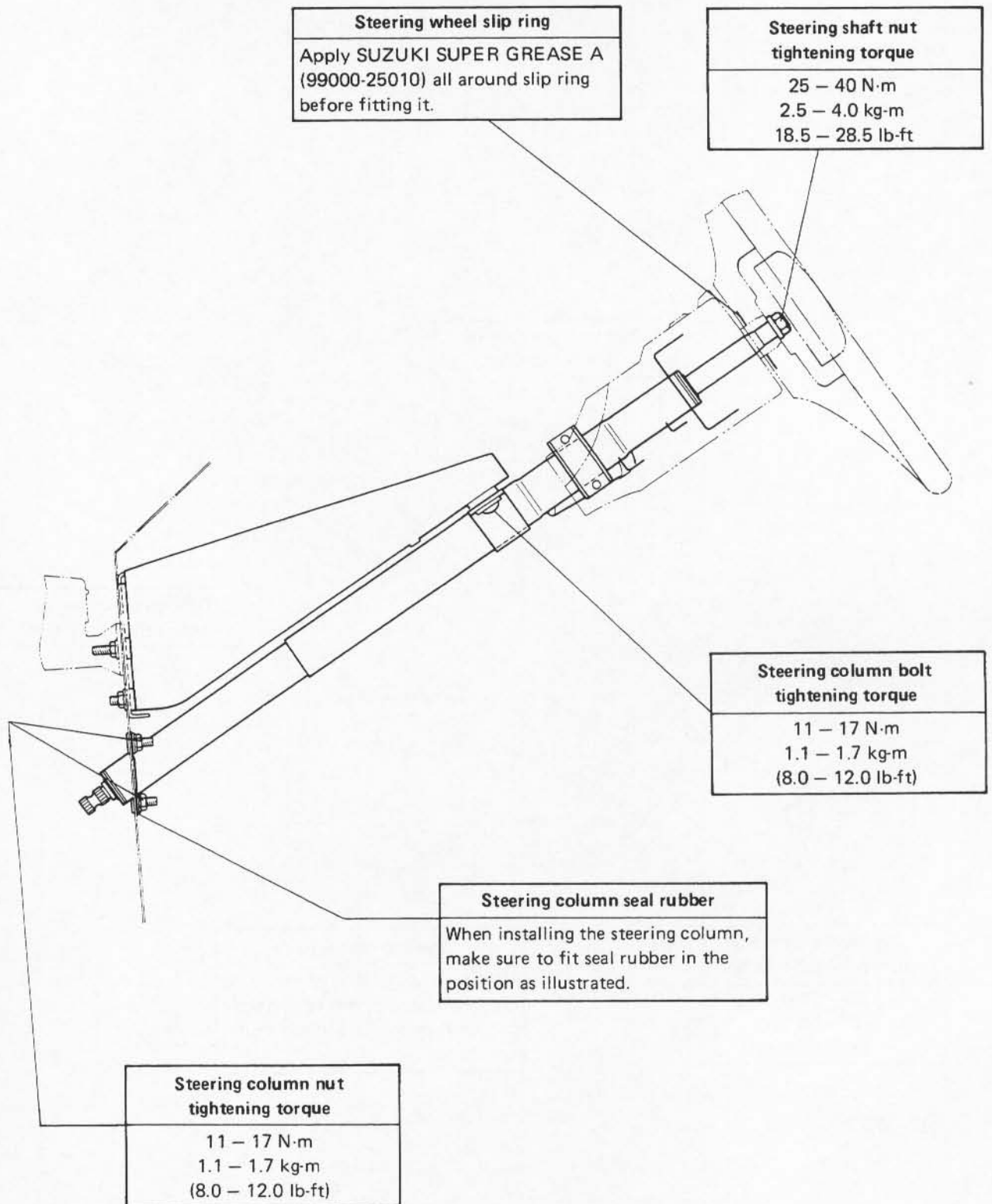


Fig. 18-31

## Steering Lower Shaft and Joint

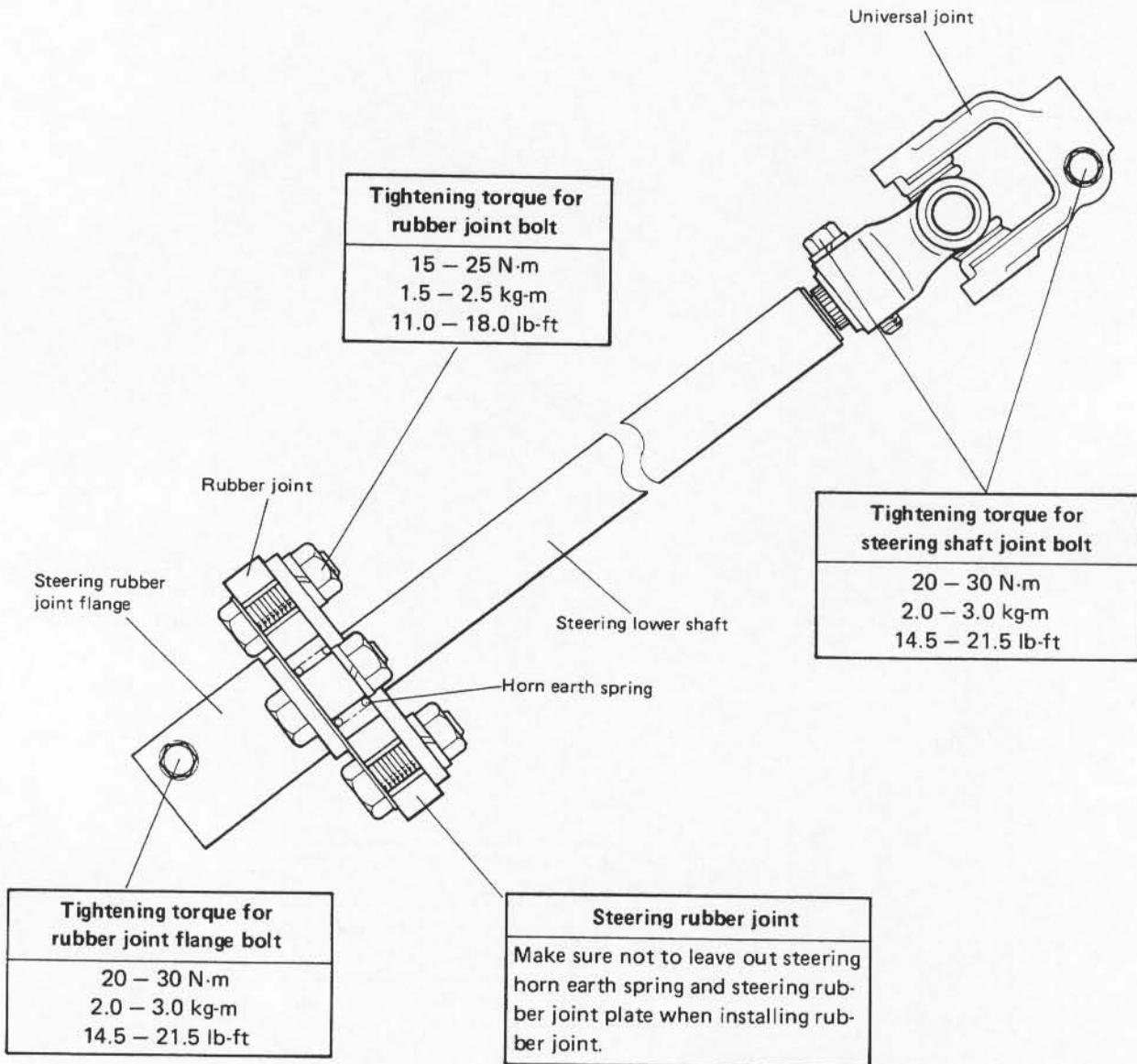


Fig. 18-32

### Steering Handwheel

Two requirements must be met, among others, in installing and setting steering wheel: 1) check to be sure that handwheel play meets specification, and 2) set it in such a way that, with front wheels in straightforward state, its two spokes are horizontal.

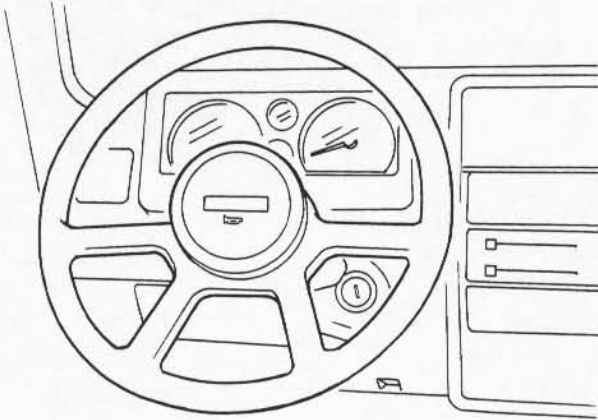
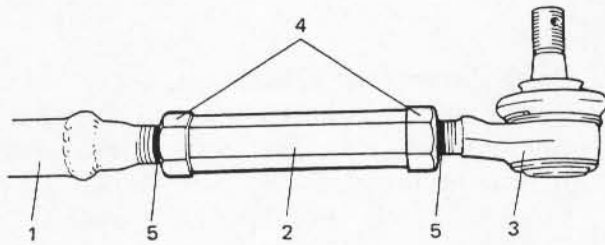


Fig. 18-33

### Tie Rod and Tie Rod End

1) Install tie rod end to tie rod, aligning each lock nut to respective marks scribed before disassembly.



1. Tie rod
2. Turnbuckle
3. Tie rod end
4. Lock nut
5. Marking to be made

Fig. 18-34

- 2) Connect tie rod end to knuckle and tie rod to drag rod. Tighten castle nut until holes for split pin are aligned, but only within specified torque.
- 3) Bend split pin.
- 4) Inspect for proper toe (Refer to 18-8 WHEEL ALIGNMENT).
- 5) After confirming proper toe, tighten tie rod end lock nuts to specified torque.

## 18-8. WHEEL ALIGNMENT

Front alignment refers to the angular relationship between the front wheels, the front suspension attaching parts and the ground. Generally, the only adjustment required for front alignment is toe setting. Camber and caster can't be adjusted. Therefore, should camber or caster be out of specification due to the damage caused by hazardous road conditions or collision, whether the damage is in chassis frame (body) or in suspension should be determined and damaged body should be repaired or damaged suspension should be replaced.

### Toe Setting

Toe is the turning in or out of the front wheels. The purpose of a toe specification is to ensure parallel rolling of the front wheels (Excessive toe-in or toe-out may increase tire wear). Amount of toe can be obtained by subtracting "A" from "B" as shown in figure and therefore is given in mm (in.).

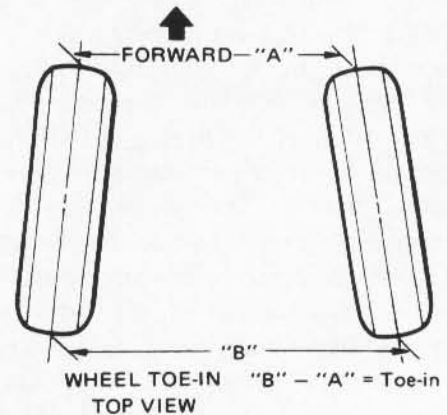


Fig. 18-35

## Camber

Camber is the tilting of the front wheels from the vertical, as viewed from the front of the car. When the wheels tilt outward at the top, the camber is positive. When the wheels tilt inward at the top, the camber is negative. The amount of tilt is measured in degrees.

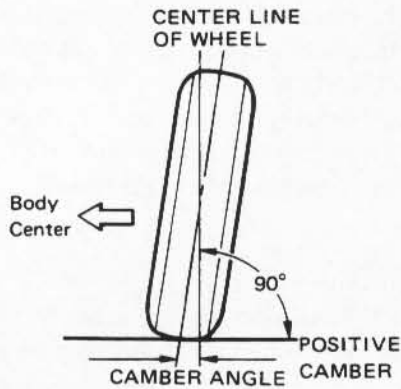


Fig. 18-36

## Toe Adjustment

1. Before making any adjustment affecting toe setting, the following checks and inspections should be made to insure correctness of alignment readings and alignment adjustments:

- 1) Check all tires for proper inflation pressures and approximately the same tread wear.
- 2) Check steering and suspension system for looseness. If excessive looseness is noted, it must be corrected before adjusting.
- 3) Check for run-out of wheels and tires.
- 4) Consideration must be given to excess loads, such as tool boxes. If this excess load is normally carried in the car, it should remain in the car during alignment checks.
- 5) Consider condition of the equipment being used to check alignment and follow manufacturer's instructions.
- 6) Regardless of equipment used to check alignment, the car must be on a level surface both fore and aft and transversely.
- 7) Check to be sure that front wheels are set in straightforward driving position.

2. Toe is adjusted by changing tie rod length. Loosen tie rod end lock nuts first and then rotate turnbuckle ① to align toe-in to specification. At this time, thread length "A" and "B" should be equal. After adjustment, tighten lock nuts to specified torque.

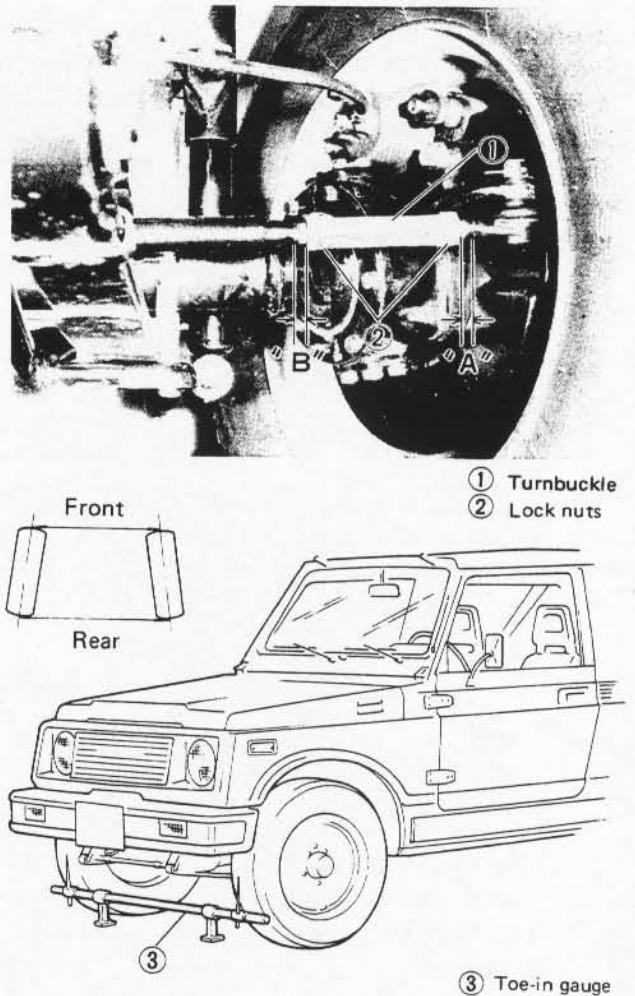


Fig. 18-37

## Camber and Caster Adjustment

Should camber or caster be found out of specifications upon inspection, locate its cause first. If it is in damaged, loose, bent, dented or worn suspension parts, they should be replaced. If it is in chassis frame (car body), repair it so as to attain specifications.

To prevent possible incorrect reading of camber or caster, car front end must be moved up and down a few times before inspection.

## Reference Information:

### SIDE SLIP:

For inspecting front wheel side slip with side slip tester:

Side slip limit: Less than 3 mm/m  
(Less than 0.118 in/3 ft)

If side slip exceeds this limit, toe-in or front wheel alignment may not be correct.

## 18-9. MAINTENANCE SERVICES

### Steering Handwheel Play

The wheel play is proper if it is anywhere between 10 and 30 mm (0.4 and 1.2 in.). An unusually large play means that the ball-and-socket joints are loose or that the wear in the steering gear box is excessively large.

Replacement of the worn joint will provide a proper handwheel play.

If steering handwheel play is excessive though no each joint of steering system rattles, adjust worm shaft starting torque of steering gear box by referring to item of "Adjustment of worm shaft starting torque."

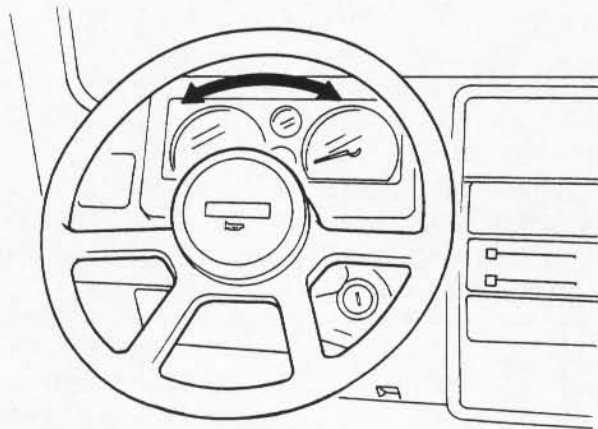


Fig. 18-38

### Steering Shaft Joint

Check universal joint of the steering shaft for rattle and damage. If rattle and damage is found, replace defective part with a new one.

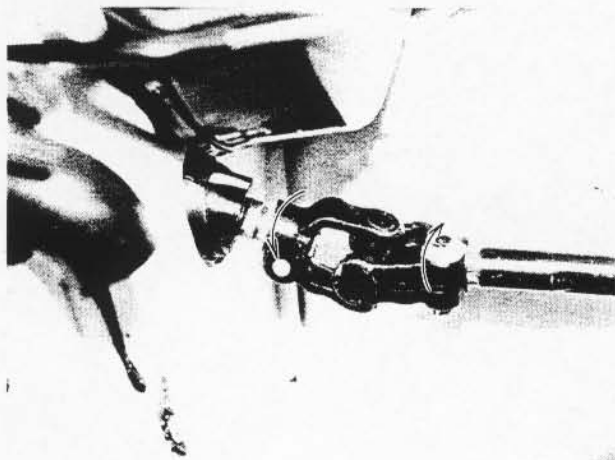


Fig. 18-39

### Steering Rubber joint

Inspect rubber joint for evidence of crack or breakage, and make sure that its bolts are tight.

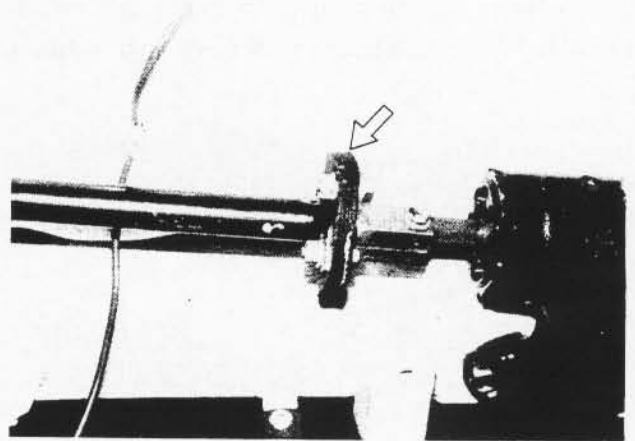


Fig. 18-40

### Steering Link & Tie Rod

Inspect steering link and tie rod for bend and rattle where they are joined. Inspect ball joint boots in steering system for leaks, detachment, tear or other damage. If one of such malconditions is found, replace defective part with a new one.

Check the following bolts and nuts ( ① - ⑦ ) for tightness and retighten them as necessary.

Refer to "RECOMMENDED TORQUE SPECIFICATIONS" in this section for tightening torque.

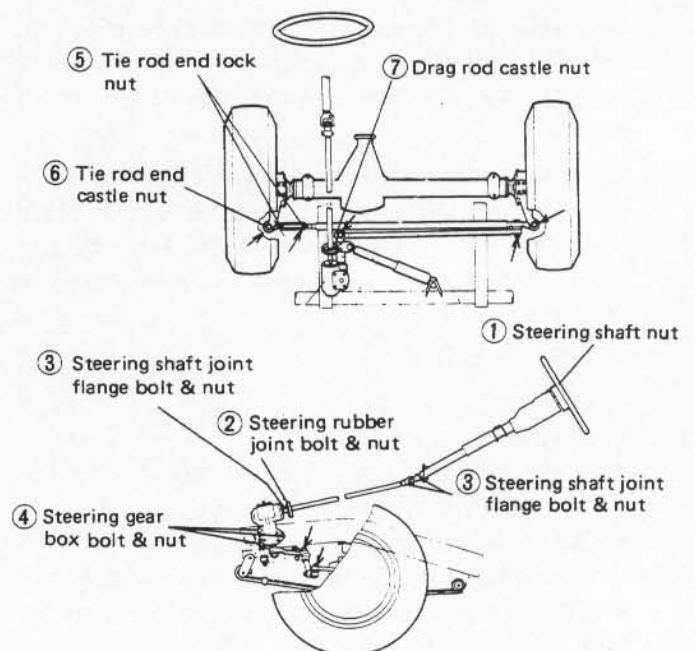


Fig. 18-41



### Steering Gear Box

Check steering gear box for evidence of oil leakage. If leakage is found, repair or replace and then refill specified oil to specified level. Refer to "18-5 INSPECTION OF COMPONENT" in this section for steering gear box oil.

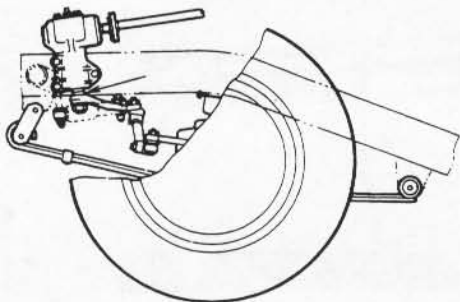


Fig. 18-41-1

### Tires

When replacement is necessary, the original equipment type tire should be used. Refer to Tire Placard.

Replacement tires should be of the same size, load range and construction as those originally on the car. Use of any other size or type tire may affect ride, handling, speedometer/odometer calibration, vehicle ground clearance and tire or snow chain clearance to body and chassis.

#### NOTE:

Do not mix different types of tires on the same car such as radial, bias and bias-belted tires except in emergencies, because car handling may be seriously affected and may result in loss of control.

It is recommended that new tires be installed in pairs on the same axle. If necessary to replace only one tire, it should be paired with the tire having the most tread, to equalize braking traction.

#### [Inspection]

- Check tires for uneven or excessive wear, or damage. If defective, replace.
- Check inflating pressure of each tire and, as necessary, adjust pressure to specification.
- Check wheels for dent, crack or other damage.
- Check wheel nuts for tightness.

Tightening torque for wheel nuts	50 – 80 N·m 5.0 – 8.0 kg·m (36.5 – 57.5 lb·ft)
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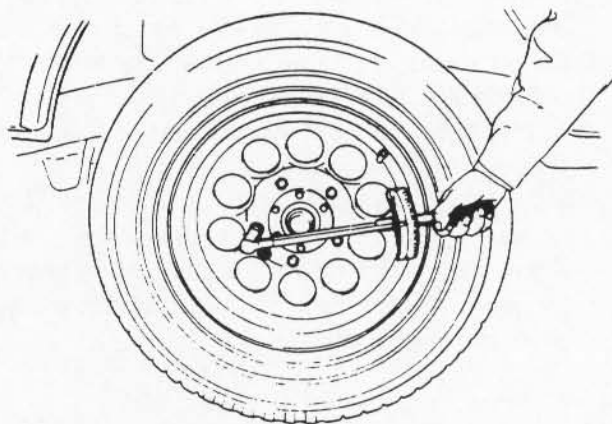


Fig. 18-42

#### [Tire wear indicator]

Check wear indicator shown in figure, and replace tire when its wear is the same level as the indicator.

Tire service limit	Less than 1.6 mm (0.063 in.) depth of tread at two places.
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#### NOTE:

The mud & snow tire has a platform to indicate wear in addition to tire tread wear indicator. It shows up when 50% of tire tread is worn out. When driving on muddy or snowy roads, check if its wear is the same level as the platform and if it does, replace the tire.



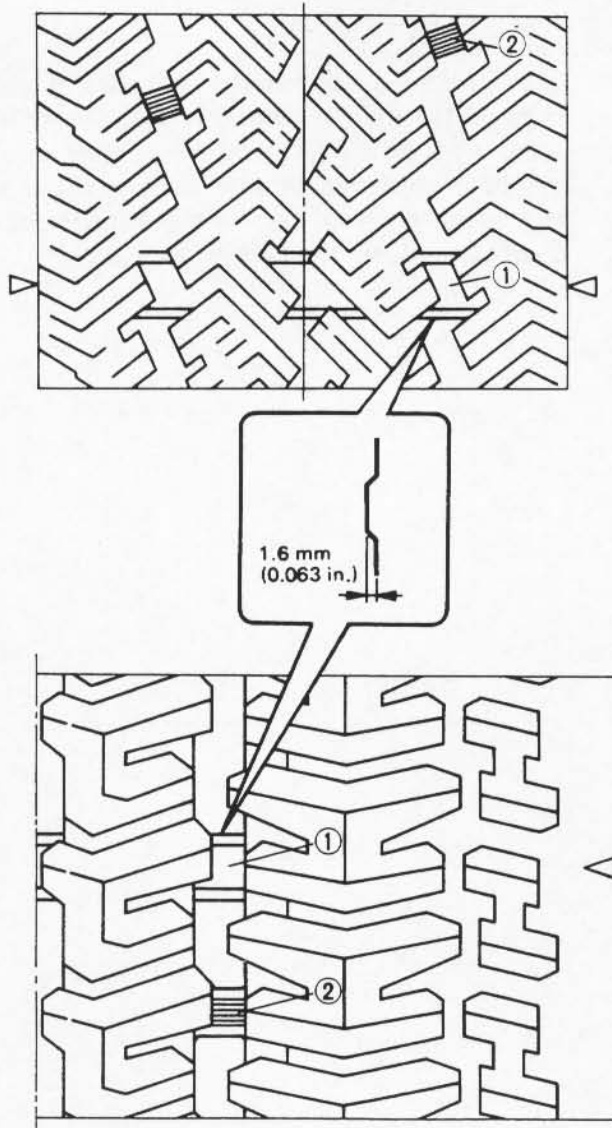


Fig. 18-43 ① Tire tread wear indicator  
② Wear indicating platform

[Inflation of tires]

- Tire inflation pressures are listed on the Tire Placard at driver's side body front panel next to instrument panel.
- Tire inflation pressures should be checked (including spare tire) at least monthly and when significantly changing the load in the car.
- Always check tire inflation pressures when tires are "cold".
- Always use tire pressure gauge when checking inflation pressure.
- Be sure to reinstall tire inflation valve caps to prevent dirt and moisture from getting into valve core, as they may cause air leakage.

- If air loss occurs while driving, do not drive on the deflated tire more than is needed to stop safely. Driving even a short distance on a deflated tire can damage a tire and wheel beyond repair.

[Tire rotation]

"Rotate" tires at the regular intervals in order to equalize tire wear and thereby make full use of each tire. Refer to below figure for the scheme of rotation. Adherence to this scheme prolongs tire life.

**NOTE:**

Before installing wheels, remove any build-up of corrosion on the wheel mounting surface and brake drum or disc mounting surface by scraping and wire brushing. Installing wheels without good metal-to-metal contact at the mounting surfaces can cause wheel nuts to loosen, which can later allow a wheel to come off while the car is moving.

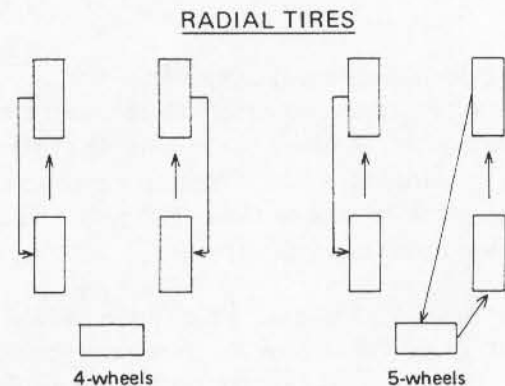
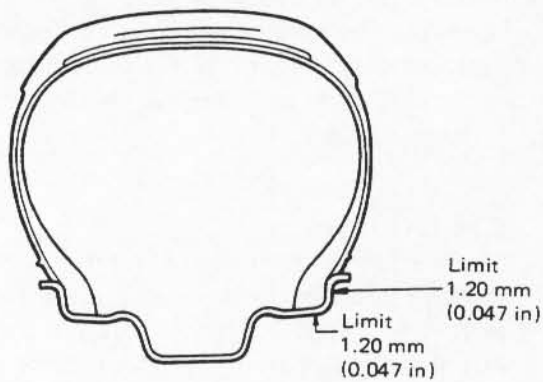


Fig. 18-44

[Wheels]

Wheels must be replaced if they are bent, dented, have excessive lateral or radial runout, leak air through welds, have elongated bolt holes, if lug nuts won't stay tight, or if they are heavily rusted. Wheels with greater runout than shown in below figure may cause objectional vibrations. Replacement wheels must be equivalent to the original equipment wheels in load capacity, diameter, rim width, offset and mounting configuration. A wheel of improper size or type may affect wheel and bearing life, brake cooling, speedometer/odometer calibration, car ground clearance and tire clearance to the body and chassis.



\*TOTAL INDICATOR READING  
 IGNORE INDICATOR "JUMPS"  
 DUE TO WELD SEAMS, PAINT  
 RUNS, SCRATCHES, ETC.

Fig. 18-45

Wheel repairs that use welding, heating, or peening are not approved. All damaged wheels should be replaced.

[Tire demounting and mounting]

Use a tire changing machine to mount or demount tires. Follow the equipment manufacturer's instructions. Do not use hand tools or tire irons alone to change tires as they may damage the tire beads or wheel rim.

Rim bead seats should be cleaned with a wire brush or coarse steel wool to remove lubricants, old rubber and light rust. Before mounting or demounting a tire, the bead area should be well lubricated with an approved tire lubricant.

After mounting, inflate to 220 kPa (32 psi) so that beads are completely seated.

**WARNING:**

**Do not stand over tire when inflating. Bead may break when bead snaps over rim's safety hump and cause serious personal injury.**

**Do not exceed 220 kPa (32 psi) pressure when inflating. If 220 kPa (32 psi) pressure will not seat beads, deflate, re-lubricate and reinflate.**

**Over inflation may cause the bead to break and cause serious personal injury.**

Inflate to specified pressure.

[Tire repair]

There are many different materials and techniques on the market to repair tires. As not all of these work on all types of tires, tire manufacturers have published detailed instructions on how and when to repair tires. These instructions can be obtained from the tire manufacturer.

## 18-10. RECOMMENDED TORQUE SPECIFICATIONS

Fastening parts	Tightening torque		
	N-m	kg-m	lb-ft
Steering shaft nut	25 – 40	2.5 – 4.0	18.5 – 28.5
Steering shaft rubber joint bolt	15 – 25	1.5 – 2.5	11.0 – 18.0
Steering shaft joint flange bolt	20 – 30	2.0 – 3.0	14.5 – 21.5
Steering gear box nut	70 – 90	7.0 – 9.0	51.0 – 65.0
Drag rod castle nut	30 – 70	3.0 – 7.0	22.0 – 50.5
Tie rod end castle nut	30 – 55	3.0 – 5.5	22.0 – 39.5
Tie rod end lock nut	70 – 100	7.0 – 10.0	51.0 – 72.0
Steering damper stay nut	18 – 28	1.8 – 2.8	13.5 – 20.0
Steering damper nut	35 – 55	3.5 – 5.5	25.5 – 39.5
Steering damper pin nut	22 – 35	2.2 – 3.5	16.0 – 25.0
Steering column bolt & nut	11 – 17	1.1 – 1.7	8.0 – 12.0