GROUP 3

SUSPENSION AND STEERING

FRONT SUSPENSION

CONTENTS

DESCRIPTION AND OPERATION

SUSPENSION DESCRIPTION

GT

The GT uses a maintenance-free independent front wheel suspension and features unequal length control arms and a transverse three-leaf spring. The entire front suspension is attached to the front cross member and can be removed as a unit if so desired.

The engines installed in the GT are not supported by mounting brackets but rest on a separate cross member. The front suspension cross member is reinforced in the area of the attachment to the frame. A one-part damper plate is installed between cross member and frame.

Ball joints are employed in the conventional manner to provide pivoting joints between the control arms and steering knuckles. Upward movement of the control arms is limited by two large rubber bumpers attached to the cross member.

Road shock is dampened by the double direct acting shock absorbers and a transverse double or triple steel band spring. In addition, the shock absorber limits downward travel of the control arms.

All moving parts, including ball joints, have no need for lubrication as they have been pre-lubricated for the life of the vehicle.

For distinguishing the individual front suspension cross members, a red label with black letters is stuck onto the front side of the shock absorber support. See Figure 3A-3.

Opel 1900. Manta

The front wheel suspension has coil springs and control arms of different length.

The stabilizer is designed to act as a tie strut. The end is supported in a rubber bushing which is located in a piece of tubing welded into the longer control arm.

To minimize brake torque, the horizontal shafts of

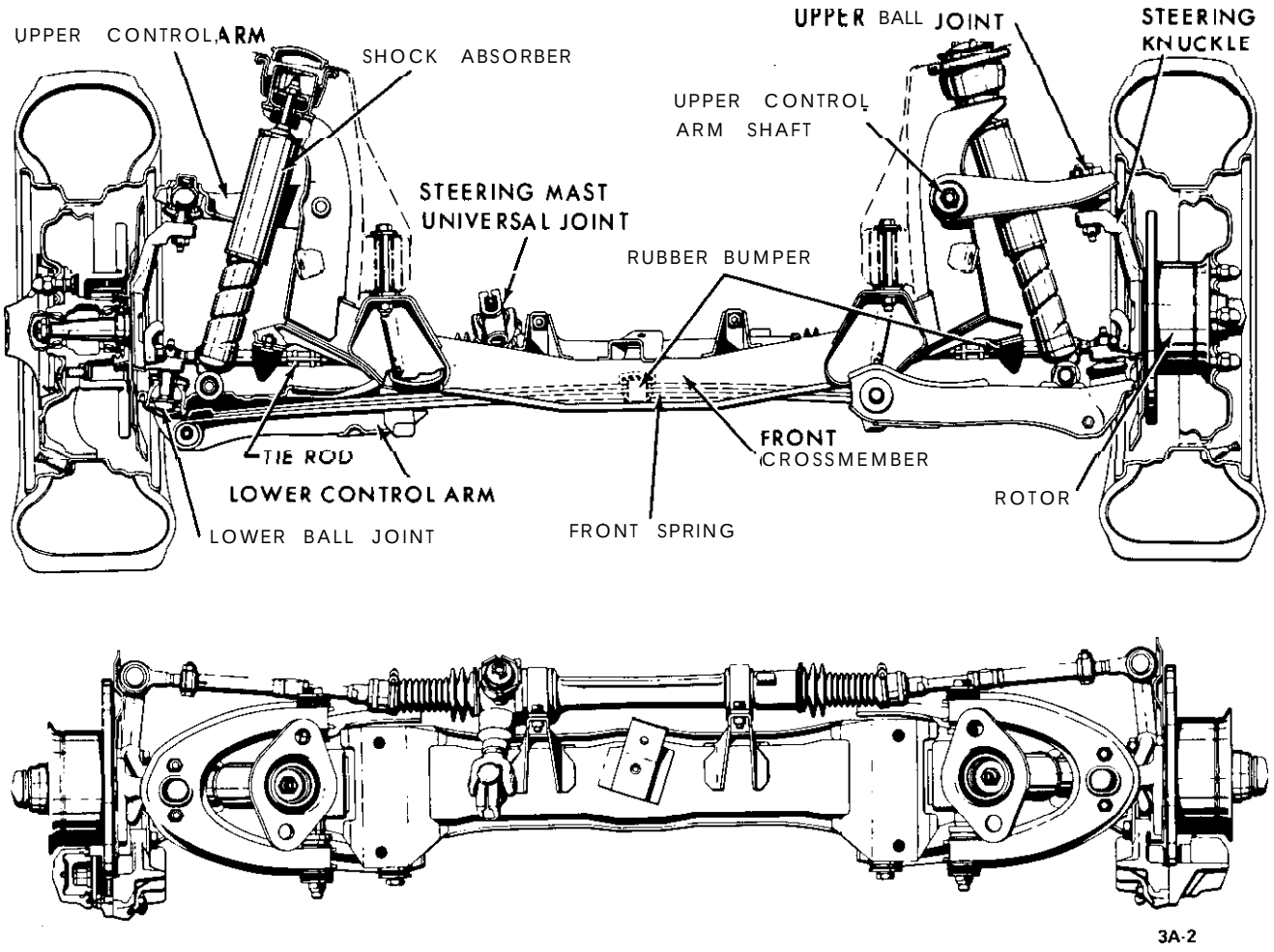

Figure 3A-2 GT Front Suspension (Disc Brakes)

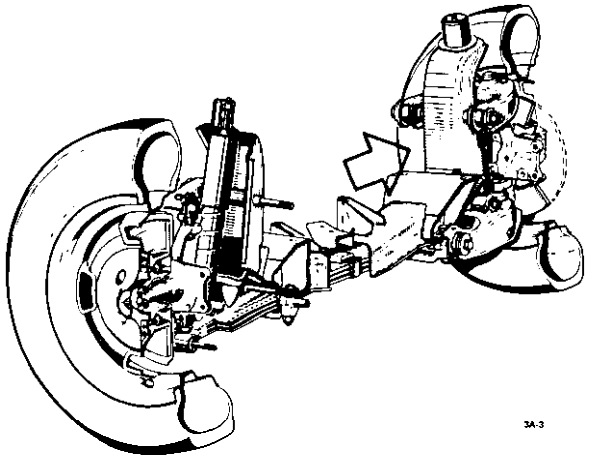

Figure 3A-3 Cross Member Marking

the upper and lower control arm are not in parallel (anti- dive).

The lower control arm is connected to the steering knuckle with a ball joint.

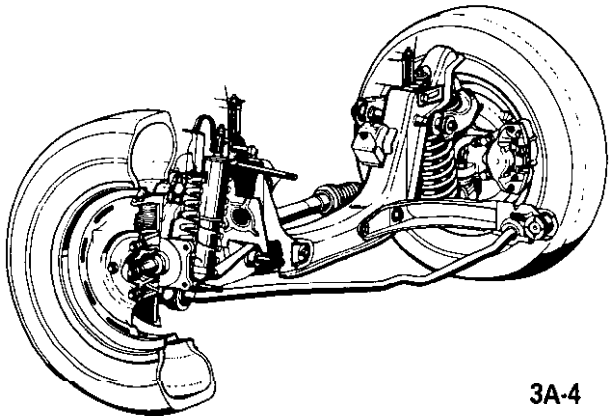

Figure 3A-4 Front Suspension . Opel 1900 Manta

The two cross-members to body supports are attached to the horizontal part of the cross-member with two bolts. The *outer bolt* serves simultaneously as support for the lower control arm. As the bolt is inserted from the front, the cross-member to body support can be removed without the lower control arm. The ***inner bolt*** attaches simultaneously to the steering.

The stabilizer is U-shaped and supported in rubber bushings in the two cross-members to body supports.

The complete front suspension is attached to the underbody in four places.

The engine damper blocks are bolted to the inside of the inclined parts of the cross-member.

The front wheel bearings are roller bearings.

All front suspension joints are maintenance-free.

MAINTENANCE AND ADJUSTMENTS

FRONT WHEEL BEARING ADJUSTMENT

1. If wheel has not previously been removed from the car, remove grease cap, cotter pin, and spindle nut. Discard cotter pin.

2. Torque spindle nut to 18 lb.ft. while rotating wheel. This will allow the bearings to settle.

3. Back off spindle nut 1/4 turn. If slot and cotter pin hole are staggered, further back off nut 1/12 turn, ***but do not tighten,*** until next slot in nut is in alignment with hole in spindle. Install ***new*** cotter pin. A properly adjusted wheel bearing has a small amount of end play and a loose nut when adjusted in the above manner.

MAJOR REPAIR

REMOVAL AND INSTALLATION OF FRONT SUSPENSION

(COMPLETE ASSEMBLY)

Removal GT

1. Prior to raising front end of car, apply parking brake and block rear wheels.

2. Raise front end of car with a jack. It is recommended that a wood block be placed between the jack and the front cross member to prevent damage to the cross member.

3. Support front end of car by placing floor stands under jacking brackets.

4. Support engine-transmission assembly in uppermost position with jack stand at rear of engine, or an alternate method would be to use Engine Holding Fixture, Tool J-23375. See Figure 3A-5.

Install tool by removing upper engine mount nut and installing fixture. Replace nut and tighten. The engine will now be supported by the tool between the frame rails.

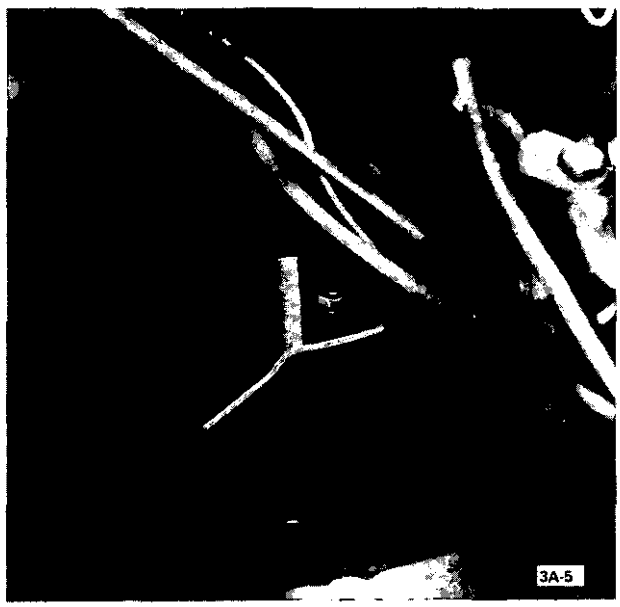

Figure 3A-5 Engine Holding Fixture Installed

5. Loosen steering mast at the lower universal joint and take out clamp bolt. Loosen clamp at the upper universal joint and lift steering mast upwards until it is free at the lower universal joint. See Figure 3A-6.

6. Disconnect brake lines at brake hose.

7. Disconnect shock absorber at upper mounting. It is necessary to remove air cleaner. See Figure 3A-24.

8. Disconnect engine mounts at cross member.

9. Remove front suspension cross member attaching nuts and lower the cross member.

Removal Opel 1900 - Manta

1. Prior to raising front end of car, apply parking brake and block rear wheels.

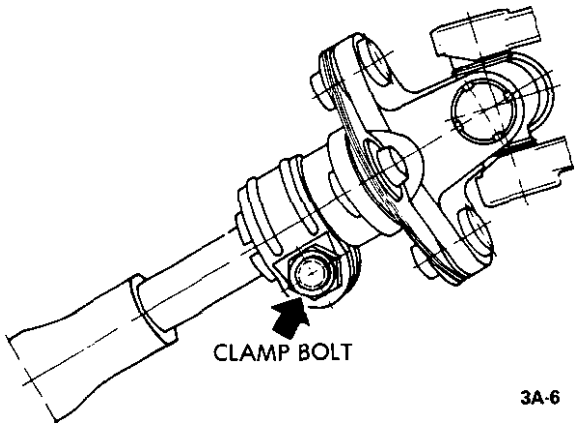

Figure 3A-6 GT Steering Mast Joint

2. Install Hooks J-23697 before jacking up car to assure proper loading of suspension bushings and mounts. See Figure 3A-7.

3. Raise front of vehicle and support with stands.

4. Remove front wheels.

5. Remove guard plate. See Figure 3A-8.

6. Remove brake line retainers on both sides. The brake system remains closed. Unscrew brake calipers and suspend them in wheel house.

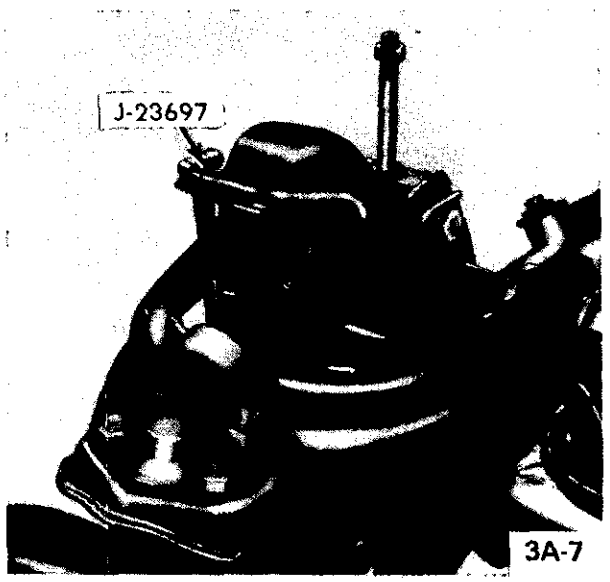

Figure 3A-7 Installing Hooks J-23697

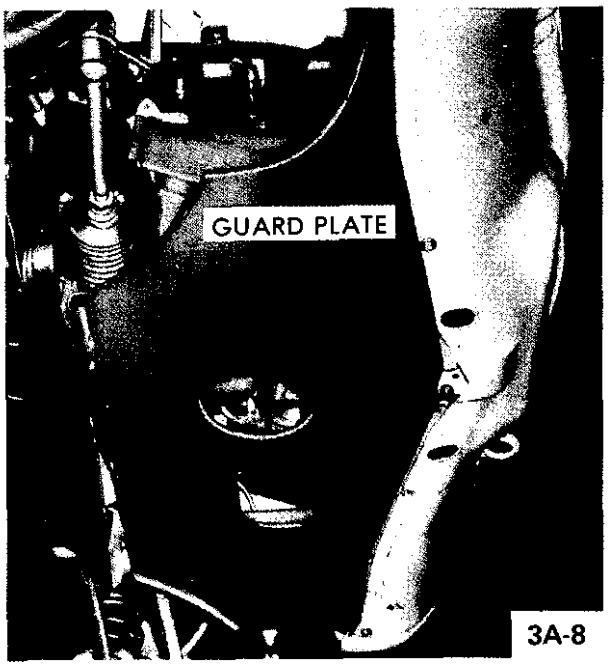

Figure 3A-8 Removing Guard Plate

7. Suspend engine with a suitable engine lifter, similar to the one shown in Figure 3A-9.

8. Unscrew lower steering mast clamp bolt out of pinion flange. See Figure 3A- 10.

9. Unscrew front left and right engine mount from damper block.

10. On top and in the rear, unscrew front suspension

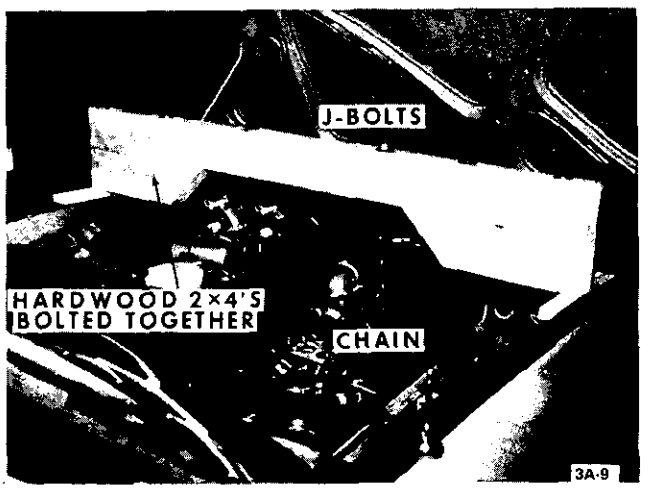

Figure 3A-9 Suitable Engine Lifter

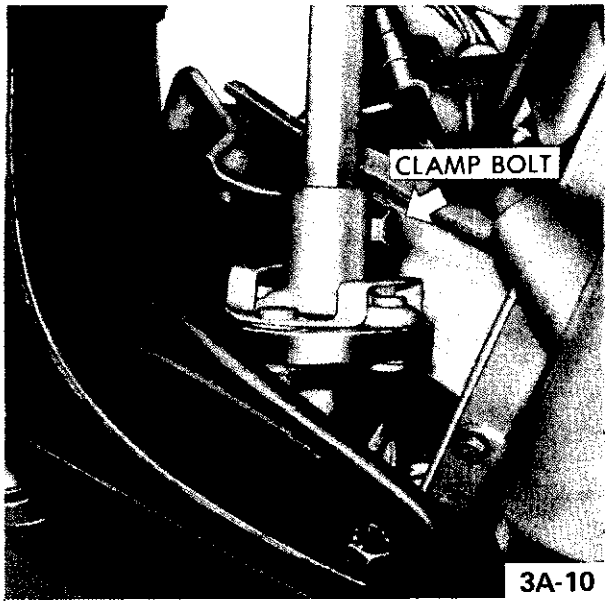

Figure 3A-10 Steering Mast Clamp Bolt

assembly at the cross member to body support from frame and let it down onto jack. See Figure 3A-11.

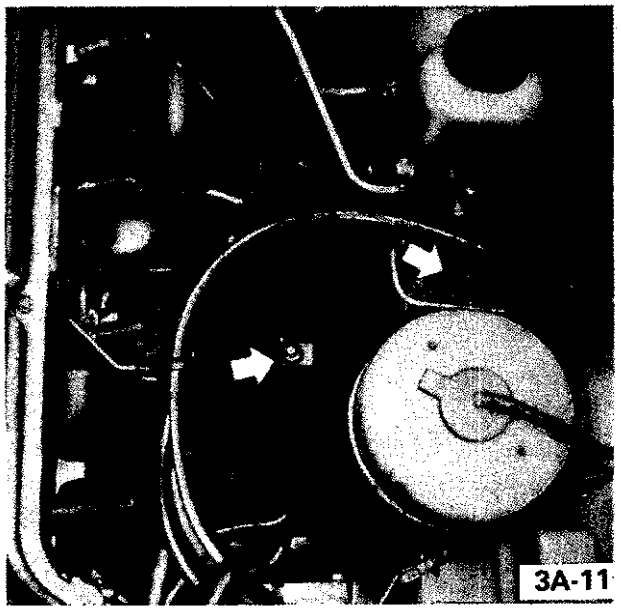

Figure 3A-11

Installation GT

CAUTION: ***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 or lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.***

1. Support front suspension and cross member on jack and raise into position.

2. Attach cross member to front frame rail. Torque to 36 lb.ft.

3. Install engine mounting nuts. Remove engine support.

4. Install shock absorber mounting bolts and install air cleaner.

5. Connect brakes hoses and bleed brakes as outlined in Group 5.

6. Install radiator mounting bolt in support cross member.

7. Push steering column downwards until a 1/8" clearance is obtained between steering wheel hub and switch cover.

8. With steering wheel in centered position and front wheels straight ahead, tighten the clamp bolt at the lower universal joint to 22 *lbs.ft.* and the clamp at the upper universal joint to *14 lbs.ft. See* Figure 3A-6.

9. Install mast guide sleeve stop bolt. Always install new lock plate. See Figure 3A-7.

10. Remove front support stands and lower vehicle.

Installation Opel 1900 - Manta

1. With jack, lift up front suspension assembly so that the individual attaching points coincide. At the same time, insert lower steering mast into pinion flange. See Figure 3A-12.

2. In the rear bolt cross member to body support. Torque to 58 ft.lbs. When doing this with a suitable tool, counterhold damper bushing which is installed in a certain position, to prevent it from turning. For this purpose, detach heat deflector plate on right vehicle side.

3. Torque front suspension assembly to frame attachment to 47 ft.lbs.

4. Torque lower steering mast to pinion flange attachment clamp bolt to 22 ft.lbs.

5. Reinstall both brake calipers. Torque to 72 ft.lbs. Install brake line retainer.

6. On both sides install upper control arm ball joint. Torque bolts to 29 ft.lbs.

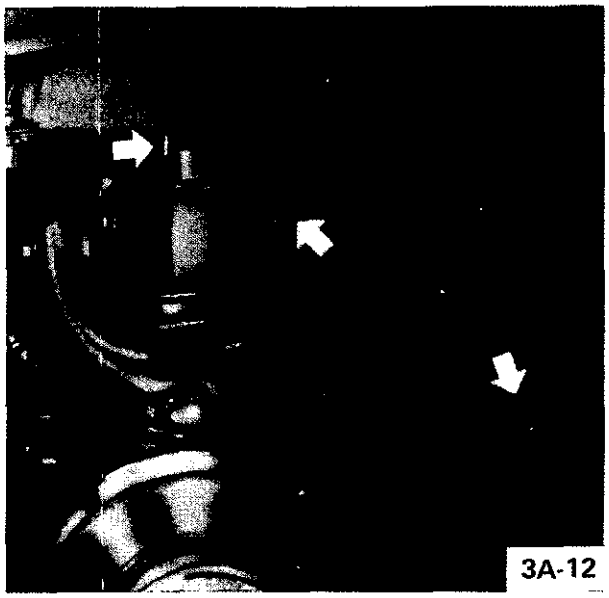

Figure 3A-12 Front Suspension Attaching Points

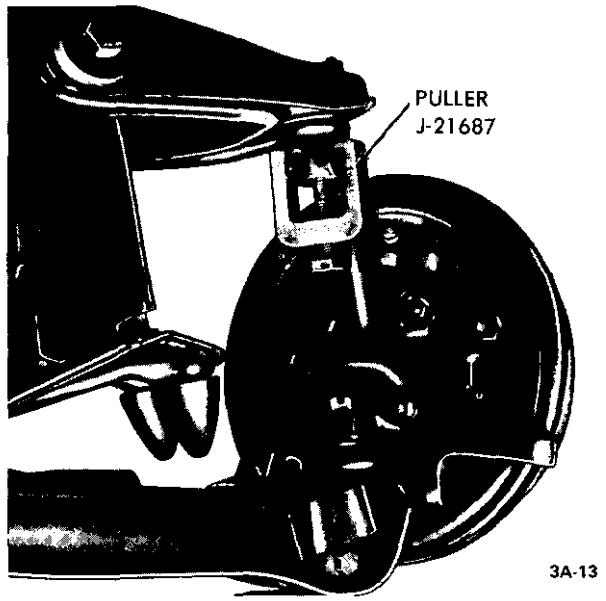

Figure 3A-13 Upper Ball Joint

Always use new self-locking nuts.

7. Reinstall guard plate.

8. Crosswise torque wheel nuts to 65 ft.lbs.

UPPER BALL JOINT REMOVAL AND INSTALLATION

Removal

I. Place jack under spring eye and raise car. Remove wheel from car.

2. Remove cotter pin and castle nut from upper ball joint stud. Discard cotter pin.

3. Press ball stud from steering knuckle using puller J-21687, and remove two (2) bolts attaching ball joint to upper control arm. See Figure 3A-13.

4. If dust cap on upper ball joint is torn or missing, the ball joint should be replaced.

Installation

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1. Install upper control arm ball joint with the off center holes in flange showing towards the steering knuckle spindle.

2. Install two (2) bolts attaching ball joint to upper control arm. Torque nuts to 29 lb.ft.

3. Install upper ball joint stud in steering knuckle and torque castle nut to 29 lb.ft. on GT and 40 lb.ft. on Opel 1900 - Manta.

4. Install new cotter pin, and replace wheel.

5. Always check caster and camber after installing new ball joints.

LOWER BALL JOINT REMOVAL AND INSTALLATION

New lower ball joints have an axial play of up to .020 inch. The maximum permissible axial play of older ball joints is .080 inch. At an axial play of more than .080 inch, the lower ball joint must be replaced. If the dust cap is torn, loose, or missing, the lower ball joint must also be replaced. See Figure 3A-14.

The lower ball joints are checked for wear by using Checking Gauge J-23402 for the GT, and using Checking Gauge J-23745 for the Opel 1900 - Manta. See Figure 3A-15.

Removal GT

1. Raise car and support at rear of front frame rails.

2. Remove front wheel.

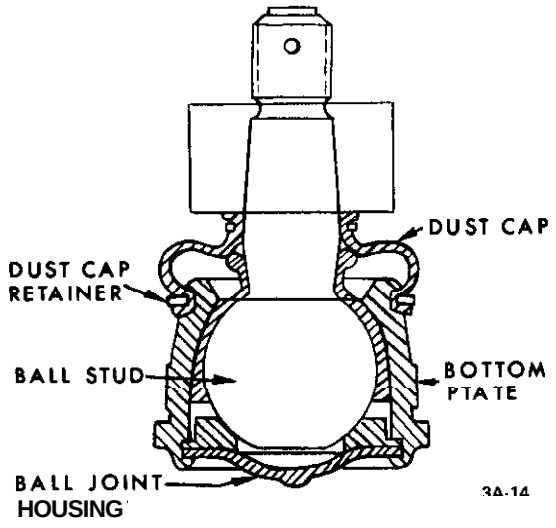

Figure 3A-14 Lower Ball Joint

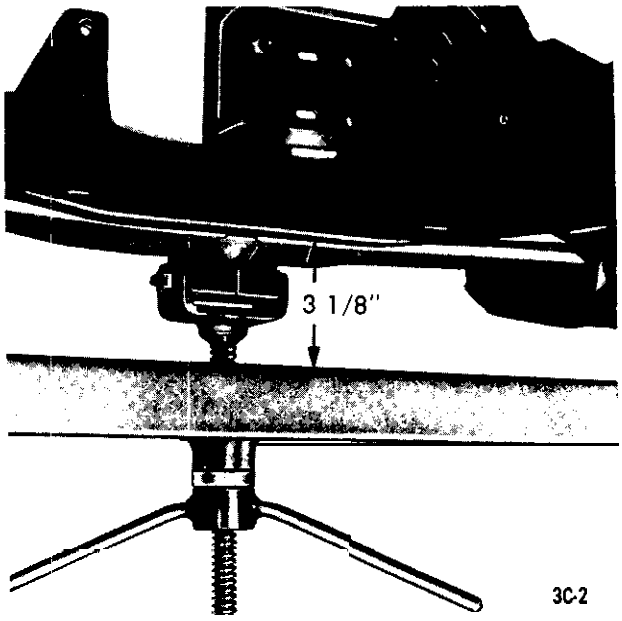

Figure 3A-16 Spring Compressor

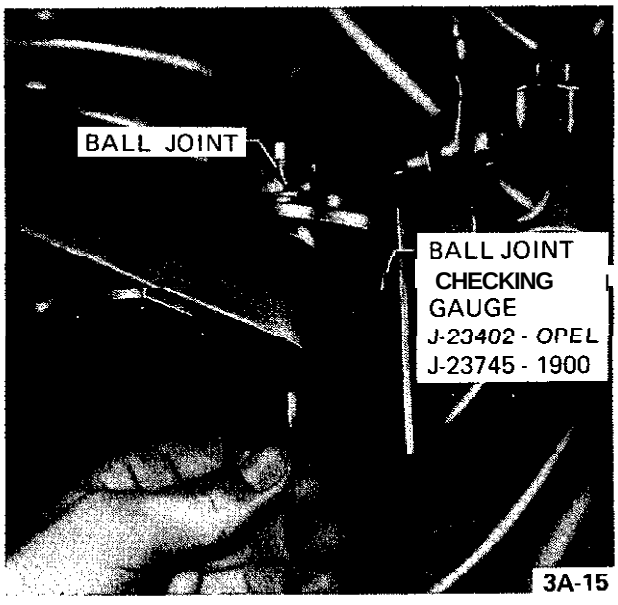

Figure 3A-15 Ball Joint Checking Gauge Installed

3. Remove cotter pin from castle nut on ball joint stud and back off castle nut two (2) turns. Hit ball stud a sharp blow to break it loose. DO NOT REMOVE NUT.

4. Install spring compressor (J-21689) and compress spring until a distance of 3-1/8" is achieved between spring compressor and lower spring leaf. See Figure 3A-16.

5. Disconnect shock absorber to lower control arm attachment bolt and swing shock absorber out of the way.

6. Remove castle nut from ball joint stud. Prior to the removal of the lower ball joint from the control arm, note the position of the locating notch, shown in Figure 3A-17, in the rim of the ball joint housing. Scribe or mark the control arm to facilitate alignment of the replacement ball joint during installation.

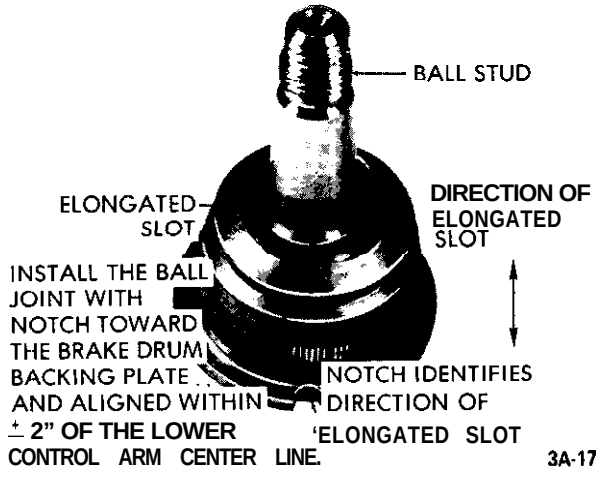

Figure 3A-17 Lower Ball Joint Notch - GT

7. Pry off dust cap retainer and remove dust cap being careful not to damage it.

8. Press ball stud out of lower control arm.

Removal Opel 1900 - Manta

Before raising vehicle, install Hooks J-23697 on respective vehicle side to cross member and upper control arm. See Figure 3A-7.

1. Raise car and support at rear of front frame rails.

2. Remove front wheel.

3. At the lower control arm ball joint, remove castle nut cotter pin and slacken back nut so that the thread can no longer be damaged.

4. With a suitable drift, detach ball joint from steering knuckle. With jack, lift up lower control arm, unscrew castle nut and remove Hooks J-23697.

5. Unscrew upper control arm ball joint and suspend front wheel hub and brake caliper in wheel house. Do not turn upper control arm ball joint flange, as this would result in a change of camber.

6. Remove defective lower control arm ball joint using Tools J-9519 and Receiver J-23754.

Installation GT

CAUTION: ***Fasteners are important attachingparts 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 numer 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.***

1. When pressing the ball joint in place, make certain the locating notch in the lower rim of the ball joint matches the alignment reference mark placed on the lower control arm prior to removal. The notch in the ball joint bottom plate, identifying the direction of the elongated slot, must point towards the brake drum backing plate. See Figure 3A-17. Alignment must be within 2 degrees of lower control arm centerline. If proper positioning of the ball joint is not accomplished, the result is a limitation of the necessary ball stud movement. If ball stud movement is limited, an interference between the ball stud and housing is created, and binding or even fracture may occur. Replacement ball joints may or may not have marking notch as shown in Figure 3A-20. If it does not have a marking notch, the joint is completely symetrical and may be installed in any position. When pressing in ball joint do not press on bottom plate, but on ball joint housing only.

2. Install dust cap on lower ball joint and fill with chassis lubricant. Attach dust cap retainer.

3. Press ball joint into steering knuckle. Use J-9519-3 as installer **and** J-21690 as a supporting sleeve.

4. Install castle nut on ball joint stud and torque to 40 lb.ft. Install new cotter pin.

5. Reconnect shock absorber to lower control arm and torque to 30 lb.ft.

6. Remove spring compressor.

7. Install front wheel, and lower the car.

8. Always check caster and camber after ball joint replacement.

Installation Opel 1900 - Manta

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1. Drive new ball joint into lower control arm using Tools J-9519 as installer and J-23755 as a supporting sleeve. Do not strike onto ball joint **bottom.**

The ball joint is maintenance-free. It is supplied as an assembly only and cannot be disassembled further.

2. On new lower control arm ball joint, make sure that the marking groove in the housing bottom in alignment with the axis of the lower control arm. Permissible deviation: minus 2 degrees to plus 2 degrees.

This is required, to obtain the maximum freedom of movement of the ball stud in the housing. See Figure 3A-18.

3. Attach steering knuckle together with front wheel hub and brake caliper to lower control arm ball joint. Torque castle nut to 54 ft.lbs.

4. Attach ball joint to upper control arm and torque to 29 ft.lbs. Always use new self-locking nuts.

5. Install wheel and tighten nuts to a torque of 65 ft.lbs.

6. Lower car and check caster and camber.

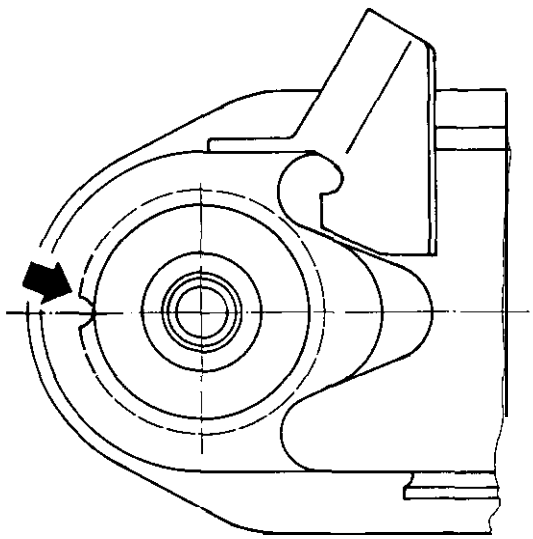

Figure 3A-18 Lower Ball Joint Notch Opel 1900 · Manta

UPPER CONTROL ARM REMOVAL AND INSTALLATION

Removal GT

1. Raise car and support at rear of front frame rails.

2. Remove front wheel.

3. Install spring compressor and compress spring until there is 3-1/8" between compressor and lower spring leaf.

4. Remove cotter pin and castle nut from upper ball joint stud. Discard cotter pin.

5. Use tie rod remover J-21687 remove ball joint from steering knuckle. 6. Support brake drum to relieve tension on brake hose.

7. Remove hex nut from upper control arm shaft. Remove shaft and washers from shock absorber sup port. Do not damage threads on control arm shaft.

8. Remove control arm from car. Do not lose inner toothed washers. Note size and location of toothed washers.

Removal Opel 1900 . Manta

1. Raise car and support at rear of front frame rails.

2. Remove front wheel

3. Unscrew upper control arm to cross member self-locking attaching nut.

4. Unscrew ball joint from upper control arm. Do not turn upper control arm ball joint flange, as this would result in a change of camber.

5. Support front wheel hub so that brake hose is not stressed.

6. Pull out upper control shaft to cross member attaching bolt and remove control arm. Shims have to be reinstalled in their original location to maintain the proper caster setting.

Installation GT

CAUTION: ***Fasteners are important attaching parts in that they could affect the 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.***

If rubber bushings on control arms are worn, arms must be replaced.

1. Slide rubber rings over bushings. Slide rings over inner sleeves of bushings. Place control arm in position on shock absorber support, installing toothed washers in their ***original*** positions. See Figure 3A-19.

2. From front to rear, install control arm shaft. If necessary, align washers and control arm bushings with a small drift prior to installing control arm shaft. See Figure 3A-19.

3. Tighten hex nut on control arm shaft finger tight.

4. Increase tension on spring compressor in order to relieve tension on control arm shaft. Then torque hex nut on control arm shaft to 33 lb.ft.

5. Press ball joint stud into steering knuckle and torque castle nut to 29 lb.ft. Install new cotter pin.

6. Remove spring compressor and lower car.

7. Check front end alignment.

Installation Opel 1900 · Manta

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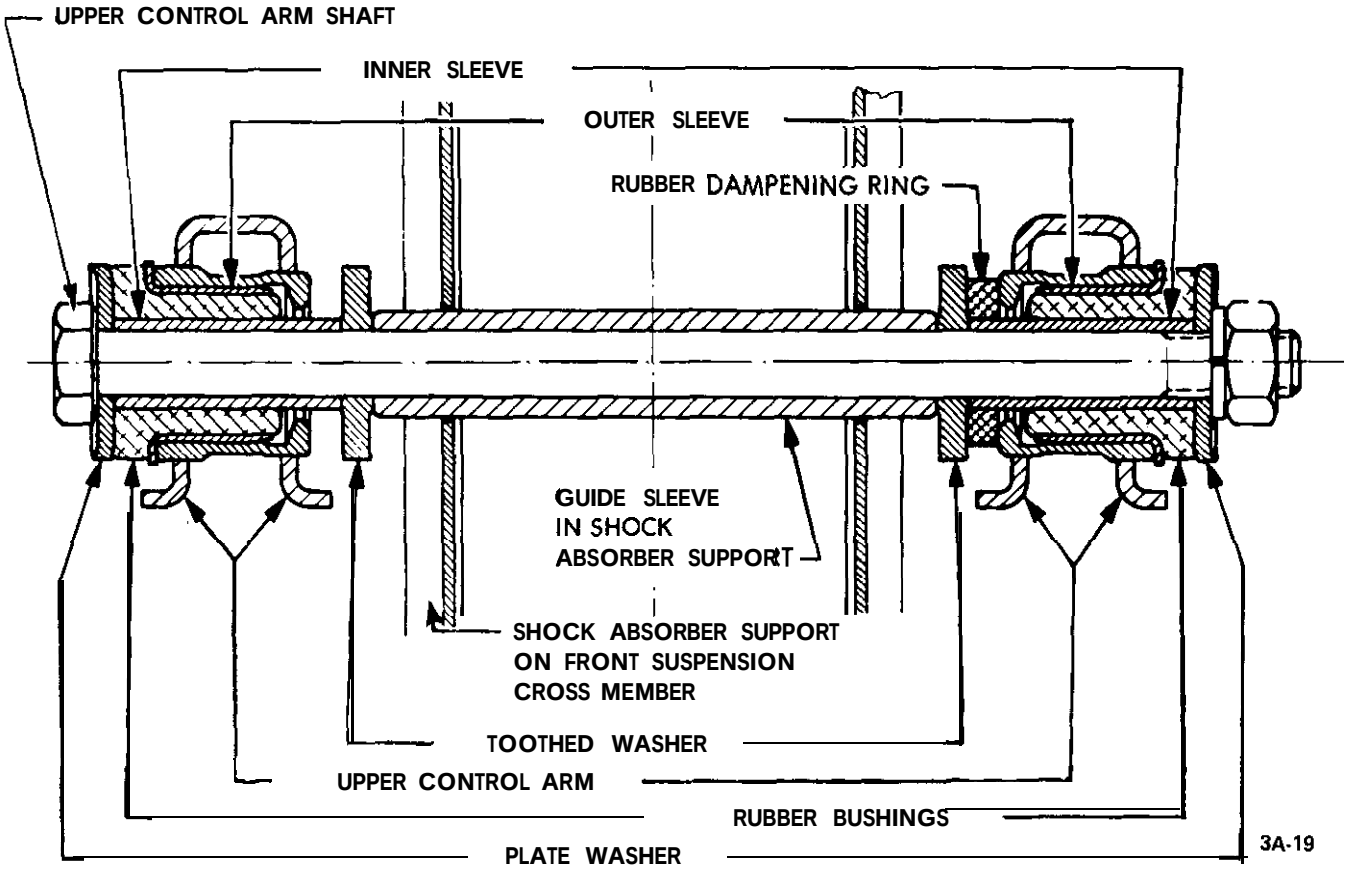

Figure 3A-19 Upper Control Arm Shaft and Bushings

placement part of lesser quality or substitute design. Torque valves must be used as specified during reassembly to assure proper retention of these parts.

1. On installation of the upper control arm, make sure that damper bushing with the rubber shoulder on both sides is always located in the rear.

2. Attach upper control arm to cross member and torque to 40 lb.ft. Always use new self-locking hex nut. The upper control arm must be tightened in horizontal position only. This applies also to all other attaching joints in connection with rubber damper bushings in the control arms of the front suspension so that the rubber parts under load are in an almost twist-free condition. This position exists, if the hooks J-23697 are used.

3. Attach ball joint to upper control arm and torque to 29 lb.ft.

4. Install wheel and torque nuts to 65 lb.ft. Lower car.

LOWER CONTROL ARM REMOVAL AND INSTALLATION

Removal GT

1. Raise car and support at rear of front frame rails.

2. Remove front wheel.

3. Remove cotter pin from castle nut on ball joint stud and back off castle nut two (2) turns. Hit ball stud a sharp blow to break it loose. DO NOT REMOVE NUT.

4. Install spring compressor (J-21689) and compress spring until a distance of 3-1/8 inches is achieved between spring compressor and lower spring leaf.

5. Disconnect and compress shock absorber.

6. Support rail of spring compressor with a jack. Remove lower control arm from frame cross member. Nuts may have to be removed with a punch. See Figure 3A-20. Discard the lock nuts.

7. Remove lower ball joint stud nut. Slightly lower

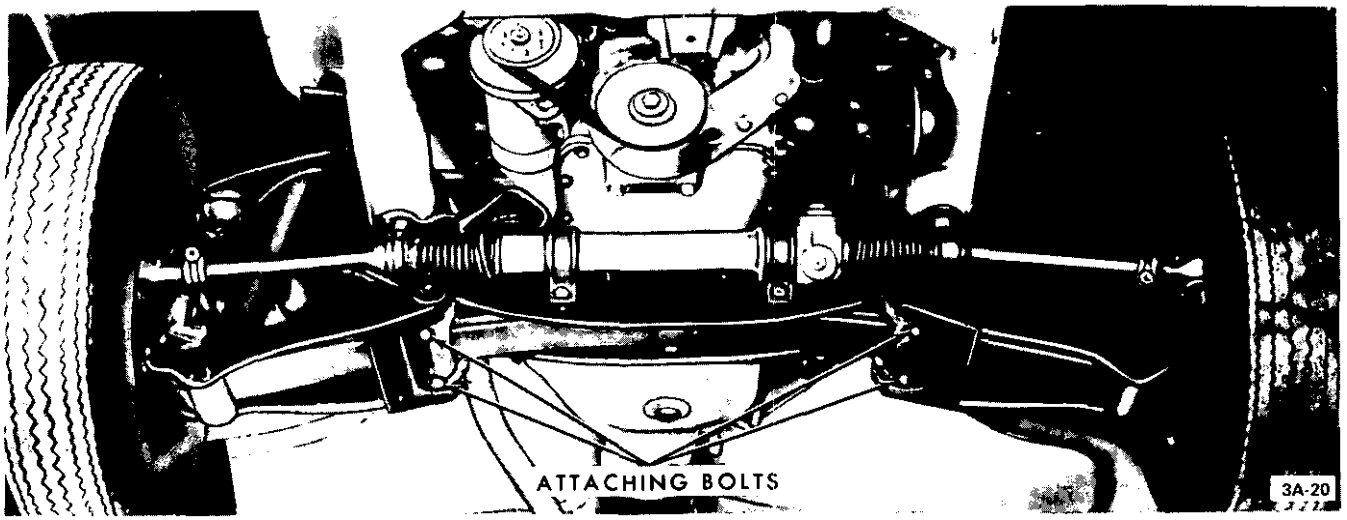

Figure 3A-20 Lower Control Arm Attachment

jack so that spring and lower control arm assembly is removed from the front cross member and steering knuckle.

8. Lower jack, spring compressor, and front spring with control arm assembly. Remove lower control arm to spring nuts.

9. Release spring compressor and remove control arm attaching bolts and control arm.

Removal Opel 1900 - Manta

1. Prior to raising car, install upper control arm hooks J-23697.

2. Raise car and support with stands. Hoist should **be** left in the raised position to maintain pressure on lower control arm.

3. Remove front wheel.

4. Detach both stabilizer supports from cross member to body support.

5. In lower control arm, remove self-locking hex head bolt from stabilizer support and remove washer.

6. Using a pry **bar,** pry stabilizer bar out of lower control arm support.

7. Remove shock absorber.

8. At lower control arm ball joint, remove castle nut cotter pin and remove nut.

9. With suitable drift, detach lower control arm ball joint from steering knuckle.

10. Loosen nut that retains lower control to front cross member.

11. Slowly lower hoist to release spring tension.

12. **Swing lower control arm downwards and remove front spring.**

13. Remove nut that retains lower control arm to front cross member and remove lower control arm.

Installation GT

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1. Attach lower control arm to front spring eye. Torque bolts to 18 lb.ft.

2. Install spring compressor and with a jack raise spring compressor with spring and control arm assembly into position for pressing ball joint into steering knuckle.

3. Press ball joint into steering knuckle. Use J-9519-3 as installer and J-21690 as a supporting sleeve.

4. Install castle nut on ball joint stud and torque to 54 lb.ft. Install new cotter pin.

5. Attach lower control arm to frame cross member using new lock nuts.

6. Reconnect shock absorber to lower control arm and torque to 30 lb.ft.

7. Remove spring compressor.

8. Install front wheel, and lower the car.

9. Check front end alignment.

Installation **Opel 1900 Manta**

CAUTION: *Fasteners are important attachingparts in that they could affect the-performance of vital components and systems, and/or could result in major repair expenses. 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.***

1. Loosely attach lower control arm to front cross member.

2. Properly seat spring between lower control arm and cross member.

3. Raise jack and place lower control into position.

4. Attach lower control ball joint to steering knuckle and torque nut to 54 lb.ft.

5. Tighten lower control arm to cross member bolt to 43 lb.ft.

6. Attach stabilizer bar to lower control arm and torque to 87 lb.ft.

7. Attach stabilizer bar to cross member to body support.

8. Install shock absorber and torque lower attaching nut and bolt to 30 lb.ft.

9. Install nuts on upper shock absorber attaching studs. Tighten nuts until a distance from top of nut to stud is approximately 1/2 inch.

10. Install front wheels and tighten nuts to 65 lb.ft.

11. Remove stands and lower car.

STEERING KNUCKLE REMOVAL AND INSTALLATION

Removal GT

1. Raise car and support with stands.

2. Remove wheel nuts. Remove wheel assembly.

3. Remove two (2) bolts holding caliper to steering knuckle. See Figure 3A-21. Hang caliper on a wire from the upper control arm as shown in Figure 3A-22.

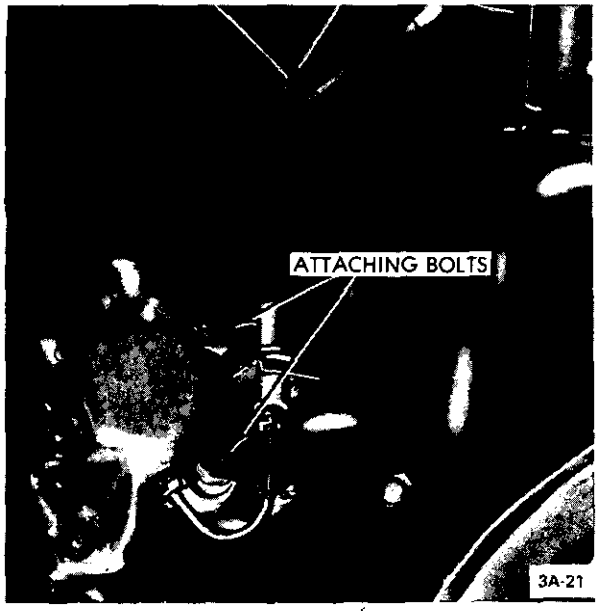

Figure 3A-2 1 Caliper Attachment

4. Remove spindle grease cap. Remove cotter pin and spindle nut. Remove wheel hub with disc.

5. Install J-21689 spring compressor and compress spring until 3-1/8" clearance is obtained between spring compressor and lower spring leaf.

6. Remove upper ball joint using tie rod remover, J-21687.

7. Remove shock absorber at lower attachment *only*.

8. Remove lower ball joint using J-21687 remover and remove steering knuckle. Remove dust shield from steering knuckle.

Removal Opel 1900 - Manta

1. Raise car and support with stands.

2. Detach brake caliper and steering arm from steering knuckle.

3. Remove castle nut cotter pin, unscrew nut and pull steering knuckle off upper control arm ball joint.

4. Unscrew brake caliper and suspend it in wheel house.

5. Remove front wheel hub.

6. Unscrew steering arm and brake cover plate from

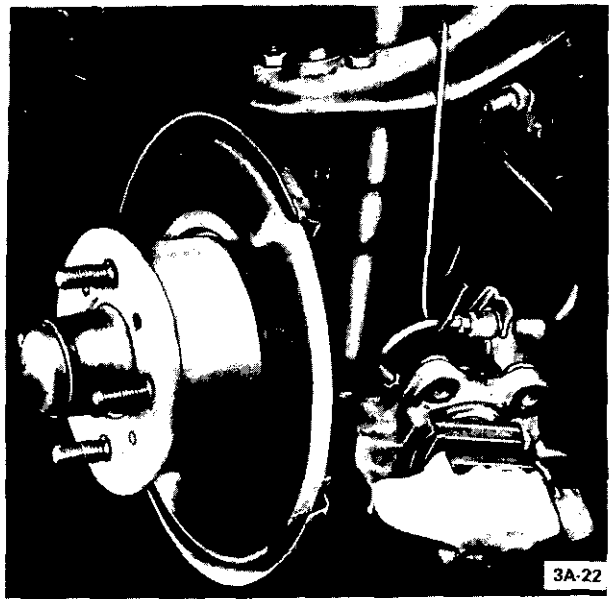

Figure 3A-22 Caliper Removed and Hung by Wire

steering knuckle. Swing steering arm and tie rod to the side.

7. Remove castle nut cotter pin, unscrew nut and pull steering knuckle off lower control arm ball joint.

Installation GT

CAUTION: ***Fasteners are important attachingparts 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.***

1. Always replace paper gasket when installing dust shield on steering knuckle. Lightly ***coat*** both surfaces of paper gasket with chassis lubricant before installation and torque attaching bolts to 47 lb.ft.

2. Install lower ball joint in steering knuckle. Torque castle nut to 54 lb.ft. Install new cotter pin.

3. Attach shock absorber at lower end. Torque bolts to 30 lbs. ft.

4. Install upper ball joint. Torque castle **nut to 29** lb.ft. Install new cotter pin.

5. Remove spring compressor.

6. Install hub and disc on spindle and tighten spindle nut as stated under MAINTENANCE AND ADJUSTMENTS in this section.

7. Install caliper on steering knuckle and torque bolts to 72 lb.ft. See Figure 3A-21.

8. Install wheel and torque wheel nuts to 65 lb.ft.

Installation Opel 1900 - Manta

CAUTION: ***Fasteners are important attachingparts 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 equivalent parts, 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.***

1. Attach steering knuckle to lower control arm ball joint. Torque castle nut to 54 lb.ft.

2. Attach brake cover plate and steering arm to steering knuckle. If required, install new paper gasket ***between*** cover plate and steering knuckle. Care for proper seat of T-head bolts. See Figure 3A-23.

Figure 3A-23 Attaching Brake Cover Plate

3. Install front wheel **hub** and brake caliper.

4. Attach steering knuckle to upper control arm ball joint. Torque castle nut to 40 lb.ft.

5. Steering arm to steering knuckle - 58 lb.ft.

6. Brake caliper to ***steering*** knuckle - 72 lb.ft.

7. Adjust front wheel bearing clearance.

8. Remove **stands** and lower car

SHOCK ABSORBER REMOVAL AND INSTALLATION

Removal Opel 1900 - Manta

1. Raise car and support with stands.

2. Remove upper attaching nuts from shock absorber.

3. Remove lower attaching nut, lockwasher, and bolt.

4. Compress shock absorber and remove from car.

Removal GT

1. Remove air cleaner. See Figure 3A-24.

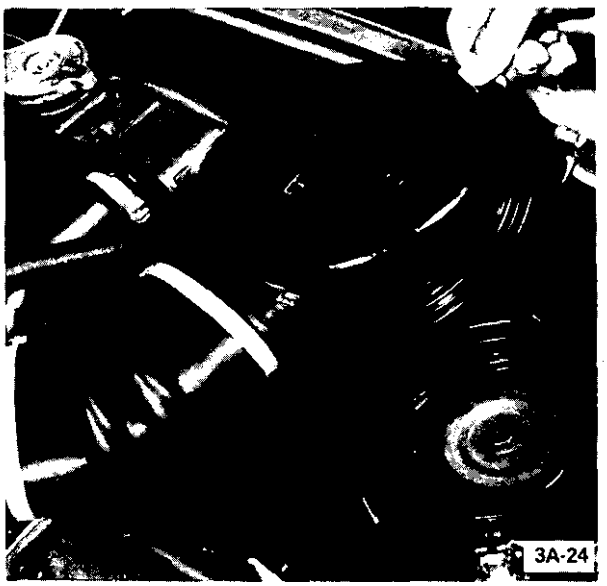

Figure 3A-24 Removal of Air Cleaner

2. Remove plastic cover over shock absorber upper attachment.

3. Raise car and support with stands.

4. Remove upper attaching nuts from shock absorber.

5. Remove lower attaching nut, lockwasher, and bolt.

6. Compress shock absorber and remove from car.

Installation Opel 1900 - Manta

1. Inspect shock absorber for damage and seal leaks. Always replace the upper and lower rubber grommets when replacing a shock absorber.

2. Install the lower grommet retainer and grommets on shock absorber. Compress shock absorber and place in position.

3. Install lower attaching bolt and nut. Torque to 30 lb.ft.

4. Install nuts on upper attaching studs. Tighten nuts until distance from top of nut to stud is approximately 1/2 inch. See Figure 3A-25.

5. Install plastic cover.

Installation GT

1. Inspect shock absorber for damage and seal leaks. Always replace the upper and lower rubber grommets when replacing a shock absorber.

2. Install the lower grommet retainer and grommets on shock absorber. Compress shock absorber and place in position.

3. Install lower attaching bolt and nut. Torque to 30 lb. ft.

4. Install nuts on upper attaching studs. Tighten nuts until distance from top of nut to stud is approximately 1/2 inch. See Figure 3A-25.

5. Install plastic cover.

6. Install air cleaner.

FRONT SPRING REMOVAL AND INSTALLATION

Removal (GT)

1. Raise car and support at rear of front frame rails with stands.

2. Remove front wheels.

3. Remove cotter pin from castle nut on lower ball joint studs and back off castle nut two (2) turns. Hit ball stud a sharp blow to break it loose. *Do not remove nut.*

4. Install J-21689 spring compressor and compress the spring until 3-1/8" clearance is obtained between spring and compressor.

5. Disconnect both shock absorbers at their lower attachment. Compress both shock absorbers.

6. Support the rail of J-21689 Spring Compressor with a jack. Remove lower control arm to cross member attaching nuts and bolts.

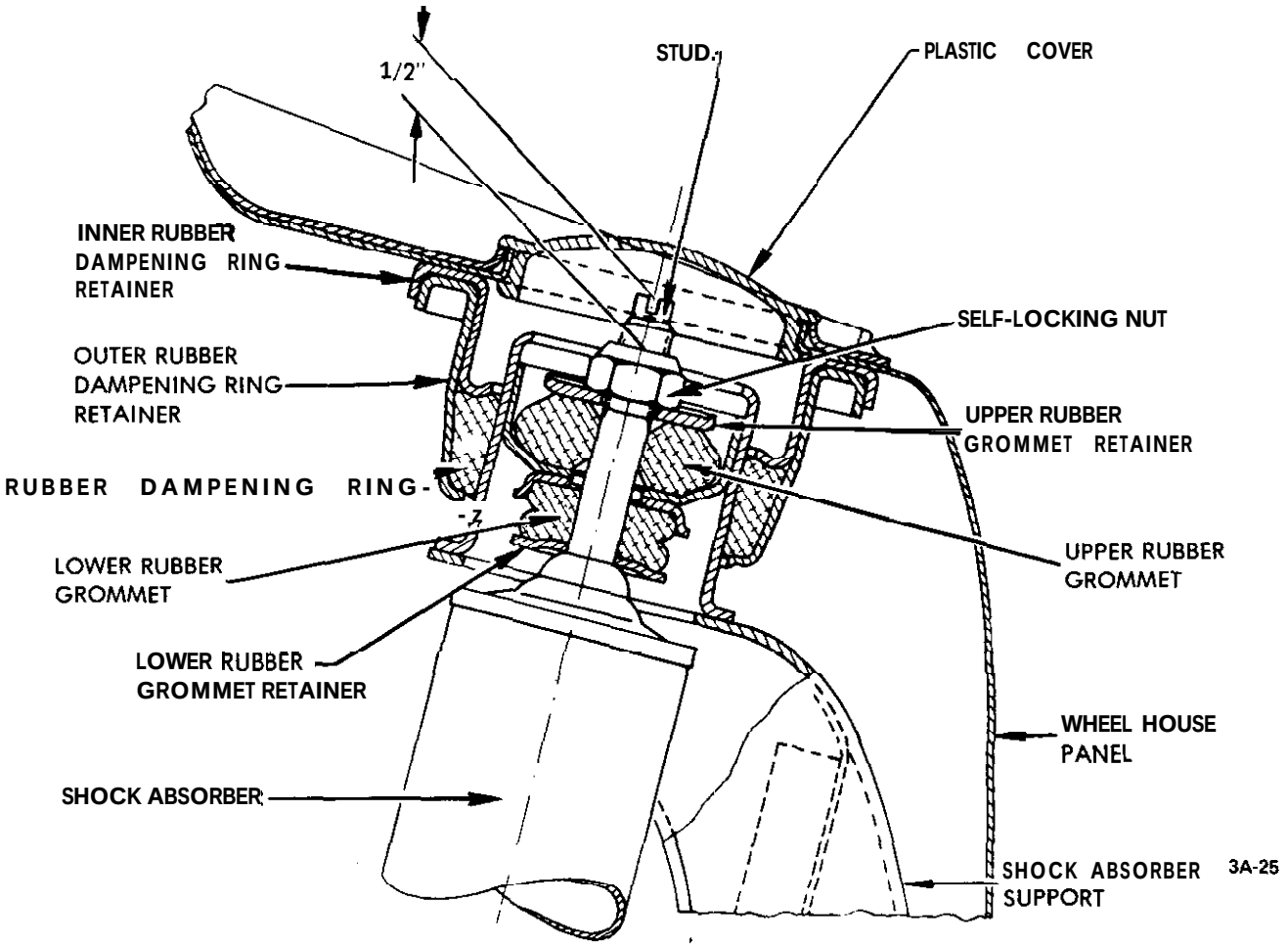

Figure 3A-25 Shock Absorber Upper Attachment

7. Remove lower ball joint stud nuts. Slightly lower jack so that the spring and lower control arm assembly is removed from the front cross member and steering knuckle.

8. Lower jack, spring compressor, and front spring and control arm assembly. Remove lower control arm to spring nuts.

9. Relieve tension on spring compressor and remove control arm attaching bolts and control arms.

Removal (Opel 1900 - Manta)

1. Prior to raising car, install upper control arm hooks J-23697.

2. Raise car and support with stands. Hoist should be left in the raised position to maintain pressure on lower control arm.

3. Remove front wheel.

4. Detach both stabilizer supports from cross member to body support.

5. Remove shock **absorber.**

6. At lower control arm ball joint, remove castle nut cotter pin and ***remove nut.***

7. With suitable drift, detach lower control arm ball joint from steering knuckle.

8. Loosen nut that retains lower control to front cross member.

9. Slowly lower hoist to release spring tension.

10. Swing lower control arm downwards and remove front spring.

Installation (GT)

CAUTION: ***Fasteners are important attachingparts 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.

1. Attach lower control arm to front spring eye. Torque bolts to 18 lb.ft.

2. Install spring compressor on spring and compress spring to appropriate length.

3. Raise jack with spring compressor, spring and control arm assembly into position under the car.

4. Install lower ball joints and torque nuts to 54 lb.ft. Install new cotter pin.

5. Attach lower control arms to frame cross member using new lock nuts.

6. Attach both shock absorbers. Torque bolts to 30 lb.ft.

7. Remove spring compressor.

8. Install front wheels.

On replacement of the damper bushings on the front springs, only the one-part damper bushing is installed for either the two-leaf or three-leaf spring. For proper location of the marking lugs, see Figure 3A-26.

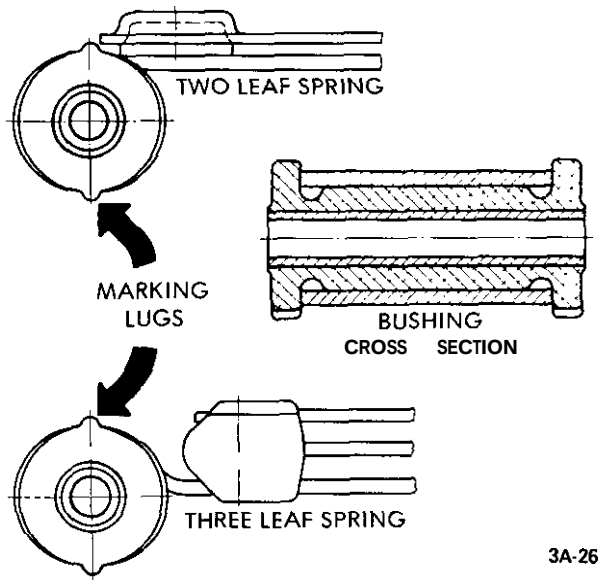

Fig. 3A-26 Front Spring Damper Bushing.

Installation (Opel 1900. Manta)

CAUTION: ***Fasteners are important attachingparts 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.***

1. Properly seat spring between lower control arm and cross member.

2. Raise jack and place lower control into position.

3. Attach lower control ball joint to steering knuckle and torque nut to 54 lb.ft.

4. Tighten lower control arm to cross member bolt to 43 lb.ft.

5. Attach stabilizer bar to cross member to body support.

6. Install shock absorber and torque lower attaching nut and bolt to 30 lb.ft.

7. Install nuts on upper shock absorber attaching studs. Tighten nuts until a distance from top of nut to stud is approximately 1/2 inch.

8. Install front wheels and tighten nuts to 65 lb.ft.

9. Remove stands and lower car.

SPECIFICATIONS

BOLT TORQUE AND FRONT END ALIGNMENT

SPECIFICATIONS

Torque Specifications

Use a reliable torque wrench to tighten all parts listed to insure proper tightness without straining or distorting parts. These specifications are for clean and lightly-lubricated threads only; dry or dirty threads produce increased friction which prevents accurate measurement of tightness.

Location	Torque Lb.Ft.
Front Suspension Crossmember to Front Frame	36
Clamp, Steering Mast to Steering Mast Flange (GT)	15
Clamp, Steering Mast to Steering Mast Flange (1900 - Manta)	22
Clamp, Upper Universal Joint (GT)	14
Clamp, Lower Universal Joint (GT)	22
Wheel Nuts	65
Lower Control Arm Shaft to Lower Control Arm	40
Lower Control Arm Ball Joint to Steering Knuckle	54
Upper Control Arm Ball Joint to Steering Knuckle (GT)	29
Upper Control Arm Ball Joint to Steering Knuckle (1 900 Manta)	40
Upper Control Arm Ball Joint to Upper Control Arm	29
Shock Absorber to Lower Control Arm	30
Steering Arm to Steering Knuckle (1900 - Manta)	58
Brake Backing Plate or Brake Disc Shield and Steering Arm to Steering Knuckle (GT)	
Hex Head Bolt M 10	47
Hex Head Bolt M 8	18
Brake Backing Plate to Steering Knuckle (1900 Manta)	58
Brake Caliper to Steering Knuckle	72
Lower Control Arm to Front Spring Eye (GT)	18
Brake Disc to Front Wheel Hub	36
Upper Control Arm to Crossmember (1900 - Manta)	40
Lower Control Arm to Crossmember (1900 - Manta)	43
Steering Gear Housing to Front Suspension Crossmember (GT)	18
Steering Gear Housing to Front Suspension Crossmember (1900 - Manta)	30
Stabilizer Bar to Lower Control Arm (Opel 1900 - Manta)	87
Tie Rod Clamp Bolts (GT)	12
Castle Nut, Tie Rod to Steering Arm	29
Upper Control Arm Shaft to Shock Absorber Support and Upper Control Arm (GT)	33
Cross Member to Body Support Attachment	58
Front Suspension Assembly to Frame	47

Front End Alignment Specifications

Model	Caster'	Camber"	Toe-In" Min.-Max.	Outer Wheel When Inner Wheel at 20
1900	'3 1/2-6 1/2	-1±1/2	1/8-3/ 16	19 1/4
GT	3±1	1±1/2	1/32-1/8	18 1/2

*Permissible deviation from left to right wheel - Max. 1'.

STEERING LINKAGE

CONTENTS

DESCRIPTION AND OPERATION

DESCRIPTION AND OPERATION OF TIE RODS

Tie rods on the GT are connected to both rack ends by means of a ball joint. Two rubber bellows between ball joint and steering gear housing protect rack and ball joints against dirt, dust and mud. The ball joints of the tie rods do not require service.

Tie rods on the Opel 1900 and Manta are connected to both rack ends by means of a axial joint. Two rubber bellows between the axial joint and steering gear housing protect the rack and axial joints against dirt, dust, and mud. The ball joint of the tie rod ends on the Opel 1900 and Manta are maintenance free and must not be disassembled.

MAJOR REPAIR

REMOVAL AND INSTALLATION OF TIE RODS

Removal

In order to avoid the possibility of dirt entering the steering gear assembly via the rack, it is recommended that rods and area immediately surrounding the gear assembly be wiped free of loose dirt prior to removal.

1. Remove cotter pins securing nuts on tie rod ends and remove nuts. Discard cotter pins.

2. Using remover J-21687, pull outer tie rod ball studs out of steering arms. See Figure 3B-2.

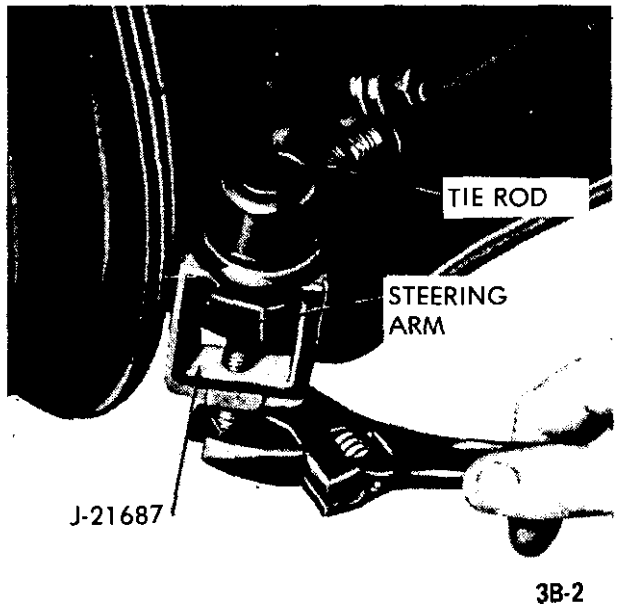

Figure 3B-2 Removing Ball Stud

3. Remove clamp securing one end of rubber bellows to tie rods and slip bellows off tie rods to expose nut or lock plates. See Figure 3B-3.

4. On the GT, bend up round edges of lock plate from tie rod ball studs and unscrew ball studs From rack. See Figure 3B-4.

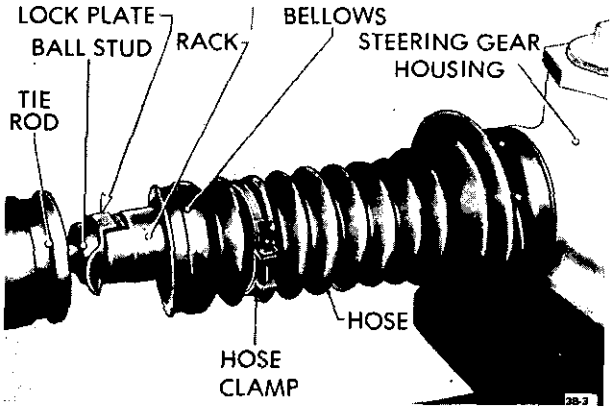

Figure 3B-3 Bellows Removed From Tie Rod GT

5. On the Opel 1900 - Manta, unscrew tie rod from axial joint. It is important that rack be held secure with open end wrench to prevent damage to rack teeth.

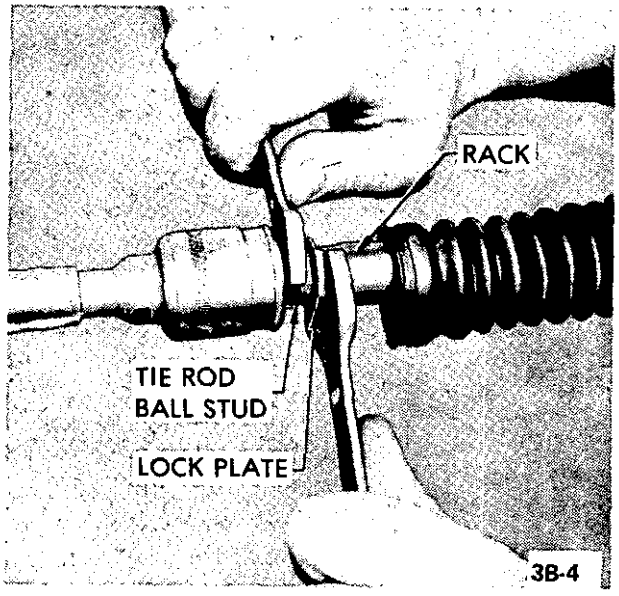

Figure 3B-4 Removing Tie Rods. GT

Installation . GT

CAUTION: *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 or lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.*

1. Install new lock plates onto tie rod ball studs and screw ball studs into rack while holding bent tab of lock plates against flat on rack. Torque ball studs 43 lb.ft. See Figure 3B-5. It is important that rack be held secure with open end wrench to prevent damage to rack teeth.

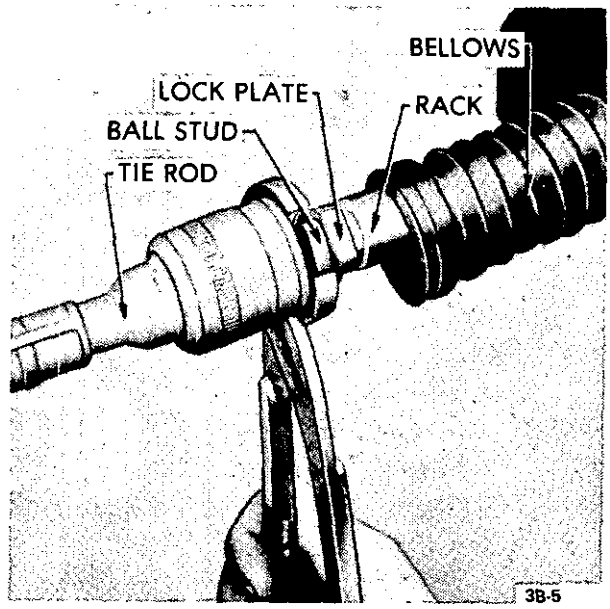

Figure 3B-5 Bending Lock Plate Over Ball Stud . GT

2. Bend round edges of lock plate over flat on ball stud to lock ball stud in position.

3. Position rubber bellows and hose clamps over tie rods and adjust clamp so that wire ends are pointing in same direction as adjusting screw. Check that bellows are not twisted and will compress and expand properly.

4. Connect outer tie rod ball stud to steering arm, torque castle nut to 29 lb.ft., and lock in position with new cotter pin.

Installation Opel 1900 . Manta

CAUTION: *Fasteners are important attachingparts 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 valves must be used as specified during reassembly to assure proper retention of these parts.*

1. Screw tie rod into axial joint.

2. Attach tie rod end to steering arm and torque nut to 29 lb.ft. Install new cotter pin.

3. Adjust toe-in and then torque lock nut of both tie rods to 47 lb.ft.

4. Attach rubber bellows to axial joint using hose clamp.

DISASSEMBLY AND REASSEMBLY OF TIE RODS

The ball joint of the tie rod end on the Opel 1900 • Manta is maintenance free and must not be disassembled.

Disassembly • GT

1. Loosen tie rod clamp bolt and unscrew outer tie rod ball stud from tie rod. See Figure 3B-6.

2. Remove retainer ring from outer ball stud of tie rod and take off rubber sealing cap.

Reassembly GT

1. Install rubber sealing cap and retainer ring onto outer ball stud.

2. Screw outer tie rod ball stud into tie rod and tighten clamp bolt.

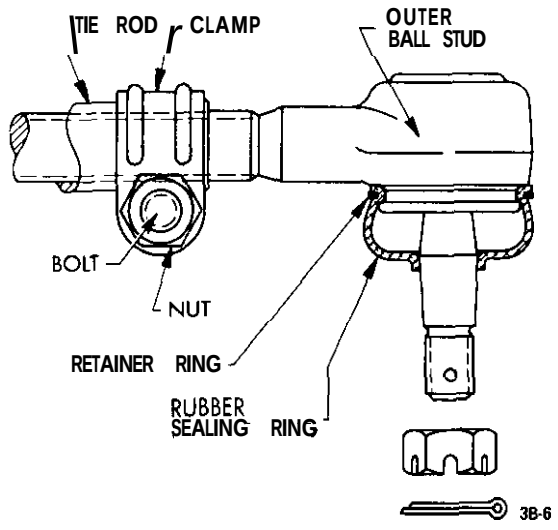

Figure 3B-6 Tie Rod and Outer Ball Stud

CAUTION: ***Fasteners for tie rods 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.***

SPECIFICATIONS

TIGHTENING SPECIFICATIONS

Location	Torque Lb.Ft.
Ball Stud to Rack (GT)	43
Ball Stud to Steering Arm (GT)	29
Tie Rod End to Steering Arm (1900 . Manta)	29
Tie Rod Lock Nut (1900 • Manta)	47

FRONT END ALIGNMENT

CONTENTS

DESCRIPTION AND OPERATION

FRONT WHEEL ALIGNMENT

Wheel alignment is the mechanics of adjusting the position of the front wheels in order to attain the least steering effort with a minimal amount of tire wear.

Correct alignment of the chassis is essential to proper alignment of front and rear wheels. Briefly, the essentials are that the frame must be square in plain view within specified limits, that the top and bottom surfaces of the front cross member must be parallel fore and aft, and that the upper and lower control arm must be at correct location in respect to shafts and the front cross member. All bushings, ball joints and bolts must be of proper torque and in usable condition.

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 or tires may 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 wheels are out of alignment.

Close limits on caster, front wheel camber, and theoretical king pin inclination are beneficial to car handling, but require only reasonable accuracy to provide normal tire life. With the type of front suspension used, the toe-in adjustment is much more important than caster and camber are as far as tire wear is concerned.

Caster and camber adjustments need not be consid**ered** unless visual inspection shows these settings to be out, or unless the car gives poor handling on the road. 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 other front end alignment adjustments.

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

MAINTENANCE AND ADJUSTMENTS

Inspection Before Checking Front Wheel Alignment

Before making any adjustment affecting caster, camber, toe-in, theoretical king pin inclination, or steer-

ing geometry, the following checks and inspections must 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 (see Wheel and Tire Specifications - Section 3G).

2. Check front wheel bearings for looseness and adjust if necessary (see Front Suspension Adjustments - Section 3A).

3. Check for run-out of wheels and tires, (see Section 3G).

4. Check wheels and tires for balance and correct if out-of-balance (See Section 3G).

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

6. Check shock absorber action and correct if necessary. Consideration must be given the optional equipment on the car, undercoating, dirt, etc.

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.

ADJUSTING CASTER (GT)

CAUTION: *Front suspension 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 ifreplacement 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.*

To change caster, three washers are available - one with a .12″ thickness, one that is .36″ thick, and one .24″ thick. *To increase caster* place one of the thin washers at the front of the control arm shaft and one of the thick washers at the rear. *To decrease caster* place one thick washer at the front of the control arm shaft and one thin washer at the rear.

1. Position jack below front suspension cross member and raise front end of car.

2. Place jack stands below front frame side members and remove front wheel on side which caster is to be adjusted.

3. Install front spring compressor J-21689 and compress spring. See Figure 3C-2.

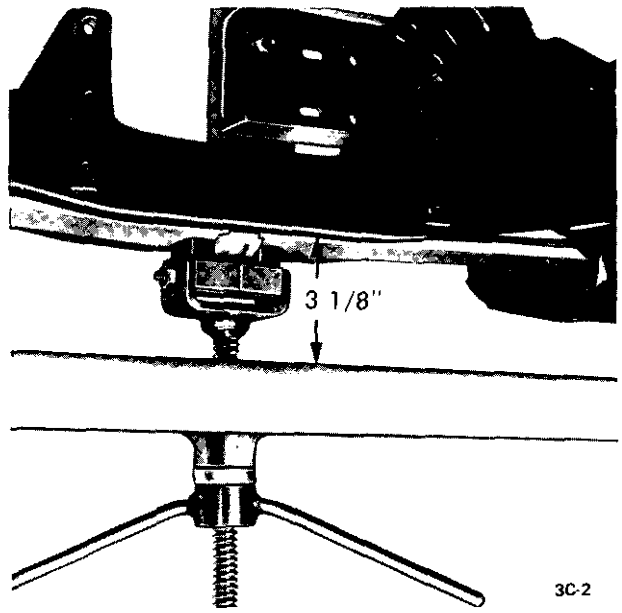

Figure 3C-2 Spring Compressor J-2 1689 Installed

4. Remove upper control arm shaft,

5. Remove upper control arm from shock absorber support, being careful not to lose toothed washers.

6. Adjust caster by installing selective toothed washers on both sides of control arm shaft, between control arm and shock absorber support. Never use more than one washer at any one location. The total thickness, front and rear washer, must equal .48″. There are only two possible caster changes that can be made.

7. Using a drift to align holes, replace control arm shaft in the direction as shown in Figure 3C-3. Torque hex nut to 33 lb.ft. Make certain that crown of both plate washers shows outward.

8. Remove spring compressor, and install front wheel and torque wheel nuts to 72 ft. Ibs.

9. Recheck caster.

ADJUSTING CASTER (OPEL 1900. MANTA)

1. Jack up vehicle and remove front wheel on the side on which caster is to be adjusted.

2. Support vehicle below both lower control arms. See Figure 3C-4.

3. Unscrew hex nut from upper control arm shaft and pull out shaft.

4. Adjust caster by replacing washers (A) (front) and

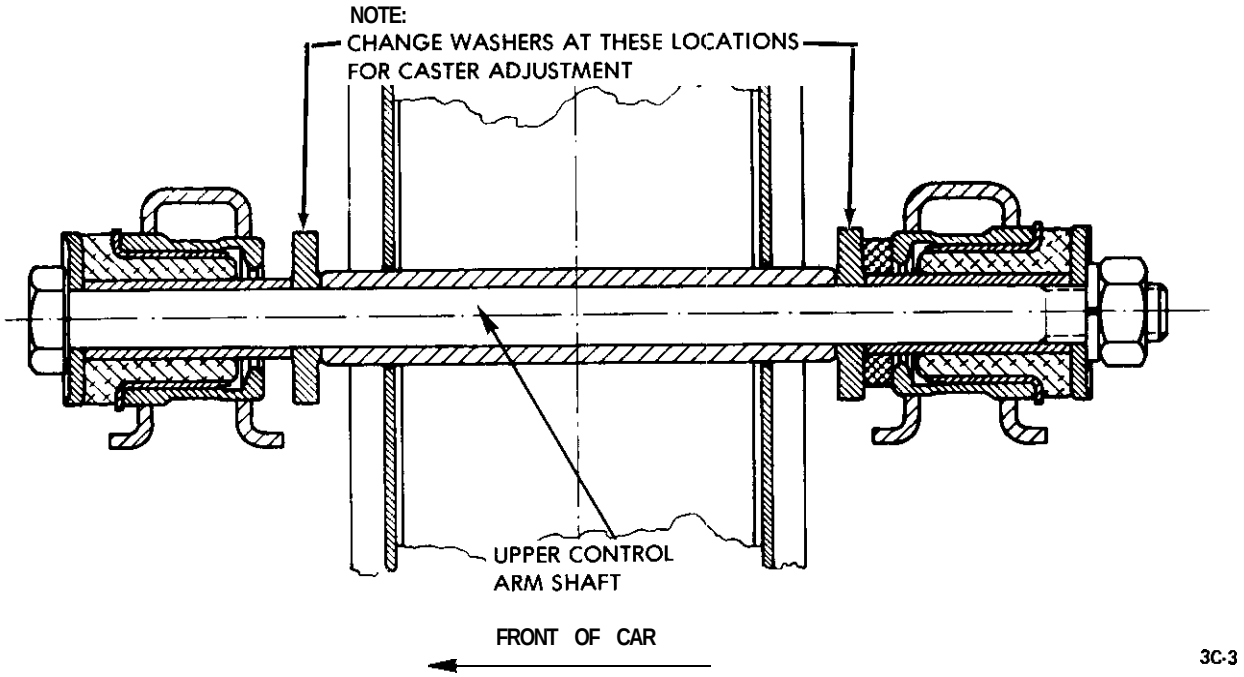

Figure 3C-3 Upper Control Arm Shaft and Bushings

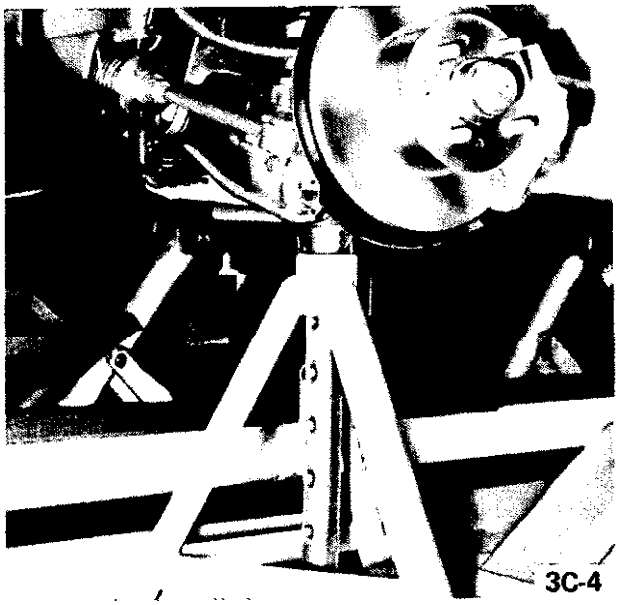

Figure 3C-4 Supporting Vehicle at Both Lower Control Arms

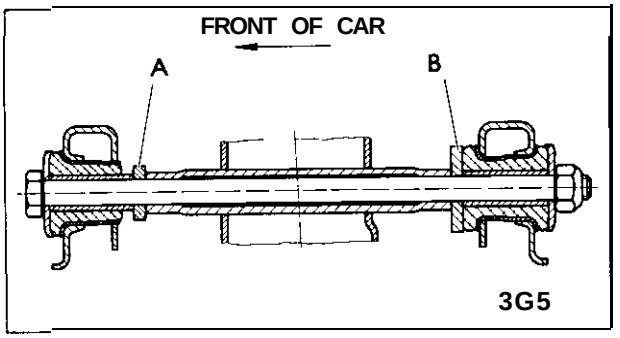

Figure 3C-5 Caster Adjustment Washer Location - Opel 1900 - Manta

(B) (rear) between upper control arm and shock absorber **support. See** Figure 3C-5.

5. One .24" thick washer each is installed in production on each car side. Consequently, only two adjustments are possible by adding washers of different thickness.

6. One .12" in front and one .36" in the rear (caster increase of 1 degree) or one .36" in front and one. 12" in the rear (caster decrease of 1 degree). Never add several washers in one place. The washers B installed in production have a larger outer diameter than the washer A. For service, the Parts and Accessories Department supplies only larger washers with an outer diameter of 1.57".

7. Insert control arm shaft from front towards the rear into upper control arm and shock absorber support. Observe that the crown of both plate washers shows inwards. See Figure 3C-5.

8. Torque hex nut of control arm shaft to 40 ft.lbs. Always use new self-locking nut.

9. Torque wheel nuts to 75 ft.lbs.

10. Recheck caster setting.

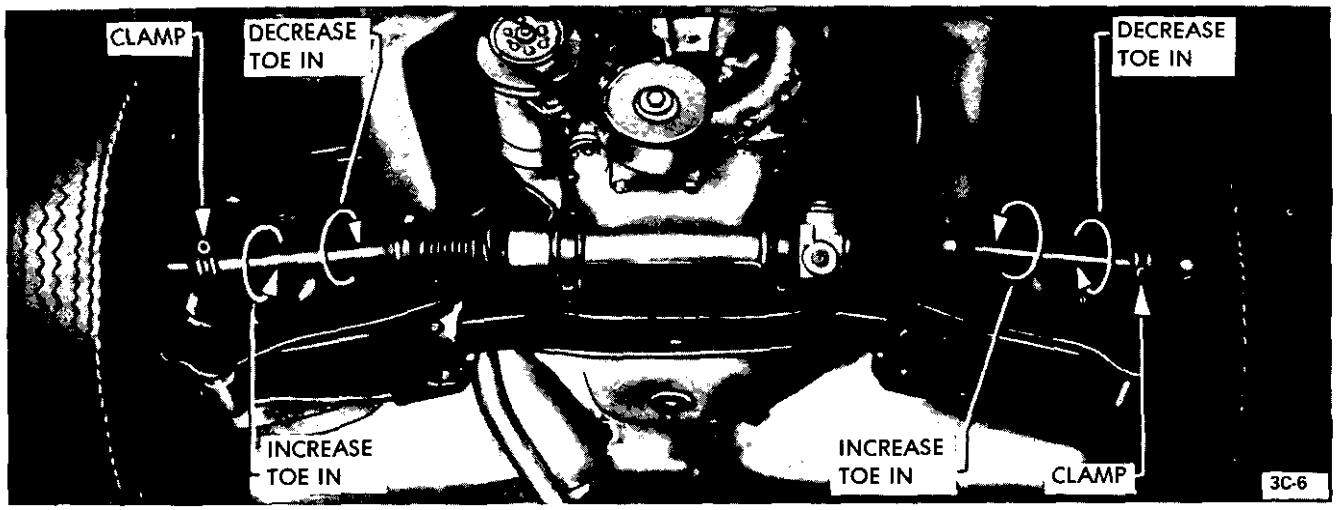

Figure 3C-6 Adjusting Toe-In (GT)

ADJUSTING CAMBER

Camber is adjusted by turning the upper ball joint flange 180 degrees. This means that only two possible camber adjustments can be made. At the factory **camber** is set at the smallest possible positive camber setting for GT and smallest possible negative camber for Opel 1900 - Manta. Rotating the flange will make **camber** more positive on GT and more negative on Opel 1900 - Manta.

1. Raise front end of car using wood block on jack to prevent damage to front cross member.

2. Support car below lower control arm and remove front wheel on side to be adjusted.

3. Remove ball joint from upper control arm and front steering knuckle.

4. Lift upper control arm and turn the ball joint flange through 180 degrees.

5. First tighten both ball joint attaching bolts on upper control arm and then the ball stud castle nut. Torque to 29 ft. lbs. on GT and 44 ft.lbs. on Opel 1900 - Manta. Install new cotter pin.

6. Install front wheel and torque wheel nuts to 72 lb.ft. on GT and 75 lb.ft. on Opel 1900 - Manta.

7. Recheck camber.

ADJUSTING TOE-IN (GT)

Toe-in is adjusted by rotating the tie rod sleeves. Refer to Figure 3C-6.

1. Recheck caster and camber before proceeding with toe-in adjustment. If correct, adjust toe-in.

2. Set wormshaft and ball nut to steering gear high point by turning steering wheel half way from one stop to the other, noticing the following:

(a) With the steering wheel hub button removed, the "marking" on the steering shaft end should be in a horizontal position.

(b) The steering wheel spokes should also be in a centered position.

3. Remove wire clamps on left and right tie rod and push back bellows.

4. Loosen clamp bolts and tie rods. See Figure 3C-4.

5. The toe-in should be 1/32" - 1/8".

When adjusting toe-in, never grip tie rod on inner ball stud joint. To avoid ball stud resting against inside of hole in tie rod outer end, center outer end of each tie rod to the ball stud.

6. Pull bellows over tie rods and attach with wire clamps. The bellows must not be twisted and wire ends must show towards steering gear adjusting screw opening.

7. Torque clamp bolts to 12 lb.ft.

8. After toe-in adjustment, turn steering wheel several times completely towards the left and right to determine whether bellows are properly attached to the tie rods and steering gear housing.

ADJUSTING TOE-IN (OPEL 1900. MANTA)

The adjustment of the toe-in has always to be carried out on both tie rods.

1. Loosen lock nut of left and right tie rod and slacken back nut.

2. Remove hose clamp for rubber bellows attachment from respective axial joint and adjust toe-in by turning axial joint. When doing this, observe that the rubber bellows, having a tight seat on thejoint, is not twisted. If necessary, lubricate seat of bellows and hold back bellows when turning. See Figure 3C-7.

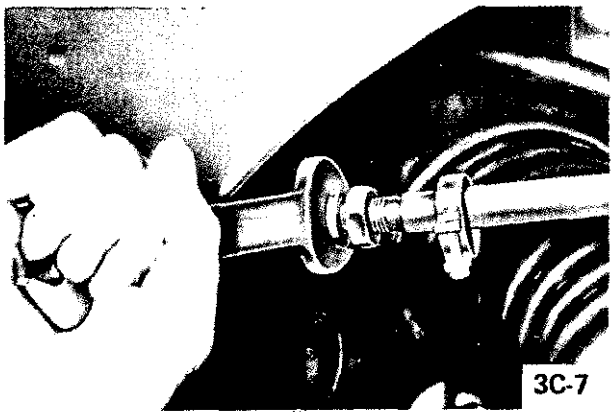

Figure 3C-7 Adjusting Toe-In Opel 1900 Manta

3. Toe-in should be l/S" - 3/16".

4. Torque lock nut of left and right tie rod to 47 ft.lbs.

5. Attach respective rubber bellows with hose clamp, making sure that clamp bolt points towards the front. The rubber bellows must not be twisted, i.e., the individual grooves of bellows must be in vertical position.

6. After adjustment, turn steering several times to the left and right to determine if a proper attachment of both rubber bellows to the steering gear housing is warranted.

CHECKING THEORETICAL KING PIN INCLINATION

When checking theoretical king pin 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.

With camber known to be within specified limits, theoretical king pin inclination should check to 8.5 degrees for Opel 1900 - Manta, and 6 degrees for GT.

If camber is incorrect beyond limits of adjustment and theoretical king pin inclination is correct, or nearly so, a bent steering knuckle is indicated.

There is no adjustment for theoretical king pin inclination as this factor depends on the accuracy of the front suspension parts. Distorted parts should be replaced with new parts.

The practice of heating and bending front suspension parts to correct errors must be avoided as this may produce soft spots in the metal in which fatigue and breakage may develop in service.

Specifications

FRONT END ALIGNMENT

MODEL	CASTER °	CAMBER °	TOE-IN MIN.. MAX.	OUTER WHEEL WHEN INNER WHEEL AT 20 °
1900	‘ 3 1/2 - 6 1/2	-1±1/2	1/8 - 3/16	19 1/4
GT	3±1	1±1/2	1/32 - 1/8	18 1/2

* Permissable deviation from left to right wheel - maximum 1".

STEERING GEAR ASSEMBLY

CONTENTS

DESCRIPTION AND OPERATION

DESCRIPTION AND OPERATION OF STEERING GEAR ASSEMBLY

The Opel 1900 - Manta and GT steering gear is the rack and pinion type. The steering gear pinion shaft, connected to the lower end of the steering column, moves the rack to the left or right thereby transmitting the turning motion of the steering wheel to the tie rods and steering arms.

The steering gear housing is held to the cross member **by** rubber bushings and clamps. The bushings serve to prevent driving noises and vibrations from being transmitted into the passenger compartment. A pinion shaft is seated in the upper portion of the steering gear housing and is supported by a needle bearing in the upper housing, and a bushing in the lower housing. The pinion is not adjustable.

A rubber "0" ring seal is provided for sealing needle bearing, and a second "0" ring for sealing pinion bushing. The rack and pinion shaft are held in mesh by a thrust spring and shell. See Figure 3D-2.

The pressure of the thrust spring may be varied by means of an adjusting screw. The spring forces the sintered bronze shell against the rack, which in turn is held against the pinion shaft. Backlash in the steering gear is avoided, and road shocks are effectively absorbed.

The rack is seated in the long neck of the steering gear housing in a self-lubricating sintered metal bushing. It is laterally guided by the sintered bronze shell in the adjusting screw opening, and in the short gear housing neck by the rack guide bushing. See Figure 3D-3.

MAINTENANCE AND ADJUSTMENTS

ADJUSTMENTS OF STEERING GEAR

Adjustment of Steering Gear

Adjustment of the steering gear assembly is accomplished by turning the adjusting screw in or out. See Figure 3D-2.

Positioning of the adjusting screw exerts a pressure on the rack, thereby varying the backlash between the pinion and rack.

1. Set steering gear to high point by positioning front wheels straight ahead with steering wheel centered. Flexible coupling bolt hole will be positioned horizontal (or parallel) to the rack.

2. Thread adjusting screw into steering gear housing

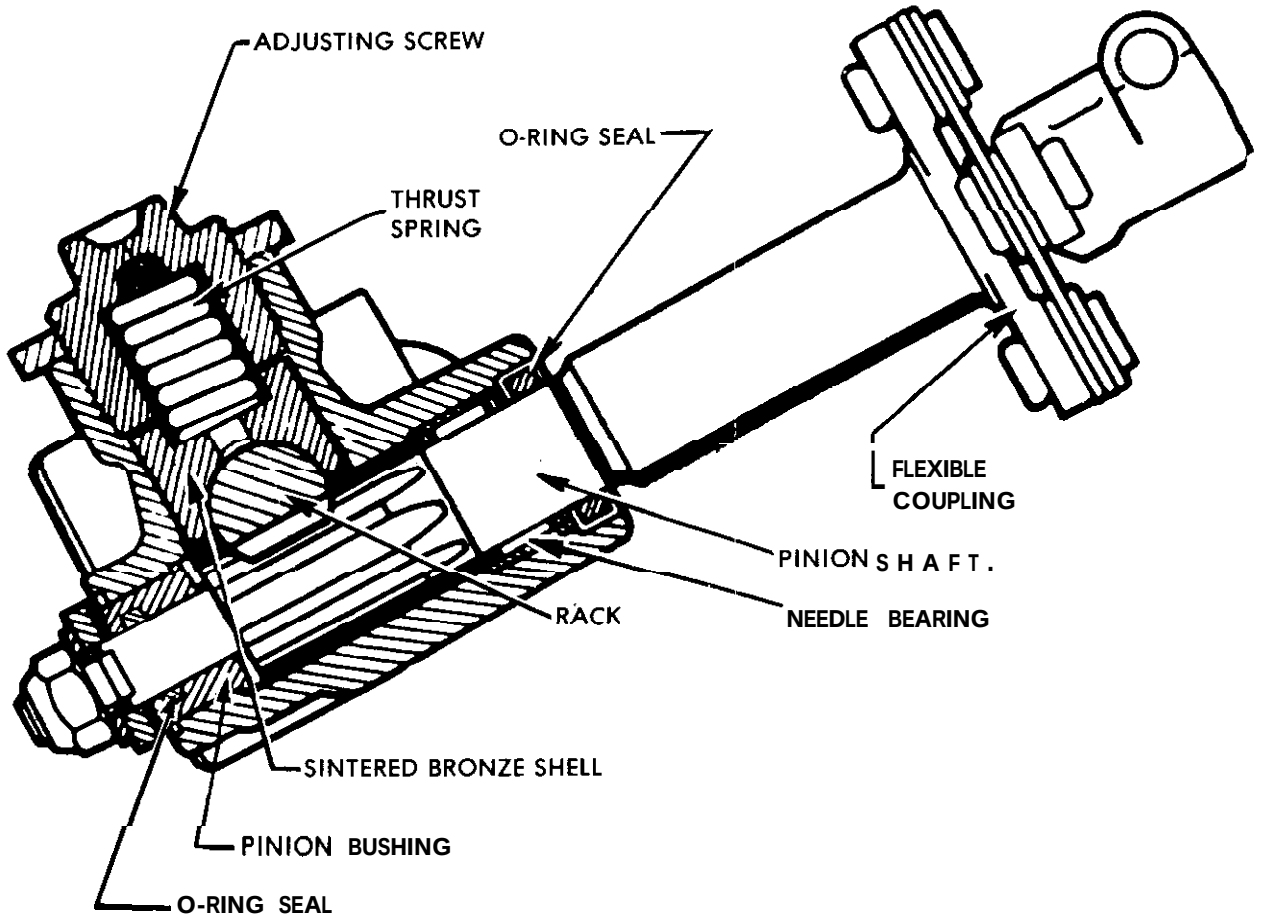

Figure 3D-2 Steering Gear Assembly - End View

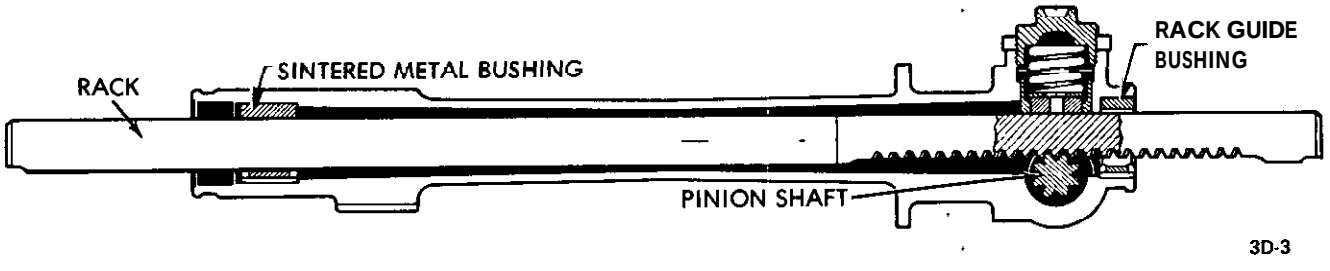

Figure 3D-3 Steering Gear Assembly Front View

until a resistance is felt. By threading in adjusting screw when steering gear is set to highpoint, the sintered bronze shell is pushed against the rack so that the rack is blocked.

3. Back off adjusting screw 1/8 to 1/4 of a turn.

4. Tighten lock nut to a torque of 43 lbs.ft.

5. Fill area under pinion shaft rubber boot with steering gear lubricant and slide boot into position.

MAJOR REPAIR

REMOVAL AND INSTALLATION OF STEERING GEAR ASSEMBLY AND TIE RODS

Removal. GT

1. Remove rubber knee protector pad.

2. Loosen clamp securing flexible coupling to steering shaft.

4. Remove stop bolt (see Figure 3D-4) from underside of steering column (secures steering shaft bushing to mast jacket), and pull steering wheel rearward approximately three inches.

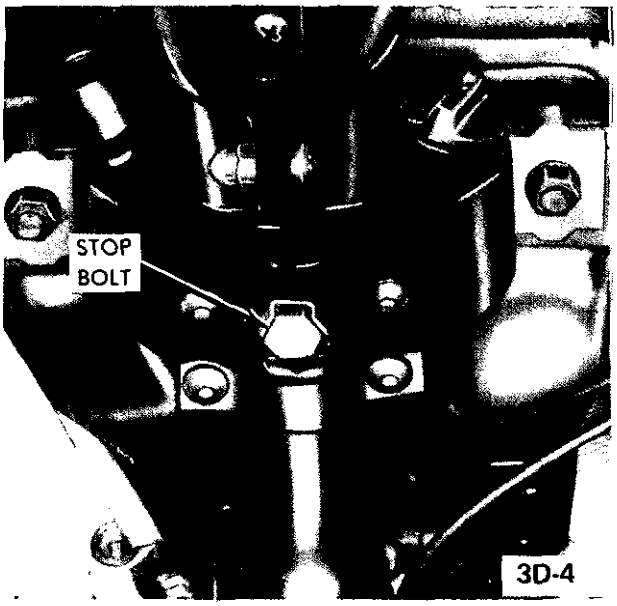

Figure 3D-4 Stop Bolt

4. Remove cotter pin located on left and right tie rod ends and unscrew nut.

5. Using remover J-21687, press ball studs out of steering arms (see Figure 3D-5).

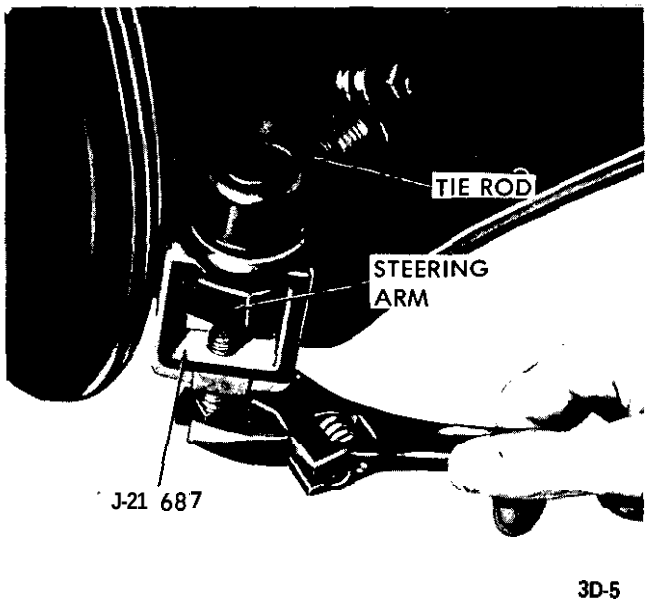

Figure 3D-5 Removing Ball Stud

6. Remove four attaching bolts securing steering gear to front suspension cross member (see Figure 3D-6) and lift off steering gear assembly and tie rods.

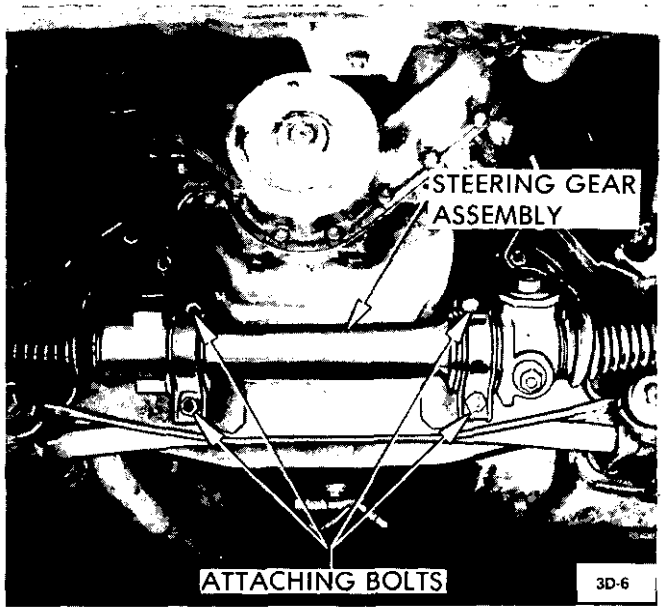

Figure 3D-6 Steering Gear Assembly Attaching Bolts

Removal (Opel 1900 - Manta)

1. Remove splash shield from lower deflector panel and both side members. See Figure 3D-7.

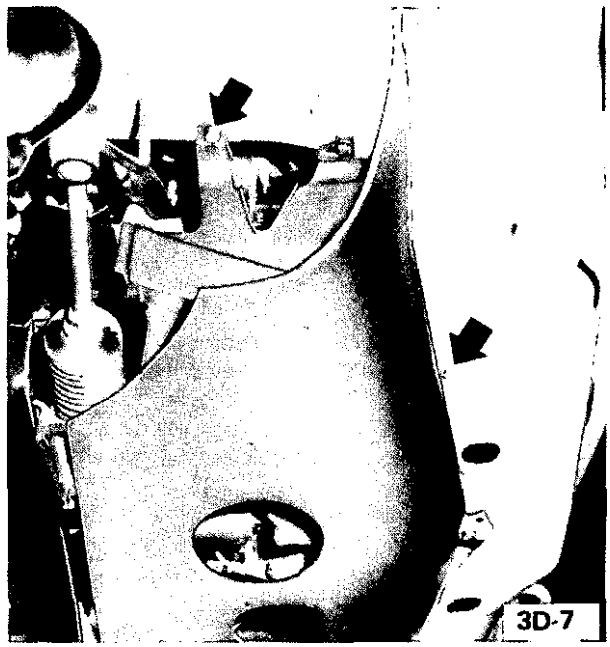

Figure 3D-7 Removing Splash Shield

2. Remove clamp bolt securing flexible coupling to steering shaft. See Figure 3D-8.

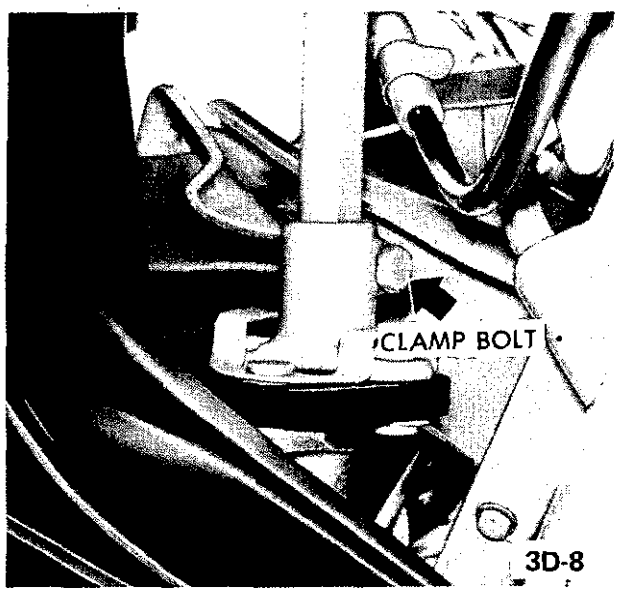

Figure 3D-8 - Removing Clamp Bolt

3. Remove cotter pin located on left and right tie rod end and unscrew nut.

4. Using Tool J-21687, press tie rod ends out of steering arms.

5. Disconnect steering gear housing from front suspension cross member and remove steering gear together with tie rods.

Installation . GT

CAUTION: ***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.***

1. Position steering gear on front suspension cross member and torque attaching bolts to 18 lb.ft.

2. Position tie rod ball studs in steering arms; install nuts and torque to 29 lb.ft. Lock in position with new cotter pins.

3. Fully turn steering wheel so that flat or cutout surface on lower portion of steering shaft is parallel to flexible coupling bolt hole.

4. Install the lower end of steering shaft to the flexible coupling and adjust dimension between steering wheel hub and direction signal switch housing cover to 1/8 and 3/32 inch. Maintain adjustment by tightening flexible coupling bolt and nut to 15 lb.ft. Lock the bolt and nut in position with lock-plate tabs.

5. Reinstall stop bolt into steering column.

6. Full turn steering wheel both right and left. If any resistance is noticeable, it will be necessary to remove the steering column and correct the cause.

D. Installation (Opel 1900 - Manta)

CAUTION: ***Fasteners are important attachingparts 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.***

1. Prior to installation, set steering gear to high point. The steering wheel spokes point downwards in an oblique angle. The elongated cutout of the lower steering mast must coincide with the clamp bolt hole of the pinion flange.

2. Position steering gear on front suspension cross member and torque attaching bolts to 29 lb.ft.

3. Position tie rod studs in steering arms. Install nuts and torque to 29 lb.ft. Lock in position with new cotter pin.

4. Install the lower end of the steering shaft to flexible coupling and torque clamp bolt to 22 lb.ft.

5. Attach guard plate to both side members and lower deflector panel.

DISASSEMBLY AND ASSEMBLY OF STEERING GEAR ASSEMBLY WITH TIE RODS

Disassembly - GT

1. Carefully clamp gear assembly in soft jaw vise and slip clamps and rubber bellows off gear housing to expose area where ball joint screws into rack.

2. Bend up round edges of lockplates from tie rod ball studs and disconnect tie rod ball studs from rack. See Figure 3D-9). It is important that rack be held secure with open end wrench to prevent damage to rack teeth.

3. Loosen adjusting screw lock nut; remove adjusting screw from steering gear housing, and take out thrust spring and sintered bronze shell. See Figure 3D-11.

4. Rotate gear assembly in vise so that pinion shaft portion of assembly is held by vise, and remove pinion nut, flat washer, and special washer.

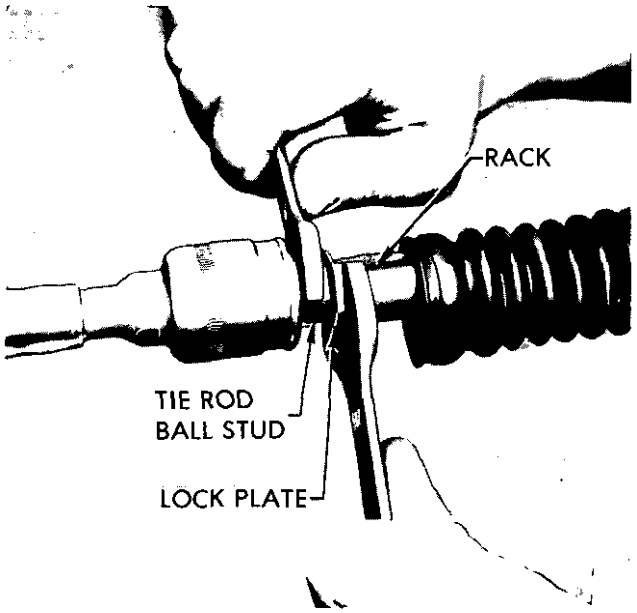

Figure 3D-9 Removing Tie Rods

5. Remove pinion shaft from gear assembly, and then withdraw rack from gear assembly.

6. From steering gear housing remove "0" rings from retainer and pinion bushing. Also take out thrust washer. See Figure 3D-17.

Disassembly (Opel 1900 - Manta)

1. Carefully clamp steering gear assembly in soft jaw vise.

2. Disconnect left and right tie rod end from respective axial joint (locknut). See Figure 3D-10. The ball joint of the tie rod end is maintenance-free, must not **be** disassembled and has to **be** replaced as an assembly only.

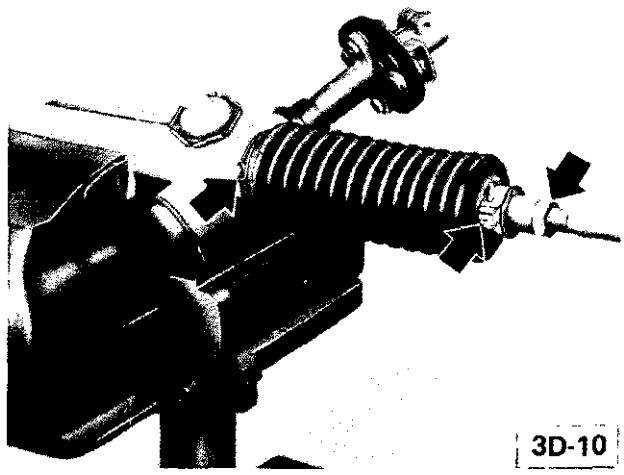

Figure 3D-10 Removing Tie Rod Ends from Axial Joint

3. Remove clamping wire and hose clamp from rubber bellows. Remove bellows from steering gear housing and axial joint. See Figure 3D-10.

4. Disconnect ball stud of axial joint from rack (lock plate, stop plate). To do this, counterhold rack with open-end wrench to avoid damage to the teeth. See Figure 3D-11. The axial joint is maintenance-free, must not be disassembled and has to be replaced as an assembly only.

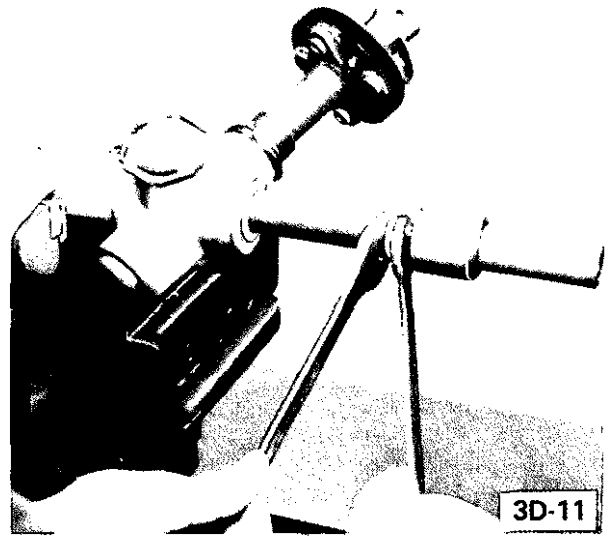

Figure 3D-11 - Removing Axial Joint

5. Loosen adjusting screw locknut, screw out adjusting screw and remove thrust spring as well as bearing shell out of adjusting screw opening.

6. Remove sheet metal cap from steering gear housing and remove hex nut from pinion. Do not turn pinion in end position.

7. Pull pinion and rack out of steering gear housing.

Reassembly. GT

1. Clamp steering gear housing in a soft jaw vise as shown (see Figure 3D-17) and reassemble new "0" rings onto retainer and pinion shaft bushing. Also install thrust washer onto pinion bushing.

Coat all moving parts during reassembly with suitable steering gear lubricant. Fill long end of housing with approximately 1-3/4 oz. steering gear lubricant.

2.. Insert long toothless end of rack into short end of housing until rack protrudes equally (approximately 2- 7/8 inch) out of both ends of housing. See Figure 3D- 13.

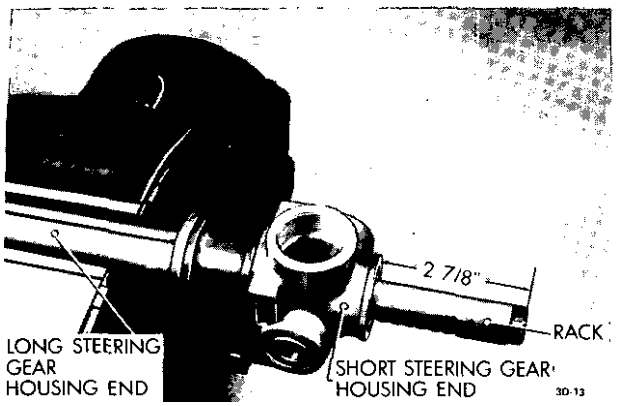

Figure 3D-13 Steering Gear Housing With Rack

Check to insure that three air channels of sintered metal bushing (See Figure 3D-17) are not obstructed by lubricant. If air channels are blocked, a vacuum condition in the bellows **may result** during operation of the gear assembly. Under such circumstances, the bellows will be drawn inward and jam into the rack teeth.

3. Reassemble pinion shaft into gear assembly so that spline in pinion shaft meshes with twelfth tooth of the rack. Use pinion mounting sleeve J-21712 during installation of pinion shaft to avoid damage to "0" ring in pinion bushing. When reassembling pinion shaft into gear housing, be sure that pinion is so positioned that bolt hole in pinion shaft flexible coupling is on top and parallel to the rack. See Figure 3D-14.

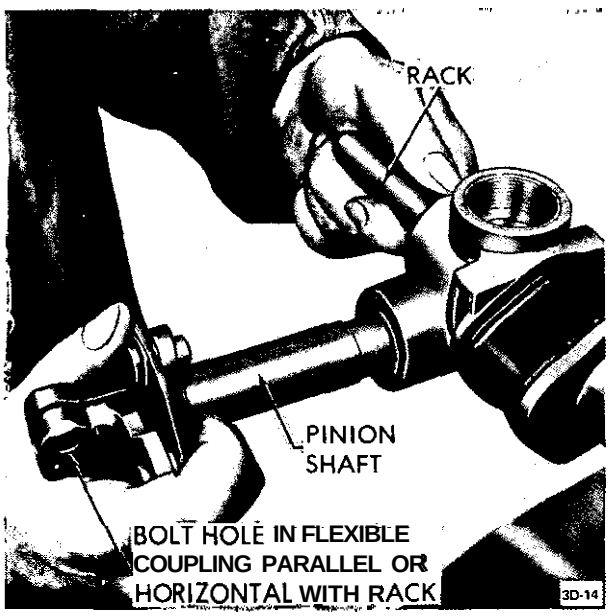

Figure 3D-14 Installing Pinion Shaft

4. Reassemble special washer, flat washer, and new pinion nut onto pinion shaft. Torque pinion nut to 11 lb.ft. Do not exceed torque due to possibility of jamming gear.

5. Place sintered bronze shell into steering gear housing **and** fill adjusting hole with Calcium Soap No. 2.

6. Reassemble thrust spring, adjuster screw and locknut on gear assembly.

Final adjustment of adjuster screw is performed after gear assembly and tie rods are installed in car. See Maintenance and Adjustments in this section for adjustment of steering gear.

7. Place rubber bellows, clamps, and new lock plates on ball stud portion of tie rods; and screw ball studs into rack while holding bent tab of lock plate against flat on rack. Torque ball studs 43 lb.ft. See Figure 3D-9. It is important that rack be held secure with open **end** wrench to prevent damage to rack teeth.

8. Bend **round** edges of lock plate over flat on ball stud to lock ball stud in position. See Figure 3D-15.

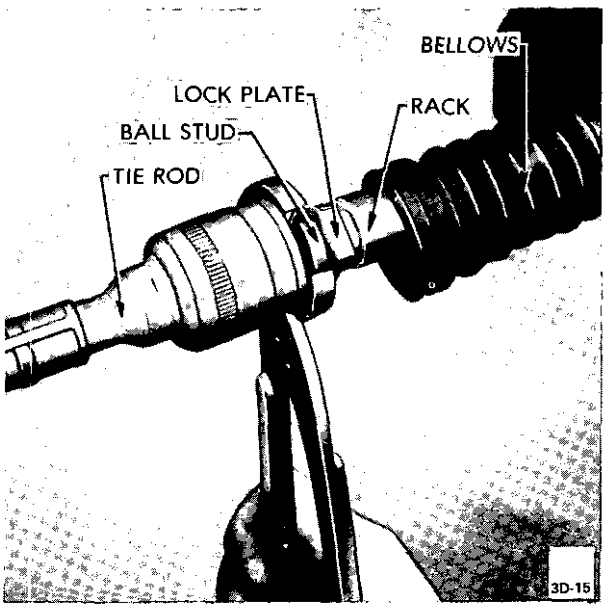

Figure 3D-15 Bending Lock Plate Over Ball Stud

9. Properly position rubber bellows and clamps over tie rod and gear housing and adjust clamps so that ends are pointing same direction as adjusting screw. Check that bellows is not twisted and will compress and expand properly.

Reassembly (Opel 1900 - Manta)

1. Clamp steering gear housing in a soft jaw vise and reassemble new "0" rings onto retainer and pinion shaft bushing. Also, install thrust washer onto pinion bushing.

Coat all moving parts during reassembly with suita-

ble steering gear lubricant. Fill long end of housing with approximately 1 3/4 oz. steering gear lubricant.

2. Insert long toothless end of rack into short end of housing until rack ends (A) protrude equally out of both ends of housing. See Figure 3D-16.

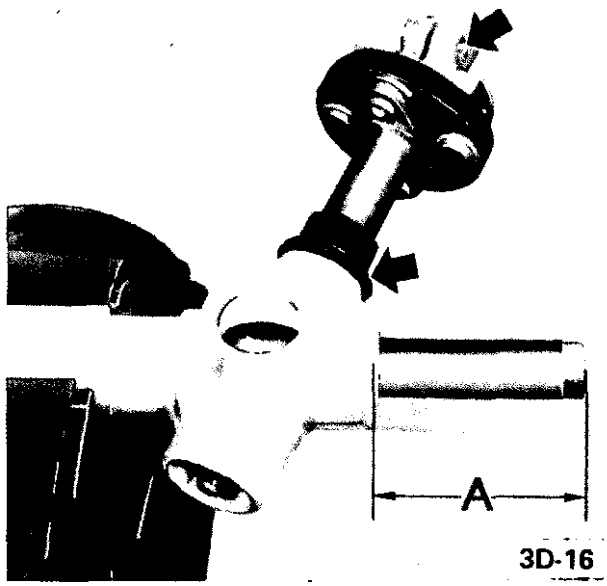

Figure 3D-16 - Steering Gear Housing With Rack

Check to insure that three air channels of sintered metal bushing are not obstructed by lubricant. If air channels are blocked, a vacuum condition in the bellows may result during operation of the gear assembly. Under such circumstances, the bellows will be drawn inward and jam into the rack teeth.

3. Reassemble pinion shaft into gear assembly so that spline in pinion shaft meshes with twelfth tooth of the rack. Use pinion mounting sleeve J-21712 during installation of pinion shaft to avoid damage to "0" ring in pinion bushing. When reassembling pinion shaft into gear housing, be sure that pinion is so positioned that bolt hole in pinion shaft flexible coupling is on top and parallel to the rack. See Figure 3D-16.

4. Reassemble special washer, flat washer, and new pinion nut onto pinion shaft. Torque pinion nut to 11 lb.ft. Do not exceed torque due to possibility of jamming gear.

5. Place sintered bronze shell into steering gear housing and till adjusting hole with suitable steering gear lubricant.

6. Reassemble thrust spring, adjuster screw and locknut on gear assembly. Torque locknut to 43 lb.ft.

7. Screw ball stud of the axial joint together with stop plate onto both ends of the rack. Torque to 47 lb.ft. Counterhold rack with open-end wrench.

8. Slide rubber bellows onto axial joint and steering gear housing. Attach rubber bellows with loose clamp and clamping wire. Check that rubber bellows is not twisted.

SPECIFICATIONS

Tightening Specifications

Part	Location	Torque Lb.Ft.
Bolt	Flexible Coupling Clamp (GT)	15
Bolt	Flexible Coupling Clamp (1 900 - Manta)	22
Nut	Tie Rod Ball - Connects to Rack (GT)	43
Nut	Ball Stud - Axial Joint to Rack (1900 - Manta)	47
Nut	Tie Rod Lock Nut (1900 - Manta)	49
Bolt	Steering Gear Housing to Front Suspension Crossmember (GT)	18
Bolt	Steering Gear Housing to Front Suspension Crossmember (1 900 - Manta)	29
Nut	Adjusting Screw Lock Nut	43
Nut	Pinion	11
Nut	Tie Rod to Steering Arm	29

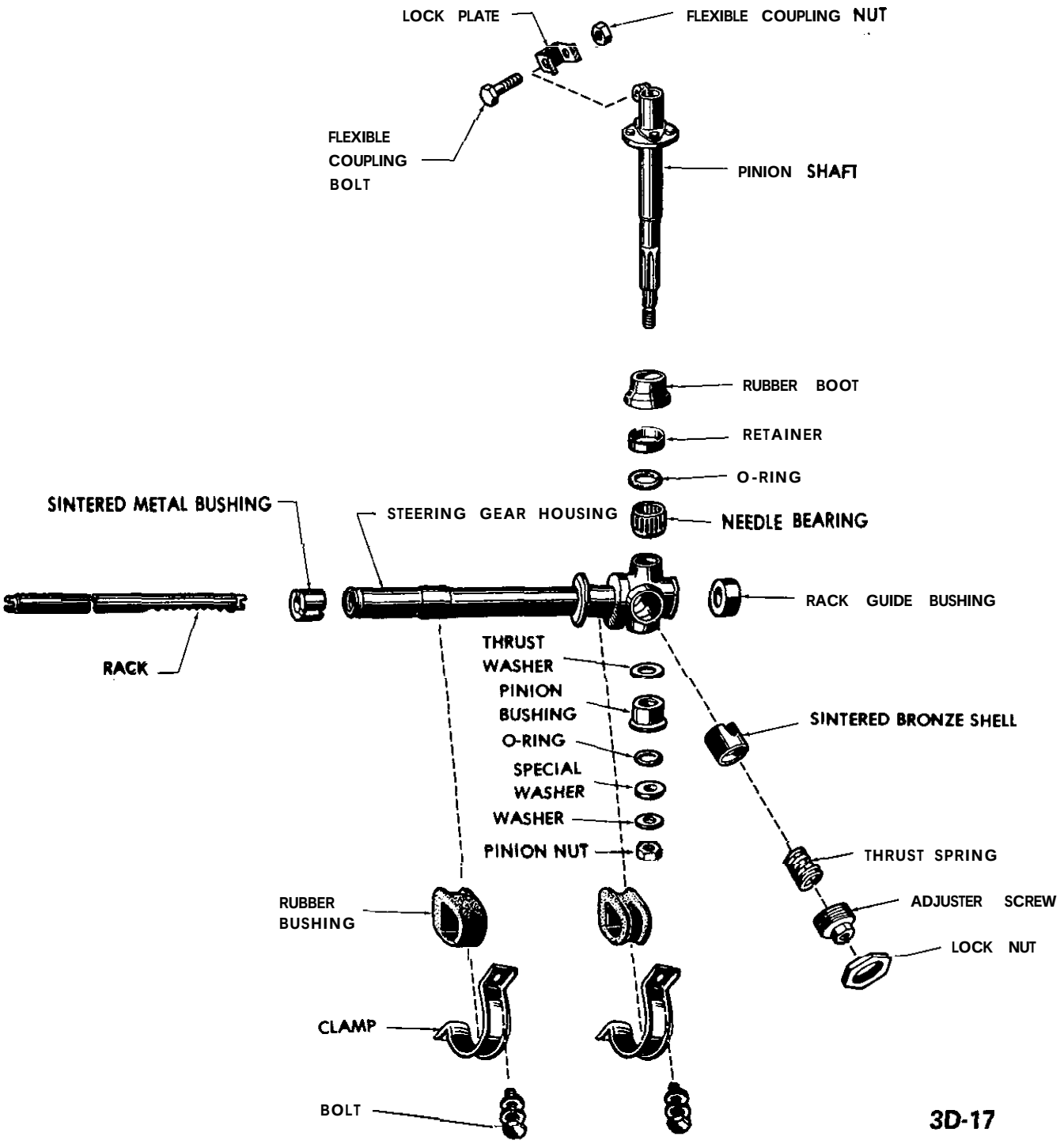

Figure 3D-17 Steering Gear Assembly Exploded View

OPEL 1900 AND MANTA STEERING COLUMN ASSEMBLY

CONTENTS

DESCRIPTION AND OPERATION

DESCRIPTION AND OPERATION OF DIRECTIONAL SIGNAL LEVER

The direction signal switch lever is a multi- purpose lever controlling direction signals, passing signal and headlight high and low beams. See Figure 3E-2.

The direction signal lever is provided with a two-step mechanism for operation of headlight high and low beams, and passing signal (not in N.J.). With headlights off, moving the lever repeatedly towards steering wheel flashes headlights as a passing signal. With headlights on, moving the lever repeatedly towards steering wheel up to first stop also flashes passing signal regardless whether or not the direction signals are switched on. When the lever is moved up to the second stop, the headlights are changed from high to low beam or vice versa. On all 1900 Rallye cars, when switching from low to high beam position, with the fog lamp instrument panel switch ON

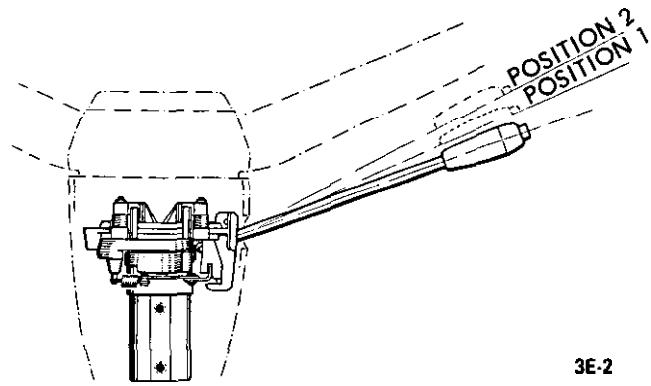

Figure 3E-2 Directional Signal Lever Position for Headlamp Operation

and ignition switch in RUN position, the fog lights are automatically switched off. Direction signals work in the normal manner; pushing the lever up for right turn signal and pulling the lever down for left turn signal.

DESCRIPTION AND OPERATION OF HORN

The horn button is located in the center part of the steering wheel. The horn is actuated by pushing on the ends of the spokes for the Opel 1900 - Manta and by pushing on the center horn button on 57R, 57L, and GT. The button is provided with a plug connection for each springloaded plunger. See Figure 3E-3.

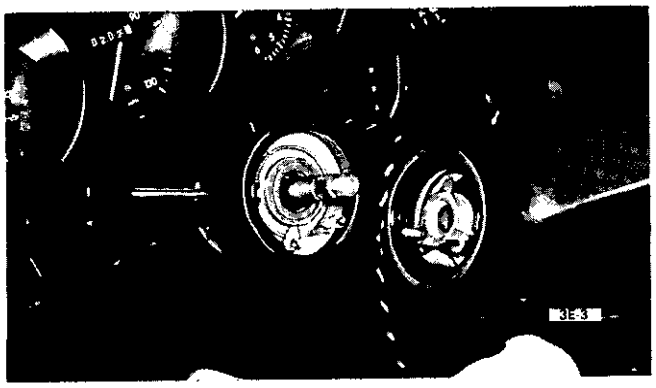

Figure 3E-3 Horn Button Connections (Opel 1900 Manta)

DESCRIPTION OF STEERING COLUMN ASSEMBLY

The steering column mast jacket is provided with a tube-frame section (See B of Figure 3E-4) with bulges which compresses or folds itself, if a sufficiently large energy is exerted to one or other end of the steering mast jacket assembly. This tube-frame section absorbs most of the energy. The steering column consists of two parts, the upper and lower mast jacket assembly and'the steering shaft. The upper steering mast is firmly connected to the tube while the lower steering mast is clearance-free attached to the tube by means of injected plastic (See Figure 3E-4). Consequently, the steering mast withstands all torsional stresses.

As soon as the primary energy becomes effective, the plastic pins (c) shear off and the steering shaft compresses. Thereafter the steering mast **jacket** is partly compressed.

A slide-off base is welded to the steering mast jacket. It is provided with two (2) slots for the respective attaching bolts. A metal piece (See Figure 3E-4) is located in each slot which is attached to the slide-off **base** with injected plastic. The open sides of the slots face the driver so that the primary energy cannot push the steering mast jacket assembly into the passenger compartment. The secondary energy caused **by** the driver can on the other hand effect a shearing of the plastic pins and loosening of the slide-off base so that it moves downwards. Thereby the steering mast jacket assembly is compressed further and absorbs the impact energy to a large extent.

The energy absorbing steering is not more susceptible to damage than a standard steering. However, the steering mast jacket assembly, especially if removed, has in contrast with the standard steering to be given a different treatment.

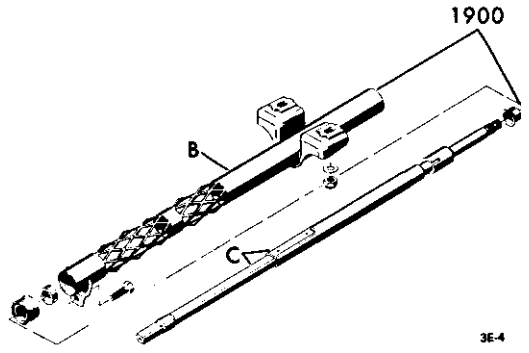

Figure 3E-4 Energy Absorbing Steering Column

The energy absorbing steering column must **by no** means be subject to impacts or blows. A sharp blow onto the exposed steering shaft ends, leaning onto steering column or dropping may loosen or even shear off the plastic attachments which bring **about** rigidity of assembly. In spite of a steering column damaged in this way the operating function of the steering is retained due to the lateral flattenings on steering shaft tube and lower steering shaft. However, after a short period of operation rattling noises will be noticeable so that the steering column has to be replaced. For pulling steering wheel off steering column use appropriate special tool. Therefore, it is of importance that the instructions for removal and installation as well as disassembly and assembly are Strictly adhered to.

MAJOR REPAIR

REMOVAL AND INSTALLATION OF STEERING COLUMN ASSEMBLY

The removal of this assembly is only necessary for

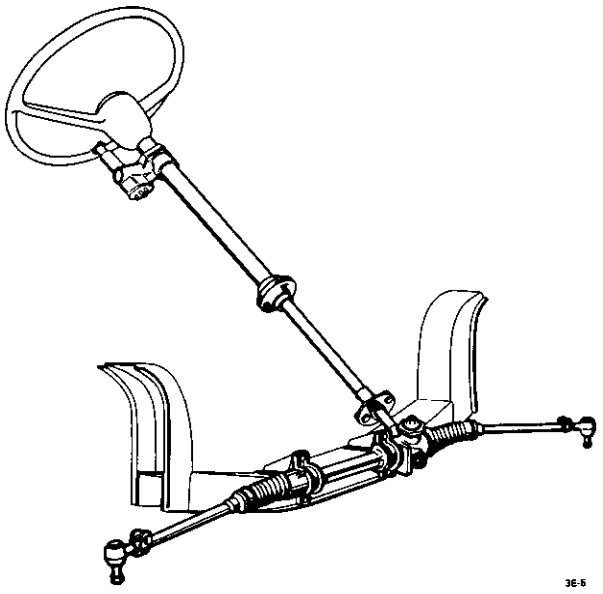

Figure 3E-5 Steering Column Assembly With Gear

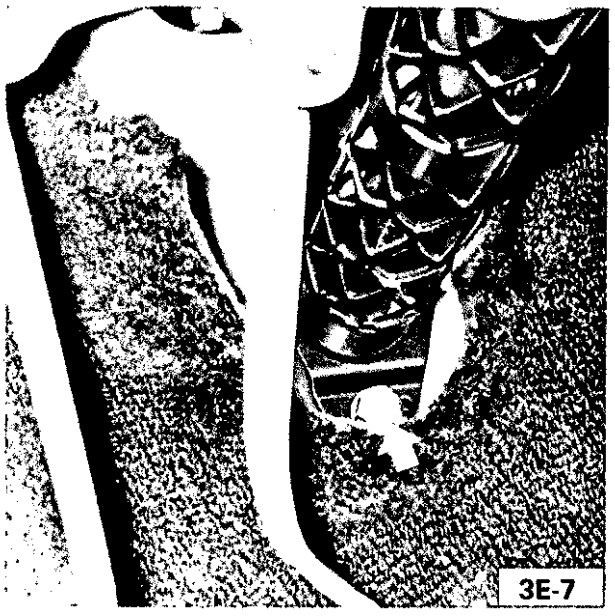

Figure 3E-7 - Steering Mast Jacket Attachment

replacement of steering column or steering ignition lock parts.

Removal (Opel 1900 . Manta)

1. Disconnect battery.

2. From underside of car, remove clamp screw of upper steering mast out of universal joint flange. See Figure 3E-6.

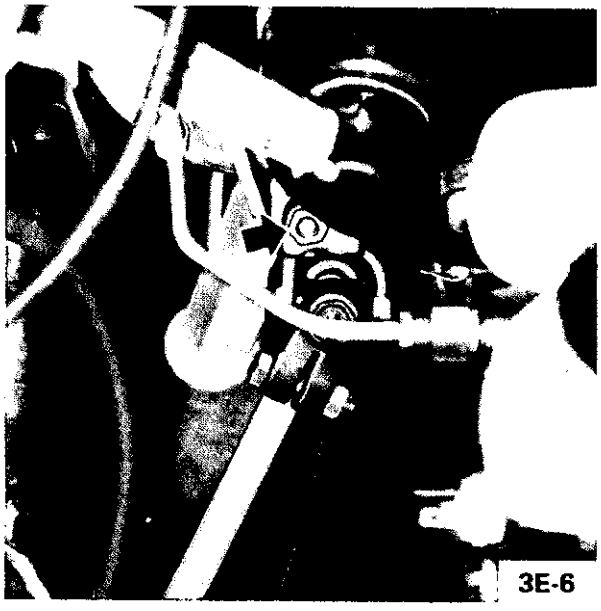

Figure 3E-6 Upper Steering Mast Clamp Screw

3. Remove hex nut from steering mast jacket attachment at front of dash panel. See Figure 3E-7.

4. Pull off signal switch, as well as steering and ignition lock wire sets.

5. Unscrew slide-off base from underside of instrument panel and remove steering column assembly from car. See Figure 3E-8. Carefully put down assembly. Avoid impacts and blows to steering column assembly.

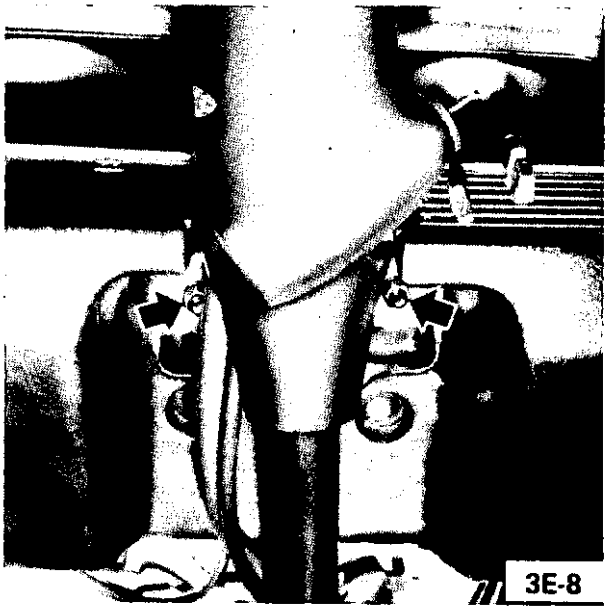

Figure 3E-8 - Slide-Off Base Attaching Nuts

Installation (Opel 1900. Manta)

CAUTION: ***Fasteners are important attaching parts in that they could affect the performance of vital com-***

ponents and systems, and/or could result in major repair expense. They must be replaced with one or 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.

On installation, make sure steering wheel spokes point downwards and steering gear is in high point.

1. Carefully insert steering mast into universal joint flange.

2. Loosely attach slide-off base attaching nuts at underside of instrument panel.

3. Attach steering mast jacket at front of dash, using a notched hex nut.

4. Torque nuts at slide-off base to II lb.ft.

5. Tighten screw at steering mast clamp to 22 lb.ft.

6. Reconnect wires to directional signal switch and ignition switch.

7. Reconnect battery.

REMOVAL AND INSTALLATION OF STEERING WHEEL

This procedure may be performed with the steering column assembly either removed or installed in the car.

Removal

1. Disconnect battery.

2. Pry off horn cap and remove wires from cap. See Figure 3E-3.

3. **Bend** lockplate tabs down and take off steering shaft nut and lockplate.

4. Install steering wheel remover J-21686 as shown in Figure 3E-9 and pull off steering wheel.

Installation

1. Before installing steering wheel, lubricate return pin and sliding area on directional signal switch return cams and horn contact ring.

2. Make sure that clamp bolt in steering shaft flange is on top.

3. Make sure notch on steering shaft face is in horizontal position.

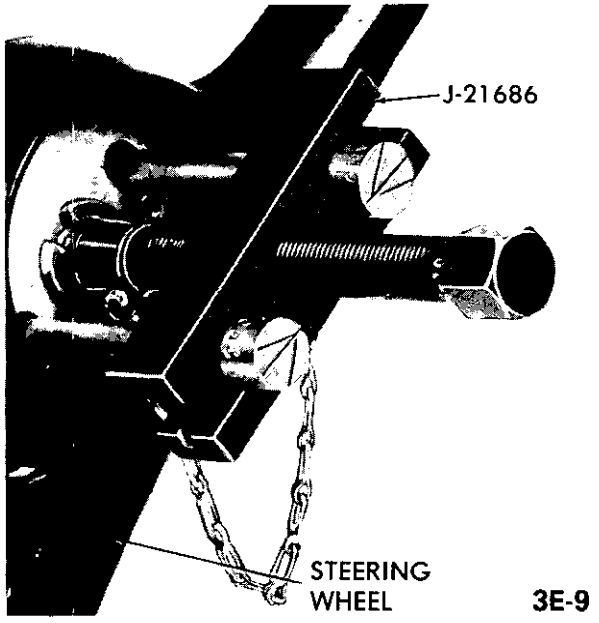

Figure 3E-9 Removing Steering Wheel

4. With the steering wheel centered, place the steering wheel onto the steering shaft.

5. Install steering wheel lockplate and **nut.** Torque to 11 lb.ft.

CAUTION: ***This steering wheel to steering shaft 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.***

6. Bend lockplate tabs up, connect horn cap wires and replace cable and cap.

7. Reconnect battery.

REMOVAL AND REPLACEMENT OF HORN CONTACT RING

1. Remove steering wheel.

2. Cut off defective contact ring at wire.

3. Strip wire approximately 1/8".

4. Install new part and solder connection with resin core solder.

5. Lubricate contact ring with lubriplate, or equivalent.

6. Reinstall steering wheel.

DISASSEMBLY AND REASSEMBLY OF DIRECTIONAL SIGNAL SWITCH

This procedure may be performed with the steering column assembly removed or installed in the car.

Disassembly (Opel 1900. Manta)

1. Remove steering wheel (see paragraph above).

2. Pull off signal switch and steering and ignition lock wire set.

3. Pull directional signal lever out of seat. Lever is held in place by a lock ball.

4. Unscrew lower half of signal switch housing cover. See Figure 3E-10.

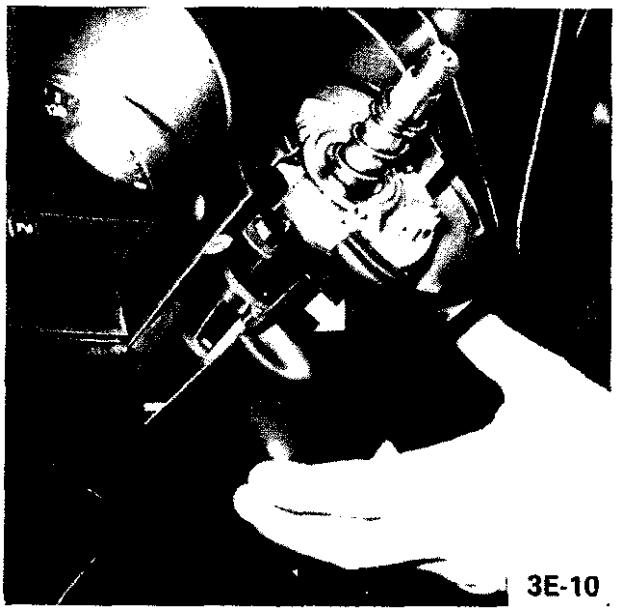

Figure 3E-10 Lower Half of Signal Switch Housing Cover

5. Remove hex nut from steering mast jacket attachment at front of dash panel. See Figure 3E-7.

6. Unscrew slide-off base from underside of instrument panel and remove upper part of signal switch housing cover. See Figure 3E- 11.

7. Place a thick piece of wood onto front seat and let down steering mast jacket assembly. When doing this, the front seat must be in its front position.

8. Centerpunch tear-off bolt for steering and ignition lock bracket attachment. Drill a. 12 in. (3mm) diameter hole, using an angular-type drill and with a bolt remover with left-hand twist screw out bolt. See Figure 3E-12.

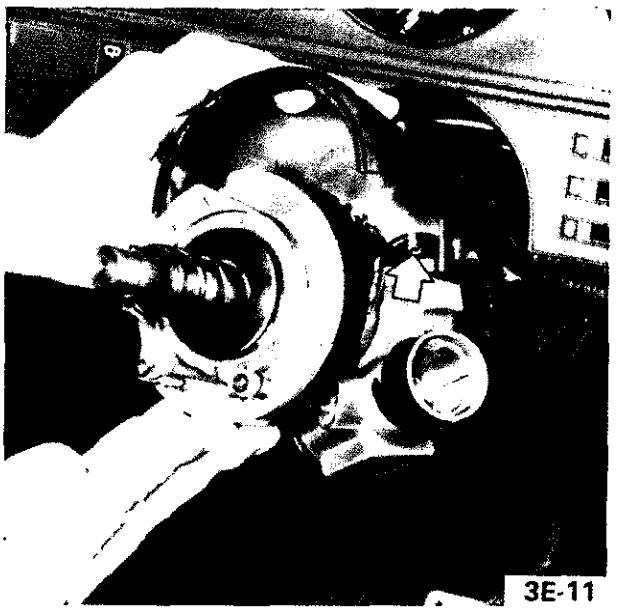

Figure 3E-11 Removing Upper Part of Signal Switch Housing Cover

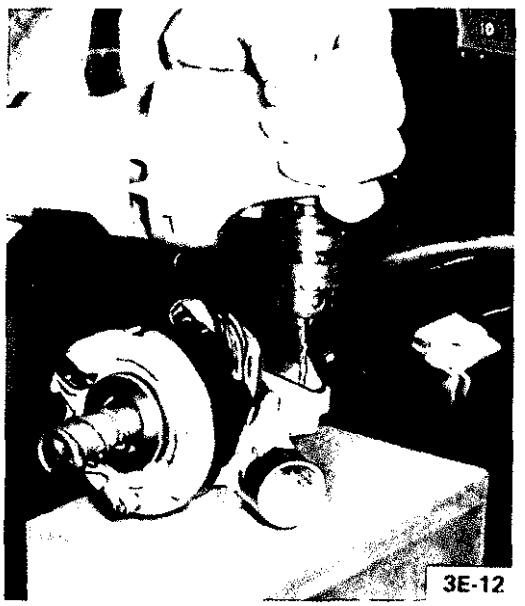

Figure 3E-12 Removing Tear-Off Bolt

9. Remove steering and ignition lock, as well as signal switch from steering mast jacket and *loosely* attach slide-off base below instrument panel.

Reassembly (Opel 1900 • Manta)

1 When replacing a new directional signal switch, install new bearing and snap ring in switch assembly.

2. Install signal switch, as well as steering and ignition lock, to steering mast jacket. To do this, screw

on steering and ignition lock bracket using a new tear-off bolt (hexagon head tears off).

3. Disconnect slide-off base, install upper half of signal switch housing cover, and loosely reattach slide-off base.

4. Attach steering mast jacket at front of dash panel. See Figure 3E-7.

5. Torque slide-off base attaching nuts to 11 lb.ft.

6. Install lower half of signal switch housing cover and connect signal switch, as well as steering ignition lock wire set.

7. Install steering wheel and torque nut to 11 lb.ft. Always use new lock plate.

DISASSEMBLY AND REASSEMBLY OF STEERING AND IGNITION LOCK CYLINDER AND ELECTRICAL SWITCH FROM MAST JACKET ASSEMBLY

Disassembly. GT

Disconnect the **battery** before proceeding.

1. Remove steering wheel.

2. Turn ignition switch to ON position.

3. Insert a suitable rod into stop pin hole on side of steering and ignition lock (See Figure 3E-13) and take out steering and ignition lock cylinder.

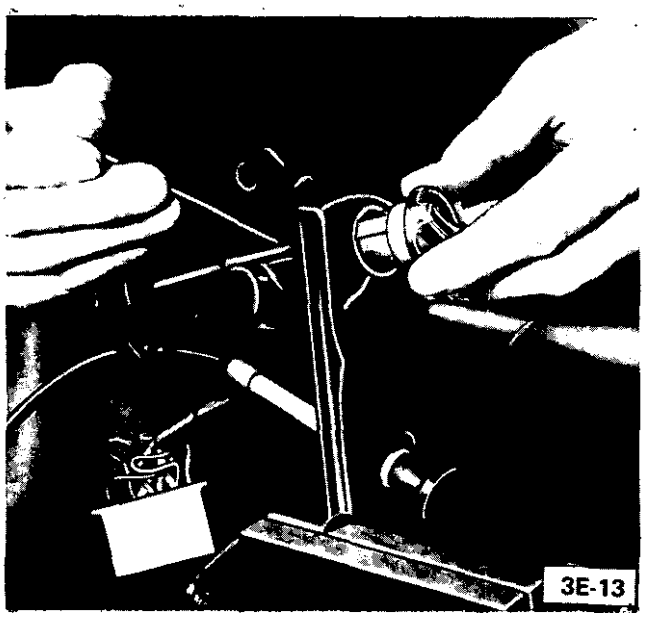

Figure 3E-13 Removing Ignition Lock Cylinder

4. Remove two screws securing electrical switch to steering and ignition lock housing and take out switch.

Disassembly (Opel 1900 . Manta)

1. Remove steering wheel.

2. Unscrew split signal switch housing cover and remove lower half. See Figure 3E-10.

3. Remove lock cylinder by pushing in lock spring of the cylinder using a piece of wire. Cylinder must be in the " 1" position. See Figure 3E-14.

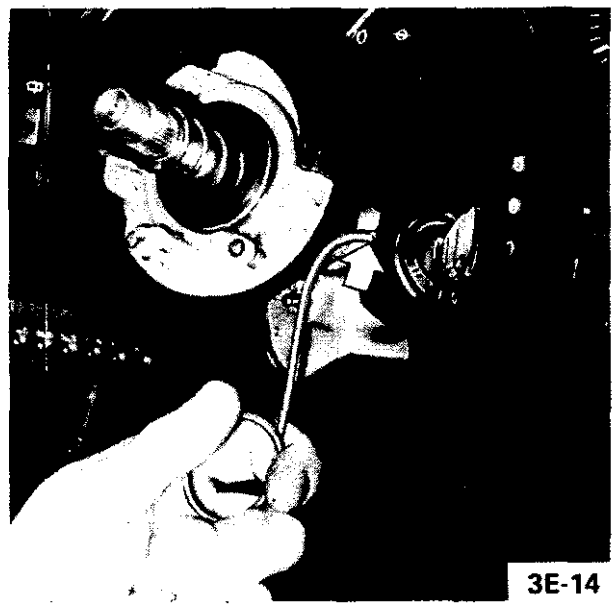

Figure 3E-14 Removing Lock Cylinder

Reassembly

1. On the GT reassemble electrical switch into steering and ignition **lock** housing and rotate switch until: (1) cam in lock housing recess fits into slotted hole in rear of electrical switch, and (2) projection on electrical switch fits into recess on lock housing.

2. On the Opel 1900 - Manta, insert lock cylinder in the " 1" position into housing. Install lower half of signal switch housing.

3. Reinstall steering wheel.

SPECIFICATIONS

Steering Column Tightening Specifications

Part	Location	Torque Lb.Ft.
Nut	Steering Wheel Retaining (1900 - Manta)	11
Bolt	Steering Column Flexible Coupling (1900 - Manta)	22
Nut	Slide Off Base Attaching (1 900 - Manta)	10
Nut	Mass Jacket (1 900 - Manta)	11
screw	Steering Mast Clamp (1900 - Manta)	22

GT STEERING COLUMN ASSEMBLY

CONTENTS

DESCRIPTION AND OPERATION

DESCRIPTION OF STEERING COLUMN

The Energy Abosrbing, Locking Steering Column assembly is used on the GT. This column is designed to compress under impact. When an automobile is being driven, the forward movement of the automobile and the forward movement of the driver both constitute a form of energy or force. When an automobile is involved in a frontal collision, the primary force (forward movement of the car) is suddenly halted, while the secondary force (the driver) continues its forward direction. A severe collision generally involves these two forces - the primary and the secondary forces. The secondary impact occurs when the driver is thrust forward onto the steering wheel and column.

The Energy Absorbing Column is designed to absorb these primary and secondary forces to the extent that the severity of the secondary impact is reduced. During a collision, the steering column compresses and thereby reduces its tendency to move rearward into the driver's compartment. A split second later when the driver is thrown forward (the secondary impact) his energy is also partially abosrbed by the compression characteristics of the column.

The Energy Absorbing, Locking Column assembly may be easily disassembled and reassembled. The serviceman should be aware that it is important that only the specified screws, bolts and nuts be used as designated during reassembly, and that they are tightened to their specified torque. This precaution will insure the energy absorbing action of the assembly. Particular care should be exercised to avoid using overlength bolts as they may prevent a portion of the assembly from compressing under impact. Equally as important is correct torquing of all bolts and nuts.

When the Energy Absorbing, Locking Column is

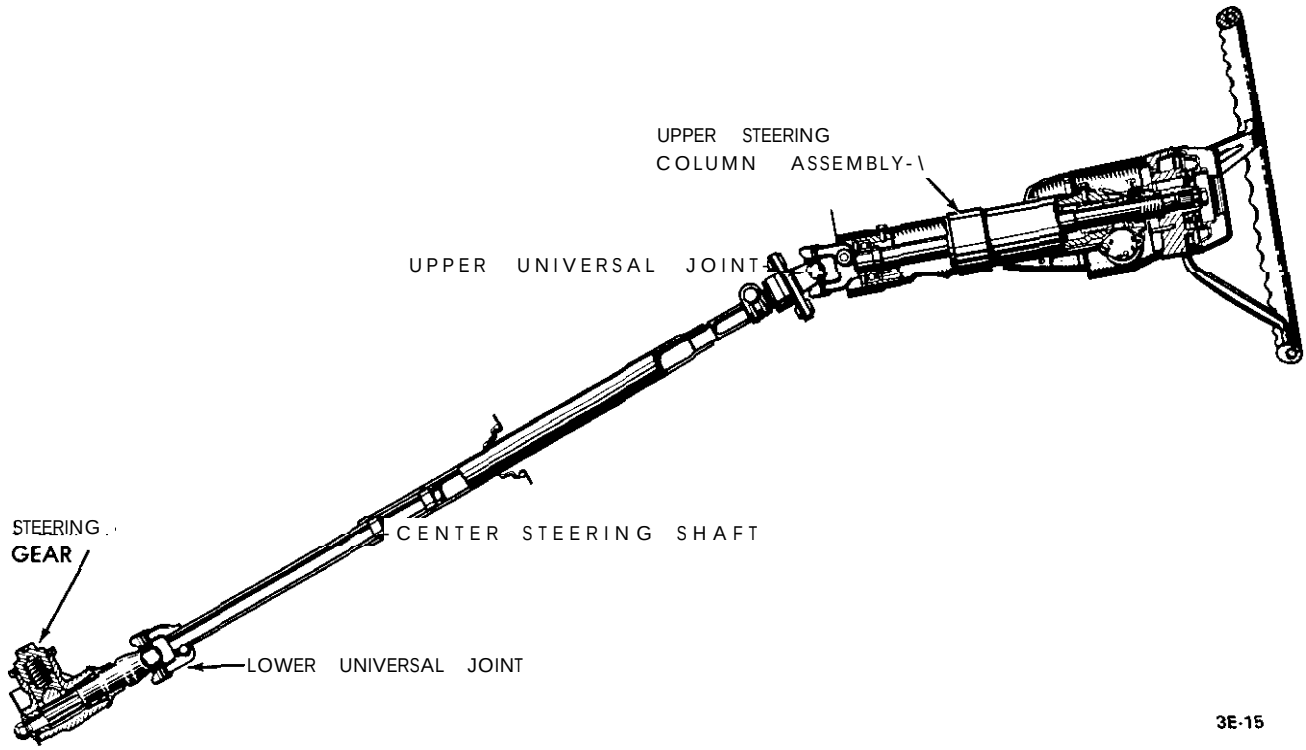

Figure 3E-15 GT Steering Column Assembly

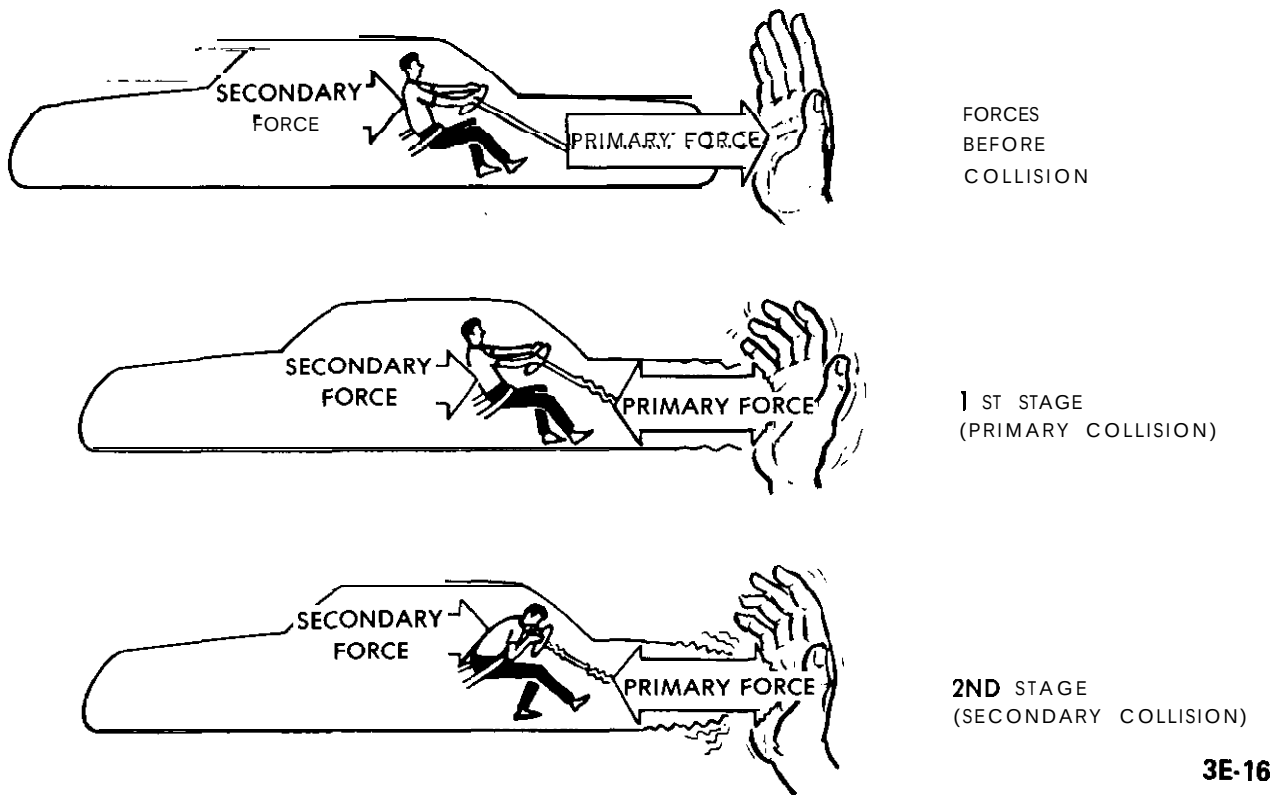

Figure 3E-16 Reaction of Forces in a Collision

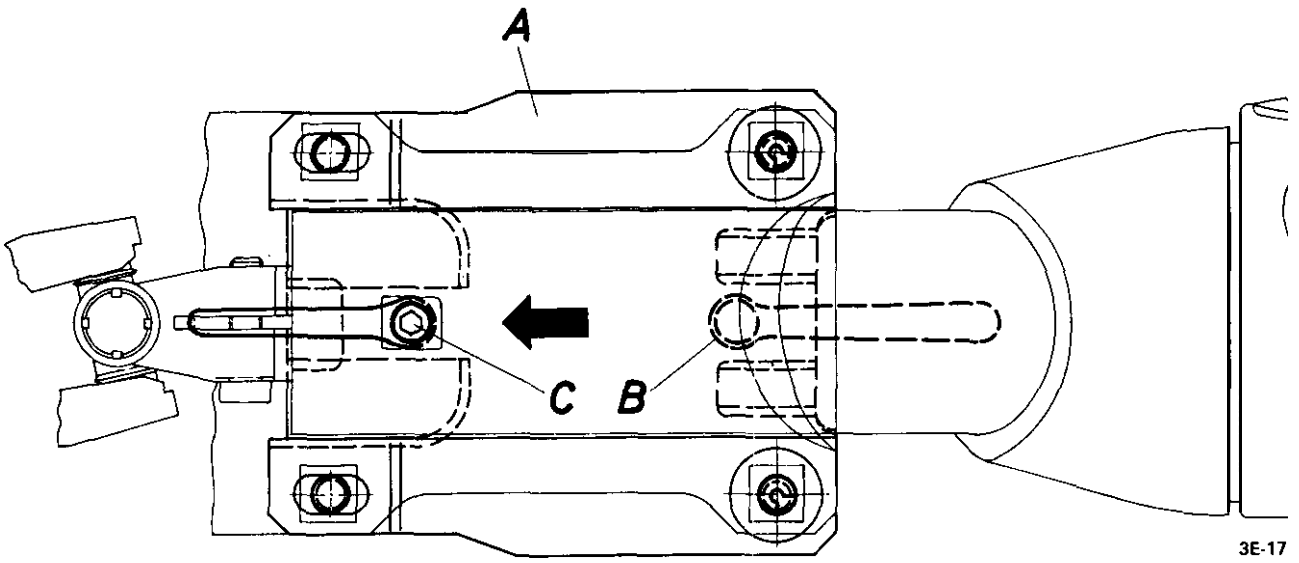

Figure 3E-17 Steering Column Bracket

installed in a car it is no more susceptible to damage through usage than an ordinary column; however, when the column is removed, special care must be taken in handling this assembly. *Only the specified wheel puller should be used.*

When the column is removed from the car, such actions as a sharp blow on the end of the steering shaft laying things across or on top of the column assembly, leaning on the column assembly, or dropping of the assembly could shear or loosen the plastic fasteners that maintain column rigidity or possibly bend the assembly causing a binding condition. *It is therefore important that the removal and installation and the disassembly and reassembly procedures be strictly followed when servicing this assembly.*

The steering column assembly is attached with a bracket (A) at four points to the connecting brace below the instrument panel. See Figure 3E-17. The two upper bolts are designed as tear-lock-bolts. A bolt (B) is welded to the bracket which engages in an narrowing elongated hole. The same applies to the upper bolt (C) of the steering column lower bearing attachment which engages in a hole of the connecting brace.

As soon as a sufficiently large secondary energy becomes effective, the steering mast jacket slides towards the front whereby the bolt (B) as well as the bolt head (C) is additionally pushed into the respective narrowing elongated holes. Both elongated holes are arranged so that the primary energy cannot push the steering mast assembly into the passenger compartment.

The GT steering column incorporates two universal joints to allow for the offset between the steering column and the gear assembly.

The upper steering column assembly is connected to the center steering shaft with one universal joint, while the lower universal joint connects the center steering shaft to the steering gear pinion shaft.

REMOVAL AND INSTALLATION

REMOVAL AND INSTALLATION OF STEERING WHEEL

This procedure may be performed with the steering column assembly either removed or installed in the car.

Removal

1. Disconnect battery.

2. Remove horn cap.

3. Bend lockplate tabs down and remove steering wheel nut, lockplate and washer.

4. Mark shaft and wheel hub for reassembly alignment.

5. Remove steering wheel using steering wheel puller J-21686. Do not rap on end of puller in order to free wheel from shaft as this would very likely loosen plastic injections that maintain steering shaft rigidity. Striking of underside of steering wheel to jar it

loose must never be done. The only recommendation for freeing frozen steering wheels is to use a penetrating lubricant.

Installation

1. Before installing steering wheel, lubricate return pin and slide area on direction signal switch return cams and horn ring contact.

2. With steering wheel properly aligned to shaft, install lockplate and nut. Torque nut to 15 lb.ft.

CAUTION: ***This steering wheel to steering shaft 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.***

3. Bend up lockplate tab and install horn cap.

4. Reconnect battery.

REMOVAL AND INSTALLATION OF IGNITION LOCK CYLINDER

Removal

This procedure may be performed with the steering column assembly either removed or installed in the car.

1. Remove steering wheel, as outlined previously in this Group.

2. Position lock cylinder to run position.

3. Using suitable piece of wire, push in lock cylinder retaining pin and remove lock cylinder. See Figure 3E- 18.

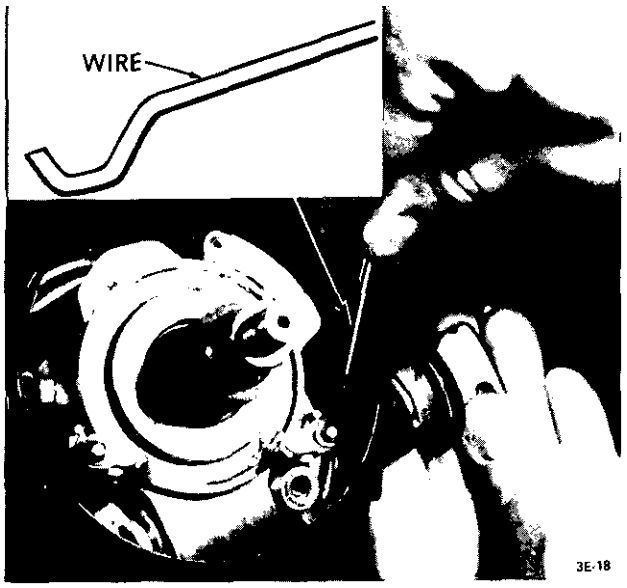

Figure 3E-18 Removing Lock Cylinder

Installation

1. Insert lock cylinder into lock cylinder housing.

2. Install steering wheel, as outlined previously in this section.

REMOVAL AND INSTALLATION OF STEERING COLUMN ASSEMBLY

Removal

1. Position steering so that front wheels are straight ahead.

2. Loosen steering shaft upper universal joint lower clamp bolt. See Figure 3E-19.

3. Drill off heads of both tear bolts by first drilling an 3/16 inch pilot hole and then inserting a 1/4 inch bolt extractor to remove lockbolt.

4. Disconnect ignition (white) and direction signal (black) wire set plugs.

5. Support steering column assembly and remove both hex. head bolts.

6. Pull steering column assembly off center steering shaft. Do not apply any force as plastic injections in center steering shaft may be loosened and shaft would then require replacement.

Installation

CAUTION: ***Fasteners are important attachingparts 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.***

1. Install steering column assembly onto steering shaft and torque steering shaft upper universal joint lower clamp bolt to 14 lb.ft.

2. Install hex head bolts and torque to 14 lb.ft.

NOTE: ***Be sure to install ground wire.***

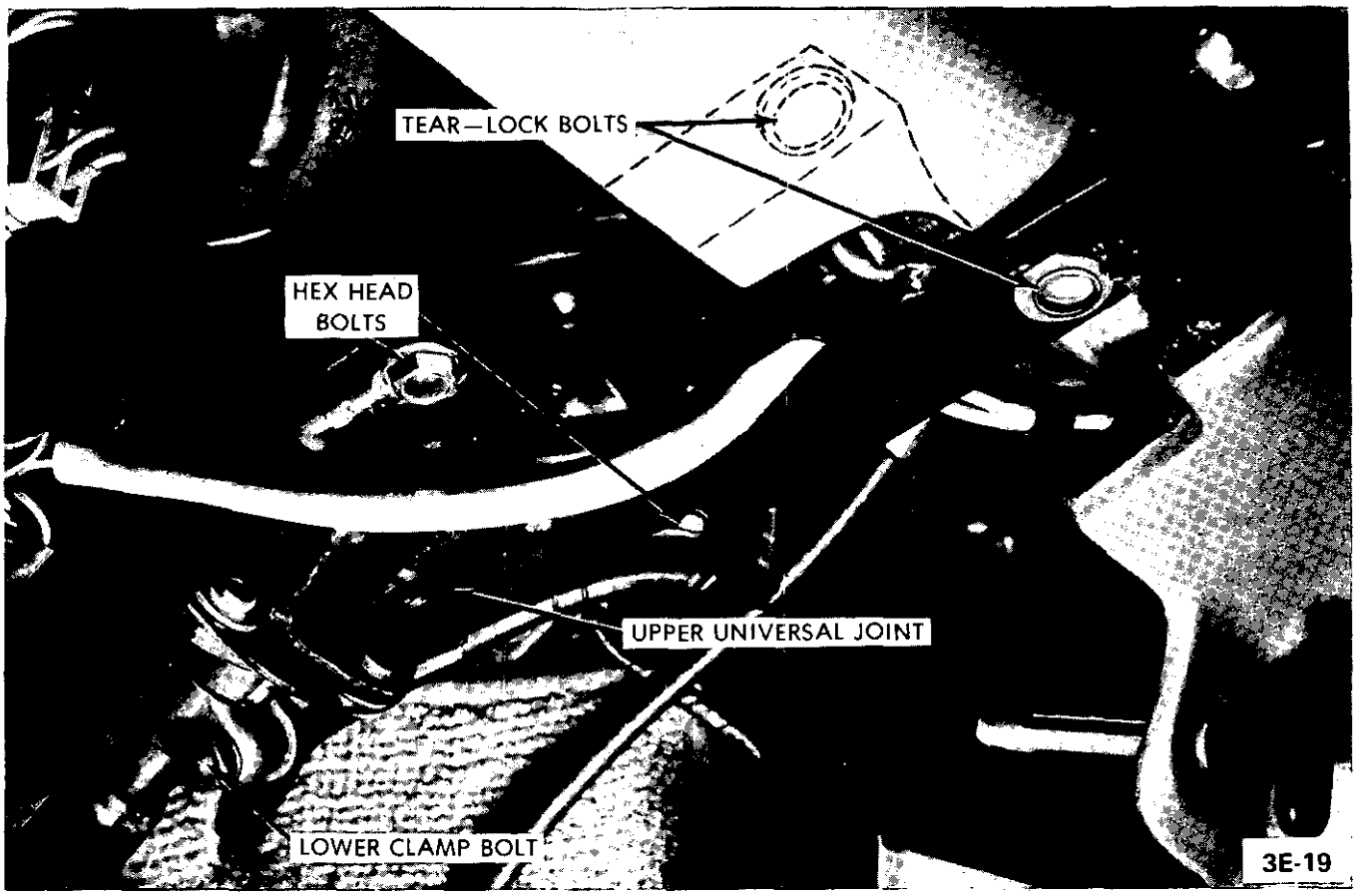

Figure 3E-19 Steering Column Attachments

3. Install new tear bolts and tighten until hex head of bolt is tom off.

4. Reconnect ignition and direction signal wire sets.

REMOVAL AND INSTALLATION OF CENTER STEERING SHAFT

Removal

Steering shaft must be handled carefully so as not to loosen plastic injections as shaft would then require replacement.

1. Position steering so that front wheels are straight ahead.

2. Loosen steering shaft upper universal joint lower clamp bolt.

3. Remove steering shaft lower universal joint upper clamp screw.

4. Carefully push center steering shaft up into steel washer joint until lower end is free.

5. Remove steering shaft through bottom.

Installation

CAUTION: *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 or lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.*

1. Install steering shaft through bottom and position into upper universal joint.

2. Insert shaft into lower universal joint and torque bolt to 22 lb.ft.

3. Torque upper universal joint bolt to 14 lb.ft.

REMOVAL AND INSTALLATION OF IGNITION SWITCH AND/OR STEERING LOCK

Removal

1. Remove ignition lock cylinder, see previous paragraph in this section.

2. Disconnect ignition (white) wire set plug.

3. Remove steering lock retaining screw. See Figure 3E-20.

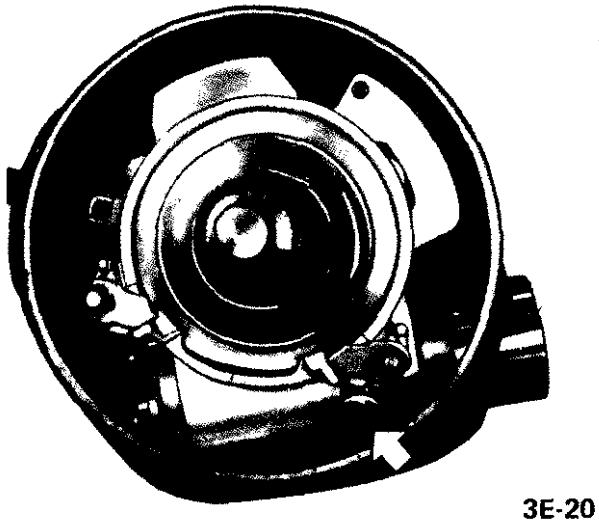

Figure 3E-20 Steering Lock Retaining Screw

4. Remove direction signal switch lever.

5. Remove three screws securing signal switch cover to housing.

6. To remove housing cover, (a) pull cover toward direction signal switch and move it slightly to the right. See Figure 3E-21. (b) Turn cover toward the left and move it further to the right so that the left retaining screw ear is positioned under the left signal switch return cam. See Figure 3E-22. (c) Insert direction signal switch lever into oblong opening in cover and push steering lock into housing and remove cover. See Figure 3E-37.

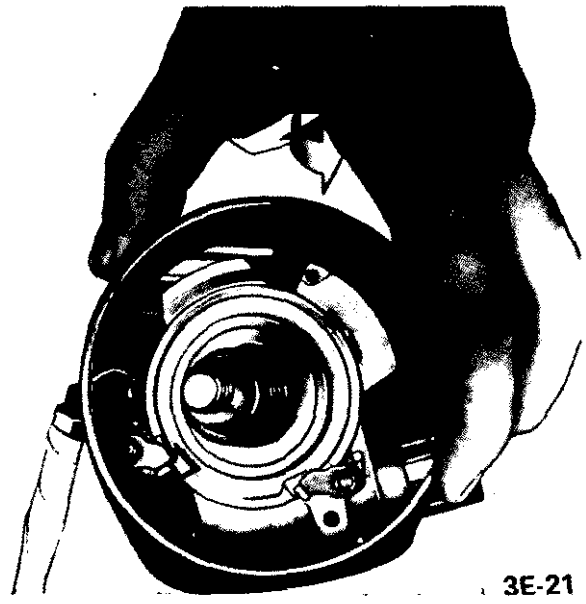

Figure 3E-2 1

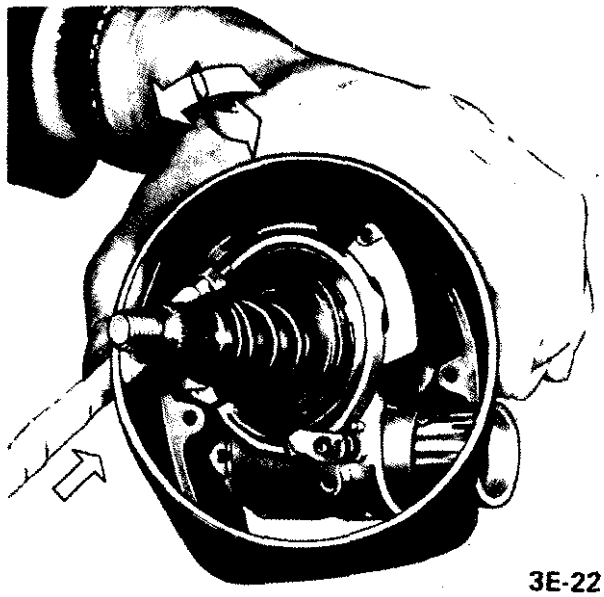

Figure 3E-22

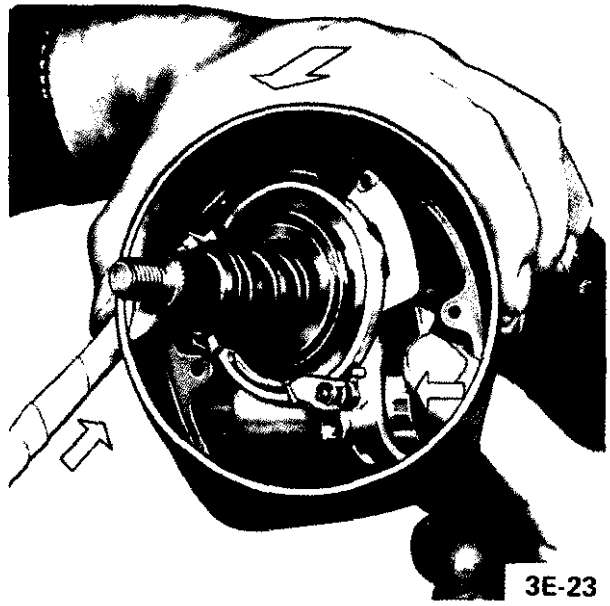

Figure 3E-23

7. Remove ignition switch electrical unit. See Figure 3E-24.

8. Remove wires from connector plug making certain to note location of each.

9. Tape wire ends together and remove electrical unit and wire harness.

Installation

1. Position electrical unit wire harness through column and reconnect to connector plug.

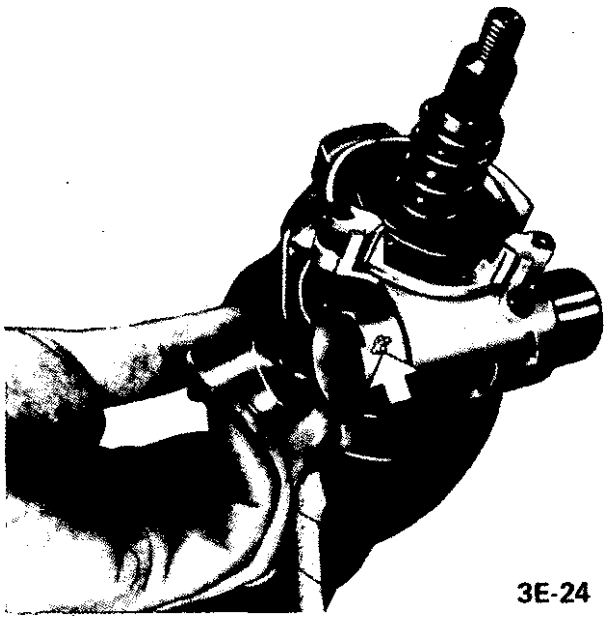

Figure 3E-24 Removing Electrical Unit

Before installing electrical unit be sore unit is in RUN position. Using a Philips screwdriver, turn inner sleeve to the tight until a springy resistance is felt. See Figure 3E-25.

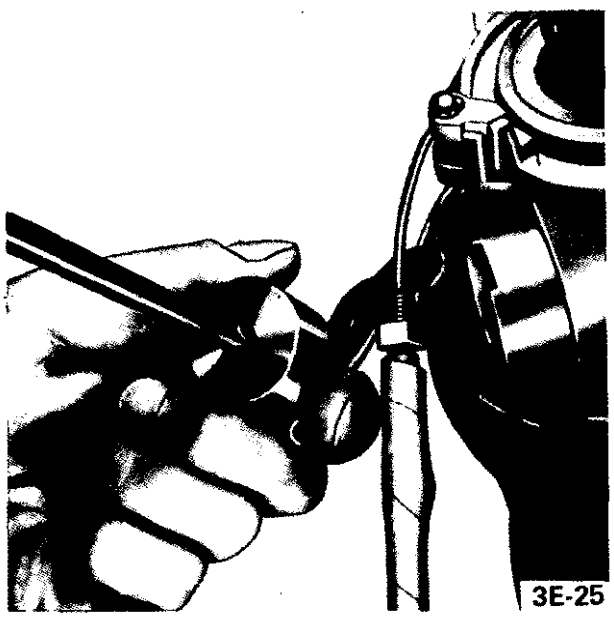

Figure 3E-25 Checking for RUN Position

2. Install ignition switch electrical unit. See Figure 3E-24.

3. Install housing cover **by** attaching with three (3) screws.

4. Install steering lock retaining screw. See Figure 3E-20.

5. Reconnect ignition (white) wire set plug.

6. Install direction signal switch lever.

7. Install ignition lock cylinder. See previous paragraph in this section.

REMOVAL AND INSTALLATION OF UPPER STEERING BEARING AND/OR DIRECTION SIGNAL SWITCH

Removal

1. Remove ignition switch and steering lock, see previous paragraph in this section.

2. Disconnect direction signal (black) wire set plug.

3. Remove wires from connector plug making certain to note location of each.

4. Remove screws and direction signal housing and switch assembly. See Figure 3E-26.

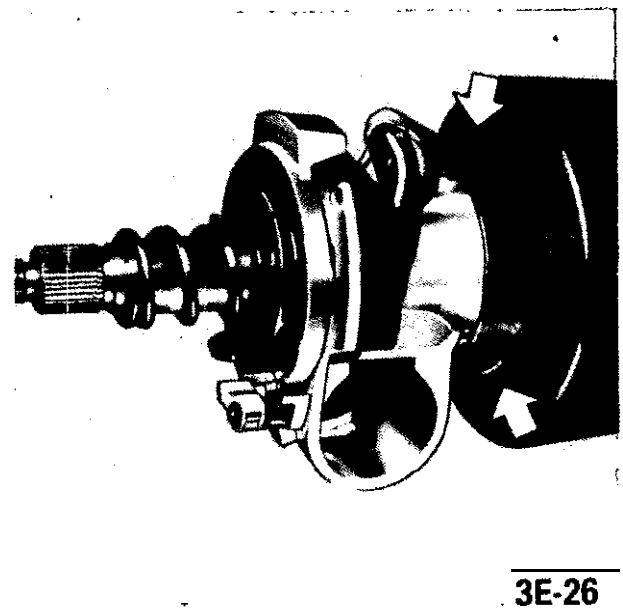

Figure 3E-26 Removing Direction Signal Switch Assembly

5. To remove upper bearing, pull horn wire out of bearing housing and pry out bearing assembly using a flat screwdriver. See Figure 3E-27.

Installation

1. If upper bearing has been removed, install by using the thumbs of both hands being sure to line bearing up with notched portion of housing.

2. Install direction signal housing and switch assembly. See Figure 3E-26.

3. Reposition wires into connector plug and connect direction signal wire set.

4. Install ignition switch and steering lock

REMOVAL AND INSTALLATION OF STEERING COLUMN LOWER BEARING

Removal

The following is with steering column assembly removed.

1. Remove steering wheel.

2. Remove screws securing lower bearing housing to mast jacket.

3. Remove steering shaft together with universal joint and bearing and housing.

4. Remove universal joint from shaft. See Figure 3E-28.

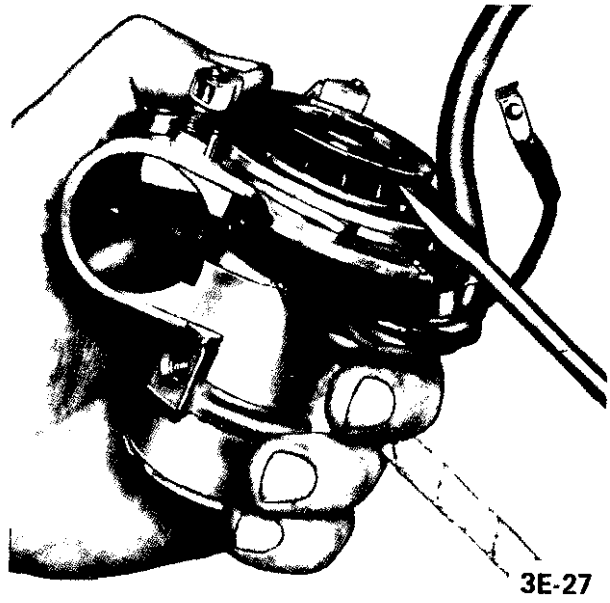

Figure 3E-27 Removing Upper Bearing

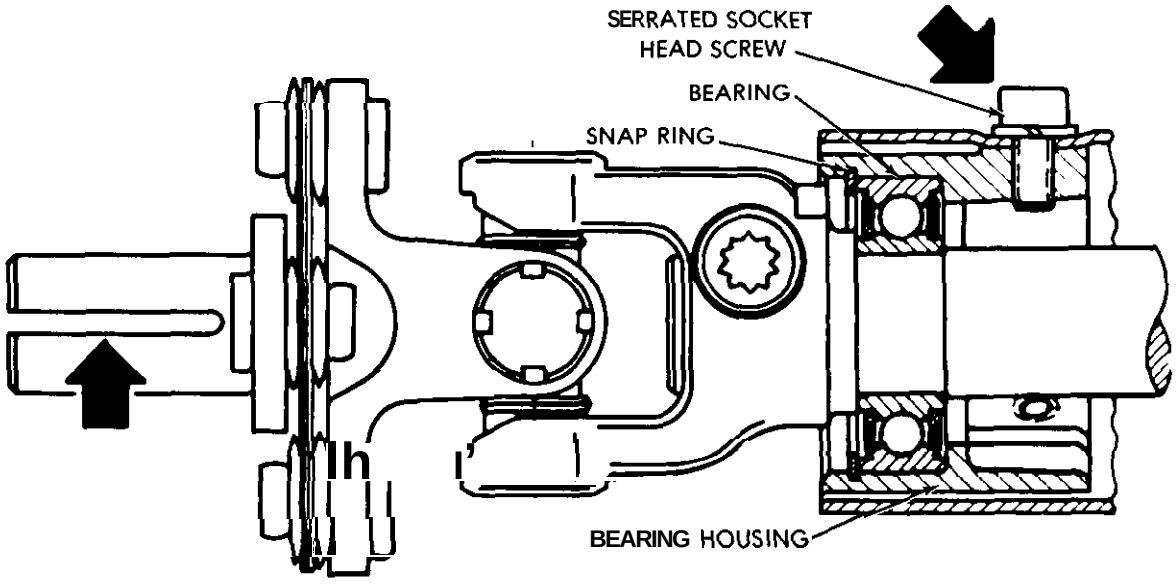

Figure 3E-28 Removing Lower Bearing

5. Remove bearing retainer snap ring and remove bearing.

Installation

1. Install bearing and bearing retainer snap ring.

2. Install universal joint and torque to 22 lb.ft.

3. Install steering shaft, together with universal joint bearing and housing to mast jacket. Serrated socket head screw must be installed on top side of steering column assembly. See Figure 3E-28.

4. Install steering wheel. On installation of steering wheel, make sure that with flats of lower portion of universal joint horizontal, the center steering wheel spoke must be vertical.

PART	LOCATION	TORQUE LB.FT.
	Steering Wheel	15
	Upper Universal Joint - Lower Clamp	14
Bolt	Upper Universal Joint - Hex Head	14
Bolt	Lower Universal Joint	22

REAR SUSPENSION

CONTENTS

DESCRIPTION AND OPERATION

DESCRIPTION AND OPERATION OF REAR SUSPENSION

All Opels utilize the three link rear suspension arrangement. This rear suspension consists of coil springs, track rod, shock absorbers and lower control arms.

The coil springs set between two seats which arc situated ahead of the rear axle housing.

The track rod is utilized on all models to control the lateral stability of the rear axle assembly. It is of tubular design. A stabilizer rod is used on all Wagons as well as Fast Backs and Sedans. The GT is not equipped with a stabilizer rod.

The lower control arms are of tubular design and function as two links of the three link suspension system. They are attached to the underbody through brackets welded to the side rails and to the rear axle assembly through the front portion of the spring seat bracket. The lower control arms control the fore and aft movement of the rear axle assembly.

The third link in this suspension system is the torque tube which is connected to the differential carrier and also to the underbody through rubber bushings in the central joint support bracket.

The torque tube in conjunction with the lower control arms absorb all acceleration and braking torque.

MAJOR REPAIR

REAR SHOCK ABSORBER REMOVAL AND INSTALLATION

Removal

NOTE: The trim panel under the spare tire must be removed on the GT to gain access to attaching nuts.

1. Remove upper attaching nut, retainer and rubber grommet.

2. Remove lower attaching nut and rubber grommet retainer, compress shock absorber and remove from lower mounting pin.

Installation

1. Replace upper and lower rubber grommets, if necessary, before installing shock absorber.

2. Extend shock absorber and position in car. Attach at lower end first, torque nut to 15 lb.ft. on the GT, and torque to 47 lb.ft. on the Opel 1900 - Manta.

3. Install rubber grommet, retainer and self-locking nut at top of shock absorber. Torque to 10 lb. ft. Always use new self-locking nuts.

REAR SPRING REMOVAL AND INSTALLATION

Rear Spring Removal

1. Raise rear of car with floor jack under differential carrier and support with jack stands positioned under side jack brackets. See Figure 3F-2.

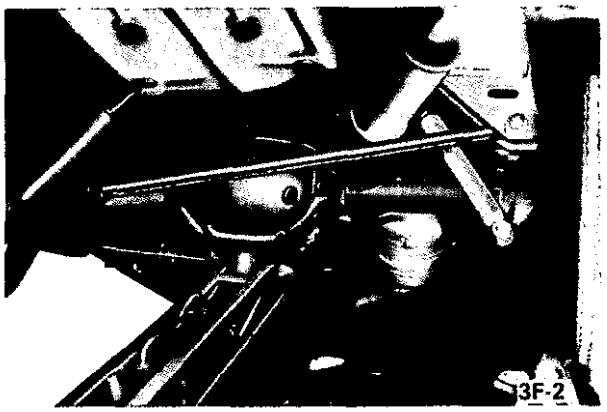

Figure 3F-2 Raising Rear of Car

2. Remove rear wheels.

3. Disconnect shock absorbers from rear axle.

4. Disconnect stabilizer and shackles, if equipped, from frame.

5. Lower rear axle assembly as far as possible without putting the brake hose under stress.

6. If necessary, tilt the rear axle assembly to remove springs. See Figure 3F-3. Note the upper and lower rubber damper rings.

Figure 3F-3 Removing Coil Spring

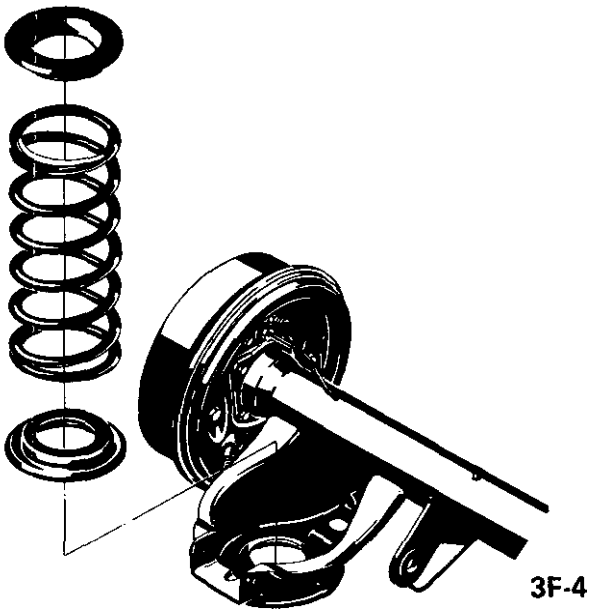

Figure 3F-4 Installing Coil Spring

Rear Spring Installation

1. Make certain the lower damper rings are properly positioned in the spring seats and position the springs in their respective position in the damper rings. See Figure 3F-4.

2. Properly install upper damper rings on springs.

CAUTION: *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.

3. Raise rear axle assembly to compress springs in their seats.

4. Attach shock absorbers and tighten retaining nuts to 15 lb.ft. For the GT and 47 lb.ft. for the Opel 1900 Manta.

5. Attach stabilizer shackles, if equipped, to axle brackets and tighten bolts to 25 lb. ft. with vehicle at curb weight.

6. Install rear wheels torquing lug nuts to 65 lb.ft.

7. Remove jack stands.

LOWER CONTROL ARM REPLACEMENT

Removal

This operation can be performed with the vehicle standing at curb height or elevated.

1. Disconnect parking brake cable from support bracket on control arm.

2. Loosen and remove front and rear control arm attaching bolts and remove control arm.

installation

1. On 1900's and Manta's place a load of approximately 350 lbs. in luggage compartment or on the GT, place a load of approximately 150 lbs. on driver's seat. Torque control arm attaching nut and bolts to 18 lb.ft on GT's and 23 lb.ft. on the 1900 - Manta.

2. Connect parking brake cable to support bracket on control arm.

STABILIZER ROD REPLACEMENT

Removal

1. Raise and support rear of vehicle.

2. Disconnect stabilizer rod to shackle bolts.

3. Disconnect stabilizer rod to underbody retainers and work stabilizer rod out from under vehicle.

Installation

1. Work stabilizer rod into position and loosely attach stabilizer to underbody retainers.

2. Connect stabilizer rod to shackles.

3. With the vehicle standing on its wheels or the rear axle assembly lifted, tighten stabilizer rod to underbody bracket bolts to 15 lb. ft.

4. Remove jack stands and lower vehicle.

TRACK ROD REPLACEMENT

Removal

1. Lift rear of car and suitably support.

2. Disconnect track rod from rear axle and frame side member.

Installation

1. Loosely connect track rod first to side member and then to the rear axle.

2. On the 1900 - Manta, load luggage compartment of vehicle with approximately 350 lbs. or on the GT, place a load of approximately 150 lbs. on driver's seat and tighten track rod attaching bolts to specified torque.

3. Remove supports (jack stands) and lower vehicle.

SPECIFICATIONS

REAR SUSPENSION SPECIFICATIONS

Tightening Specifications

Use a reliable torque wrench. Specifications are for clean and lightly-oiled threads.

Part	Name	Torque Lb.Ft.
Nut	Wheel Nuts	65
Nut	Control Arm Attaching (GT)	16
Nut	Control Arm Attaching (1 900 - Manta)	23
Bolt	Stabilizer Rod to Underbody Retainers	15
Nut	Shock Absorber Lower Attachment (GT)	15
Nut	Shock Absorber Lower Attachment (1900 Manta)	47
Nut	Shock Absorber Upper Attachment	10
Bolt	Stabilizer Shackle to Axle Bracket	25

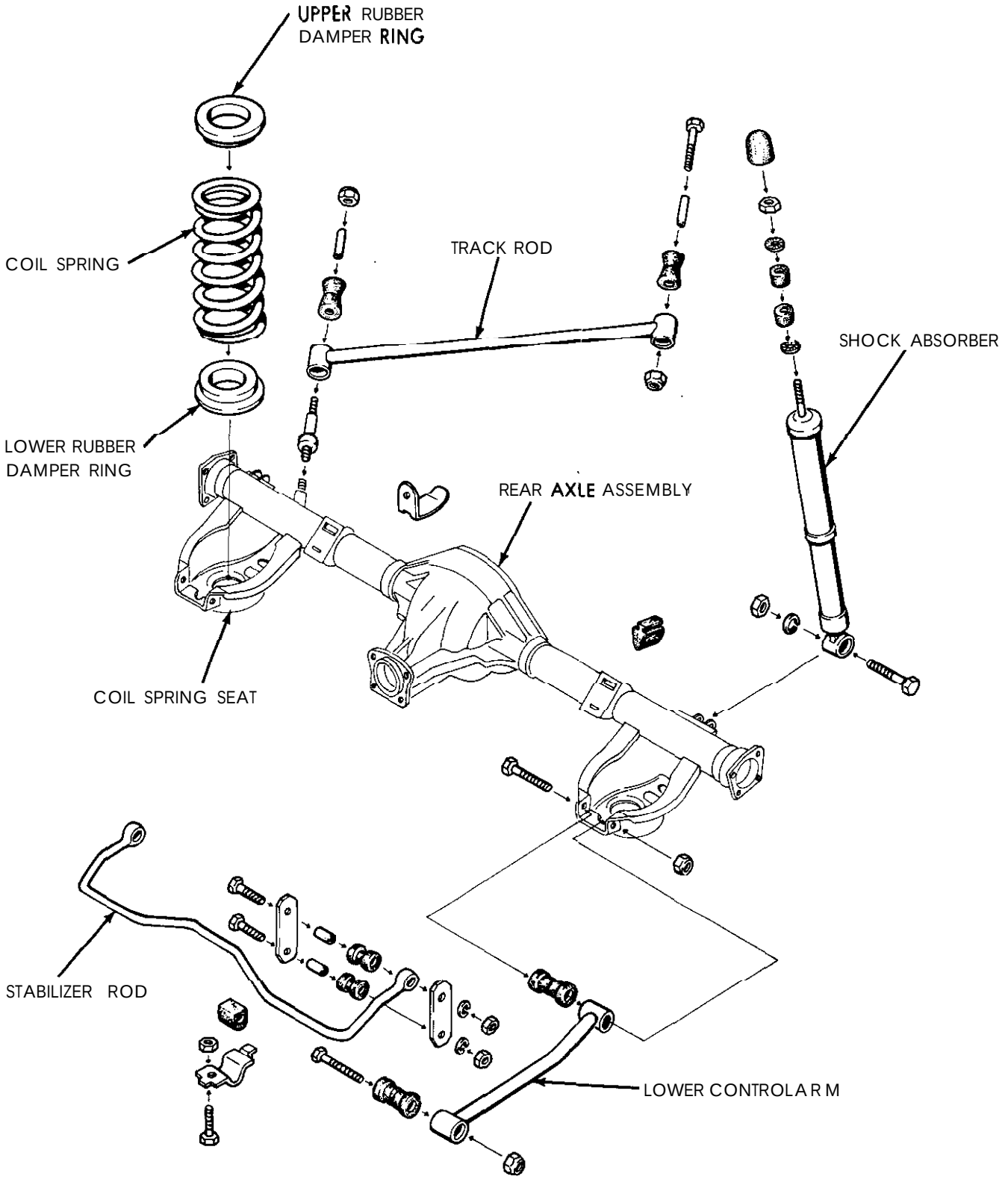

Figure 3F.5 Exploded View Rear Suspension

WHEELS AND TIRES

CONTENTS

DIAGNOSIS

CAR ROUGHNESS AND VIBRATION

Possible Causes

To assist in the diagnosis and correction of some of the more stubborn cases of tire vibration and roughness conditions that may be encountered, the following information is offered:

VIBRATION, or a quivering motion condition, noticeable by feel through the steering column, steering wheel, floor pan, or by hood and fender shake, usually originates from the front wheels and tires. Front end vibration, when caused by unbalanced front wheels, can be generally felt as steering wheel "nibble".

A vibration felt through the seats as a side-to-side disturbance can usually be attributed to the rear wheels and tires.

Both front and rear vibration can be noticed mainly at highway speeds, usually over 60 mph.

ROUGHNESS, noticeable primarily at speeds between 40 and 65 mph, can be felt (and occasionally heard), and is due to certain irregularities in the tire. Roughness usually sets up a "trembling" feel or a shuddering effect.

Road-Test With Owner

When a ride complaint is encountered, first check inflation pressures and perform tire inspection, including removal of any foreign material on tire tread or wheel large enough to upset balance.

Tire inflation pressure recommendations are very important at all times and particularly so on all ride complaints. Raising or lowering tire pressures to "improve" mileage or traction should not be attempted.

Next, road-test the car with the owner, if possible, and have the owner explain the specific ride disturbance.

After road-testing, raise car on hoist and proceed to isolate the offending tire/wheel assembly.

Reproducing the Disturbance

In an attempt to reproduce the disturbance experienced in the ride, a wheel spinner can be used on the front wheels of the car.

The rear wheels may be spun by placing car in "Drive" with engine running.

When spinning rear wheels, never exceed a speedometer speed of 35 mph with a standard rear axle assembly, or 75 mph on one with a positive traction rear axle. Excessive speeds may cause damage to the rear axle assembly.

Jack up both rear wheels by placing the jack under the differential housing. Spin one wheel and tire with the opposite wheel held from rotating by holding the

parking brake cable. Spin the other wheel using the same procedure.

By spinning the wheels, the offending tire will cause vibration that may be felt by touching the bumper or fender. By the process of elimination, proceed on tires that cause vibration as follows:

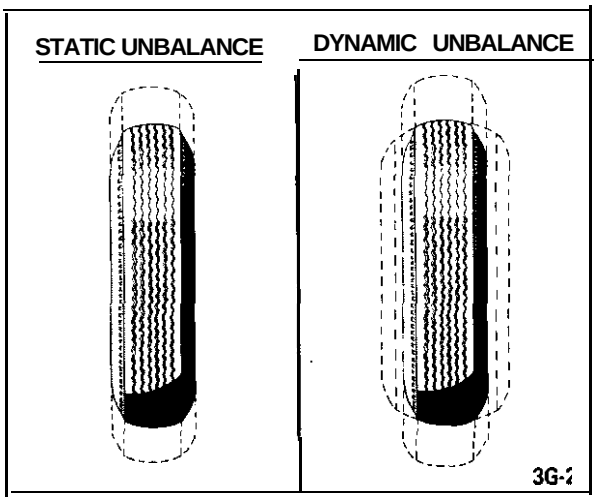

Figure 3G-2 Static and Dynamic Unbalance

Unbalance

Check for tire/wheel unbalance An unbalanced wheel assembly that is causing a vibration can, in most cases, be reduced to an acceptable level by static and dynamic wheel and hub balancing. Correct by rebalancing, Figure 3G-2. It is recommended that an on-the-car balancer be used for balancing.

A tire/wheel assembly that is in balance may still be causing a vibration when the car is driven, but may not set up a vibration when the wheel is off the ground and submitted to the spinner test. In such cases, the next step is to check radial and lateral runout.

Runout

A runout gauge should be used to determine the amount of total radial and lateral runout at the tire that causes the vibration. See Figures 3G-3 and 3G-4.

A guide to runout maximum totals is as follows:

.035 inch Radial - Wheel

.050 inch Radial - Tire/Wheel Assembly

.045 inch Lateral - Wheel

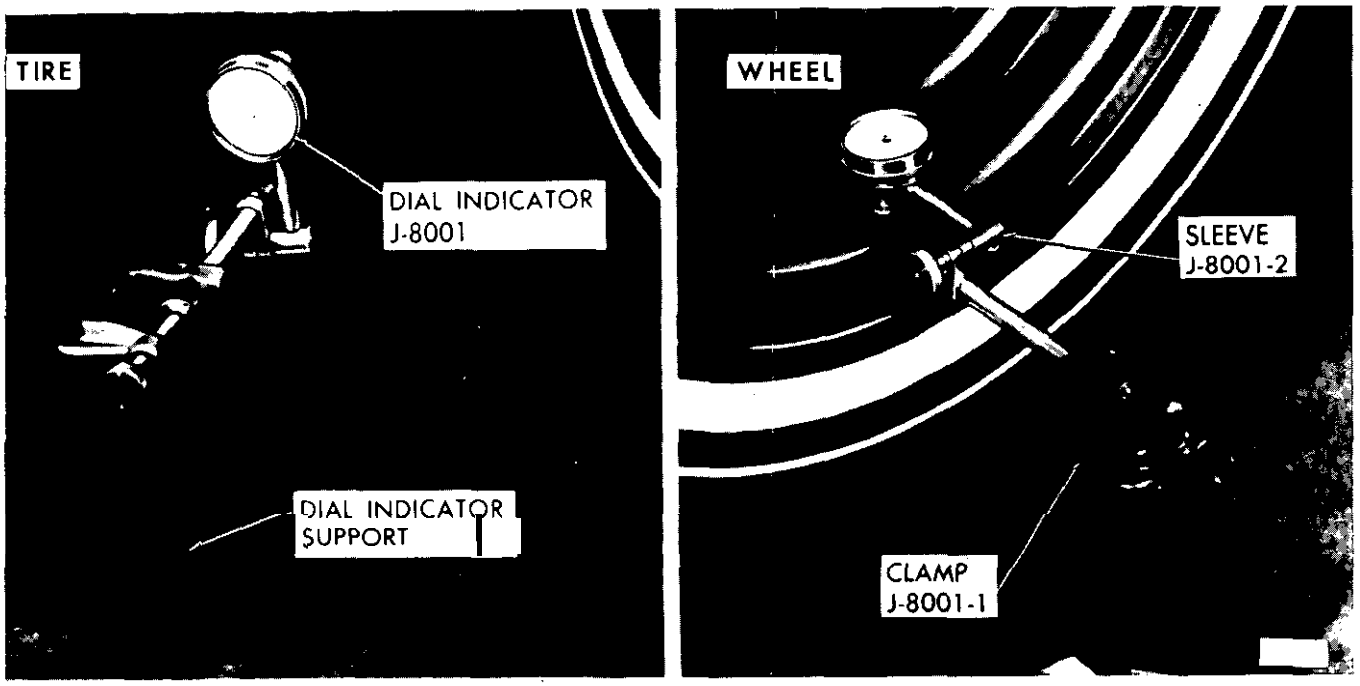

Figure 3G-3 Checking Radial Runout

Figure 3G-4 Checking Lateral Runout

.050 inch Lateral - Tire/Wheel Assembly

If the tire and wheel runouts are beyond any of the maximum totals above, the tire should be repositioned 180 degrees opposite its original location on the wheel. Refer to Figure 3G-5. This will, in most cases, reduce the runout and vibration to a satisfactory level.

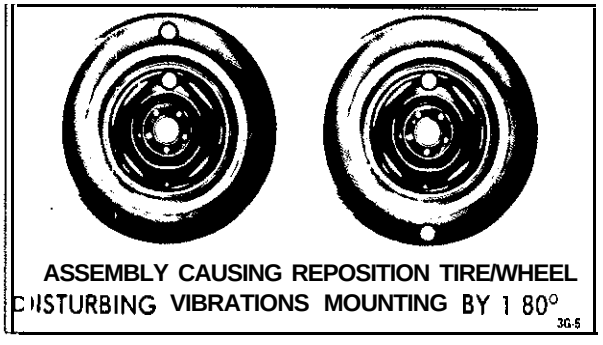

Figure 3G-5 Repositioning Tire on Wheel

There is no more work involved in repositioning a tire on a wheel than there is in putting on a new tire, and repositioning has a better chance of correcting the difficulty.

It is important that only the tire/wheel assemblies that are causing the disturbances be repositioned.

Since normally only one, and occasionally two, tire/-wheel assemblies per vehicle could be causing the disturbing vibration, it is recommended that repositioning be performed only when required. Repositioning of non-disturbing assemblies could cause these assemblies to create vibration or roughness problems.

After repositioning, balancing the tire/wheel assembly is always necessary. It is very important that the tire/wheel assembly be balanced accurately.

At this point, the car should be road-tested again to assure that the disturbance has been corrected.

Tire Grinding

Tire grinding is very effective in eliminating tire complaints due to excessive tire runout. Grinding can be accomplished on or off the car. Grinding is approved by Opel, if done as recommended by the equipment manufacturer

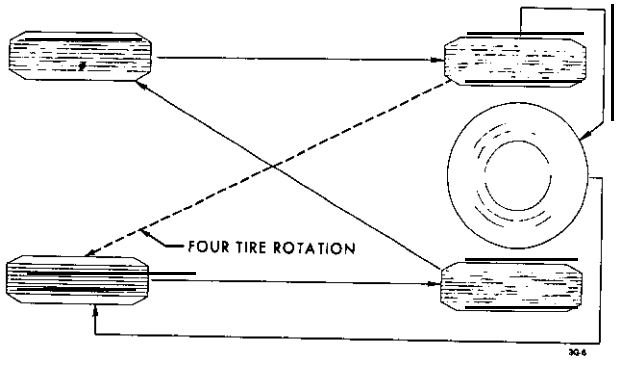

Figure 3G-6 Tire Rotation

Tire Wear Irregularities

An additional cause of vibrations may sometimes be tire wear irregularities. These can also produce noise disturbances, and can be generally corrected by rotating the tires, Figure 3G-6. Before proceeding further, locate and correct the cause of the irregular tire wear. See Figure 3G-7.

Use the criss-cross method of rotation of tires only when all four tires are equally worn. In some instances, it may be necessary to put the truest running assemblies (those with the lowest tolerances) on the front of the car.

Wheel Nut Torque end Tightening Specifications

During all wheel installations, it is important to use the correct procedure for installing wheel nuts and torquing them uniformly and in proper sequence. This is important in order to avoid possible distortion of the brake drum or disc, and to minimize damage to lug and nut threads and wheel stud holes.

To assure uniform tightening of wheel lug nuts, the following procedure is recommended:

1. Install wheel lug nuts in a criss-cross pattern and tighten just enough to seat wheel against hub. This assures proper piloting of the wheel on its hub.

2. Tighten lug nuts uniformly to proper torque of 65 lb.ft. using criss-cross pattern.

An impact wrench should not be used, as uniform torque control cannot be maintained.

Summary of Diagnosis end Correction of Tire and Wheel Vibration

1. Inflate all tires to recommended pressure and road-test car with owner to define problem.

2. Spin front tire/wheel assemblies with wheel driving equipment. Rear wheels may be spun with tires off the ground and with one wheel held at a time. The offending tire may cause vibration that may be felt by touching the bumper or fender. By process of elimination, determine offending tire/wheel assembly.

3. Check for tire/wheel unbalance. Balance, if necessary.

4. Check each tire/wheel assembly on the car for radial runout on the tire tread. Wheel and tire assemblies exceeding .050 inches may be considered as offending assemblies. Offending tire/wheel assembly should be deflated and the tire repositioned (indexed) 180 degrees from original location.

5. After repositioning, rebalance tire/wheel assembly (static and dynamic preferred).

6. Test drive and evaluate correction.

The following procedure should be used to determine cause of roughness or vibration with car in operation at various speeds:

1. Jack up all wheels having jack support rear end of car at center of rear axle housing.

2. With transmission in “Drive”, run engine at various car speeds to note speeds at which vibration or roughness occurs.

3. Remove rear wheels and run engine again at the critical speeds noted in step 2. If roughness is gone, the condition is caused by unbalanced wheel and tire assemblies.

4. If roughness still exists with rear wheels removed, remove rear brake drums and repeat the running test. Elimination of the roughness indicates out of balance brake drums.

5. If roughness still exists with brake drums removed, run engine with transmission in “Neutral”. Elimination of the roughness indicates that propeller shaft is out of balance. Continued roughness indicates an out-of- balance engine.

ABNORMAL TIRE WEAR

General Operating Conditions

Assuming that there is no misalignment condition to cause abnormal wear, the life of tires depends largely upon car operation conditions and driving habits.

Tires wear at a much faster rate in some localities than in others because of road and operating conditions. Some types of roads are much more abrasive than others. Tire wear is also dependent upon the number of hills and mountains which the car must go up and down, the severity of grades, the number of starts and stops, driging speeds, the amount of rain and snow, and prevailing temperatures. ***Tire wear increases rapidly with speed, temperature, and load*** on *tire.* Tires used at low speeds, in cool climates, or with light loads will have longer life than tires used for high-speed driving in hot climates with heavy loads.

Driving habits have a very important hearing on tire life. A careful driver may obtain much greater mileage from a set of tires than would be obtained by a

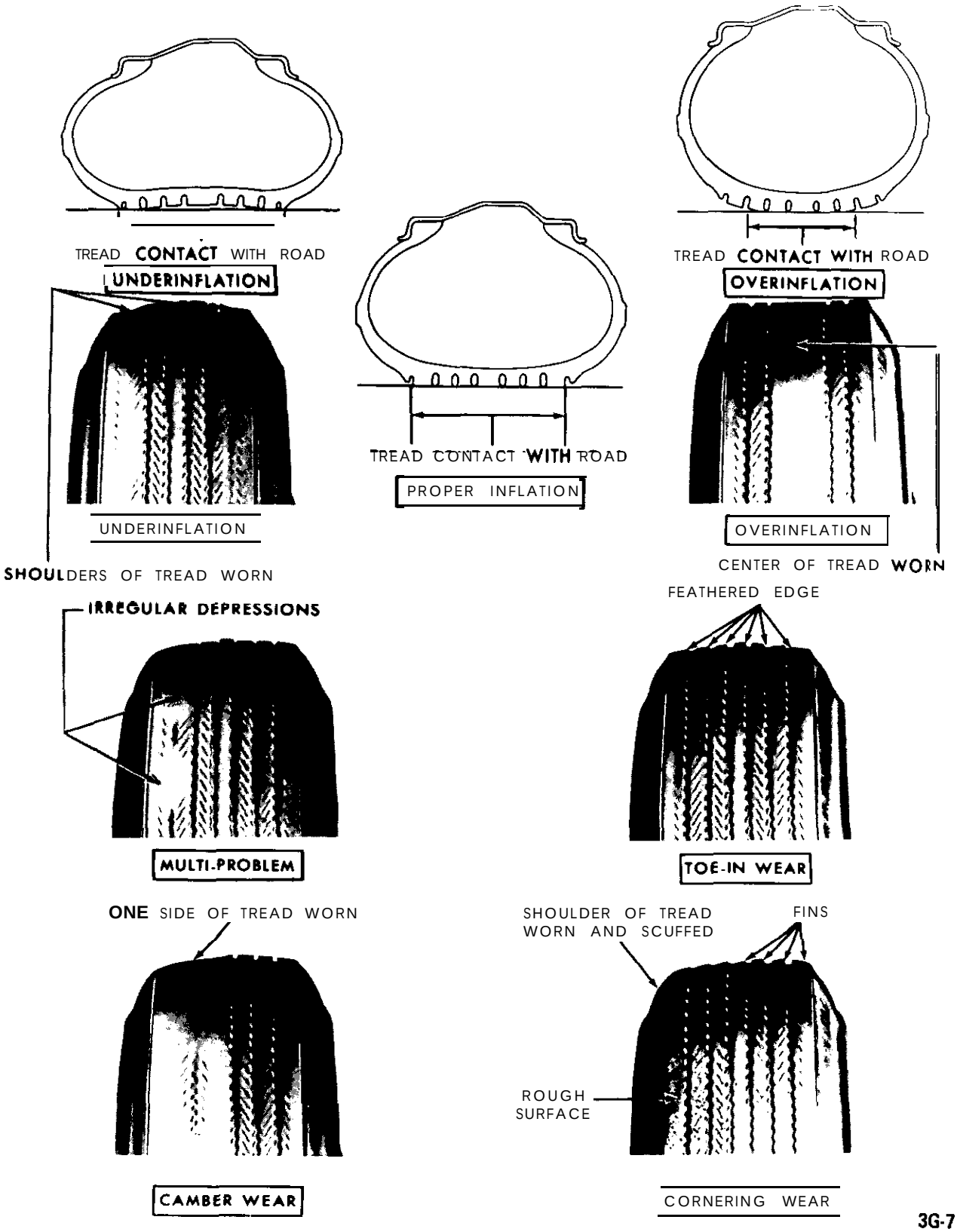

Figure 3G-7 Uneven Tire Wear

severe or careless driver. Rapid acceleration and deceleration, severe application of brakes, taking turns at excessive speed, high-speed driving, and striking curbs or other obstructions which lead to misalignment are driving habits which will shorten the life of any tire.

Maintenance of proper inflation pressure and periodic interchanging of tires to equalize wear are within the control of the driver. Underinflation raises the internal temperature of a tire greatly due to the continual friction caused by the flexing of the side walls. Tire squealing on turns is an indication of underinflation or excessive speed on the turns. A combination of underinflation, high road temperatures, and high-speed driving will quickly ruin the best tire made.

High speed on straight highways or expressways normally causes more rapid wear on the rear than on the front tires, although cupping of front tires can result if the tires are not periodically switched from wheel to wheel. Driving turns and curves at too high a rate of speed causes the front tires to wear much faster than the rear tires.

An inspection of the tires, together with information as to locality in which the car has been operated will usually indicate whether abnormal wear is due to the operating conditions described above or to mechanical faults which should be corrected.

The various types of abnormal tire wear and their causes are described in the following paragraphs.

Shoulder or Underinflation Tread Wear

When a tire is underinflated, the side walls and shoulders of the tread carry the load, while the center of tread folds in or compresses due to the low internal air pressure. This action causes the shoulders to take all of the driving and braking load, resulting in much faster wear of shoulders than of the center of tread. See Figure 3G-7. For maximum results in handling, riding and tire life, tire inflation pressures should never be allowed to go below the specified minimum pressure.

Continuous high-speed driving on curves, right and left, may produce tread wear very similar to underinflation wear and might very easily be mistaken for such. Side thrust when rounding turns causes wear on the sides of tire tread. In making a turn to the left, especially at high speeds, the outside shoulder of the right tire and the inside shoulder of the left tire take the side thrust and naturally receive the most wear. The only possible correction is to advise slower speeds on curves. Do not increase tire inflation pressures beyond specified limits, as this will cause center or over-inflation wear. See paragraph below.

Canter or Overinflation Tread Wear

Excessive wheel camber, either positive or negative, causes the tire to run at such an angle to the road surface that one side of the tread wears much more than the other. See Figure 3G-7.

When tire inflation pressures are maintained within the specified limits, the tire will make a full contact across the entire width of tread, thereby distributing the wear evenly over the total surface of the tread area.

Cross or Toe Tread Wear

When the front wheels have an excessive amount of either toe-in or toe-out, the tires are actually dragged sideways when they travel straight down the road and cross wear or scraping action takes place rapidly wearing away the tread of tires. This cross wear condition will usually produce a tapered or feathered edge on the ribs of the tire tread. See Figure 3G-7. In most cases, this can be detected by rubbing the hand across the tire tread.

If the tapered or feathered edges are on the inner sides of the ribs on one of both sides, it indicates that one or both tires have excessive toe-in, while the same condition in the outer sides of ribs indicates excessive toe-out. Usually, ***excessive toe-in causes excessive tire wear on the outer edge of the right front tire and toe-out causes tire wear on the inner edge of the left front tire. See Section 3C for toe-in correction.***

Cornering wear caused by high-speed driving on curves (see following paragraph) sometimes has the appearance of toe wear. Care must be used to distinguish between these two types of wear so that the proper corrective measures will be used.

Side or Camber Wear

Excessive wheel camber, either positive or negative, causes the tire to run at such an angle to the road surface that one side of the tread wears much more than the other. See Figure 3G-7.

The amount or angle of the camber wear will be governed by the amount of positive or negative camber. Tire tread wear very similar in appearance to camber wear may be caused by driving on turns at excessive speeds. This "cornering" tread wear (see paragraph below) cannot be corrected by change of camber angle.

Adjustments for specified camber are covered in Section 3C.

Cornering **Tread Wear**

The modern independently-sprung automobile allows the driver to negotiate turns at a high rate of speed with a greater feeling of safety. This fact is responsible for a comparatively new type of tread wear that can easily be mistaken for toe or camber wear.

When a car is making a turn, the tires are supposed to be rolling in a circle. When the turn is **made at** high speed, however, centrifugal force acting on the car causes the tires to be distorted sideways and to slip or skid on the road surface. This produces a diagonal cross type of wear, which in severe cases will result in a fine or sharp edge on each rib of the tire treads.

Cornering wear can be distinguished from toe or **camber** wear by the rounding of the outside shoulder of the tire and by the roughening of tread surface in this section denoting severe abrasion. See Figure 3G-7.

No alignment or tire pressure cahnge can be made that will relieve cornering wear. Only the driver can effect a cure and that is by slowing down on curves.

Heel and Toe Tread Wear

Heel and toe wear is a saw-tooth effect with one end of each tread block worn more than the other.

The end which wears is the one that first grips the road when the brakes are applied. High-speed driving and excessive "se of the brakes will cause this type of irregular tire wear. This type of wear will occur on any type of block tread design. See Figure 3G-7.

Heel and toe wear is not so prevalent on the rear tires because of the propelling action which creates a counteracting force which wears the opposite end of the tread block. These two stresses on the rear tires wear the tread blocks in opposite directions and result in more even wear while on the front tires, the braking stress is the only one which is effective. This may be counteracted by interchanging tires.

A small amount of irregular wear, slightly saw-toothed in appearance, at the outer segments of tires is a normal condition and is due to the difference in circumference between the center and the outer edges of the tire tread. This saw-toothed appearance, however, will be exaggerated by underinflation, improper toe-in, or both.

Cupped or Scalloped Type Tire Wear

Cupping or scalloping is associated with **wear** on a car driven mostly at highway speeds without recommended tire rotation. Factors which promote cupping include underinflation, incorrect toe-in setting or camber setting, and steady highway speeds on smooth, paved surfaces as opposed to gravel or rough asphalt.

The following recommendations suggest action that may be taken to help prevent cupping.

1. Rotate tires as recommended in Figure 3G-6.

2. Frequently inspect front tires for irregular wear due to underinflation, improper toe-in setting, or camber setting. Regardless of the original cause of cupped tread wear on either front tire, no alignment or balance job, however perfect, can prevent future excessive wear of the spots. Once a front tire acquires flat or cupped spots, additional wear will continue at a rapid rate. At the time of correction, however, the cupped tire should be interchanged with a rear tire on which the tread runs true. The cupped tire will, to a certain degree, true itself on a rear wheel.

Although not normally the cause of cupping, the following factors can contribute to the problem.

Looseness of parts in the suspension system, such as worn steering knuckle ball joints, loose wheel bearings, inoperative shock absorbers, and any excessive looseness throughout the steering system all tend to allow the front wheels to kick around and, if any of the wheel alignment factors are incorrect, irregular spotty tire tread wear of one type or another may result.

Wobble or runout of a tire, either front or rear, due to bent wheel or to tire being improperly mounted will cause uneven wear.

MAINTENANCE AND ADJUSTMENTS

DEMOUNTING AND MOUNTING TUBELESS TIRES

Due to "se of symmetrical rims, tires must be mounted over the narrow rim shoulder i.e., over outside rim flange.

When demounting a tubeless tire "se care to avoid damaging the rim-seal ridges on tire beads ***DO NOT USE TIRE IRONS TO FORCE BEADS A WA Y FROM WHEEL RIM FLANGES.***

When tire is removed, inspect it carefully to determine whether loss of air was caused by puncture or by improper fit of beads against rim flanges. If improper fit is indicated, check wheel as follows: Do not reuse dented rims.

1. Clean rims thoroughly, using No. 3 coarse steel wool to remove all oxidized rubber, soap solution, etc. Remove rust with wire brush.

2. Inspect butt weld and other **areas** of **rim contacted by** tire beads to make certain there is no groove or high spot. Remove any groove or high spot **by** tiling smooth.

3. Inspect valve stem and replace it if damaged. Make certain that valve stem is properly installed to provide an air tight joint.

4. Before mounting a tubeless tire on a wheel, moisten a cloth with mounting compound or soap solution and wipe rim-seal **ridges** of both beads to remove all foreign substances.

5. Moisten base of both beads with mounting compound or soap solution to help beads snap into place when tire is inflated. Start tire over rim flange at point opposite valve stem.

6. Inflate tire until both beads are firmly seated against rim flanges and temporarily over inflate. Leak test wheel and tire assembly and if satisfactory, reduce to recommended pressure.

WHEEL AND TIRE BALANCE

Wheel and tire balance is the equal distribution of the weight of the wheel and tire assembly around the axis of rotation. Wheel unbalance is the principal cause of tramp and general car shake and roughness and contributes somewhat to steering troubles.

The original balance of the tire and wheel assembly may change as the tire wears. Severe acceleration, severe brake applications, fast cornering and side slip wear the tires out in spots and often upset the original balance condition and make it desirable to rebalance the tire and wheel as an assembly. Tire and wheel assemblies should be rebalanced after punctures are repaired.

Because of the speed at which cars are driven, it is necessary to test the wheel and tire assembly for dynamic balance. Dynamic balancing of a wheel and tire assembly must be done on a machine designed to indicate out-of-balance conditions while the wheel is rotating on the car. Since procedures differ with different machines, the instructions of the equipment manufacturer must be carefully followed.

SPECIFICATIONS

General Specifications

Wheels	
Opel 1900 - Manta and GT	5J x 13
Tires	
1900 - Manta	165-13
GT	165-13

Tire Size and Pressures (Pounds Per Square Inch Cold)

Model	Tire Size	Recommended Pressure Front	(Standard Inflation) Rear
51.53.54.57	165-13	24 PSI	32 PSI
57R,57L	165-13	23 PSI	26 PSI
77	165-13	19 PSI	23 PSI

NOTE:

1. Tire inflation pressures may increase as much as 6 pounds per square inch when hot.

2. For continuous high-speed operation (over 75 MPH), increase tire inflation pressures 4 pounds per square inch over the recommended pressures up to a maximum of 30 pounds per square inch cool for 4 ply rating tires. When the 4 psi pressure adjustment for sustained high speed with maximum vehicle load

would require inflation pressures above the maximum allowable, speed must be limited to 75 miles per hour.

3. Cool tire inflation pressure: After vehicle has been inoperative for 3 hours or more, or driven less than one mile. Hot tire inflation pressure: After vehicle has been driven 10 miles or more at 60-70 MPH.

4. Vehicles with luggage racks do not have a vehicle load limit greater than specified.

5. When towing trailers, the allowable passenger and cargo load must be reduced by an amount equal to the trailer tongue load on the trailer hitch.

Torque Specification

Wheel Nuts	65 lb.ft.

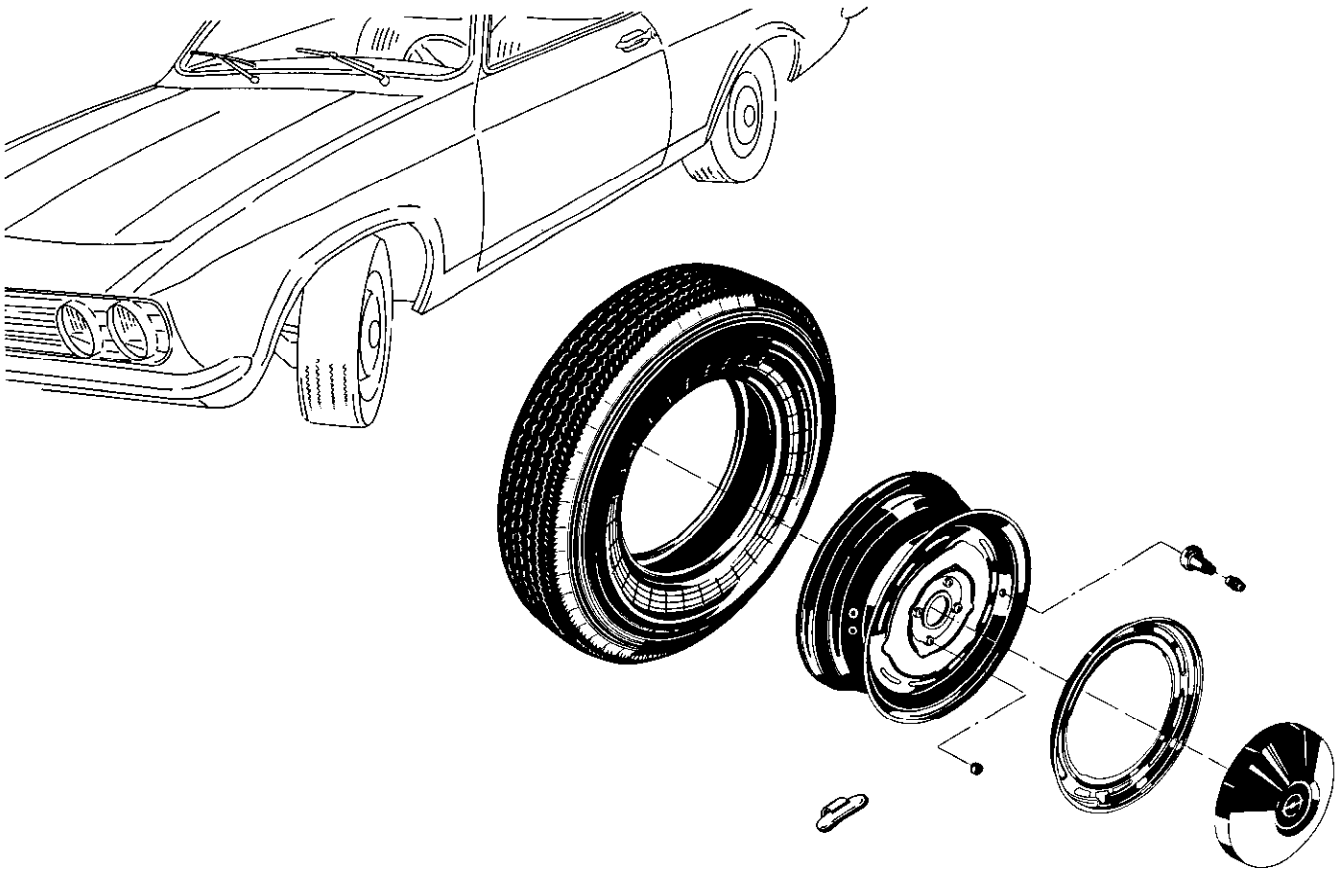

Figure 3G-8 Wheel and Tire - Exploded View