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MC-9
CRUSADER II

MAINTENANCE MANUAL
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MC-9 MAINTENANCE MANUAL

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INTRODUCTION

This manual contains operation, maintenance and overhaul information on MC-9 Model Coach. Information in this manual pertains to standard and commonly used optional equipment.

Vehicle operation from the driver's standpoint is contained in a separate operator's manual. Detroit Diesel engine information is found in a separate service manual. Allison transmission information is contained in the appropriate vendor service manual which, like the engine manual, is supplied separately.

All information contained in this manual is based on the latest product information available at time of publication. We reserve the right to make publication changes at any time.

HOW TO USE THIS MANUAL

This manual is divided into major sections in the sequence shown on the section index. All major sections are divided into sub-sections containing descriptions, operation, maintenance, replacement, overhaul and specification information on related systems and components. A section index appears on the first page of each major section.

PAGE AND ILLUSTRATION NUMBER

Manual pages and illustrations are numbered consecutively within each major section.

SPECIFICATIONS

Service data, torque limits and tolerances are listed at the end of most sections under the heading “Specifications.” Manufacturer's model or part numbers are provided where applicable for component identification. Detail service part numbers must be obtained from the MC-9 Model Parts Manual.

SERVICE INFORMATION BULLETINS

Service Bulletins are issued, when required, to supplement or supersede information in this manual. Information in the bulletins should be noted and filed for future use.

CUSTOMER SERVICE

Universal Coach Parts of Northlake, IL. and Motor Coach Industries, Ltd., Service Parts Division of Canada, know your coach best and are interested in your complete satisfaction. Both offer genuine factory parts for this MC-9 Model and all other TMC/MCI Coach Models.

Service departments in both Roswell, N.M. (U.S. service) and in Winnipeg, Canada (all Canadian service) stand ready to serve you. Their addresses are:

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Proper maintenance is important to the safe and reliable operation of the MC-9 Model coach. The service procedures recommended and described in this manual are effective methods for performing service operations. In some instances, the use of special tools is recommended. These tools should be used when and as recommended.

Various WARNINGS, CAUTIONS and NOTICES are contained in this manual. They should be read carefully to minimize the risk of personal injury or the possibility that improper service methods may be used which could damage the coach and render it unsafe. It is important to note that these cautions and notices are not all inclusive. We could not evaluate and advise users of all conceivable ways in which service may be done or of the possible hazardous consequences of each way. We have not attempted to do this. Therefore, anyone who uses a service procedure or tool not recommended by the manufacturer should first satisfy himself that neither his safety nor vehicle safety will be jeopardized by the particular method he selects. REFER TO PAGE ii FOR CAUTIONARY INFORMATION PERTAINING TO WELDING.
FRONT AXLE ASSEMBLY

DESCRIPTION

Effective with unit 41089 the front axle assembly is a tubular type of Reversed Elliot design. Axle construction consists of a tempered seamless steel tube with forged steel king pin ends. On units prior to 41089, the front axle is a forged steel drop center I-beam type. King pin ends are integral parts of the axle center. See figure 1-1.

Steering knuckles have grease fittings in both king pin bosses for lubrication of the knuckle bushings. The bushings are of the "Sy Steer" type on all models after September 1986. Prior to that, the bushings are bronze. Covers and plugs prevent dust and moisture from entering bushings and serve as seals.

The brake shoe spider is doweled and bolted to the steering knuckle. Dowel pins are also used to locate air suspension mountings.

The two steering knuckle assemblies are connected to each other by a tie rod. Tie rod is threaded at each end and held in position by clamp bolts. Right-hand and left-hand threads are provided on the tie rod to facilitate toe-in adjustment. Stop screws installed at each end of axle center limit turning angle of front wheels.

On the tubular style axles, to detect development of fatigue cracks, approximately two quarts of diesel fuel are installed in the hollow tube section. Any axle which leaks should be replaced.
WELDING CAUTION

Since welding is a procedure which may be carried out either as allowed (explicitly or implicitly) by instructions in this manual or carried out by an independent decision of the coach owner/operator, the following information pertaining to welding should be read before beginning any welding procedure. The prohibitions and requirements contained therein must be followed during the welding procedure.

1. Welding must be done only by a qualified and experienced person.
2. Adequate ground contacts and barriers must be positioned as required to protect components (wiring, brake lines, hydraulic lines, etc.) from damage due to heat, contact by weld splatter arcing or other potentially damaging events associated with welding.
3. On any coach, turn battery switch to "OFF."
4. For coaches equipped with a battery equalizer, after performing step 3 above:
   a. Disconnect the ground at the equalizer.
   b. Disconnect the battery leads.
5. If coach has ATEC or DDEC, remove the ATEC/DDEC power control fuses.
6. Any applicable welding instructions or prohibitions given by a procedure must be heeded.
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Steering knuckles are bushed in the upper and lower pin bosses so that they may turn freely about the pin. Bushings are grooved on the inside to allow grease to flow uniformly to high-pressure areas. Grease fittings are installed at both upper and lower king pin bosses.

On the earlier MC-9 front axles the tapered steering knuckle pins are drawn into the axle center by tightening the nut at the upper end of the pin. On the later MC-9 this is a straight type knuckle pin is used. The straight type pin is held in place by draw keys in the knuckle.

Wheel bearings, air suspension, steering and brake parts which are mounted on the front axle are described in the applicable sections of this manual.

LUBRICATION

Periodic lubrication according to the recommendations in the lubrication section of this manual should be carried out. Points which require lubrication are the steering knuckle pins, tie-rod ends and drag link ends. These are provided with grease fittings for pressure lubrication.

MAINTENANCE

Periodic inspection of the front axle assembly should be made to see that all bolts are tight and that no damage or distortion has taken place. Suspension support stud nuts, U-bolt nuts, tie-rod arm and steering arm nuts, and stop screws should be checked and tightened if necessary to the torque specifications shown at the end of this section. Attention should also be given to the condition of the steering knuckle pin and bushings. If excessive looseness is found at this point, the bushings and pins should be replaced.

The axle manufacturer recommends that the bronze or "Easy Steer" king pin bushings be replaced when the range of side-to-side tire movement reaches 0.030 inch or when the bushings are worn to a maximum of 0.10 inch on their diameter.

NOTE: These measurements are made with the wheel bearings tightened on the spindle.

With new bushings installed, the range of side-to-side tire movement should not exceed 0.010 inch maximum. Refer to Figure 1-2.

Looseness in the steering linkage under normal steering loads is sufficient cause to immediately check all pivot points for wear regardless of accumulated mileage. Steering linkage pivot points should be checked each time the axle assembly is lubricated. Any indication of lateral movement is found, cross tube ends should be removed for inspection. Looseness at the steering linkage pivot points can be visually detected during movement of the vehicle steering wheel.

Steering knuckles, king pins, and bushings may be replaced without removing the axle from the coach.

Figure 1-2. Side-To-Side Tire Movements With New And With Worn King Pin Bushings.

WARNING: Do not attempt to repair, remove or reinstall front axle with the vehicle supported by jacks only.

FRONT AXLE REMOVAL (Prior to unit 41089)

To remove the entire front axle assembly first block the rear wheels to prevent the vehicle from rolling. Raise the front end of the coach with jacks until the bottom of the coach body is approximately 18" (457.2 mm) from the floor. Block the body in this position as indicated in Section 3 under Coach Jacking Points.

CAUTION: Do not raise the body in such a way that the entire weight of the front axle will hang on the suspension bellows assemblies. Damage to the bellows may result.

1. Remove tires and wheels as detailed in Section 15.
2. Exhaust air pressure from the suspension air tank by opening the drain tank at bottom of the air filter.
3. Disconnect the height control valve link, and pull down on the height control valve arm to exhaust air from the front inner beams.
4. Disconnect the hose from the front brake chambers.
5. Disconnect the steering drag link.
6. Disconnect both ends of all radius rods as outlined in this section under Radius Rods.

7. Remove nuts from all bolts attaching air springs lower beam rings to the axle tower.
8. Remove shock absorbers as outlined in this section under Shock Absorbers.
9. Lower the axle assembly on jacks until air spring bead ring bolts are cleared of the suspension supports. The axle can now be carefully removed from under the vehicle.

Removal of the axle assembly is the reverse of removal. Make sure that air springs mounting pads on axle towers are clean.

STRAIGHTENING AXLE CENTER - Before Unit 41089

The earlier MC-9 front axle center is a steel forging, hot treated for strength and resistance to bending and torsional strain. If the center is bent or twisted less than approximately 5 degrees from the original shape, it may be straightened. However, it is recommended that this work be done only by mechanics whose work is thoroughly familiar with such operations and where the proper facilities are available. Parts which are distorted more than approximately 5 degrees from the original shape must be replaced, since such distortion exceeds the elastic limit of the material causing fractures which may result in failure under ordinary operating conditions.

CAUTION: Do not attempt to straighten front axles with tubular style axle centers. Never apply heat to a front axle forging. Front axle should be straightened cold only.

STEERING KNUCKLE DESCRIPTION

Later MC-9 coaches have front axles with straight knuckle pins. The earlier MC-9 models have axles with tapered knuckle pins.
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7. The straight style knuckle pin is retained in the knuckle by means of threaded draw keys at the top and bottom of the knuckle. Remove the draw keys as follows:

a. Loosen locknut on key and turn it out to the end of the threads. The end of the nut should be flush with the draw key end.

b. With a brass drift and a hammer, firmly strike the end of the nut to loosen the draw key.

**NOTE:** Failure to strike the draw key squarely may result in a damaged key, causing removal difficulties.

c. Remove the nut and key from the axe center.

The tapered style knuckle pin is retained in the knuckle by a nut on the threaded upper end. Remove the knuckle pin cotter pin and nut. Refer to figure 1-6.

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STEERING KNUCKLE REMOVAL

1. Block the rear wheels to prevent the vehicle from rolling. Jack up front of coach so that tires clear floor. Block up securely at this position and remove jacks. Refer to Section 3. Coach Jacking Points.

**WARNING:** Do not attempt to disassemble or perform knuckle repair with vehicle supported by jacks only.

2. Remove front wheels, hubs and bearings as directed in Section 15.

3. Remove brake chambers and brake shoe hardware from steering knuckle. Detach brake shoe spindles from knuckle and remove spider, camshaft and slack adjuster as an assembly.

4. Remove drag link and tie rod from steering arm. Refer to Steering, Section 11.

5. Remove nuts from steering arms and drive arms out of steering knuckles.

**NOTE:** It is not necessary to remove steering arms unless service or inspection is necessary.

6. Upper and lower knuckle pin covers are present on the newer style axles with straight type knuckle pins. The original MC-9 axle, with the tapered knuckle pin, has a cover on the top of the pin only. Remove the capscrews from the covers and the gasket(s) beneath the cover. See figure 1-5.

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The tapered type knuckle pin has an expansion plug and lock ring at its lower end. Remove the lock ring with a pair of snap ring pliers. Dislodge and remove the expansion plug with a small drift.

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The following precautions and procedures will allow the pins to be removed with minimum danger of personal injury or damage to the knuckle pins and bushings.

- Straight type knuckle pins may be removed through the top or bottom of the knuckle. Tapered pins can only be removed through the bottom of the knuckle.
- Do not strike the knuckle pin directly with a steel hammer. The pins are made of hardened steel. Personal injury can result from flying chips and splinters and, in the case of the tapered style pin, the threads on the upper end will be damaged.
- If the bushings are not to be replaced, precautions must be taken not to damage them with the bronze drift. Grind off any filing on the end of the drift which will contact the pin. Wrap lace around the drift 1/16" thick for the first inch from the end of the drift. This is especially important when the bushings are of the "Easy Steer" type used with the straight type knuckle pin.

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9. If servicing the straight pin type knuckle, lift off the knuckle assembly, thrust bearing and shafts. If servicing the tapered pin style knuckle, remove the knuckle pin sleeve, and lift off steering knuckle, thrust bearing, spacer washers, and backplate assembly. Refer to figure 1-9.
If seal is being installed in a knuckle which has bronze bushings:
1. Place steering knuckle bottom side up in a vise equipped with soft metal protectors. Position upper knuckle boss (top end down) between jaws of vise and lock securely.

NOTE: Seals must be oriented as shown. Reversal of a seal will prevent purging of grease.

2. With the top end of the knuckle held firmly in this position, place the seal over the knuckle counterbore, with the rubber lip facing up.

3. Using a suitable sleeve and a bronze drift, tap the seal into the knuckle until it bottoms against the bushing or counterbore. See figure 1-11.

STEERING KNUCKLE SEALS

Inspect the grease seals for tears, rips and deterioration. Do not remove the seals from the steering knuckle unless replacement is necessary or if the knuckle is to be rebushed. If seal is to be removed, pry it out with a screwdriver. Refer to figure 1-10.

Figure 1-10. Grease Seal Removal.

Figure 1-11. Installation of Grease Seal (Bronze or "Easy Sleeer" Bushed Knuckles).

Figure 1-12. Grease Seal Installed in Knuckle With "Easy Sleeer" Bushings.

4. Repeat this procedure by reversing the knuckle for the lower seal.

NOTE: In the absence of a suitable driver, do not tap the seal in with a hammer. Set the seal in the opening and cover it with a rigid flat metal plate. Tap the plate with a hammer directly over the seal until the seal is flush with the machined surface. Do not drive the seal any further.

If the seal is installed in a knuckle which has "Easy Sleeer" bushings:
1. Follow instructions 1 and 2 for above bronze bushed knuckles.

2. Using a suitable sleeve and a bronze drift, tap the seal into the knuckle bore until it is flush with the machined surface as shown in figure 1-12.

STEERING KNUCKLE BUSHINGS

The earlier MC-9 front axles have bronze steering knuckle bushings; the later MC-9 front axles have Rockwell "Easy Sleeer" bushings. The tool shown in figure 1-13 should be used when removing or replacing the bushings. The tool shown in figure 1-14 should be used to size the bushings.

These tools may be used with either type of bushing, but the diameter of the cutting surface of the reamer will vary, depending on whether the reamer is used on bronze or "Easy Sleeer" type bushings.

Figure 1-13. Tool - King Pin Bushing Removal & Installation.

Figure 1-14. Reamer - King Pin Bushing.

The tools can be made from round steel bar stock. A reaming tool (part number 20-312) for the "Easy Sleeer" type bushings may also be purchased.
SIZING NEW BUSHINGS

There are several methods of sizing the bushings but the only method which will give accurate size and alignment of the bore is reaming. Honing and burnishing do not provide good bushing bore alignment. Easy steer bushings are made of too resilient a material for them to be sized with a burnishing ball or bar.

The recommended procedure for reaming the bushings is as follows:

1. Position the knuckle in a vise with soft metal shims to protect the knuckle. It is preferable to have the king pin vertical.

2. Gently slide the reamer pilot through the upper bushing until the reamer cutters begin to engage the upper bushing. See figure 1-17.

3. Begin rotating the reamer and applying a light downward pressure with your hand at the same time. Do not force the reamer by applying too much downward force. The reamer can be rotated at any speed but should be done smoothly.

4. After the reamer sizes most of the upper bushing, support the reamer so that it does not drop to the bottom bushing as it completes the cut.

5. After the upper bushing has been sized, gently slide the reamer through until it engages the bottom bushing. See figure 1-18. Repeat steps 3 and 4 for the bottom bushing.

Figure 1-17. Size Upper Bushing.

Figure 1-18. Sizing Lower Bushing.
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REASSEMBLY - AXLE CENTER TO STEERING KNUCKLE

THRUST BEARING INSTALLATION

The earlier MC-9 front axle does not have a seal at the thrust bearing under the steering knuckle. The later MC-9 front axles have a seal at the thrust bearing.

NOTE: Some of the thrust bearings used in front axles have a word "TOP" stamped on the flat face of the bearing retainer. The stamped word "TOP" should not be used for bearing installation purposes. Refer to the following instructions for proper bearing positioning.

Prior to putting the thrust bearing in the axle center-knuckle assembly, if the bearing has a seal, assemble the bearing and seal by holding the bearing so that the opening between the bearing cage and the retainer is up. Then snap the seal securely over the opening. See figure 1-19.

Figure 1-19. Bearing And Seal Assembly.

The assembly of the axle center and knuckle now proceeds as follows:

1. Position and support the steering knuckle assembly on the axle center.

2A. Thrust Bearings With Seals — With the seal positioned on top of the thrust bearing, slide the bearing and seal assembly between the lower face of the axle center and the upper face of the knuckle yoke. See figure 1-20.

Figure 1-20. Installing Knuckle And Seal Assembly.

Figure 1-21. Installing Thrust Bearing (No Seal).

NOTE: The thrust bearing must be seated on the upper face of the lower knuckle yoke. The seal must cover the opening between the bearing cage and retainer. Always install the bearing and seal assembly in the axle with the seal on top. See figure 1-20.

Figure 1-22. Shimming Axle And Knuckle.

Alignment of the pin hole in the knuckle and axle center is now required for pin installation. While looking down through the knuckle pin hole, shift the knuckle to align it with the axle center. Now align the shims to be flush with the axle center around the entire circumference of the knuckle pin hole. The shim alignment can only be done through the upper bushing. Any protrusion of any portion of the shim will prevent the knuckle pin from passing through and result in a damaged shim.

NOTE: Shims are delicate and sharp. Extreme caution should be exercised while aligning shims so as not to cut fingers or bend the inside diameter of the shims.

Damage to the shims during this entire procedure requires disassembly and replacement of the damaged parts.

4A. To install the straight type pin: a. Smeared chassis grease on the bottom half of the knuckle pin and insert it slowly into the top of the knuckle. King pins are marked with the Rockwell logo, part number and the word "O" on the top end of the pin. Rotate the pin to align the draw-screw slots with the draw key holes in the axle. Slowly push the pin through the bushing, seal and shim pack. The pin should slide through the shim pack freely. Any resistance greater than a hand push indicates misalignment. Remove the pin and realign the components. After the pin is inserted through the shim pack, a brass hammer may be used to assist in installation. Care must be taken not to dislodge the lower grease seal as the king pin enters the lower knuckle yoke.

b. Center the king pin in the knuckle to equalize the distance from the top and bottom surfaces. For knuckles with a bottom welsh plug arrangement, increase the bottom gap to allow for assembly of the welsh plug and snap ring.

c. Lightly tap the draw keys into position, flat side toward king pin; do not firmly seat them until after the end play measurement. Install the lower draw key from the front side and the upper draw key from the rear. Assemble so the wedge ends of the two keys contact the king pin and torque to restrict pin from moving while the end play is measured. The procedures for end play measurement and for seating the draw keys will be found later in this section.

NOTE: Never install both draw keys from the same side.

5. Measurement of knuckle end play:

NOTE: A procedure for measuring end play with axle installed on coach and with wheels and tires installed can be found later in this section.

NOTE: The use of shim gauges (feeler gauges) for measurement of clearance tolerances on steering knuckles is not recommended. These will not give an accurate reading of end play. Use only a dial indicator.

NOTE: End play is the free movement of the steering knuckle up and down along the axis of the pin. Some end play is required to prevent binding of the knuckle while turning and to provide a passage for grease to purge during bushing lubrication. Excessive end play can cause interference between the king pin and end caps or retainers.
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1. Repeat steps 5a. through 5e. with the knuckle in the full right and left turn positions. This is necessary to be sure that no binding or excessive play is present during turns.

IMPORTANT: If binding exists or zero end play is measured anywhere in the full travel of the knuckle, remove shims as required to obtain end play of .001" to .025".

IMPORTANT: After measuring knuckle clearance (end play) of over .025", add shims between upper knuckle pin boss and axe center end, as required, to obtain an end play of .001"-.025" (.02-.64 mm) through full range of turn.

NOTE: Normal seating of the thrust bearing, seal and shims will increase the end play reading after a short time in service.

6. Seating Draw Keys — The knuckle pins on later MC-9 units are retained by draw keys. After the specified end play is obtained, seat the draw keys firmly with a hammer and drift (figure 1-27).

2. Gaskets do not have a top or bottom orientation and may be installed in either position.

3. Caps do require orienting the flat side toward the gasket and knuckle. The flat sealing side contains no numbering or lettering.

4. Torque fasteners to 20-30 lb. ft.

5. On the axes of earlier MC-9 coaches:

a. Place washer plug into the lower knuckle bore with the rounded (convex) side toward the king pin.

b. Install lock ring

c. Bushing Lubrication:

A. Grease upper bushing first, then the lower bushing. Use molybdenum disulfide grease. If grease does not flow through the thrust bearing, it will be necessary to raise the knuckle with a jack to close off passage of grease around the thrust bearing. Repack the lower bushing and thrust bearing, then remove jack.

B. Rotate knuckle lock to help distribute the grease. Note the knuckle will now be noticeably harder to rotate than during the end play measurement. This is normal.

C. Repeat step A.

D. On models using draw keys fill the voids in the draw key zones with grease to prevent corrosion and ease future disassembly.

E. The steering knuckle/axle center reassembly is now complete.

Install flanged locknut and torque to 30-40 lb. ft.

7. Securing Tapered King Pins — On earlier MC-9 coaches with drop forged axle centers (which have tapered king pins), the procedure for securing the pin is given in step 48.

8. Installation of King Pin Caps and Welsh Plugs:

IMPORTANT: Before king pin caps and/or welsh plugs are installed, recheck draw keys and king pin nut to be sure the final staking or torquing procedure has been completed. Omission of the final king pin securing steps may result in damaged or broken king pins and axle centers.

A. On the axles of later MC-9 coaches:

1) Align king pin caps and gaskets and assemble to knuckles with capscrews and washers.

2) Gaskets do not have a top or bottom orientation and may be installed in either position.

3) Caps do require orienting the flat side toward the gasket and knuckle. The flat sealing side contains no numbering or lettering.

4) Torque fasteners to 20-30 lb. ft.

B. On the axles of earlier MC-9 coaches:

1) Place washer plug into the lower knuckle bore with the rounded (convex) side toward the king pin.

2) Install lock ring

c. Bushing Lubrication:

A. Grease upper bushing first, then the lower bushing. Use molybdenum disulfide grease. If grease does not flow through the thrust bearing, it will be necessary to raise the knuckle with a jack to close off passage of grease around the thrust bearing. Repack the lower bushing and thrust bearing, then remove jack.

B. Rotate knuckle lock to help distribute the grease. Note the knuckle will now be noticeably harder to rotate than during the end play measurement. This is normal.

C. Repeat step A.

D. On models using draw keys fill the voids in the draw key zones with grease to prevent corrosion and ease future disassembly.

E. The steering knuckle/axle center reassembly is now complete.
TIE ROD ENDS

The tie-rod assembly is of three-piece construction composed of a rod and two end assemblies. See figures 1-29 and 1-30. The tie-rod end automatically compensates for wear on bearing surfaces. The tie-rod end stud is held in contact with the bearing surface by tension of a spring which holds the seat tightly against the inner end of the stud. An end plug, retained by a locking ring, holds the internal tie-rod end parts in position. Excessive play indicates that the bearing surfaces are worn, and new tie-rod end assemblies should be installed.

Some coaches non-repairable ends are used. These assemblies must be replaced as a complete unit.

Socket wear is indicated by ball stud turning torque and socket end movement. End movement may be checked with the ball stud attached to its mating arm. It is force sufficient to overcome the spring pressure is applied to the end of the forging. The amount of movement is an indicator of wear. New socket assemblies should have an end movement of not more than 0.20 inches (5.08 mm). Maximum allowable wear on socket end is 0.08 inches (2.08 mm).

To check the turning torque value between the tie rod end assembly stud and the ball cavity, the socket must be removed from the vehicle. Minimum allowable torque value is 5 in. lbs. (565 Nm).

REMOVAL

To remove tie-rod ends from the tie-rod assembly, remove cotter pins and nuts from tie-rod ends, and support the steering arm to prevent bending. A small drift, rap the side of the tie-rod end to loosen it. Loosen clamp bolts and remove tie-rod ends from the tie-rod tube.

REPAIR (REPAIRABLE ENDS ONLY)

Pry end plug lock out of groove in body. Remove plug, seat, and spring. Remove grease retainer. Stud and bearing assembly can then be removed from the tie-rod end body.
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C. Axle caster: The fore and aft inclination from vertical of the steering knuckle. "Positive caster" is inclination of the top of the steering knuckle towards the rear of the vehicle. "Negative caster" is the inclination of the top of the steering knuckle towards the front of the vehicle. "Zero" caster means no inclination of the steering knuckle.

D. King pin inclination: The amount king pins are inclined inward at the top.

E. Steering geometry: The science of keeping the front wheels in proper alignment during left or right turns.

CAMBER

Wheel camber is the tilting of the front wheels from the vertical center line. Outward inclination at top provides positive camber and inward inclination provides negative camber.

Camber variations may be caused by wear at wheel bearings and steering knuckle bushings or by bent knuckle or sagging axle center.

Excessive positive camber results in irregular wear of tires at outer shoulders. Negative or reverse camber causes wear at inner shoulders. Ease of steering is also affected by any deviation from specified camber.

Position front wheels on turning plates in a straight ahead position. Attach alignment gauges to each wheel spindle. Record the camber readings for each wheel and compare with specifications. Refer to figure 1-32 and Front Axle Specifications Chart at the end of this section.

TOE-IN ADJUSTMENT

Wheel toe-in is the distance the front wheels are closer together at the front than at the rear of axle.

Incorrect toe-in results in excessive tire wear caused by side slippage. Unstable steering with a tendency to wander may also result. The following steps are to check and adjust toe-in.

NOTE: Make sure vehicle is on a level floor.

Do not measure toe-in with the front axle jacked up. The toe-in should be measured with the weight of the vehicle on the axle.

1. Jack up the front axle.
2. Use paint or chalk and whiten the center area of both front tires around the entire circumference.
3. Position a scribe or pointed instrument against the whitened part of each tire and rotate the tires. The scribe must be held firmly in place so that a single straight line is scribed all the way around the tire.
4. Place a full-floating turning radius gauge plate under each wheel. Lower the vehicle and remove the lock pins from the gauge plates. If full-floating turning radius gauge plates are not available, lower the vehicle and move it backward and then forward approximately 6 feet (1.8 m).
5. Position trammel bar at rear of tires and adjust pointers to line up with scribe lines and lock in place (scale should be set on zero). Pointers must be raised to spindle height on the tire as shown (figure 1-31).
6. Position the trammel bar at the front of the tires. Adjust scale end so that pointers line up with scribe marks.
7. Read toe-in or toe-out from the scale. Scale should read toe-in 1/16" ± 1/16" (1.56 mm ± 1.56 mm) (see figure 1-31).
8. If adjustment is necessary, loosen the tie-rod clamps and turn tie rod as required, then tighten the clamps. If the vehicle is not on gauge plates, move it backward, then forward about 6 feet (1.8 m).
9. Recheck the toe-in to ensure that it is correct.

Figure 1-31, Trammel Bar With Pointers Set At Spindle Height.

CASTER

King pin inclination (bench check)

TOE-IN ADJUSTMENT

B Minus A ........................ Caster (inches)
C .............................. Camber (inches)
D .............................. King Pin Inclination (degrees)
F Minus E ........................ Caster (degrees)
G .............................. Vertical
H .............................. Centerline of King Pin
I .............................. King Pin Inclination (degrees)
K Minus J ........................ Caster (degrees)
L Minus M ........................ Caster (inches)
(Measure at Front of Axle)

Refer to "Front Axle Specifications" for numerical values.

Figure 1-32, Alignment Chart.
TROUBLESHOOTING

1a. Rapid or Uneven Tire Wear
   - Incorrect toe-in setting
   - Improper tire inflation
   - Unbalanced tires

1b. Toe-in Control
   - When setting toe-in, it is important to neutralize the component and tire deflections by backing up and then going forward and re-checking the toe-in. This is especially important with radial tires. The check and possible re-set should be followed even if bearing plates are used.

2. Hard Steering
   - Low power steering system pressure
   - Improper assembly or adjustment of steering gear box
   - Inadequate or improper lubrication of knuckle pins
   - Improper caster
   - Tight draglink or tie rod ends
   - Worn thrust bearing

3. Rapid Wear of Cross Tube Ends
   - Inadequate or improper lubrication
   - Severely corrosive environment
   - Failure of protective dust cover.

4. Bent or Broken Cross Tube, Bent or Broken Steering Arm or Cross Tube Arm
   - Excessive power steering system pressure
   - Misadjusted power steering cut-off
   - Operational (curling)

5. Heavily Worn or Broken Steering Arm Ballstud
   - Overtightened draglink
   - Inadequate or improper lubrication

6. Excessive Wear of Knuckle Pins and Bushings
   - Worn or missing seals and gaskets
   - Improper type of grease
   - Inadequate lubrication frequency
   - Improper lubrication technique
   - Inadequate lubrication frequency due to extreme operating conditions such as abrasive dust and sandy environments

7. Front Axle Shimmies or Vibration
   - Incorrect master setting
   - Wheels and/or tires not properly balanced
   - Worn shock absorbers

SPECIFICATIONS

FRONT AXLE SPECIFICATIONS

AXLE CENTER - EARLIER MC-9
Type: ............................................. I Beam
Allowable Twist (Variation Between Ends) ...................................... 9°

AXLE CENTER - LATER MC-9
Type: ............................................. Tubular
Allowable Twist (Variation Between Ends) ...................................... 9°

STEERING KNUCKLES - EARLIER MC-9
Spindle Diameter: Inner Bearing ............................................. 2.562-2.561 in. (65.062-65.057 mm)
Outer Bearing .................................................. 2.125-2.124 in. (53.970-53.957 mm)
Up-And-Down Movement .................................................. 0.005-0.065 in. (127-1.65 mm)
Bushing Bore Diameter .................................................. 1.919-1.921 in. (48.743-48.793 mm)

STEERING KNUCKLES - LATER MC-9
Spindle Diameter: Inner Bearing ............................................. 2.625-2.624 in. (66.662-66.637 mm)
Outer Bearing .................................................. 2.125-2.124 in. (53.962-53.936 mm)
Up-And-Down Movement .................................................. 0.005-0.065 in. (127-1.65 mm)
Bushing Bore Diameter .................................................. 1.919-1.921 in. (48.743-48.793 mm)

STEERING KNUCKLE BUSHINGS - EARLIER MC-9
Material ............................................................. Bronze
Inside-Line Ream .................................................. 1.794-1.795 in. (45.555-45.580 mm)
Line Bumah .................................................. 1.797-1.798 in. (45.631-45.657 mm)

STEERING KNUCKLE BUSHINGS - LATER MC-9
Material ............................................................. "Easy Steer"
Ream Diameter .................................................. 1.796-1.795 in. (45.618-45.593 mm)

KING PIN - EARLIER MC-9
Type: ............................................. Tapered
Diameter - Large End .................................................. 1.794-1.793 in. (45.566-45.542 mm)
Small End .................................................. 1.310-1.309 in. (33.261-33.236 mm)

KING PIN - LATER MC-9
Type: ............................................. Straight
Diameter .................................................. 1.794-1.793 in. (45.566-45.542 mm)

FRONT WHEEL ALIGNMENT - LATER MC-9
Camber (B minus A) .................................................. 1/4° ± 1/4° (Curbside)
Caster Angle (G) .................................................. 4 1/2°-5 1/2° (Roadside)
Toe-In (E minus F) .................................................. 0-1/8 in. (0-0.156 mm)
King Pin Inclination (D) .................................................. 6°-15° (Curbside)
Track: 102" Wide Models .................................................. 5 1/2° (Roadside)
96" Wide Models .................................................. 5 1/4° (Roadside)

Track: 102" Wide Models .................................................. 5 1/2° (Roadside)
96" Wide Models .................................................. 5 1/4° (Roadside)
MC-9 MAINTENANCE MANUAL

SPECIFICATIONS

FRONT WHEEL ALIGNMENT - EARLIER MC-9

- Camber (B minus A) ........................................... $\frac{1}{4}^\circ \pm \frac{3}{16}^\circ$ Neg (Curbside)
- Caster Angle (D) ........................................... $2.5^\circ \pm 1^\circ$ Pos
- Toe-in (E minus F) .......................................... 0-1/4 in. (0-1.88 mm)
- King Pin inclination (D), Right ....................... 6.25°
- King Pin inclination (D), Left ......................... 5.75°
- Track ......................................................... 79.7 in. (2,024 mm)

TORQUE SPECIFICATIONS

- King Pin Nuts .................................................. 350-590 ft. lbs. (475-529 Nm)
- Tie Rod End Clamp Bolt Nuts ......................... 55-65 ft. lbs. (75-88 Nm)
- Tie Rod End Steer Nuts .................................... 165-180 ft. lbs. (224-244 Nm)
- Steering Arm Nuts ......................................... 350-380 ft. lbs. (475-529 Nm)
- Radius Rod Retainer Bolt Nuts ...................... 300-330 ft. lbs. (406-449 Nm)

SERVICE TOOLS

SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IN THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES, TRANSPORTATION MANUFACTURING CORPORATION, AND UNIVERSAL COACH PARTS, WHERE PRACTICAL, THEY MAY BE FABRICATED AT THE SERVICE FACILITY.

DIMENSIONS:

INCHES MILLIMETERS
A = 1.774 ± 0.001 A = 45.0596 ± 0.0254
B = 1.797 ± 0.005 * B = 45.6436 ± 0.0217
B = 1.7955 ± .0005 **
C = 1.7915 ± 0.001 C = 45.5041 ± 0.0254
D = 5.30 D = 130.0

* FOR REAMING BRONZE BUSHINGS.
** FOR REAMING EASY STEER BUSHINGS.

20-5 Tool - King Pin Bushing Removal & Installation

20-6 King Pin Bronze Bushing Reamer

20-312 King Pin "Easy Street" Bushing Reamer.
Service Bulletins will be issued from time to time to acquaint users with the latest service procedures. The number, date, and title of bulletins pertaining to this section should be noted below as soon as received. Bulletins should then be filed for future reference.

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