MODULE CONTENT

| Unit of Competency | **DIAGNOSE AND OVERHAUL DIFFERENTIAL** |
| --- | --- |
| Module Title | **DIAGNOSING AND OVERHAULING DIFFERENTIAL** |
| Module Descriptor | This unit identifies the competence required to diagnose and overhaul the differential. |
| Nominal Duration | **hours** |
| Summary of the Learning Outcomes: | |
| Upon completion of this module the student must be able to: | |
| LO1. Prepare to diagnose differential assembly | |
| LO2. Diagnose differential assembly | |
| LO3. Disassemble and evaluate differential assembly and components | |
| LO4. Assemble differential assembly and components | |
| LO5. Complete work processes | |

**LEARNING EXPERIENCES**

**LEARNING OUTCOMES NO. 1**

**PREPARE TO DIAGNOSE DIFFERENTIAL ASSEMBLY**

| **Learning Activities** | **Special Instructions** |
| --- | --- |
| Read Information Sheet 3.1-1 Prepare to diagnose differential assembly | If you have some problem with the content of the information sheet don’t hesitate to approach your Trainer.  If you feel that you are now knowledgeable on the content of the information sheet, you can now answer the self-check provided in the module. |
| Answer Self-Check 3.1-1 on Prepare to diagnose differential assembly | Try to answer the Self-check without looking at the Answer Key  Compare your answer to Answer Key 3.1-1 |
| Observe Trainer’s demonstration on Task Sheet 3.1-1 on Prepare to diagnose differential assembly | Listen carefully and attentively so that you may be able to perform a task correctly  Ask questions if are in doubt for clarification |
| Perform the Task Sheet 3.1-1 on Prepare to diagnose differential assembly | Remember the step-by-step procedure the Prepare to diagnose differential assembly |
| Evaluate the performance using the Performance Criteria Checklist 3.1-1 | Repeat the task in case fail to meet the criteria |

**INFORMATION SHEET 1.1-1**

**PREPARE TO DIAGNOSE DIFFERENTIAL ASSEMBLY**

**Learning Objectives:**

After reading this **Information Sheet**, you must be able to:

1. Made final inspection.
2. Turned-over vehicle.
3. Restored work area.
4. Managed wastes.
5. Checked and stored tools and equipment.
6. Accomplished workplace documents.

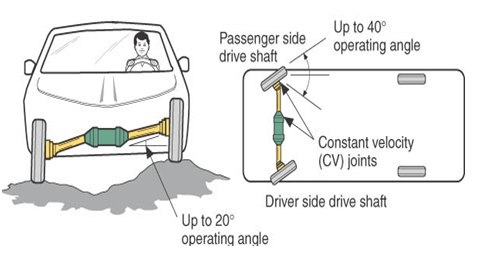
**Prepare to Inspect drive shaft and joint (CV Joint)**

The drive axle assembly transmits torque from the engine and transmission to drive the vehicle’s wheels. The drive axle changes the direction of the power flow, multiplies torque, and allows different speeds between the two drive wheels. Drive axles are used for both front-wheel-drive and rear-wheel-drive vehicles.

**front-wheel-drive (fwd) axles**

Front-wheel-drive axles, also called axle shafts, typically transfer engine torque from the transaxle’s differential to the front wheels. One of the most important components of FWD axles is the constant velocity (CV) joint. These joints are used to transfer uniform torque at a constant speed, while operating through a wide range of angles.

On front or four-wheel-drive cars, operating angles of as much as 40 degrees are common **(Figure 38-1).**  The drive axles must transmit power from the engine to front wheels that must drive, steer, and cope with the severe angles caused by the up-down movement of the vehicle’s suspension. To accomplish this, these cars must have a compact joint that ensures the driven shaft is rotated at a constant velocity, regardless of angle. CV joints also allow the length of the axle assembly to change as the wheel travels up and down.



**Figure 38-1** FWDdrive axle shaft angles.

**TYPES OF CV JOINTS**

Constant velocity joints come in a variety of styles. The different types of joints can be referred to by position (in board or outboard), by function (fixed or plunge,) or by design (ball-type or tripod).

**Inboard or Outboard Joints**

On FWD vehicles, two CV joints are used on each half shaft **(Figure 38-2).** The joint nearer the transaxle is the inner or **inboard joint,** and the one nearer the wheel is the outer or **outboard joint.** In a RWD vehicle with independent rear suspension, the joint nearer the differential can also be referred to as the inboard joint. The one closer to the wheel is the outboard joint.

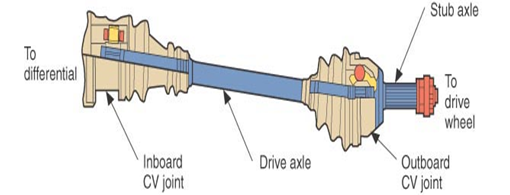


Figure 38-2 A typical FWD drive assembly. Courtesy of Perfect Circle/Dana Corporation

**Fixed and Plunge Joints**

CV joints are either a **fixed joint** (meaning it does not plunge in and out to compensate for changes in length) or a **plunge joint** (one this is capable of in-and-out movement).

In FWD applications, the inboard joint is also a plunge joint. The outboard joint is a fixed joint. Both joints do not have to plunge if one can handle the job. Further, the outboard joint must also be able to handle much greater operating angles needed for steering (up to 40 degrees).

In RWD applications with IRS, one joint one ach axle shaft can be fixed and the other a plunge or both can be plunge joints. Because the wheels are not used for steering, the operating angles are not as great. Therefore, plunge joints can be used at either or both ends of the axle shaft.

**Ball-Type Joints**

There are two basic varieties of CV joints: the **ball-type** and **tripod-type** joints can be used as either inboard or outboard joints, and both are available in fixed or plunge designs.

**fixed-Ball-Type CV Joints** The **Rzeppa** or fixed ball-type join consist of an inner ball race, six balls, a cage to position the balls and an outer housing **(Figure 38-3).**  Tracks machined in the inner race and outer housing form ball-and-socket arrangement. The six balls serve both as bearings between the races and the means of transferring torque from one to the other.



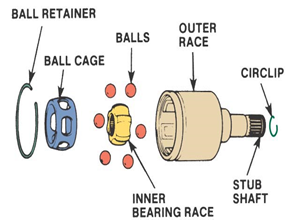
**Figure 38-3** A Rzeppa ball-type fixed CV point. *.*

If viewed from the side, the balls within the joint always bisect the angle formed by the shafts on either side of the joints regardless of the operating angle. This reduces the effective operating angle of the joint by half and virtually eliminates all vibration problems. The input speed to the joints is always equal to the output velocity of the joint—thus the description “constant velocity.” The cage helps to maintain this alignment by holding the six balls snugly in its windows. If the cage windows become worn or deformed over time, the resulting play between ball and window typically results in a clicking noise when turning. It is important to note that opposing balls in a Rzeppa CV joints always work together as a pair. Heavy wear in the tracks of one ball almost always results in identical wear in the tracks of the opposing ball.

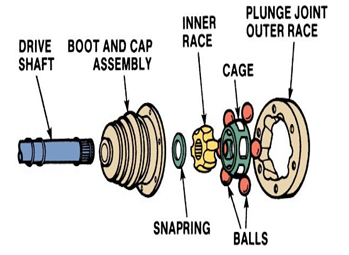
Another ball-type joints is the dish-style CV joints which is used predominantly on Volkswagen as well as on many German RWD models. Its designed is very similar to the Rzeppa joints.

**Plunging Ball-Type Joints** There are two basic style of plunging ball-type joints: the **double-offset** and the **cross groove joint.** This is a more compact design with flat, doughnut-shaped outer housing and angled groove.

The double-offset joint **(Figure 38-4)** uses a cylindrical outer housing with straight grooves and is typical used in applications that require higher operating angle ( up to 25 degrees) and greater plunge depth (up to 25 inches [60 mm]). This type of joint can be found inboard position on some front-wheel-drive half shafts board joint on FWD half shafts or at either end of a RWD independent rear suspension axle shaft.



**Figure 38-4** A double-offset CV joint.



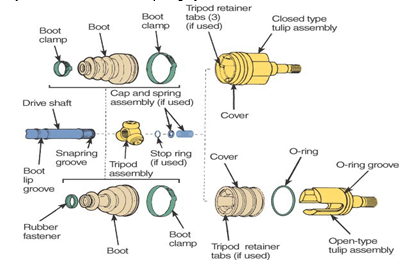
**Figure 38-5** A cross-groove joint.

The feature that makes this joint unique is its ability to handle a fair amount of plunge (up to 1.8 inches [46 mm]) in a relatively short distance. The inner and outer races share the plunging motion equally, so less overall depth is needed for a given amount of plunge. The cross groove can handle operating angles up to 22 degree

**Tripod CV Joints**

As with ball-type CV joints, tripod joints come in two varieties: plunge and fixed.

**Tripod Plunging Joints** Tripod plunging joints **(Figure 38-6)** consist of a central drive part or tripod (also known as a “spider”). This has three trunnions fitted with spherical rollers on needle bearings and an outer housing (sometimes called a “tulip” because of its three-lobed, flowerlike appearance). On some tripod joints, the outer housing is closed, meaning the roller tracks are totally enclosed within it. Oh others, the tulip is open and the roller tracks are machined out of the housing. Tripod joints are most commonly used as FWD inboard plunge joints.



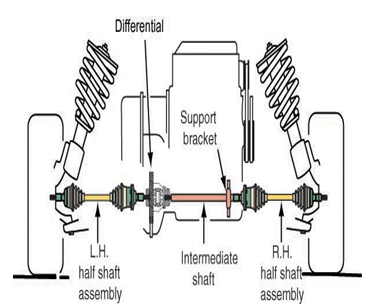
**Figure 38-6** Inner tripod plunge-type joints: closed housing and open

**Fixed Tripod Joints** The fixed tripod joint is sometimes used as the outboard joint in FWD applications. In this design, the trunnion is mounted in the outer housing and the three roller bearings turn against an open tulip on the input shaft. A steel locking spider holds the joints together.

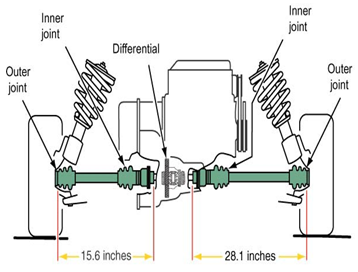
The fixed tripod joint has a much greater angular capability. The only major difference from a service standpoint is that fixed tripod joint cannot be removed from the drive shaft or disassembled because of the way it is manufactured. The complete joints and shaft assembly must be replaced if the joint goes bad.

**FRONT-WHEEL-DRIVE APPLICATIONS**

FDW half shafts can be solid or tubular, of equal **(Figure 38-7)** unequal length **(Figure 38-8),** and come with or without damper weights. Equal-length shafts are used in some vehicles to help reduce torque steer (the tendency to steer to one side as engine power is applied). In these applications, an intermediate shaft is used as a link from the transaxle to one of the half shafts. This intermediate shaft can use an ordinary Cardan universal joint (described later in this chapter) t a yoke at the transaxle. At the outer end is a support bracket and bearing assembly. Looseness of the bearing or bracket can create vibrations. These items should be included in any inspection of the drivetrain components. The small damper weight, called a **torsional damper,** that is sometimes attached to one half shafts serves to dampen harmonic vibrations in the drivetrain and to stabilize the shaft as it spins, not to balance the shaft.



**Figure 38-7** Equal lengths FWD half with an intermediate shaft.



**Figure 38-8** Unequal length FWD half shafts.

Regardless of the application, outer joints typically wear faster than inner joints because of the increased range of operating angles to which they are subjected. Inner joint angles may change only 10-20 degrees as the suspension travels through jounce and rebound. Outer joints can undergo changes of up to 40 degrees in addition to jounce and rebound as the wheels are steered. That, combined with more flexing of the outer boots, is why outer joints have a higher failure rate. On average, nine outer CV joints are replaced for every inner CV joint. That does not mean the technician should overlook the inner joints. They wear too. Every time the suspension travels through jounces and rebound, the inner joints must plunge in and out to accommodate the different arcs between the drive shafts and suspension. Tripod inner joints tend to develop unique wear patterns on each of the three rollers and their respective tracks in the housing, which can lead to noise and vibration problems.

Other Applications

CV joints are also found on the front axles of many 4WD vehicles and on vehicles with rear independent suspension systems (Figure 38-9). Their use in these designs offers the same benefits as when they are used for front-wheel drive.



**Figure 38-9** A CV-joint-equipped rear axle assembly for a vehicle with independent rear suspension.

**CV JOINT SERVICE**

With proper service, CV joints can have a long life, despite having to perform extremely difficult jobs in hostile environments. They must endure extreme heat and cold and survive the shock of hitting potholes at high speeds. Fortunately, high-torque loads during low-speed turns and many thousands of high-speed miles normally do not bother the CV joint goes unnoticed.

All CV joints are encased in a protective rubber (neoprene, natural, or silicone) or thermoplastic (Hycrel) boot. The job of the boot is to retain grease and to keep dirt and water out. The importance of the boot cannot be overemphasized because without its protection the joint does not survive. For all practical purposes, a CV joint is lubed for life. Once packed with grease and installed, it requires no further maintenance. A loose or missing boot clamp, or slit, tear, or a small puncture in the boot itself allows grease to leak out and water or dirt to enter. Consequently, the joint is destroyed.

Although outboard joints tend to wear faster than the inboard ones, the decision as to whether to replace both joints when the half shaft is removed depends on the circumstances. If the vehicle has low miles and joint failure is the result of a defective boot, there is no reason to replace both joints. On a high-mileage vehicle where the bad joint has actually just worn itself out, it might be wise to save the expense inconvenience of having the half shaft removed tiwe for CV joint replacement.

**Diagnosis and Inspection**

Any noise in the engine, drive axle, steering, or suspension is a good reason for a thorough inspection of the vehicle. A road test on a smooth surface is a good place to begin. The test should include driving at average highway speeds, some sharp turns, accelerating, and coasting. Look and listen for the following signs:

§ A popping or clicking noise when turning indicates a possible worn or damage outer joint **(Figure 38-10).** Top help identify the exact cause, put the vehicle in reverse and back up in a circle. If the noise gets louder, the outer joints should be replaced.



**Figure 38-10a** A worn cage or race can cause s click

§ A clunk during accelerating, decelerating, or putting an automatic transaxle into drive can be caused by excessive play in the inner joint on FWD vehicles. A clunking noise when putting an automatic transmission into gear or when starting out from a stop usually indicates excessive play in an inner or outer joint. Be warned, though, that the same kind of noise can also be produced by excessive backlash in the differential gears and transmission. Alternately accelerating and decelerating in reverse while driving straight can reveal worn inner plunge joint clunks or shudders.

§ A humming or growling noise is sometimes due to inadequate lubrication of either the inner or outer CV joint. It is more often due to worn or damaged wheel bearings, a bad intermediate shaft bearing on equal length half-shaft transaxles, or worn shaft bearings within the transmission.

§ A shudder or vibration when accelerating is often caused by excessive play in either the inboard or outboard joint but more likely it is the inboard plunge joint. These vibrations can also be caused by a bad intermediate shaft bearing in transaxle with equal length half shafts. On FWD vehicles with transverse mounted engines, this kind of vibration can also be caused by loose or deteriorated engine/transaxle mounts. Be sure to inspect the rubber bushing on the engine’s upper torque strap to rule out this possibility. A vibration or shudder that increases with speed or comes and goes at a certain speed may be the result of excessive play in an inner or outer joint. A bent axle shaft can cause the same problem. Note, however, that some shudder could also be inherent to the vehicle.

§ A cyclic vibration that comes and goes between 45 and 60mph (72 and 100km) may lead the technician to think there is a wheel that is out of balance. However, as a rule, an out-of-balance wheel produces a continuous vibration. A more likely cause is a bad inner tripod CV joint. The vibration occurs because one of the three rollers track has become dimpled or rough. Every time the tripod roller on the bad track hits the rough spot, it creates a little jerk in the driveline, which the driver feels as a cyclic vibration.

§ If a noise is heard while driving straight ahead but it ceases while turning, the problem is usually not a defective outer CV joints but a bad front wheel bearing. Turning changes the side load on the bearing, which may make it quieter than before.

§ A vibration that increases with speed is rarely due to CV joint problems or FWD half-shaft imbalance. An out-of-balance tire or wheel, an out-of-round tire or wheel, or bent rims are the most likely causes. It is possible that a bent half-shaft, as the result of collision or towing damage, could cause the vibration. A missing damper weight could also be the culprit.

Begin CV joint inspection **(Figure 38-11)** by checking the condition of the boots. Split, cracks, tears, punctures or thin spots caused by rubbing call for immediate boot replacement. If the boot appears rotted, this indicates improper greasing or excessive heat, and it should be replaced. Squeeze all boots. If any air escapes, replace the boot.

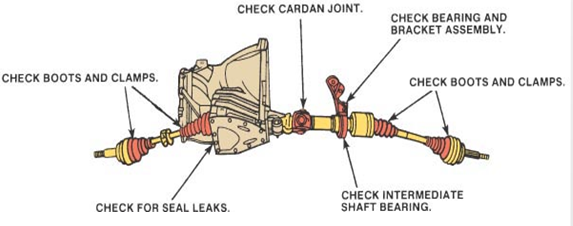


Figure 38-11 Inspection points for a FWD vehicle.

If the inner boot appears to be collapsed or deformed, venting it (allowing air to enter) might solve the problem. Place a round-tipped rod between the boot and drive shaft. This equalized the outside and inside air and allows the boot to return to its normal shape.

Make sure that all boot clamps are tight. Missing or loose clamps should be replaced. If the boot appears loose, slide it back and inspect the grease inside for possible contamination. A milky or foamy appearance indicates water contamination. A gritty feeling when rubbed between the fingers indicates dirt. In most cases, a water or dirt-contaminated joint should be replaced.

The drive axles should be checked for signs of contact or rubbing against the chassis. Rubbing can be a symptom of a weak or broken spring or engine mount, as well as chassis misalignment. On FWD transaxles with equal length half-shaft, inspect the immediate shaft U-joint, bearing, and support bracket for looseness by rocking the wheel back and forth and watching for any movement, Oil leakage around the inner CV joints indicates faulty transaxle shaft seal. To replace the seal, the half shaft must be removed.

**Obtaining CV Repair Parts**

To repair a drive axle, a complete shaft should be installed. Most aftermarket part suppliers offer a complete line of original equipment drive shafts for FWD vehicles. These shafts come fully assembled and ready for installation. This repair method eliminates the need to tear down and rebuild an old shaft.

If only the CV joints need service, a CV joint service kit should be installed. Joint service kits typically include a CV joint, boot, boot clamps and seals, special grease for lubricant (various joints require different amounts of grease; the correct quantity is packed in each kit), retaining rings, and old shaft.

Part manufacturers also produce a line of complete boot sets for each application, including new clamps and the appropriate type and amount of grease for the joint. CV joints require a special high temperature, high pressure grease. Substituting any other type of grease may lead to premature failure of the joint. Be sure to use all the grease supplied in the joint or boot kit. The same rule applies to the camps. Use only those clamps supplied with the replacement boot. Follow the directions for positioning and securing them.

Old boots should never be reused when replacing a CV joint. IN most cases, failure of the joint is caused by some deterioration of the old boot. Reusing an old boot on a new joint usually leads to the quick destruction of the joint.

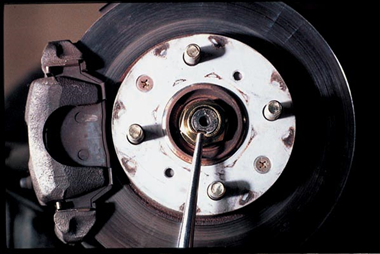
Photo sequence 37 shows the procedure for removing a typical drive axle and replacing a CV joint boot. Always refer to the Service Manual for the exact service procedure. The diagnosis and the service chart have shown in **Table 38-1** gives an idea of the types of front-wheel drivetrain problems that occurs.

**CV Joint Service Guidelines**

The following are some guidelines to follow when servicing CV joints:

v Never jerk or pull on the axle shaft when removing it from a vehicle with tripod inner joints. Doing so may pull the joint apart, allowing the needle bearing to fall out of the roller. Pull on the inner housing, and support the outer end of the shaft until the shaft is completely out.

v Always torque the bulb nuts to the vehicle manufacturer’s specifications. This is absolutely necessary to properly preload the wheel bearings. Do not guess. The specifications can vary from 75 to 235 ft-lb (101 to 318 Nm). Most axle hub nuts are staked in place after they have been tightened **(Figure 38-12).** Never use an impact wrench to loosen or tighten axle hub nuts. Doing so may damage the wheel bearings as well as the CV joints



**Figure 38-12** Most axle hub nuts are staked after they are tightened to lock them in place.

v On vehicles with antilock brakes, use care to protect the wheel speed sensor and tone ring on the outer CV joint housings. If misaligned or damaged during joint replacement, it can cause wheel speed sensor problems.

v Always recheck the alignment after replacing CV joints. Marking the camber bolts is not enough, because camber can be off as much as three-quarters of a degree due to differences between the size of the camber bolts and their holes.

**CV Shaft and Rubber Boot Care Tips**

The rubber boots need special care when you are servicing the CV joints, engine, or transaxle. The following tips might save you trouble later:

Ø Always support the control arm when doing on-the-car balancing of the front wheels to avoid high speed operation at a steep half-shaft angle. Off-the-car balancing might be a wiser choice.

Ø Do not use half shafts as lift points for raising a car.

Ø Use a plastic or metal shield over rubber boots to protect them from accidental tool damage when performing other wheel, brake, suspension, or steering system maintenance.

Ø Clean only with soap and water

Ø Avoid boot contact with gasoline, oil, or degreaser compounds.