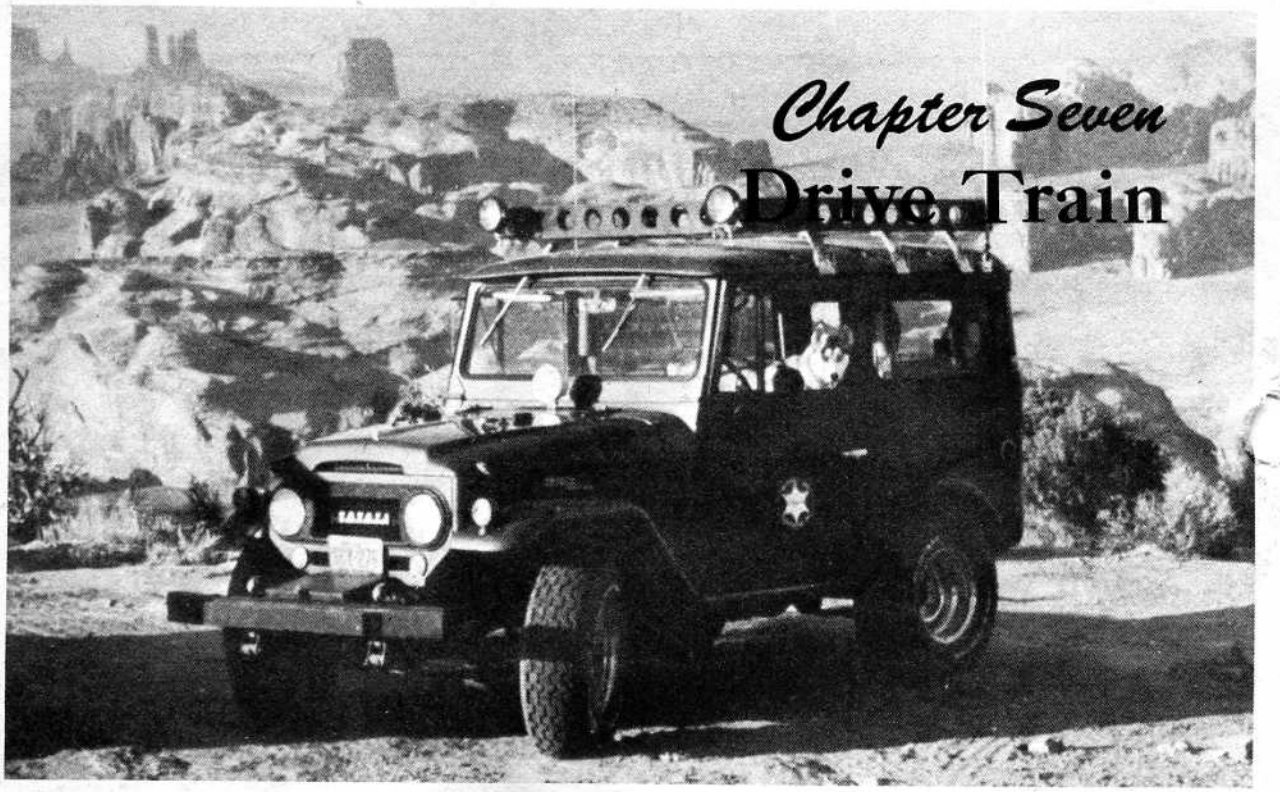


Chapter Seven
Drive Train

Driveline

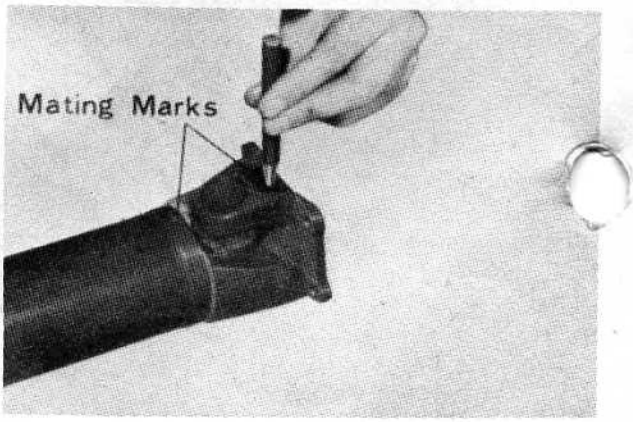
FRONT AND REAR DRIVESHAFTS

Removal and Installation

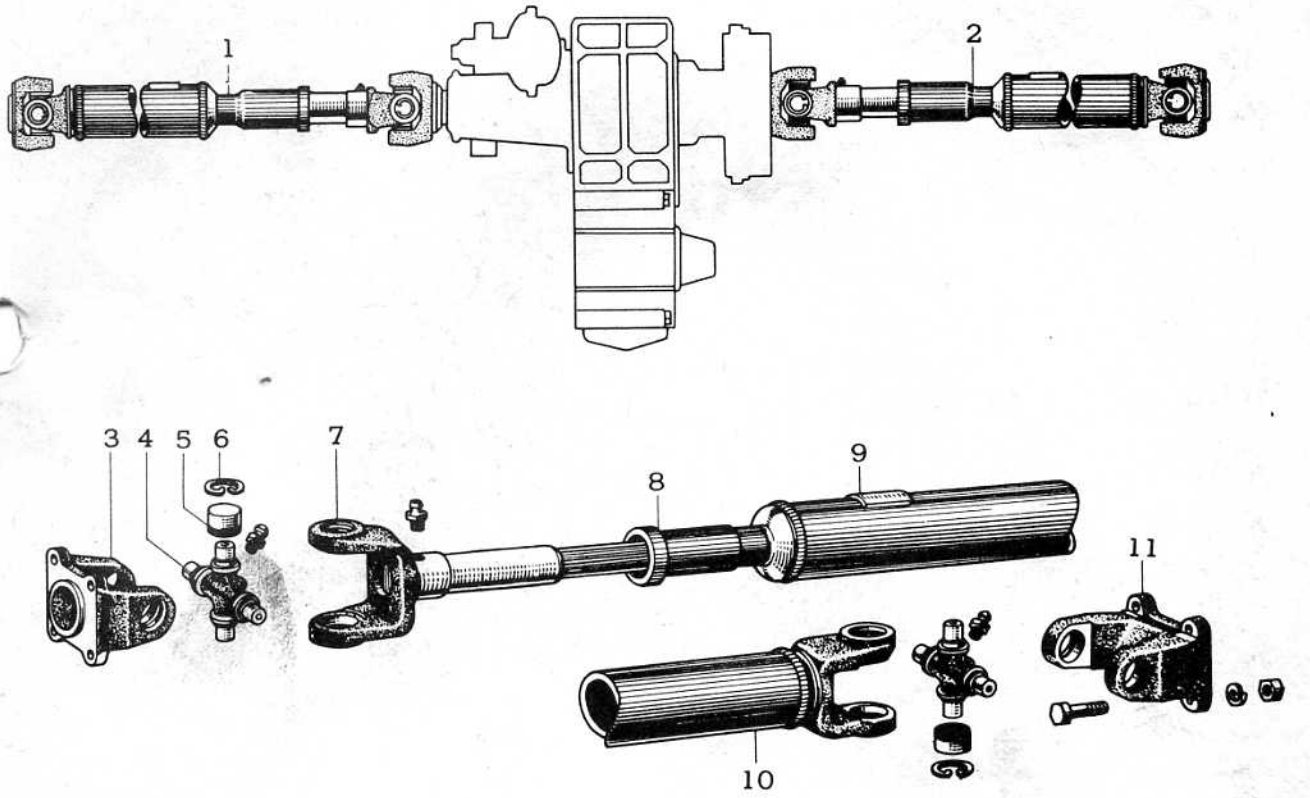
1. Remove the bolts retaining the universal joint flange yoke onto the differential and disconnect the driveshaft from the differential.
2. Remove the bolts retaining the universal joint flange on the transfer case output shaft.
3. Remove the driveshaft assembly from under the vehicle.

U-Joint Overhaul

1. Slide the universal joint slide yoke assembly out of the driveshaft.
2. Punch mating marks on both the universal joint flange yoke and the universal joint slide yoke so that the driveshaft assembly can be reassembled in the same position.
3. Remove the snap-rings from the bearing holes of the yoke.
4. Place the yoke in a vise with a small socket positioned against one of the bearing cups and a larger socket placed against the yoke on the opposite side. The larger socket must be able to receive the bearing cap when it is pressed out of the yoke.
5. Tighten the vise until the bearing caps are free of the yoke.
6. Remove the two remaining bearings from the opposite yoke in the same manner and remove the spider bearing journal.
7. Make sure that the new spiders and needle bearings in the bearing caps are well lubricated.
8. Assemble the universal joint spider and bearing caps to the yoke in the reverse manner of removal, using the smaller socket to press the bearing caps into the yoke and the larger socket to bear against the yoke bearing cap hole at the opposite end. Use a vise to press the bearing caps in place.



Matchmark the driveshaft and the yoke assemblies so that they can be installed in their original positions



The front and rear driveshaft assemblies

1. Front driveshaft
2. Rear driveshaft
3. Universal joint flange yoke
4. Universal joint spider
5. Spider bearing
6. Snap-ring
7. Universal joint slide yoke
8. Sliding shaft dust cover
9. Balance piece
10. Front driveshaft
11. Universal joint flange yoke

9. Install the hole snap-ring to secure the bearing caps.

NOTE: *Grease fittings on the universal joint spider should face toward the slide yoke.*

10. Assemble the slide yoke to the driveshaft, aligning the marks made prior to disassembly. If no marks were made, align the grease fitting on the slide yoke with the arrow mark on the driveshaft and insert the slide yoke into the driveshaft. Check the sliding joint for smooth movement.

11. Install the driveshaft assembly on e vehicle.

Rear Axle

AXLE SHAFT

Removal and Installation

1. Remove the hub cap and loosen the wheel nuts.

2. Raise the rear axle housing with a jack and support the rear of the vehicle with jackstands.

3. Drain the oil from the differential.

4. Remove the wheel nuts and take off the wheels.

5. Remove the brake drum and related parts. See Chapter 9.

6. Remove the cover from the back of the differential housing.

7. Remove the pin from the differential pinion shaft.

8. Remove the pinion shaft and its spacer from the case.

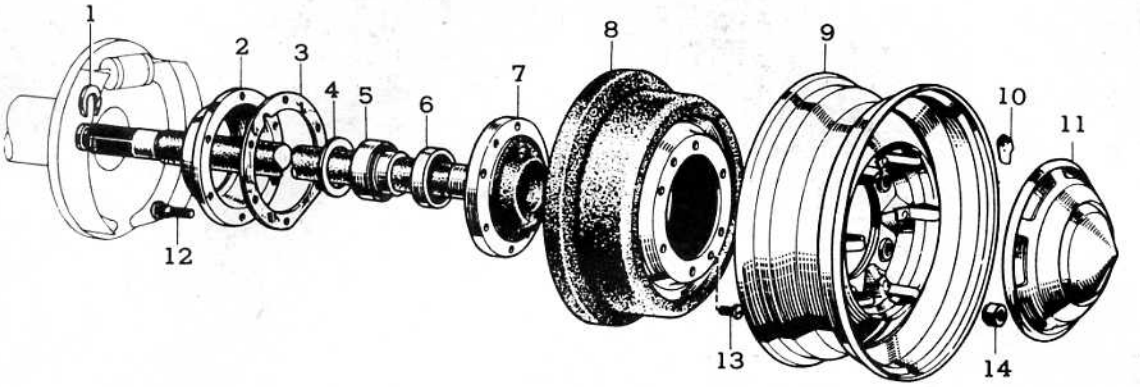
9. Use a mallet to tap the rear axle shaft toward the differential to aid in removing the axle shaft C-lock.

10. Remove the axle shaft C-lock.

11. Remove the axle shaft from the housing.

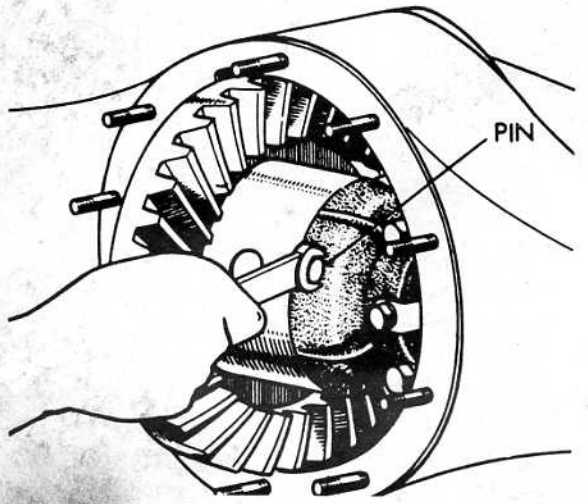
12. Repeat the removal procedure for the opposite side, if necessary.

13. Install the axle shaft in the reverse order of removal. After installing the axle shaft, C-lock, spacer and pinion



The rear axle shaft assembly and related components

1. Rear axle shaft lock
2. Brake drum oil deflector
3. Gasket
4. Spacer
5. Wheel bearing
6. Oil seal
7. Axle shaft
8. Brake drum
9. Wheel
10. Wheel balancing weight
11. Hub cap
12. Hub bolt
13. Brake drum set bolt
14. Lug nut



Removing the pin from the differential pinion shaft

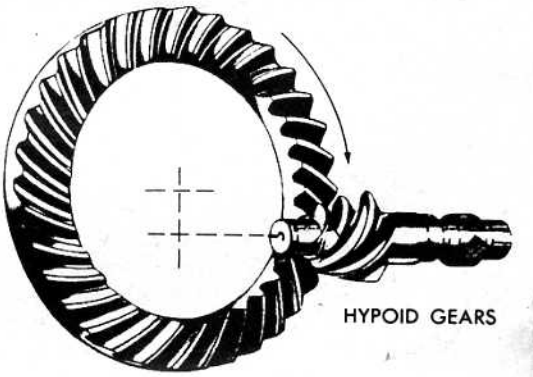
shaft, the clearance between the axle shaft and the pinion shaft should be between 0.0024–0.0181 in. The clearance is adjusted by adding or subtracting spacers behind the wheel bearing.

DIFFERENTIAL

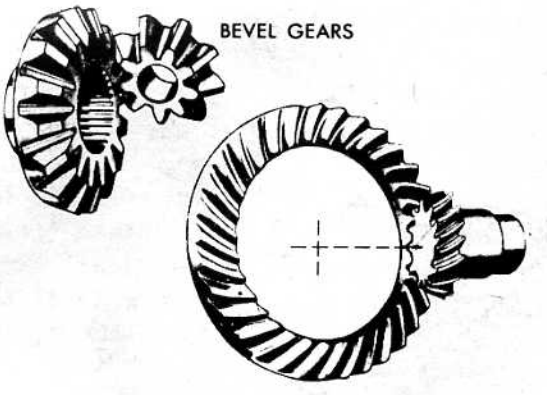
Differential service is best left to those extremely familiar with their vagaries and idiosyncrasies. A great many specialized tools are required as well as a good deal of experience.

Introduction

The rear axle must transmit power through 90°. To accomplish this, straight cut level gears or spiral bevel gears were used. This type of gear is satisfactory for differential side gears, but since the centerline of the gears must intersect, they rapidly became unsuited for



Hypoid type gears



Bevel type gears

ring and pinion gears. The lowering the driveshaft brought about a variatio of the bevel gear, which is called the hypoid gear. This type of gear does not require a meeting of the gear centerlines and can therefore be underslung, relative to the centerline of the ring gear.

Operation

The differential is an arrangement of gears which permits the rear wheels to

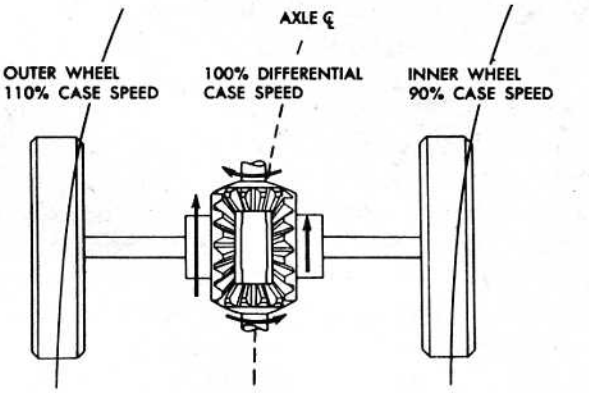
turn at different speeds when cornering and divides the torque between the axle shafts. The differential gears are mounted on a pinion shaft and the gears are free to rotate on this shaft. The pinion shaft is fitted in a bore in the differential case and is at right angles to the axle shafts.

Power flow through the differential is as follows. The drive pinion, which is turned by the driveshaft, turns the ring gear. The ring gear, which is bolted to the differential case, rotates the case. The differential pinion forces the pinion gears against the side gears. In cases where both wheels have equal traction, the pinion gears do not rotate on the pinion shaft, because the input force of the pinion gear is divided equally between the two side gears. Consequently the pinion gears revolve with the pinion shaft, although they do not revolve on the pinion shaft itself. the side gears, which are splined to the axle shafts, and meshed with the pinion gears, rotate the axle shafts.

When it becomes necessary to turn a corner, the differential becomes effective and allows the axle shafts to rotate at different speeds. As the inner wheel slows down, the side gear splined to the inner wheel axle shaft also slows down. The pinion gears act as balancing levers by maintaining equal tooth loads to both gears while allowing unequal speeds of rotation at the axle shafts. If the vehicle speed remains constant, and the inner wheel slows down to 90 percent of vehicle speed, the outer wheel will speed up to 110 percent.

Limited-Slip Differential Operation

Limited-slip differentials provide driving force to the wheel with the best traction before the other wheel begins to spin. This is accomplished through clutch plates or cones. The clutch plates or cones are located between the side gears and inner wall of the differential case. When they are squeezed together through spring tension and outward force from the side gears, three reactions occur. Resistance on the side gears causes more torque to be exerted on the clutch packs or clutch cones. Rapid one-wheel spin cannot occur, because the



Differential action while cornering

side gear is forced to turn at the same speed as the case. Most important, with the side gear and the differential case turning at the same speed, the other wheel is forced to rotate in the same direction and at the same speed as the differential case. Thus driving force is applied to the wheel with the better traction.

NOTE: *Whenever the rear of a vehicle with a limited-slip rear axle is jacked or supported, both wheels must be raised off the ground. Movement of either wheel in contact with the ground can cause the vehicle to move.*

Determining Gear Ratio

Normally, the gear ratio of an axle installed in a vehicle is listed somewhere; in service manuals, on an option list, or on a tag on the axle somewhere.

Determining the axle ratio of any given axle is an esoteric subject, relatively useless until you have to know. But, as a "junkyard art," it is invaluable.

The rear axle ratio is said to have a certain ratio, say, 4.11. It is called a 4.11 rear although the 4.11 actually means 4.11:1. This means that the driveshaft will turn 4.11 times for every turn of the rear wheel. The number 4.11 is determined by dividing the number of teeth on the pinion gear into the number of teeth on the ring gear. In the case of a 4.11, there could be 9 teeth on the pinion and 37 teeth on the ring gear ($37 \div 9 = 4.11$). This provides a sure way (although troublesome—except to those who are really interested) of determining your rear axle ratio. You must drain the rear axle and remove the rear cover, if it has one, and count the teeth on the ring and pinion.

An easier method is to jack and support the vehicle so that BOTH rear wheels are off the ground. Make a chalk mark on the rear wheel and the driveshaft. Block the front wheels, set the parking brake and put the transmission in Neutral. Turn the rear wheel one complete revolution and count the number of turns that the driveshaft makes. The number of turns that the driveshaft makes in one complete revolution of the rear wheel is an *approximation* of the rear axle ratio.

Differential Diagnosis

The most essential part of rear axle service is proper diagnosis of the problem. Bent or broken axle shafts or broken gears pose little problem, but isolating an axle noise and correctly interpreting the problem can be extremely difficult,, even for an experienced mechanic.

Any gear driven unit will produce a certain amount of noise, therefore, a specific diagnosis for each individual unit is the best practice. Acceptable or normal noise can be classified as a slight noise heard only at certain speeds or under unusual conditions. This noise tends to reach a peak at 40–60 mph, depending on the road condition, load, gear ratio and tire size. Frequently, other noises are mistakenly diagnosed as coming from the rear axle. Vehicle noises from tires, transmission, driveshaft, U-joints and front and rear wheel bearings will often be mistaken as emanating from the rear axle. Raising the tire pressure to eliminate tire noise (although this will not silence mud or snow treads), listening for noise at varying speeds and road conditions and listening for noise at drive and coast conditions will aid in diagnosing alleged rear axle noises.

External Noise Elimination

It is advisable to make a thorough road test to determine whether the noise originates in the rear axle or whether it originates from the tires, engine, transmission, wheel bearings or road surface. Noise originating from other places cannot be corrected by overhauling the rear axle.

Road Noise

Brick roads or rough surfaced concrete, may cause a noise which can be mistaken as coming from the rear axle. Driving on a different type of road, (smooth asphalt or dirt) will determine whether the road is the cause of the noise. Road noise is usually the same on drive or coast conditions.

Tire Noise

Tire noise can be mistaken as rear axle noises, even though the tires on the front are at fault. Snow tread and mud tread tires or tires worn unevenly will frequently cause vibrations which seem to originate elsewhere; *temporarily, and for test purposes only,* inflate the tires to 40–50 lbs. This will significantly alter the noise produced by the tires, but will not alter noise from the rear axle. Noises from the rear axle will normally cease at speeds below 30 mph on coast, while tire noise will continue at lower tone as car speed is decreased. The rear axle noise will usually change from drive conditions to coast conditions, while tire noise will not. Do not forget to lower the tire pressure to normal after the test is complete.

Engine and Transmission Noise

Engine and transmission noises also seem to originate in the rear axle. Road test the vehicle and determine at which speeds the noise is most pronounced. Stop the car in a quiet place to avoid interfering noises. With the transmission in Neutral, run the engine slowly through the engine speeds corresponding to the car speed at which the noise was most noticeable. If a similar noise was produced with the car standing still, the noise is not in the rear axle, but somewhere in the engine or transmission.

Front Wheel Bearing Noise

Front wheel bearing noises, sometimes confused with rear axle noises, will not change when comparing drive and coast conditions. While holding the car speed steady, lightly apply the footbrake. This will often cause wheel bearing noise to lessen, as some of the weight is taken off the bearing. Front

wheel bearings are easily checked by jacking up the wheels and spinning the wheels. Shaking the wheels will also determine if the wheel bearings are excessively loose.

Rear Axle Noises

If a logical test of the vehicle shows that the noise is not caused by external items, it can be assumed that the noise originates from the rear axle. The rear axle should be tested on a smooth level road to avoid road noise. It is not advisable to test the axle by jacking up the rear wheels and running the car.

True rear axle noises generally fall into two classes; gear noise and bearing noises, and can be caused by faulty driveshaft, faulty wheel bearings, worn differential or pinion shaft bearings, U-joint misalignment, worn differential side gears and pinions, or mismatched, improperly adjusted, or scored ring and pinion gears.

Rear Wheel Bearing Noise

A rough rear wheel bearing causes a vibration or growl which will continue with the car coasting or in Neutral. A brinelled rear wheel bearing will also cause a knock or click approximately every two revolutions of the rear wheel, due to the fact that the bearing rollers do not travel at the same speed as the rear wheel and axle. Jack up the rear wheels and spin the wheel slowly, listening for signs of a rough or brinelled wheel bearing.

Differential Side Gear and Pinion Noise

Differential side gears and pinions seldom cause noise, since their movement is relatively slight on straight ahead driving. Noise produced by these gears will be more noticeable on turns.

Pinion Bearing Noise

Pinion bearing failures can be distinguished by their speed of rotation, which is higher than side bearings or axle bearings. Rough or brinelled pinion bearings cause a continuous low pitch whirring or scraping noise beginning at low speeds.

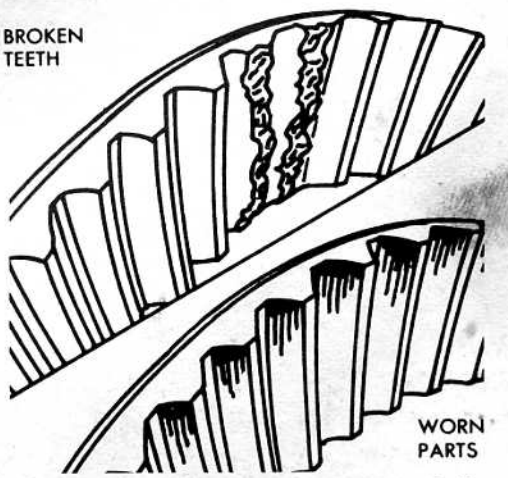
Side Bearing Noise

Side bearings produce a constant rough noise, which is slower than the pinion bearing noise. Side bearing noise may also fluctuate in the above rear wheel bearing test.

Gear Noise

Two basic types of gear noise exist. First, is the type produced by bent or broken gear teeth which have been forcibly damaged. The noise from this type of damage is audible over the entire speed range. Scoring or damage to the hypoid gear teeth generally results from insufficient lubricant, improper lubricant, improper break-in, insufficient gear backlash, improper ring and pinion gear alignment or loss of torque on the drive pinion nut. If not corrected, the scoring will lead to eventual erosion or fracture of the gear teeth. Hypoid gear tooth fracture can also be caused by extended overloading of the gear set (fatigue fracture) or by shock overloading (sudden failure). Differential and side gears rarely give trouble, but common causes of differential failure are shock loading, extended overloading and differential pinion seizure at the cross-shaft, resulting from excessive wheel spin and consequent lubricant breakdown.

The second type of gear noise pertains to the mesh pattern between the ring and pinion gears. This type of abnormal gear noise can be recognized as a cycling pitch or whine audible in either drive, float or coast conditions. Gear noises can be recognized as they tend to peak out in a narrow speed range and



Two types of damage that could cause differential noise

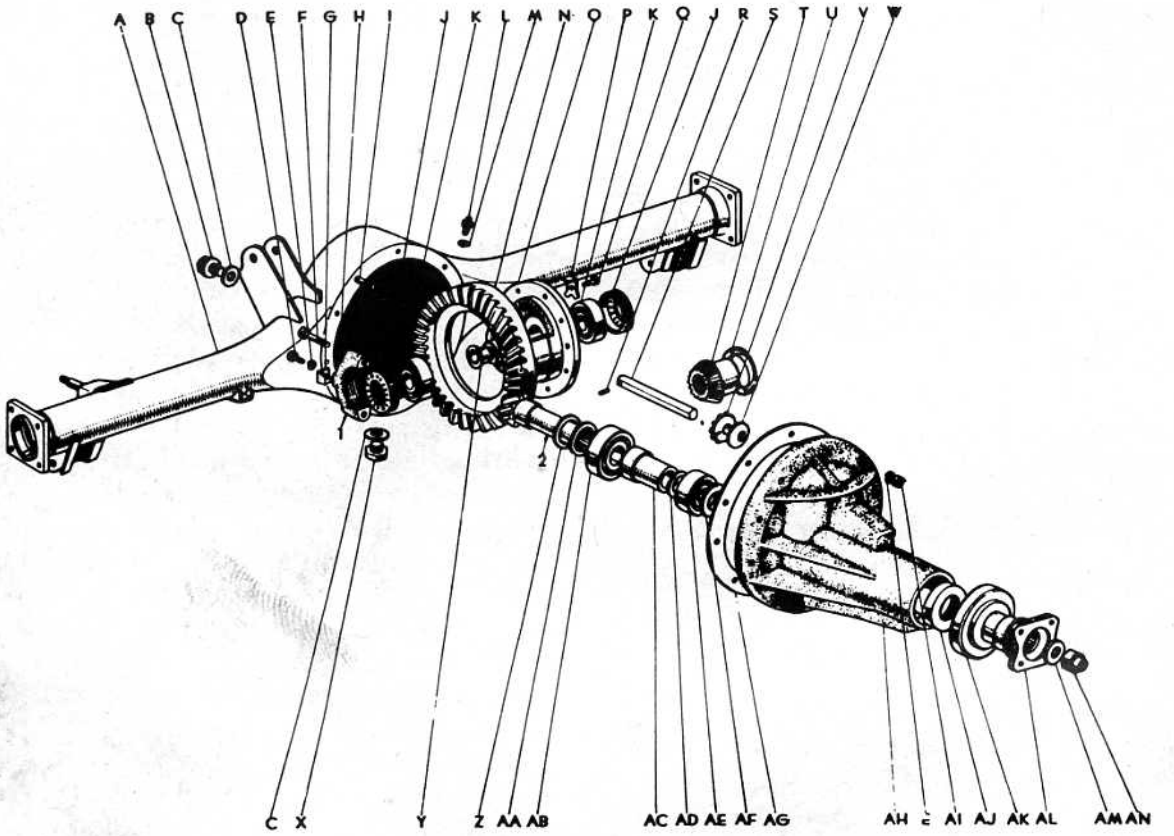
remain constant in pitch, whereas bearing noises tend to vary in pitch with vehicle speeds. Noises produced by the ring and pinion gears will generally follow the pattern below.

A. Drive Noise: Produced under vehicle acceleration.

B. Coast Noise: Produced while the car coasts with a closed throttle.

C. Float Noise: Occurs while maintaining constant car speed (just enough to keep speed constant) on a level road.

D. Drive, Coast and Float Noise: These noises will vary in tone with speed and be very rough or irregular if the differential or pinion shaft bearings are worn.



Differential components

(a)—Housing assembly
(b)—Filler plug
(c)—Gasket
(d)—Bolt
(e)—Lock washer
(f)—Hexagon bolt
(g)—Bearing adjusting nut lock
(h)—Lockwasher
(i)—Stud
(j)—Bearing adjusting nut
(k)—Bearing
(l)—Breather plug
(m)—Lockwasher
(n)—Ring gear and drive pinion 1 and 2
(o)—Case
(p)—Lockplate
(q)—Bolt
(r)—Lockpin
(s)—Pinion shaft
(t)—Side gear
(u)—Thrust washer
(v)—Pinion
(w)—Thrust washer
(x)—Drain plug
(y)—Oil reservoir
(z)—Spacer
(aa)—Shim
(ab)—Bearing
(ac)—Spacer
(ad)—Shim
(ae)—Bearing
(af)—Oil slinger
(ag)—Gasket
(ah)—Carrier
(ai)—Nut
(aj)—Oil seal
(ak)—Dust deflector
(al)—Universal joint flange
(am)—Flat washer
(an)—Nut

GENERAL DRIVE AXLE DIAGNOSTIC GUIDE

(Also see following text for further differential diagnosis.)

CONDITION	POSSIBLE CAUSE	CORRECTION
REAR WHEEL NOISE	(a) Loose Wheel.	(a) Tighten loose wheel nuts.
	(b) Spalled wheel bearing cup or cone.	(b) Check rear wheel bearings. If spalled or worn, replace.
	(c) Defective or brinelled wheel bearing.	(c) Defective or brinelled bearings must be replaced. Check rear axle shaft end-play.
	(d) Excessive axle shaft end-play.	(d) Readjust axle shaft end play.
	(e) Bent or sprung axle shaft flange.	(e) Replace bent or sprung axle shaft.
SCORING OF DIFFERENTIAL GEARS AND PINIONS	(a) Insufficient lubrication.	(a) Replace scored gears. Scoring marks on the pressure face of gear teeth or in the bore are caused by instantaneous fusing of the mating surfaces. Scored gears should be replaced. Fill rear axle to required capacity with proper lubricant.
	(b) Improper grade of lubricant.	(b) Replace scored gears. Inspect all gears and bearings for possible damage. Clean and refill axle to required capacity with proper lubricant.
	(c) Excessive spinning of one wheel.	(c) Replace scored gears. Inspect all gears, pinion bores and shaft for scoring, or bearings for possible damage.
TOOTH BREAKAGE (RING GEAR AND PINION)	(a) Overloading.	(a) Replace gears. Examine other gears and bearings for possible damage. Avoid future overloading.
	(b) Erratic clutch operation.	(b) Replace gears, and examine remaining parts for possible damage. Avoid erratic clutch operation.
	(c) Ice-spotted pavements.	(c) Replace gears. Examine remaining parts for possible damage. Replace parts as required.
	(d) Improper adjustment.	(d) Replace gears. Examine other parts for possible damage. Be sure ring gear and pinion backlash is correct.
REAR AXLE NOISE	(a) Insufficient lubricant.	(a) Refill rear axle with correct amount of the proper lubricant. Also check for leaks and correct as necessary.
	(b) Improper ring gear and pinion adjustment.	(b) Check ring gear and pinion tooth contact.
	(c) Unmatched ring gear and pinion.	(c) Remove unmatched ring gear and pinion. Replace with a new matched gear and pinion set.
	(d) Worn teeth on ring gear or pinion.	(d) Check teeth on ring gear and pinion for contact. If necessary, replace with new matched set.
	(e) End-play in drive pinion bearings.	(e) Adjust drive pinion bearing preload.
	(f) Side play in differential bearings.	(f) Adjust differential bearing preload.
	(g) Incorrect drive gearlash.	(g) Correct drive gear lash.
	(h) Limited-Slip differential — moan and chatter.	(h) Drain and flush lubricant. Refill with proper lubricant.

CONDITION	POSSIBLE CAUSE	CORRECTION
LOSS OF LUBRICANT	(a) Lubricant level too high.	(a) Drain excess lubricant.
	(b) Worn axle shaft oil seals.	(b) Replace worn oil seals with new ones. Prepare new seals before replacement.
	(c) Cracked rear axle housing.	(c) Repair or replace housing as required.
	(d) Worn drive pinion oil seal.	(d) Replace worn drive pinion oil seal with a new one.
	(e) Scored and worn companion flange.	(e) Replace worn or scored companion flange and oil seal.
	(f) Clogged vent.	(f) Remove obstructions.
	(g) Loose carrier housing bolts or housing cover screws.	(g) Tighten bolts or cover screws to specifications and fill to correct level with proper lubricant.
OVERHEATING OF UNIT	(a) Lubricant level too low.	(a) Refill rear axle.
	(b) Incorrect grade of lubricant.	(b) Drain, flush and refill rear axle with correct amount of the proper lubricant.
	(c) Bearings adjusted too tightly.	(c) Readjust bearings.
	(d) Excessive wear in gears.	(d) Check gears for excessive wear or scoring. Replace as necessary.
	(e) Insufficient ring gear-to-pinion clearance.	(e) Readjust ring gear and pinion backlash and check gears for possible scoring.

NOISE DIAGNOSIS CHART

PROBLEM	CAUSE
1. Identical noise in Drive or Coast conditions	1. Road noise Tire noise Front wheel bearing noise
2. Noise changes on a different type of road	2. Road noise Tire noise
3. Noise tone lowers as car speed is lowered	3. Tire noise
4. Similar noise is produced with car standing and driving	4. Engine noise Transmission noise
5. Vibration	5. Rough rear wheel bearing Unbalanced or damaged driveshaft Unbalanced tire Worn universal joint in driveshaft Misaligned drive shaft at companion flange Excessive companion flange runout
6. A knock or click approximately every two revolutions of rear wheel	6. Brinelled rear wheel bearing
7. Noise most pronounced on turns	7. Differential side gear and pinion wear or damage
8. A continuous low pitch whirring or scraping noise starting at relatively low speed	8. Damaged or worn pinion bearing
9. Drive noise, coast noise or float noise	9. Damaged or worn ring and pinion gear
10. Clunk on acceleration or deceleration	10. Worn differential cross-shaft in case
11. Clunk on stops	11. Insufficient grease in driveshaft slip yoke
12. Groan in Forward or Reverse	12. Improper differential lubricant
13. Chatter on turns	13. Improper differential lubricant Worn clutch plates
14. Clunk or knock during operation on rough roads.	14. Excessive end-play of axle shafts to differential cross-shaft