Installation Kit Instructions

Please read completely before beginning

Over the years we have gathered information from Gleason gear design manuals, Dana Spicer instruction manuals, technical bulletins, and General Motors repair manuals. We have personally experienced good results using the techniques in these instructions while setting up over thirty thousand differentials.

We highly recommend Timken bearings and have used them for as long as we can remember. We believe Timken bearings have held up best in all of the differentials we have assembled and disassembled. We also recommend using only new or good used parts. New parts are usually worth installing and save a lot of time and money that can be lost by using worn or questionable parts that lead to early failure.

Ring & pinion gears are designed to be set-up and run with exact tolerances. Replacing all parts every time a differential is worked on is not only unnecessary, but is ridiculous. However, any gear misalignment or deflection under load caused by worn or questionable parts, can lead to early failure that can cost a lot more than the price of replacing them the first time. Use your best judgment and remember that fixing your differential again, if it fails, will take as much time and money as it did the first time.

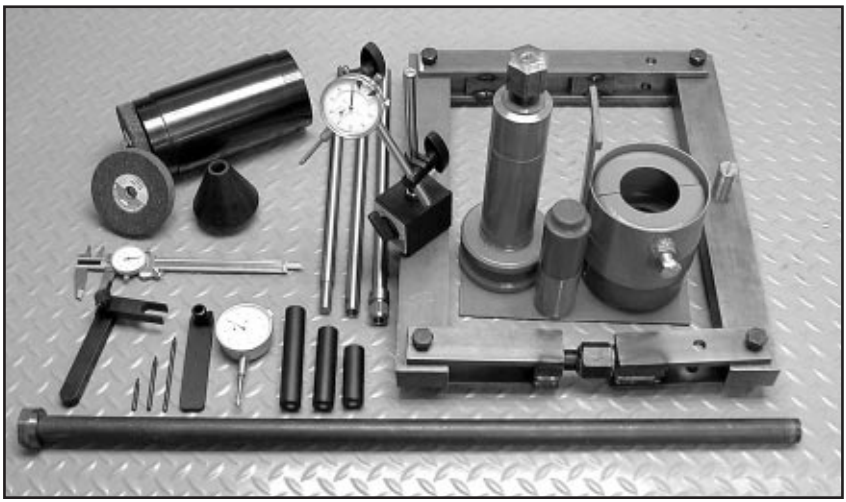
We hope that these instructions are helpful and you are able to get years of use from your differential.

Thank you Robert Hunt, Jeff Wilson, and Gregg Lloyd for your expert input and advice.

Tool List

When working on your differential you will need a wide variety of tools. It is always recommended that you use the right tools for the job. Using the correct tools will save you time and help prevent parts from being damaged. Here is a list of some of the tools that you may need:

- Dial indicator
- Genuine gear marking compound and a clean brush
- Calipers or a micrometer
- Bearing pullers
- Bearing press
- Misc. hand and air tools including:
    - Three foot long breaker bar or *strong* impact gun
    - Pinion nut socket
    - Ring gear bolt socket
    - Main cap bolt socket
    - Six point cross pin bolt wrench
    - Brake line wrench
    - Pry bars for removing the carrier case
    - 24 oz. ball peen hammer
    - 48 oz. sledge hammer
    - 48 oz. plastic dead blow hammer
    - Assorted brass punches
    - Center punch or number stamp for marking main caps
    - Oil drain pan
- Torque wrenches:
    - foot pounds
    - inch pounds



Disassembly

1. Whenever I start to work on anything I always make certain that I have everything I need *before* I start. Check all of your new parts to be sure that you have everything you need and make certain that you have received all of the parts that you ordered.

2. The next step is to lift the vehicle using an appropriate lift or a jack and safe jack stands. Always make certain that the vehicle is safe to be under before starting to work on the vehicle.

3. Then drain the oil into a suitable container. We always recycle our waste oil and hope that you will be able to recycle yours too.

4. Next, remove the axle shafts.

5. Mark both of the main caps so that you will be able to re-install them on the same side, in the same direction as they came off.

6. Keep track of the position of all of the original shims.

7. Clean and inspect all parts.

Order of Adjustments

When assembling or setting up a differential there are four basic adjustments. In the order of importance they are:

1. Pinion Depth
2. Pinion Bearing Preload
3. Backlash
4. Carrier Bearing Preload

Selecting Shims

For my first assembly I usually start with the shims that were used in the differential during the previous assembly. If the original shims from the previous assembly are not available then I recommend using the thickness listed in the specifications information.

Preparing Parts

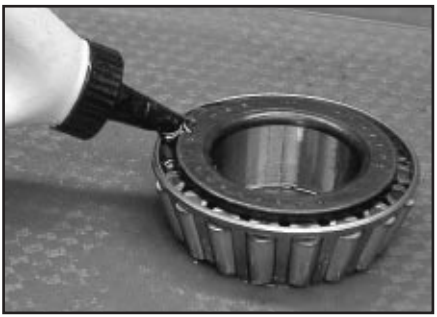
Before assembly I clean all parts, including the new ones, with clean solvent. I wash out the housing with solvent and check all of the oil passages to make certain that there are no metal particles or dirt that can lead to early wear. On many housings there are oil passages to the pinion and grooves just outside of the carrier bearings where metal particles hide. Be sure to check all passages and grooves for metal particles and dirt!

Seal Preparation

All seal surfaces can be polished with a light emery cloth or sandpaper and then wiped with a clean rag and clean oil or solvent to remove the metal particles left after sanding.

Assembly Oil

When assembling, I use a moderate coat of gear oil on all of the bearings and grease or oil on all of the seals and seal surfaces. I do *not* use bearing grease on any pinion or carrier bearings, only clean gear oil.



Pinion Trial Assembly

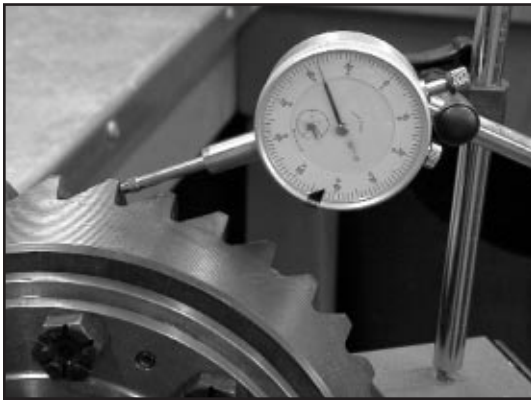
I have found it is easiest to assemble the pinion without a crush sleeve until the correct pinion depth has been established. When initially installing the pinion, I slowly tighten the pinion nut until the preload is within the assembly specifications.

Initial Carrier Assembly

I have also found it works well to assemble the carrier snug, but not tight, during trial assemblies so it is easier to remove and replace during the several attempts necessary to find the shim combination for correct pinion depth and backlash.

Adjusting Backlash

After installing the pinion, the first adjustment I make is backlash. I believe a clear indication of pinion depth can only be obtained when the backlash is within, or very close to specifications. I have found the backlash will change about 0.007" for each 0.010" that the carrier is moved. If I want to decrease the backlash by 0.007" I move the carrier 0.010" closer to the pinion. If I want to increase the backlash by 0.007" I move the ring gear 0.010" farther away from the pinion. This is not exact for all ring & pinion sets, but it is a good general guideline.



Checking the Pattern

After setting the backlash the next setting to check is the pinion depth. When checking the pinion depth I use only genuine gear marking compound. Gear marking compound gives a clear indication of gear contact without running or smearing. I usually mix a little oil with the marking compound so that it is smooth but not runny. I brush three or four of the ring gear teeth with a moderate coat of compound in two different places on the ring gear. Then I rotate the ring gear past the pinion gear four or five times to obtain a good pattern.

Important Pattern Information!

Reading the contact pattern is easy as long as I am not mislead or sidetracked. The only part of the pattern that helps me set the pinion depth correctly is the contact position with regards to the face and flank of the teeth. If the contact pattern appears to be towards the heel or the toe of the ring gear teeth I pay no attention and ***look only at the pattern position from face to flank***. The pattern will also change from heel to toe but in most cases an ideal heel to toe pattern can not be achieved. Trying to obtain a

pattern that is centered from heel to toe will usually lead to frustration and a noisy gear set. Even if it does not seem intuitive or reasonable, I am only concerned with the position of the pattern from face to flank. I have found that housing alignment and the position of the pinion bearing bore in the housing, affects the pattern from heel to toe and can not be corrected without machine work. A contact pattern that is centered from face to flank always indicates correct pinion depth even if a pattern that is centered from heel to toe can not be obtained.

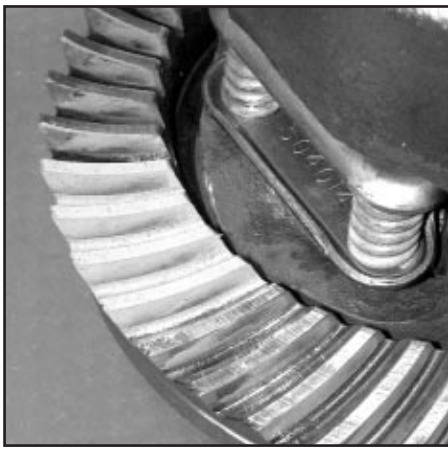
Ideal pattern

If the contact pattern is towards the ***face*** of the ring gear teeth then the pinion is ***too far away*** from the ring gear. To correct the pattern, the pinion needs to be moved towards the ring gear so that it is positioned closer to the ring gear centerline.

If the contact pattern is towards the ***flank*** of the ring gear teeth then the pinion is ***too close*** to the ring gear. To correct the pattern, the pinion needs to be moved away from the ring gear so that it is positioned farther away from the ring gear centerline.

Used Gear Sets

When setting up a used ring & pinion I am basically concerned with the pattern on the coast side of the ring gear teeth and I pay very little attention to the drive side of the gear teeth. This is true for most used gear sets but in some cases both the coast and drive side should be considered.



Used drive pattern

Adjusting Pinion Depth

When changing the pinion depth I always make large changes until the pattern is close. I consider 0.005” to 0.015” to be a large change and 0.002” to 0.004” to be a small change. Changes of 0.005” to 0.008” or more will lead to the correct pattern faster than small changes will. I purposely make adjustments that I know are moving the pinion too far. If I move the pinion too far and the pattern changes from one extreme to the other then I know that the correct pattern is somewhere between the two extremes. Once I get close to the correct pinion depth, I make smaller changes until the pattern is centered between the face and the flank of the ring gear teeth.

After the backlash and pinion depth are set I remove the carrier and set the final pinion bearing preload.

Setting Pinion Bearing Preload

In differentials that use a crush sleeve this is relatively easy. I always use a new crush sleeve for final assembly. I use oil on the pinion nut washer surface during all assemblies and red Loctite on the pinion nut threads during the final assembly. The oil on the washer surface helps the nut turn easier while it is being tightened and the red Loctite helps keep it tight.

Crush Sleeve Design

On a crush sleeve design differential it usually takes between three hundred (300) and four hundred (400) foot pounds of torque to crush the crush sleeve. Over the years I have used huge breaker bars and/or very strong air operated impact wrenches to crush the crush sleeve. I also proceed very slowly so that I get it right the first time. The pinion preload will be zero until the bearings contact the races. When the bearings contact the races the preload will increase *very* quickly. Again, I recommend taking plenty of time to set the preload carefully so that the bearings will have a long life. If the crush sleeve is over crushed and the pinion bearing preload exceeds the specified allowable range the only solution that I know of is to install another new crush sleeve and start over. After reaching the correct preload, I moderately tap both ends of the pinion to seat the bearings, races and yoke. Be careful not to hit the pinion so hard that it damages the bearings. After “seating” the pinion, I check the preload again to make certain that it is correct.

Preload Shim Design

If the differential uses shims to set the pinion bearing preload then this step may take a few times to get it right. I usually use the original shims on the first assembly or add 0.003” to the original preload shims to make up for the bearings settling into the housing. When first tightening the pinion nut I am careful to tighten it slowly so as not to damage the bearing if the preload shim stack is not thick enough.

If the preload is too ***loose*** then I remove shims so that the bearings will be tighter against the races and increase the preload.

If the preload is too ***tight*** then I add shims so that the bearings will not be as tight against the races.

I am always very careful to clean the shims completely so that there are no particles that may cause a false preload reading or cause the shim stack to change thickness over time as the vehicle is driven.

Impact on pinion nut

When making preload shim changes I like to remember where I started and which thickness' I have tried. I recommend writing down the thickness and the resulting preload of each shim combination tried.

After reaching the correct preload, I moderately tap both ends of the pinion to seat the bearings, races and yoke. Be careful not to hit the pinion so hard that it damages the bearings. After "seating" the pinion I check the preload again to make certain it is correct.

After setting the pinion depth, backlash, and pinion bearing preload I set the carrier bearing preload. I like to set the carrier bearing preload fairly tight. There are three different shim or adjustment methods that cover most differentials.

Final Backlash & Carrier Bearing Preload Adjustments

Screw Adjuster Design

The first and easiest method uses screw adjusters to set the backlash and carrier bearing preload. When setting the carrier bearing preload on this type of differential I am careful to oil the adjuster threads on both the housing and on the adjusters themselves. I am also careful about the order in which I tighten the adjusters so that the backlash stays where it should, even when under heavy loads.

The ring gear is always forced away from the pinion gear whenever it is transferring power and it is never forced toward the pinion gear. When setting the backlash and carrier bearing preload on a differential that uses screw adjusters, I start with the backlash wider than the final setting that I am adjusting it to. I always make certain the last adjustment that I make on the left adjuster is to tighten it. If the backlash becomes too tight, I start over by opening it to a position where it is too wide again by backing off pressure from the left adjuster, and then I use the right adjuster to open up the backlash again. At this point, I tighten the left adjuster which closes down the backlash toward the final setting. I always make certain that the last adjustment I make on the left adjuster is to tighten it so that there is no possibility of a space between the adjuster and the bearing race. Any space or looseness on the left side can let the carrier move when under load and this can cause the backlash to open up.

After the backlash approaches the final setting, I tighten both the left and right adjusters evenly so that the carrier bearing preload increases. I like to set the carrier bearing preload as tight as I can with a ten (10) or twelve (12) inch long spanner wrench. I have never encountered carrier bearing failure due to excessive carrier bearing preload on a screw adjuster type differential.

If the preload is close and the backlash is too ***wide***, I tighten the left adjuster a notch or two until the backlash is correct and the preload is tight.

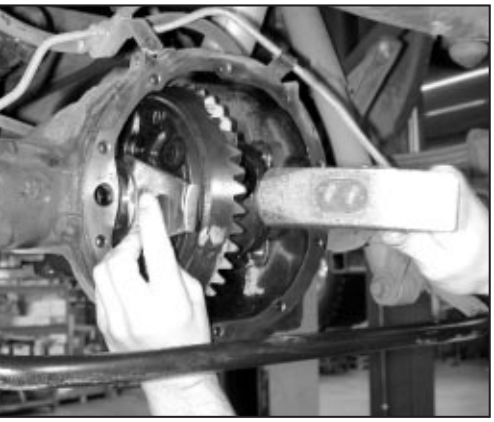
If the preload is close and the backlash is too ***tight***, I tighten the right adjuster until the backlash is correct and the preload is tight.

Like I stated before, I always make certain that the last adjustment that I make on the left

adjuster is to tighten it so that there is no possibility of a space between the adjuster and the bearing race.

Outside Shim Design

There are also designs that use shims between the carrier bearing races and the housing. On these types of differentials, I set the carrier bearing preload as tight as I can without damaging the shims while driving them in. I have seldom seen carrier bearings fail in this rearend design because of excessive carrier bearing preload. During the original set-up of this design I set the backlash with very little carrier bearing preload. After I have set the backlash I add shims to both the left and the right sides until I obtain the correct preload.



If the preload is close and the backlash is ***wide***, I add shims to the left side. This increases the carrier bearing preload and tightens the backlash at the same time.

If the preload is close and the backlash is too ***tight***, I add shims to the right side. This increases both the carrier bearing preload and the backlash at the same time.

Inside Shim Design

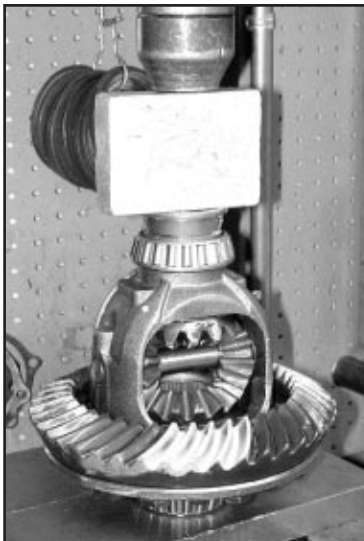
The last design uses shims between the carrier bearing and the carrier case. On this design I also set the preload very tight but not so tight that the carrier is difficult to install or remove. I keep the preload very light while setting the backlash so that the carrier is easy to remove and install. After I have set the backlash I add shims to both the left and right sides evenly until I obtain the correct preload.

If the preload is close and the backlash is ***wide***, I add shims to the left side. This increases the carrier bearing preload and tightens the backlash at the same time.

If the preload is close and the backlash is too ***tight***, I add shims to the right side. This increases the carrier bearing preload and the backlash at the same time.

Carrier bearing puller

Pressing on carrier bearing



Pattern

Now that the pinion depth, pinion bearing preload, backlash, and carrier bearing preload are set, I recheck the pattern once more to be certain that everything is perfect.

Oil

When filling the differential I use high quality name brand gear oil and make certain that I fill the unit completely.

Break-In

All new gear sets require a break-in period to prevent damage from overheating. After driving the first 15 or 20 miles it is best to let the differential cool before proceeding. I recommend at least 500 miles before towing. I also recommend towing for very short distances (less than 15 miles) and letting the differential cool before continuing during the first 45 towing miles. This may seem unnecessary but I have seen many differentials damaged from being loaded before the gear set was broken-in. I also recommend changing the gear oil after the first 500 miles. This will remove any metal particles or phosphorus coating that has come from the new gear set.

ANY OVERLOADING OR OVERHEATING WILL CAUSE THE GEAR OIL TO BREAK DOWN AND THE RING & PINION WILL FAIL.

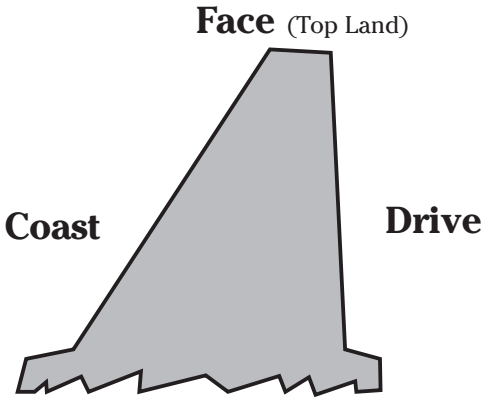
I hope that these instructions have been helpful and you get years of good service from your differential

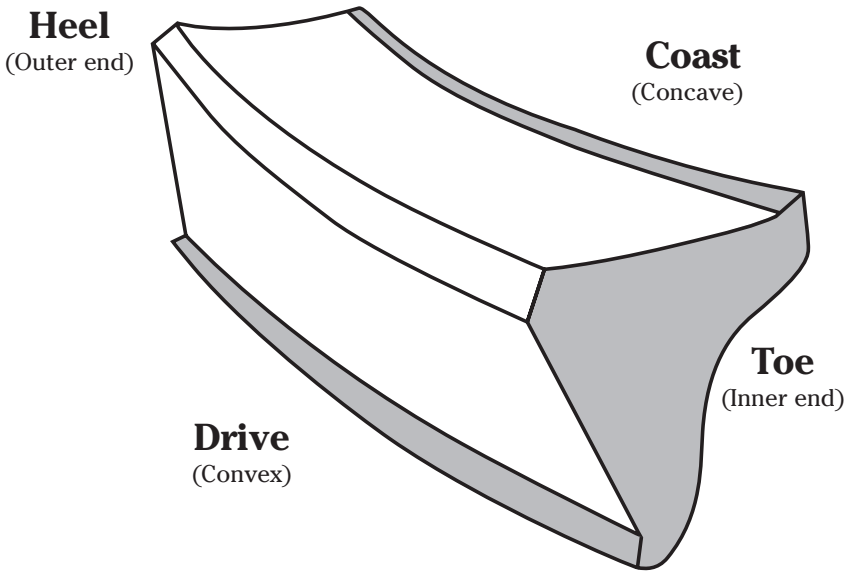
Burned ring & pinion

Tooth Nomenclature

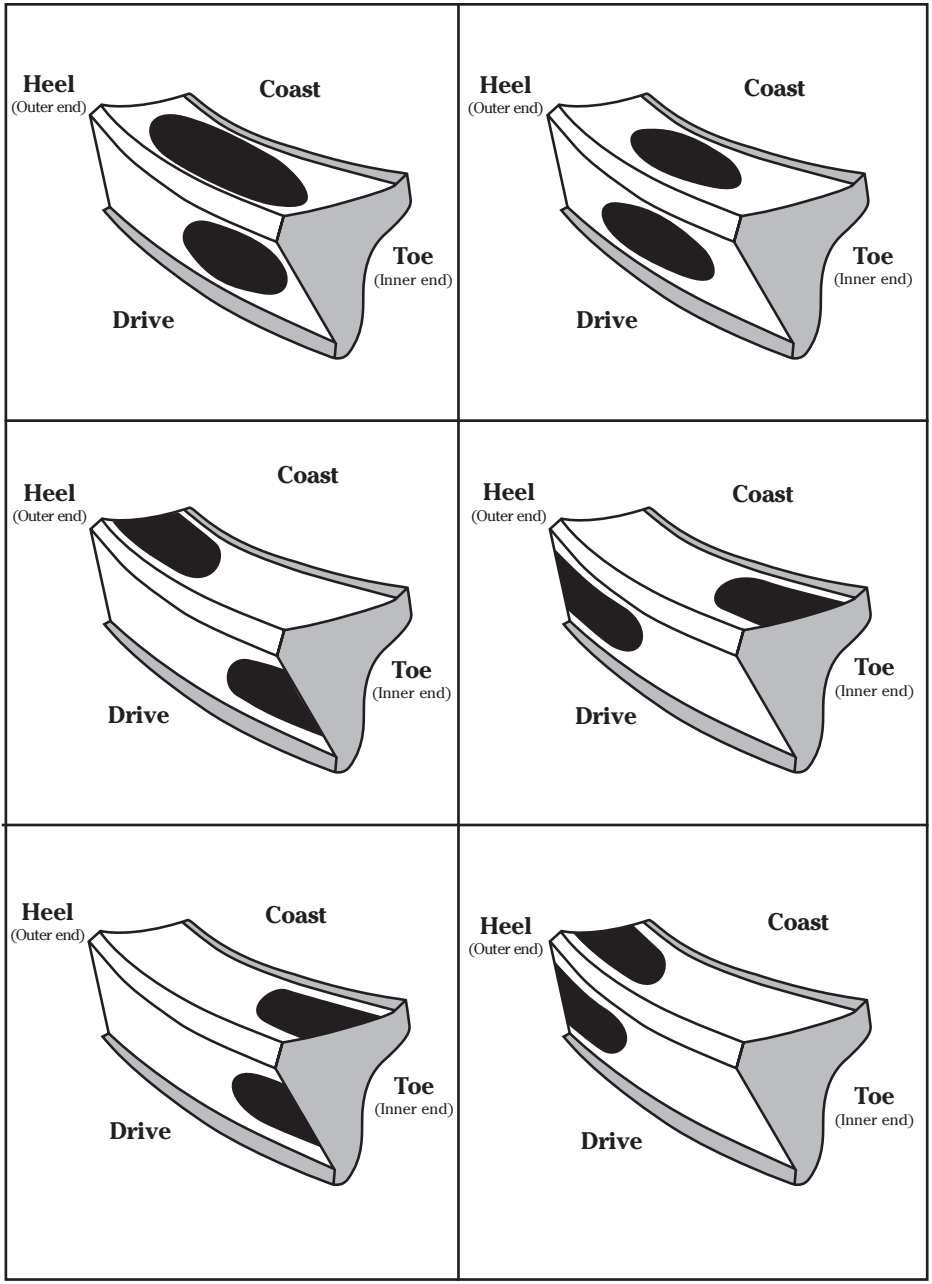
Terms for describing specific areas of the gear teeth

End view of tooth from Heel
(Outer end)

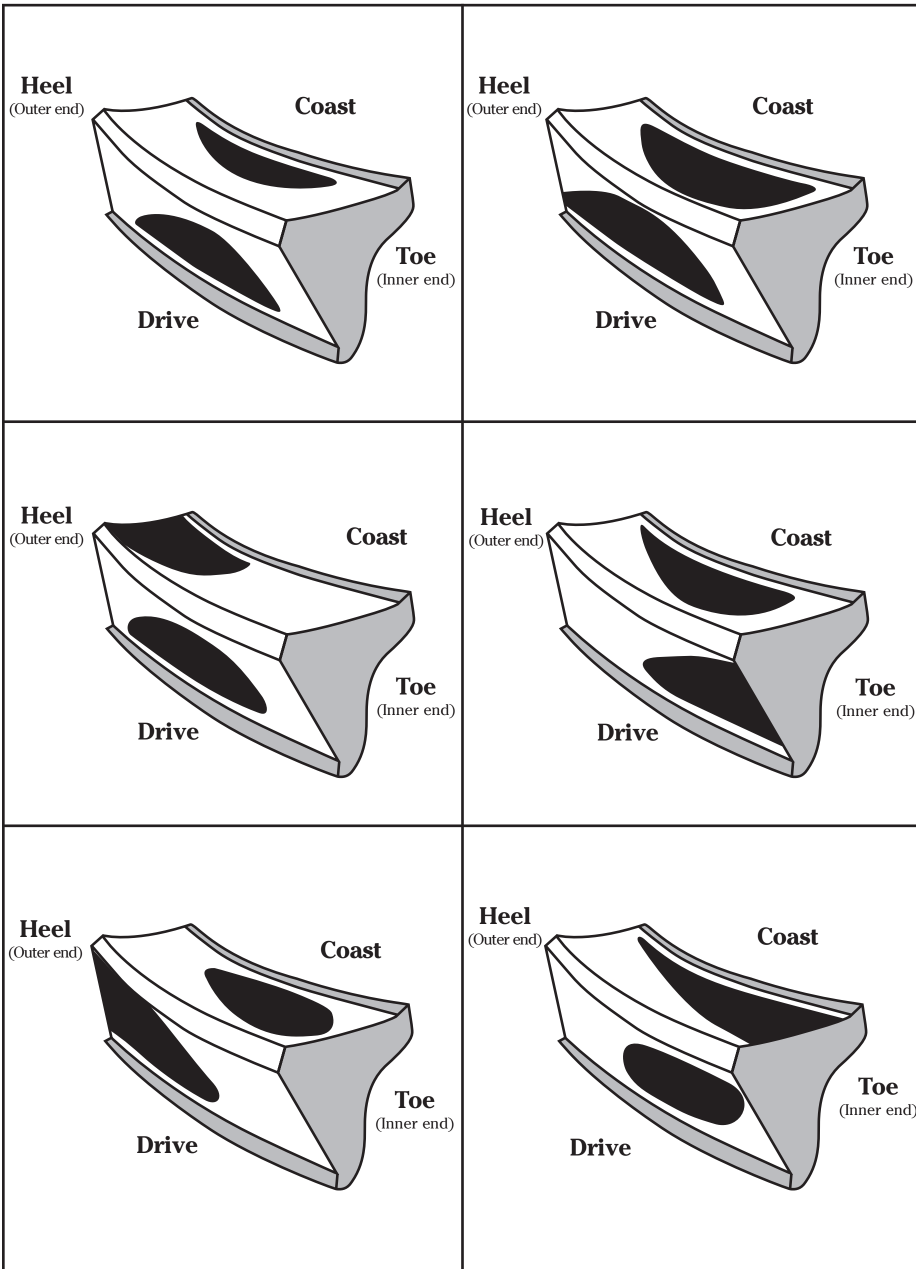




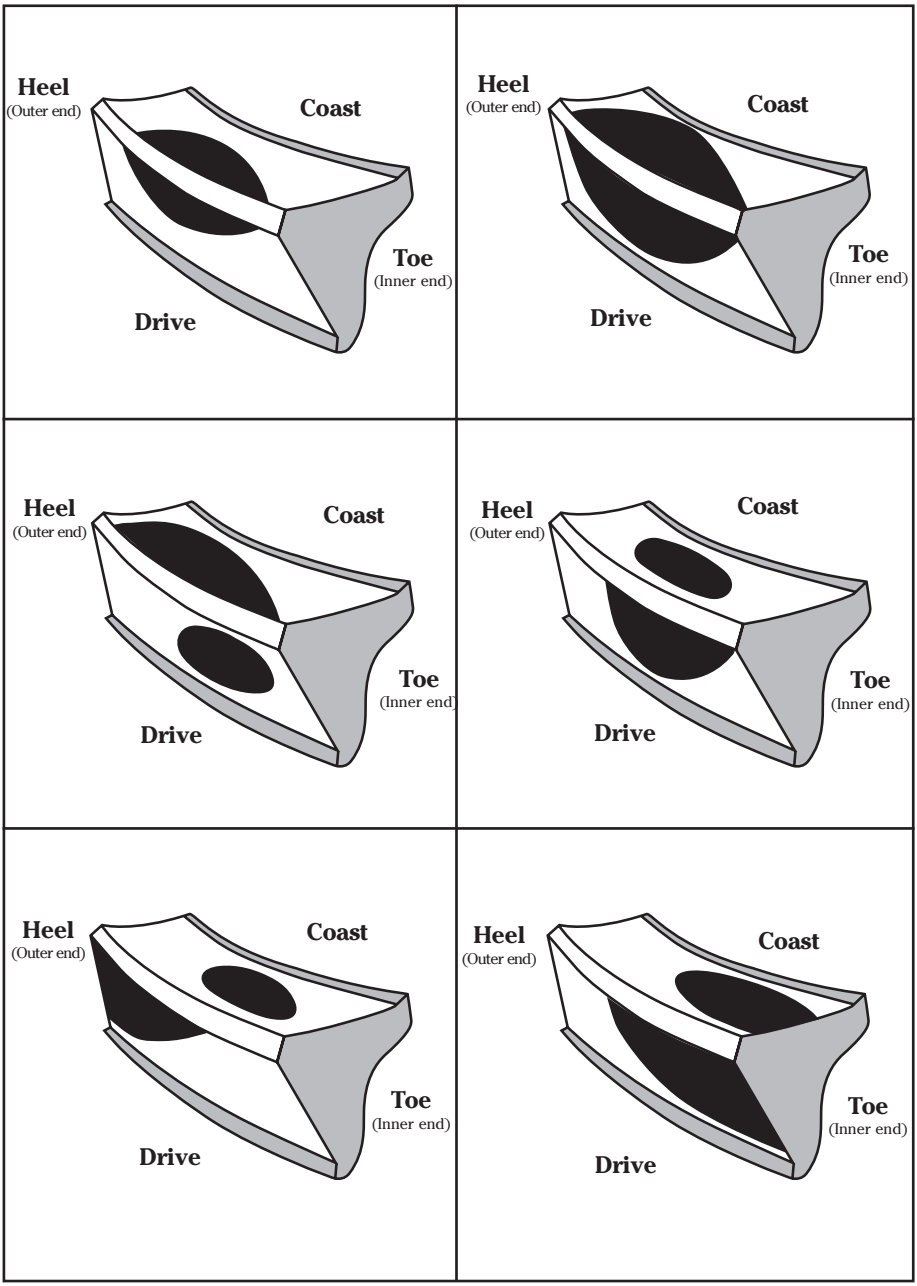
Acceptable Patterns



Pinion is Too Close



Pinion is Too Far Away

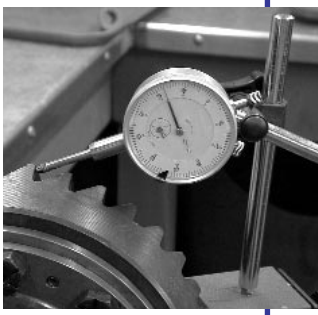


SUMMARY OF INSTRUCTIONS

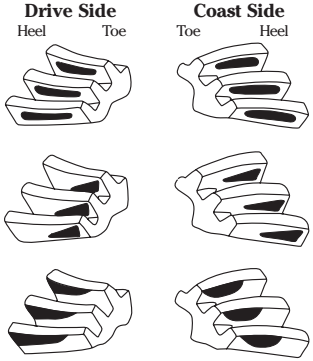
All sets are matched pairs. Make sure you have a matched set. Clean all parts before you start assembly. Apply a light coat of oil to all bearings. Examine all components and remove any burs, nicks or sharp edges that could cause components not to seat properly.

Checking Backlash

1. Set backlash to proper clearance. (See specification sheet)
2. Backlash is the free movement of the ring gear with the pinion gear fixed in place.
3. Correct backlash is obtained by shimming or adjusting the ring gear away from or closer to the pinion.
4. Pinion bearing preload should be as specified on specification sheet. This is accomplished by a preload shim pack (of various thicknesses) or a collapsible crush sleeve. A new crush sleeve should always be used during final assembly.
5. Correct pinion depth is obtained by shimming the pinion in or out, to obtain the correct tooth pattern. All housings are not shimmed in the same location, but shimming still moves the pinion closer to, or farther away from the ring gear. It is suggested that you start with the same shim thickness on the new gear set as was used on the old set.



OBTAINING PROPER GEAR PATTERN (Pinion Depth)



- Normal or desirable pattern. The pattern should be centered on the tooth from face to flank. There should usually be some clearance between the pattern and the top of the tooth (face), and always between the pattern and the bottom of the tooth (flank).
- Pinion is too close. Move the pinion away from the ring gear centerline.
- Pinion is too far away. Move the pinion towards the ring gear centerline.

PATTERN MOVEMENTS SUMMARIZED

1. Moving the ring gear closer to the pinion will decrease backlash.
2. Moving the ring gear farther away from the ring gear will increase backlash.
3. Moving the pinion closer to the ring gear will move the drive pattern deeper on the tooth (flank contact) and slightly toward the toe. The coast pattern will move deeper on the tooth and slightly toward the heel.
4. Moving the pinion further away from the ring gear will move the drive pattern toward the top of the tooth (face) and slightly toward the heel. The coast pattern will move toward the top of the tooth and toward the toe.

Set Up Specifications

DIFF MODEL	PINION BEARING PRELOAD NEW (inch lbs)	PINION BEARING PRELOAD USED (inch lbs)	B/L (0.000")	R.G. BOLT TORQUE (Foot lbs)	CAP TORQUE (Foot lbs)
AMC					
Model 20	14-19	6-8	6-10	65	65
Model 35	12-15	6-7	6-10	55	55
GENERAL MOTORS					
Olds/Pont D/O	14-19	6-7	6-10	55	70
'63-'79 Corvette	14-19	6-8	6-10	55	60
D36 Corvette	12-15	6-8	6-10	55	55
D44 Corvette	14-19	6-9	6-10	55	55
55P & 55T	14-18	6-8	6-10	55	60
7.2"	11-14	6-7	6-10	55	60
7.5"	12-15	6-7	6-10	65	60
7.75"	12-15	6-7	6-10	65	60
8.2"	12-15	6-7	6-10	55	60
8.2" Olds/Pont	12-15	6-7	6-10	55	60
8.25" IFS	14-19	6-8	6-10	65	55
8.5" & 8.6"	14-19	6-8	6-10	65	60
9.25" IFS	15-22	7-9	6-10	75	80
9.5"	15-22	7-9	6-10	75	80
12 Bolt Pass	14-19	6-8	6-10	55	60
12 Bolt Truck	13-15	6-7	6-10	55	60
14T 10-1/2"	20-35	8-11	6-10	120	135
HO72 (10" R/G)	PRESET		6-10	120	175
CHRYSLER					
7-1/4"	12-14	6-7	6-10	55	50
8-1/4"	12-15	6-8	6-10	55	60
8-3/4" '41'	13-15	6-8	6-10	55	90
8-3/4" '42'	15-25	7-10	6-10	55	90
8-3/4" '89'	14-19	6-9	6-10	55	90
9-1/4"	14-19	6-9	6-10	65	75

DIFF MODEL	PINION BEARING PRELOAD NEW (inch lbs)	PINION BEARING PRELOAD USED (inch lbs)	B/L (0.000")	R.G. BOLT TORQUE (Foot lbs)	CAP TORQUE (Foot lbs)
DANA					
D25	12-15	6-7	6-10	55	50
D27	12-15	6-7	6-10	55	50
D28	10-13	5-6	6-10	55	50
D30	12-15	6-8	6-10	55	60
D44	14-19	6-9	6-10	55	60
D50	14-19	6-9	6-10	65	60
D60, 61 & 70U	17-30	8-10	6-10	110	80
D70 & 70HD	20-35	8-10	6-10	110	80
D80	25-40	9-11	4-10	175	90
FORD					
7.5"	14-19	6-8	11-16	60	60
8.0"	12-14	6-7	10-15	60	60
8.7"	14-19	6-8	10-15	60	60
8.8"	14-19	6-8	11-16	60	60
9.0" OEM R&P	13-15	6-7	10-16	60	60
9.0" NON OEM			7-10		
9.0" Daytona	14-16	6-8			
9-3/8"	14-16	6-8	10-15	70	60
9-3/4"	15-19	6-8	10-15	75	70
10-1/4" & 10-1/2"	20-35	6-8	11-16	95	80
TOYOTA					
Passenger	11-13	5-6	6-9	55	60
7.5" F. or R.	12-15	5-6	6-10	70	70
8" F. or R.	12-15	5-6	6-10	70	70
Truck V6 R.	14-17	5-6	6-10	70	70
T100 & Tacoma	14-17	5-6	6-10	70	70