INTRODUCTION

Two of the following articles are reprinted from the CORSA COMMUNIQUE, March 1998. The third article is a critique of these articles by Bob Ballew in a letter dated 18 July, 1998. It must be remembered that everyone does things differently. All three are printed here for the information contained in all three. With this information, anyone should be able to disassemble a differential, replace the bearings and seals, setup the proper tooth contact, and go!! Of course, it would be advantageous to have a shop manual too, but not absolutely necessary.

Tech Topics

Setting Up a Differential

Mark Domzalski

For those of you who are do-it-all Corvair mechanics, here are some ideas and help in setting up a differential. It doesn't matter whether the differential is built for limited slip, also known as Positraction, or not.

I want to acknowledge Sylvan Zuercher for his tutoring and assistance during my learning process of rebuilding and setting up my daily driver differential. I rebuilt the differential on my own, but I could not have set it up properly without his help and knowledge.

As a background, I experienced an input shaft failure a while back and when I started to repair the failure, found a broken Positraction clutch pack carrier in my differential. After receiving a new input shaft from one of our Corvair vendors, I replaced the differential with a non-Posi spare that I had stored with the intent of building a new Positraction differential.

When I was at the Great Western Fan Belt Toss and Swap Meet in 1996, I found a "new old" Cidco early style Positraction clutch pack carrier housing. I purchased new Timken bearings locally, dug out a differential seal and gasket set, and ordered a new throw-out bearing shaft and Positraction clutch pack. I culled my collection of differential parts for the best Posi side gear and pinion shaft I

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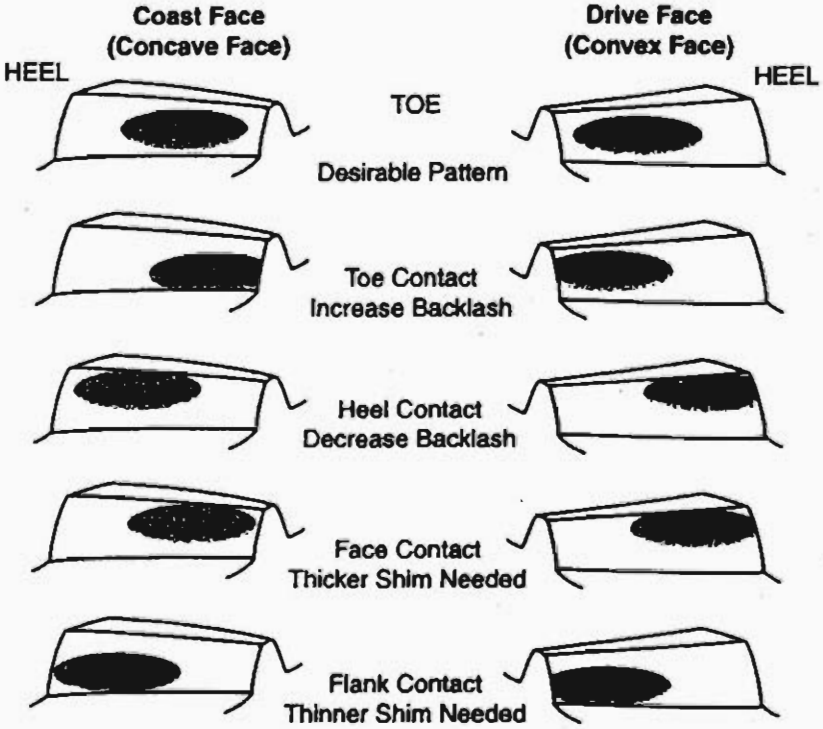
For technical help, please send a SASE to Fran Schmit, 3370 Library Ln., St. Louis Park, MN 55426, and you will receive help from one of CORSA's Tech Advisors.

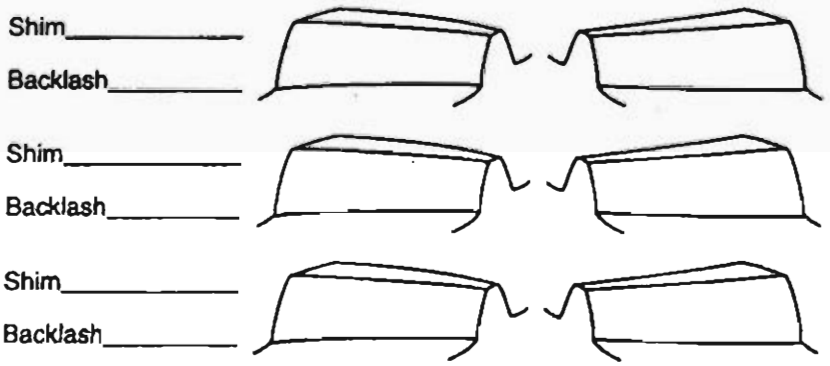
Corvair Ring Gear Contact Patterns

Gears are cut with a contact pattern about half the lenght of the tooth, the location favoring the toe end of the tooth. Under load the pattern will shift somewhat toward the heel of the tooth, and will thus become more central. Under no circumstances must the pattern be concentrated on the ends of the teeth.



Differential Ring & Pinion Gear Set-Up

Sketch contact pattern to record adjustments. Thicker shim moves pinion to rear of contact; thinner shim moves pinion to front of contact.



had. The original 3.55 ring and pinion gears were in excellent shape. The pinion shaft was inspected and deemed to be in nearly new condition. That is, the internal splines showed very little (less than 5% in our view) visible wear.

I built the differential with the original shim between the pinion gear and bearing, thinking that the ring and pinion contact and backlash would be close for that shim. I also purchased new grade 8 bolts for the carrier assembly.

When pressing in the new throw-out bearing shaft I was careful to assure that one of the notches in the shaft was aligned with the lubrication galley in the differential case. This is even more important if you try using an original shaft with only one notch to match up with the lubrication galley.

After I assembled the carrier using the shop manual and had pressed the side bearings on the assembly, I could not get the "pumpkin" into the case. The Cidco cover that I used was just a little too fat. My solution was to pull the bearing from the non-Posi side of the pumpkin, install the pumpkin, and press the bearing back on while balancing and holding the case and pumpkin on my press. Tricky but doable. After consultation with Larry Claypool and Steve Goodman, I learned that this was a unique problem. This was apparently a very early or slightly thick carrier cover. Larry was very clear that he has no problem installing the current Cidco carriers in the case with bearings on the pumpkin.

Once everything was assembled into the spotlessly clean and painted case, it was time for the setup. When you read the shop manual and look at your Corvair differential you will notice that the orientation of the gear teeth is reversed from heel to toe. This is because the illustration is pulled from the full size Chevy manual which, if you remember, is reversed from the Corvair because the engines in our vehicles are behind the axle.

Time for some desktop publishing magic. A little scanning of the Corvair shop manual, a differential setup sheet from Gleason, Inc., courtesy of Sylvan, and presto, we have a graphically accurate Corvair differential setup description with contact pattern descriptions and a worksheet to record your setup.

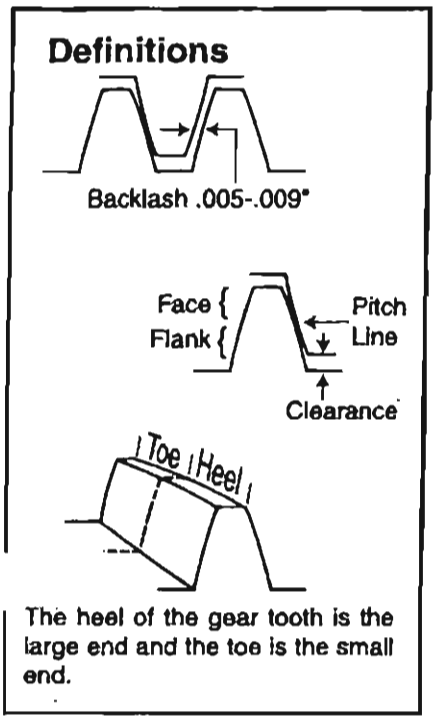
A machinist's bluing compound and a dial indicator are the basic tools needed to adjust the shimming and set the backlash for the ring and pinion gears. I could have used feeler gauges for the backlash, but the dial indicator is much more convenient and less prone to the subjective feel of clearance between the gear teeth.

I started with a 0.012" shim on the pinion shaft, and worked to a final shim thickness of 0.021" and a backlash, measured with a dial indicator, of 0.003". The contact pattern was center-forward to the toe of the teeth which will allow for maximum life and best wear on the ring and pinion gears.

I suppose it would have been nice to have the correct GM tools described in the shop manual, like Larry Claypool has, but this process does the same job. With patience, a good tutor, some common sense, and ordinary mechanic's tools, you can perform a differential setup that is textbook perfect.

The setup and worksheets have been tested by local folks out here in the high desert and work well. They seem to make the entire differential rebuild experience even more enjoyable.

After mating the differential to a thoroughly cleaned transmission, I swapped assemblies on my Rampside, filled the differential and transmission, added the whale oil (limited slip treatment), and got back on the road. I am still pleased with the driveability. There was a slight wear-in whine that disappeared after about 35 miles. The transmission and differential are still as smooth as silk. I am still amazed at how much better I can hear the engine with a quiet differential and transmission.



The heel of the gear tooth is the large end and the toe is the small end.

Overhauling a Differential

Mike McGowan

Rebuilding a differential seems to be a daunting and mysterious challenge, even to Corvair owners who have rebuilt engines and other major assemblies. The Chevrolet shop manual procedure is filled with obscure and confusing instructions, and seems to require a vast array of specialized J-tools and precision measuring devices. I believe that a simple overhaul can be performed by an amateur mechanic with modest tools. That is, if the differential to be rebuilt is intact and operable, or at worst has one thing wrong with it. If it has suffered catastrophic damage, or if you merely have a collection of mismatched parts which you want to assemble, please reconsider. It would be easier, faster, and cheaper in the long run to put everything in a basket and take it to an experienced mechanic who has done this before. But if you want to learn, by all means go ahead and try.

The advice in this article is not a substitute for the shop manual, it is a supplement to it. As with any repair job, you should first study the factory procedures to learn as much as you can. The shop manual does contain some errors and omissions, but it is an essential resource. As for tools, a well-equipped amateur mechanic should have what is necessary to disassemble, reassemble, and adjust the differential. A parts washer tank would be very useful. If pinion shims or bearing races must be changed, you will need a hydraulic press and the tools that go with it. A dial indicator would be good to have, but is not required.

The most common repair tasks on a Corvair differential are replacement of the throwout bearing shaft on manual shift transaxles, replacement of spider gears, and replacement of a bad bearing. If the failure of a gear or bearing is severe enough that hard steel debris has circulated through the gears, it may not be worth repairing. On the other hand, many diffs are candidates for overhaul because they are loose, whining, or leaking. Because the removal and installation of a differential in a Corvair is a big job, I encourage you to make certain your diff is in top condition before installing it.

The trickiest part of the job is setting up the relationship between the ring gear and the pinion gear. There are several adjustments at right angles to each other, forming a three-dimensional puzzle. They are interactive, which means that making one better may make the other one worse. One adjustment is just the turn of a screw, but the other adjustment requires disassembly, pressing off a bearing, and changing shims. The good news is that if your assembly is factory-original and no key parts have been changed or badly worn, the setup should not require changing those shims. The key parts you must keep together are the differential case, the ring and pinion gear set (they are a married pair; you should never mix a ring and a pinion from different sets, not even with an identical part number), the shims between the pinion gear and rear pinion bearing, the throwout bearing shaft or stator shaft, and the rear pinion bearing. Throwout bearing shafts should be manufactured with the same thickness, so changing that will not disrupt your setup. I have been told that roller bearing assemblies are built to very tight tolerances, and so should be interchangeable, but that might depend on where you buy your bearings.

So now that you understand what to expect, let's go ahead and rebuild your differential.

The first step is disassembly. Scrape the major crud off the outside of the case so you can get wrenches on all of the bolts. Remove the top cover and drain the fluid into a pan. Undo the locking bolts and tabs on the three big adjusting sleeves before you try to turn them. On an early model or FC, withdraw the speedometer drive gear assembly. On a late model, remove the axle yokes by bending down the lock tabs and unscrewing the center bolts; I find a big pipe wrench to be a useful tool for holding the yoke while turning the bolt. Order new locking tabs, because the ones you took off are probably rusted, bent, and torn.

Next unscrew the side adjuster sleeves, starting with the one on the right side (as installed in the car; the starter motor is on the left side). Chevrolet made a special tool with four tabs that engage the castellated lugs around the edge, but you don't have to use that. Try laying a Corvair lug wrench handle or other pry bar across the lugs to turn it. You might wish you had soaked it in penetrating oil, since it may be very hard to turn, requires many turns to remove, and does not get easier as you turn it. Resist the urge to shock it loose by hammering on those lugs; they will break off before they move. My solution was to make a tool from a scrap side adjuster sleeve and the biggest socket wrench that fits into the axle hole; I arc-welded the socket into the middle, and now I have a big tool that engages all the lugs and can be driven with an air impact wrench or breaker bar.

Once the right side adjuster is off, unscrew the pinion shaft adjuster sleeve. This is smaller and will come off easier, but again you will have to improvise a tool. Now you can withdraw the pinion shaft and put it safely aside before the ring and pinion gears chip each other while tumbling around loose in that case.

Removing the other side adjuster sleeve may not be easier, but at least you know how to do it. Before you take it out, mark one of them and note which side it goes on, so that you don't mix them up later. This is so that the side bearing races and rollers will be kept with their mates. You don't need to do this if you are going to replace the side bearings, and it's not necessary on Positraction axles because the right side adjuster sleeve is obviously thinner than the left.

Now you can remove the ring gear carrier assembly through the top of the case. This may seem like a puzzle, especially with Positraction, but it can be done. Orient the carrier assembly with the ring gear bolts upward, and the opposite side bearing pointing downward toward the bottom corner of the case which is nearest the starter motor flange. This will place the ring gear diagonally in the top cover opening. Tip one edge of the ring gear out the top and toward the starter motor flange, and the rest of the assembly should follow. If the

widest part of the carrier catches on the edge of the opening, and you think you need one more fraction of an inch to clear, notice that the side cover assembly has three small clearance notches on its edge. Rotate the assembly until one of these faces the case edge, then try again.

Once you have the differential assembly "pumpkin" out of the case, I recommend that you unbolt the ring gear and take the carrier apart completely to inspect the spider gears inside. Punch matching marks on the two halves of the carrier so that you can reassemble them in the same orientation.

Further disassembly is optional, depending on what parts you plan to replace. If the throwout bearing shaft is cracked (a common reason for undertaking this rebuild), pound it out now. If you weren't going to replace it, inspect it carefully for hairline cracks at the end. If you have any doubts about its quality, this is the time to change it. Aftermarket shafts are available of stronger material, and some can be fitted with two input shaft seals.

If any bearings are obviously due for replacement, press them off. The shop manual says that removal of the side bearing races requires drilling holes in the sleeve to punch through, but I have always been able to work out the old race by angling a punch through the axle hole and tapping in circles until it falls out. Of course the axle side seals must be removed first, but you should replace these anyway unless they are in excellent shape.

Cleaning all the parts is the next step. Be sure you have removed all O-rings and scraped off any remaining gasket material. Notice that the spider gears and side gears have washers under them which usually stick to one surface or the other; pick them off before they fall off and get lost. Clean all the internal parts in a safety solvent until they are spotless. Don't forget the inside of the pinion gear shaft; a toothbrush or shotgun bore brush works well. Cleaning the case is the biggest part of the job. I use a parts washer tub and a stiff bristle brush, and it still takes a long time. The outside of the case is usually encrusted with a mixture of road dirt and gear oil. Even if this is not a concours project, you must clean the exterior or I guarantee the grit will find its way inside during the assembly process. When you think the case is clean on the inside, dry it and probe the bottom corners and interior casting webs with your fingertip. If it doesn't pass the white glove test, clean it again.

At this point I usually do some prep work on the case, although you may not be so fussy. If your hands are bleeding from the jagged iron casting flash, you will understand why I use a small grinder to knock down all the sharp edges. This saves more pain later when you are installing it in the car. I also chase the thread holes with a bottoming tap, and dress the gasket surfaces on the top and front with a large flat file. You should use a wire brush or wire wheel to clean the threads and polish the O-ring surfaces of the adjuster sleeve bores. Lastly, make sure the lubrication galley to the rear pinion bearing is clear: there is a gutter which collects splash lube from the meshing gears and a bore which drains it down to the bearing. This bore is hard to inspect, especially if the rear bearing race has not been removed, but try to probe it with a wire or flush cleaning solvent through it to verify that there is no obstruction.

If you have a 1964-69 case with no drain plug, think about installing one. I use a magnetic plug which is the same size as the engine oil drain; Chevrolet used a large pipe plug before 1964. Other tech articles have been written about what to use and where to install it, but now is the time to do it.

You can also install a dipstick tube using 1964-65 parts; there is a boss on the right side of all later cases. Of course the car firewall will have to be cut also.

When all this is done, clean the case one more time. Paint it if you wish.

Inspection is the next step. Look at each part in good light. If you don't know the difference between good and bad bearings and gears, take questionable parts to a club meeting. In my experience, the differential (spider) gears are usually very stressed. If they fail later, you can see how much labor will be required to fix them. At this moment it is purely a parts cost, so think carefully about replacing them with new. I prefer the four-spider gear conversion which is even more reliable, but that is $200-$300 in new parts (carrier, gears, shafts) so many Corvair owners will not consider it even though it is well known as the weakest link in the differential. Four gears are mandatory for any competition use, and highly recommended for vehicles that see heavy loads or increased power, especially with manual transmissions.

If the spider gear shaft is worn enough that you can catch your fingernail where the edge of the gear rides, replace it. Side gears are usually sound, but look for spalling or other obvious defects in addition to serious wear. If equipped with Positraction, the clutch plates may be scratched and heat spotted. If you are in doubt about whether to spend the money for new clutches, go ahead and assemble the old parts and test the breakaway torque by twisting the axles against one another. Chevrolet says that the Posi should hold 50-100 foot-pounds of torque. The other thing to watch for with Positraction is the integrity of the carrier housing itself. The clutch side housing tends to fracture into pieces, especially on the 1962-64 models.

The ring and pinion gears should be serviceable unless something broke or the mileage is very high, but look at them tooth by tooth for chips or damage. While you have the pinion shaft in your hand, look through the tube toward a good light to judge the splines which engage the transmission. Good splines are 50/50 lugs and spaces; if the lugs are

noticeably narrower than the spaces between them, they are being pounded away. Failure of these splines would be catastrophic, but replacement of the pinion shaft is a big job, so if the splines look marginal get a second opinion.

The bearings should be serviceable unless the lube was contaminated with water or chips, but inspect everything. The rear pinion bearing is the most highly stressed because the gears heat it and thrust against it. If any bearing warrants replacement, that will be the one.

If you have a 1965 car, the axle yokes have undersize U-joint bolts which are infamous for breaking. Consider replacing them with the 1966-69 style.

When you have acquired replacement parts for any which failed inspection, along with a new set of gaskets and seals, you are ready for reassembly. It is, as the saying goes, the reverse of disassembly. Your careful preparation up to this point should make it easy. Just follow the shop manual, use a torque wrench on the ring gear bolts, and remember to wet all O-rings and moving parts with 90W gear lube. I use a synthetic oil because one jug of it will last the lifetime of the assembly, make my good machinery last longer, save fuel through reduced friction, and ease manual shifting on cold mornings. Consider it.

The best advice I can give at this stage is to watch your parts inventory, and check off everything on the exploded view before proceeding to the next step. It is very frustrating to finish assembly, dial in your adjustments, and then remember that you forgot to install the spider gear shaft retaining pin, or the side gear washers, or the axle nuts. I hate when that happens.

Final assembly includes setting the bearing preloads and the gear backlash. The shop manual describes procedures for this, which most people find very confusing. It also requires J-tools, an inch-pound torque wrench, and a dial indicator with stand. These tools make the adjustments more accurate, so use them if you have them. But if you do not, the following procedure will get you very close.

To set the preload for the pinion bearings, lubricate the pinion bearings and install the pinion shaft into the case before you install the ring gear carrier. Screw in the pinion bearing adjusting sleeve and tighten it until the pinion shaft is difficult to turn by hand. Now loosen it one notch at a time while turning the pinion shaft with your fingers. The spec for turning torque is 4-6 inch-pounds with used bearings or 9-11 inch-pounds with new bearings. If you do not have an inch-pound torque wrench, just estimate. The pinion gear is about three inches in diameter, so if you exert a force of two pounds with your fingers on each side to turn it, that's six inch-pounds. It should turn smoothly and freely, neither binding up nor rattling loose. When you are satisfied with the setting, make sure that the locking tab can engage the adjusting sleeve, or move the adjuster slightly. Mark the position of the sleeve in the case, then remove the pinion shaft.

To set the preload for the side bearings, lube the bearings and install the ring gear carrier assembly in the case. Screw in the side adjuster sleeves (remember, you marked which side they go back on) by roughly equal amounts until the ring gear is hard to turn. Now loosen one adjuster while turning the ring gear with your fingers until the turning torque feels correct. Check for lock tab alignment, then mark both side adjusters.

Remove the right side adjuster so that you can move the carrier aside and re-install the pinion shaft and its adjuster sleeve. Tighten the pinion bearing adjuster sleeve to its mark and install the lock tab and bolt. Then re-install the right side bearing adjuster sleeve and tighten it down to its mark. While doing this, make sure that some clearance remains between the ring and pinion gears. If they jam together, stop tightening the right side adjuster, back it out one or more full turns to its mark, then tighten the left side adjuster sleeve to its mark. If the side adjusters are tight but there is a lot of clearance between the gears, loosen the left side adjuster and tighten the right side adjuster by full turns until the gear clearance is minimal. When you are done, both side adjusters should be at their marks, you should not be able to tighten either side by a full turn, and there should be some clearance between the ring and pinion gears.

Now you can set the gear backlash. Lubricate the ring and pinion gears, and put a 9/16" box wrench on one of the ring gear bolts to turn the assembly. Loosen the left side adjuster by a counted number of notches from its mark, and tighten the right side adjuster by the same number of notches from its mark. This preserves the side bearing preload which you set up, while moving the ring gear toward the pinion gear. Rotate the ring gear back and forth, feeling the backlash. Keep moving the side adjusters, always by equal amounts, until the backlash reaches zero. At this point there will be no back-and-forth play in the gears, and you will start to feel an increased effort in turning the ring gear. The backlash specification is .003"-.010", preferably in the middle of that range. One full notch on the adjusting sleeves is .003", so loosen the right side adjuster by two notches and tighten the left side adjuster by two notches. There should be a slight rattle between the gears now. If you have a feeler gauge around .005", use it to check the gap. Turn the ring gear through a full rotation to check for defects or high spots; it should turn smoothly.

If possible, check your work by marking the gear engagement pattern. The accompanying article and worksheets can help explain this procedure. The pattern may indicate that you should adjust the backlash, then check the pattern again. A word of comfort about gear patterns: in my experience, they seldom look exactly like the pictures. The important thing is that the engagement is fairly centered, and does not run off the ends of the teeth. If making one side better makes the other side worse, remember that the drive side (the side of the ring gear you push on to make the axle roll forward) carries a bigger load more of the time, so favor the drive side if you have to compromise.

Finish the assembly by installing locking tabs and bolts on the side adjuster sleeves, plus speedometer drive (early models), axle yokes (late models), and top cover. Don't forget to fill it with lubricant after it is installed.

PRELOADING DIFFERENTIAL BEARINGS WHY???

18 July 1998
by Bob Ballew

Lets start with a procedure just about everybody in CORSA is familiar with, such as torquing down a Cylinder Head. Let us suppose you have a copy of an article written by a fellow CORSA member describing engine rebuilding and you get to the part of torquing the Head. He writes in the torque numbers required but describes the way to do it as, "Tighten up the nuts until the torque feels correct". TORQUE FEELS CORRECT?? As most everyone knows, the Head torque has to be absolutely right on the numbers using a torque wrench; too much, pulled studs; too little, blown gaskets!! This would make one wonder about the rest of the information in the article.

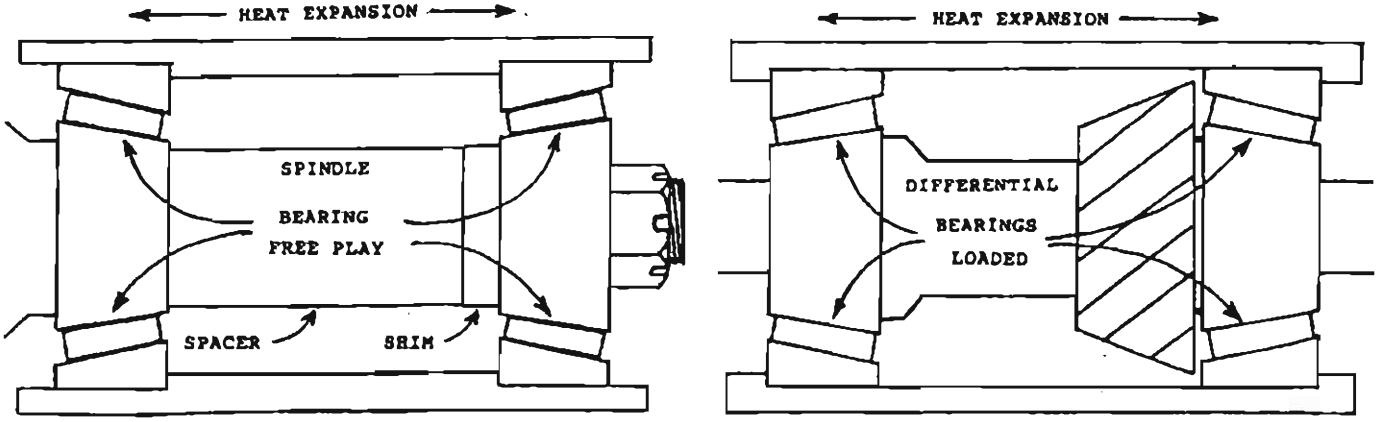
Some time back there was article in the Communique about freshening up a Differential and during the procedure for setting up the bearing Preload by hand the instructions were, "until the turning torque feels correct". FEELS CORRECT???

Most of the articles on the Differential the last few years are quite cavalier about this bearing Preloading to the point of almost ignoring it all together. Preloading is sort of like putting twelve pounds into a ten pound bag. You pull up the adjusting nuts to the bearings till all end play of the bearings is gone and then tighten the adjusting nuts up another two or three notches to Preload the bearings. In effect you are putting the bearings in a bind which causes enough friction to require quite a bit of inch pounds of torque to turn them. Sounds kind of stupid to the unknowing, but it will create a differential that will go one or two hundred thousand miles with ease. There's very few who can explain why.

Before I let the well kept secret out, lets go to another assembly that contains a set of taper roller bearings just like our differential has. The axle shafts of the 1965 Corvair are connected to the rear wheel Spindle Assemblies. These Assemblies like our Differential requires a very complicated adjustment which allows it to go that one or two hundred thousand miles without attention also. Let me quote a couple of lines from the 1965 chassis manual page 4-28.

"The wheel Spindle, Spindle support, Spindle bearings and the Spindle bearing spacer are the various items that effect wheel bearing end play. Therefore when replacing any of the aforementioned items, it will be necessary to ascertain proper adjusting SHIM thickness to maintain specified end play". How's that? SPECIFIED END PLAY!!!! Now wait one, we got tapered roller bearings in one Housing that requires being LOADED, and another Housing with the same kind of bearings that require having END PLAY!! (.001"-.006" limit, page 4-26)

Would you believe there is one thing that causes them to require these two different adjustments. Yep, that's right, and that one thing is HEAT. When you're tooling down the freeway these two Housings (Diff.& Spindle) get unbelievably HOT!! This will cause these Housings to expand more than what is inside. To counter this, we LOAD one and have END PLAY in the other. Now don't shoot, I will explain this seemingly contradiction. The following two rather simplified drawings will show the difference between the construction of the two Assemblies.



You will notice the bearings are installed 180° different from each other. The HEAT will cause one Housing to squeeze the stuff inside, and the other will allow the inside stuff to get quite loose. Now the secret is out. Let's look at it in more detail.

First the difference in the numbers of the adjustments. The numbers for the Differential are from .006" to .009" (that's how much we LOAD the bearings, remember it's two or three of the notches, .003" each) The Spindles END PLAY of it's bearings is only .001"-.006". And of course the reason for the difference in the numbers is because the Differential Housing is much much bigger than the Spindle Housings and will expand about two times more than the relatively small Spindle Housings.

The expansion of the Spindle Housing tries to spread the bearings apart, but they are held together by the shoulder of the Spindle and the Spindle Retaining Nut. But since the bearings were set up with the END PLAY required at the time of assembly, the HEAT expansion of the Housing will just snug up the bearings to take the play out of the Rollers to produce a nice smooth full contact of the Rollers at freeway speed all day long. Without that END PLAY to begin with the Rollers would be squeezed tightly together and bearing failure would be in your future.

The drawing of the Differential Housing shows just the opposite, the expansion of the Housing will create a looseness in the bearings. The Loading of the Bearings at assembly is designed to just UNLOAD the bearing preload at freeway speeds as the Housing expands due to HEAT just to the point where the

bearings are now just running in a snug mode. It doesn't take a rocket engineer to figure out that if the guy who put the Differential together only snug to begin with, would now at freeway speeds and HEAT, find himself with bearings and gears loose as a goose and pounding themselves to pieces.

How loose would the bearings end up?? Here's a test to find out. Put a spare Differential together with the side adjusters and the pinion shaft adjuster all just snug enough to remove all free play from the bearings. Now back out the side adjusting nuts one notch on the left side and one notch on the right side. Now back out the pinion shaft adjusting nut about one and a half notches. What you have done is approximately how much the housing would expand when it reached the HEAT generated at freeway speeds. Now reach in and see how much you can wiggle the pinion shaft and the ring gear assembly. That's how bad the insides of your Differential will be banging around at freeway speeds!!! I predict a short lived set of gears and bearings in your future.

The design engineers know exactly how much the housing will expand at the HEAT of freeway speeds and have gone to a lot of trouble to tell you how to counteract that with the list of torque readings to come up with the exact amount of bearing PRELOAD to end up with a 200 thousand mile unit!! Now you just go ahead and put your Differential together with the TORQUE SORTA FEELING CORRECT!!!

Don't be stupid, get a 1/4" torque wrench and read the Chassis Manual, after a while it'll make sense. These wrenches are not at the corner market, it takes some hunting around to find them. The torque wrench you need to use on a Differential is a 'Beam' type to be able to measure turning torque. The cute little one that goes "click" won't work, however it's great for oil pans and rocker covers and other small bolts. The 'Beam' type 1/4" torque wrench is shown in use in Fig. 48, page 4-19, in your 1965 Chassis Manual. The catch is, it requires some sort of an adapter to attach it. To solve that problem I have welded a 1/4" drive socket onto a spare Governor Drive Gear to use on P.G. differential's to measure the turning torque. For three or four speed differential's you need an old spare Mainshaft from the transmission that will fit the splines inside the pinion shaft and weld a 1/4" drive socket to the Mainshaft to measure that Differential's turning torque.

My 1/4" 'Beam' type torque wrench is a DURO/INDESTRO #8091A, made in USA, I ordered it through one of our local auto parts stores here in 29 Palms. If I could get one here, you folks in the big cities should have no trouble. By the way, you can get the 1/4" cute one that "Clicks" from J.C. Whitney for $25.99 for your light work.

I hope I have put the fear of God into you regarding what will happen if you don't pay exact attention to the Preload

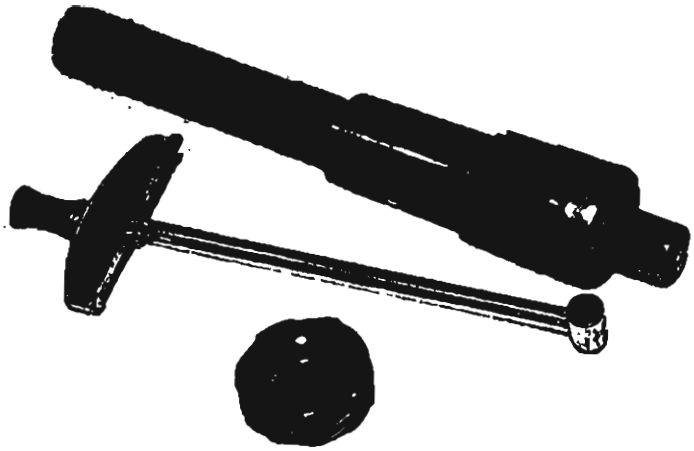
adjustments. Of the three adjustments of a Differential, the Preload is the most important. As to the other two, Tooth Pattern and Backlash, Backlash comes in last. In all the manuals it says, if the Tooth Pattern isn't right, try increasing or decreasing the Backlash. This should give you a clue that the Backlash ain't all that important.

For some strange reason Backlash seems to be the one written about the most. Maybe it's because it's the simplest one to do. After all, the adjustment .003" to .010", and to get that you turn the side adjusters one notch at a time for a movement of .003" for each notch. What could be simpler?? Well like every-thing else in a Differential, it ain't that simple. First of all, that Backlash of .003" to .010" is for BRAND SPANKING NEW GEARS!!! The Chassis Manuals are printed for the mechanics at the Chevrolet dealers repair shops. They only install NEW gear sets, never USED gear sets!! They will get next to perfect Tooth Patterns with the RIGHT shim with that Backlash adjustment. You and I however, are usually trying to put together a used set of gears.

Have you ever thought to measure the Backlash in that 100 thousand mile Differential BEFORE you took it apart to freshen it up?? I think you will discover the Backlash will be way past the .010" limit even in one that came from the factory and never been apart. .012" .015" or more would be common, and the gears would look perfect and the Pattern would be picture perfect and getting better. None of us is blessed with X-ray vision to see the few thousandths that have worn off those teeth. And what do most people do when they put that Differential back together? Yep, they put it back together and then try to set up those USED gears with the NEW GEAR Backlash adjustment. And that attempt will produce the most God awful Tooth Pattern the world has ever seen. And then to compound the problem the unknowing will start changing shims and end up with a junk Differential. When all he had to do was put these USED gears back together with the Backlash a few thousandths larger than the .010" to get back that perfect Tooth Pattern he had in the first place!!! Those are USED gears for crying out loud!! They have been running for years with .010"-plus Backlash why do you want to mess it up now? In the three dimensional world of proper Tooth Pattern there is only one spot in space for each set of gears, and for some gears that spot can only be found with the right shim and it's own distance from it's mating gear, and that distance is not always within .003"-.010".

Of the two Differential articles in the March 98 Communique only one mentioned PRELOAD. And that only was for the pinion shaft bearings using your thumbs as torque wrenches. The side bearing instructions for PRELOAD was absolutely unintelligible. Both were setting up USED gears with NEW GEAR Backlash. I'd be afraid to venture too far away from the city limits with those "Just gone through" Differentials. Have you ever bought a Corvair with an Engine that's "Just been gone through"?

Bob Ballew



Tools for Differential Preload Torque

ed. note, this picture did not turn out well. What Bob is showing is a piece of a transmission shaft with a socket welded on the end to use as a driver to insert into the splines in the pinion shaft of a manual transmission differential. The other shown is a governor drive gear with a socket welded to it to drive the pinion shaft of an automatic transmission differential. Also shown is an appropriate torque wrench.

ADDENDUM

Bob Galli

It has come to my attention that in the preceding articles, no mention is given specifically to Automatic transmission differentials. One thing that I know that needs attention is the stator shaft. This should be inspected for wear where the converter rides. I try to use a shaft that has no more than .005 wear. I have taken them out that have as much as .010+. Converter seal leaks are possible with this much wear. Also, check for wear inside the stator shaft where the ring seal on the pinion shaft rides, if it catches your fingernail, it is too much. A failed pinion bearing can cause destruction of this surface.

There are two different stator shafts, '60-'62, and '63-69.

1. '60-'62 stator shafts have 1 slot on the surface the pinion bearing presses against. They are also shorter from this surface to the surface that bares against the case, than the '63-'69 stator shaft.

2. '63-'69 stator shafts have six slots on the surface the pinion bearing presses against.

3. Differential cases are machined differently to accept the proper stator shaft, i.e., '60-'62 stator shafts must be used in '60-'62 cases, etc., etc. Pinion setting is impossible in mixed stator shaft/case assemblies. (don't ask me how I know)

4. '60-'61 cases can be identified by code letters beginning with "B", '62-'63 cases can be identified by the code letter "H", '64 cases are obvious by the spring mounting pad underneath.

5. When disassembling '62-'63 differentials, take note which style stator shaft is in it.

One other tip I have on differentials, the book shows to remove the carrier bearing races from the side adjusting sleeves by drilling a hole to punch them out. I find that if an arc welder is available, a couple of 1 1/2 inch beads in the center of the race will cause it to shrink when it cools, and it will fall out.

CHEVROLET

ADVANCE INFORMATION

TO Regional Service Engineers

ADDRESS

FROM H. A. Bangsberg

ADDRESS Central Office

SUBJECT IMPROVED REAR AXLE PINION BEARING LUBRICATION - 1962 CORVAIR AND CORVAIR "95" A. I. 62-13

DATE March 12, 1962

A design change is in process to raise the lubricant level 5/8" on all 1962 Corvair and Corvair 95 differential carrier assemblies and three-speed transmissions. This is being accomplished by re-locating the oil filler plug location on these units. Four-speed transmission filler plug location was previously one inch above the old differential lube level and will therefore, not require any modification.

Effective 2-19-62 and continuing until new parts are available, assembly plants are installing 45° Street "L" extensions at the filler plug location to effectively accomplish the same results. In addition to raising the lube level, all trans-axle assemblies are being motored to 3,000 RPM after initial fill to "pre-lubricate" the pinion bearing.

Serial numbers of the first vehicles incorporating these revisions are as follows:

Flint	108833	St. Louis	109859
Oakland	138117	Willow Run	207404

We request that you notify all Zones to be alert for all seized pinion bearings on vehicles after the above serial numbers. If any such failures are encountered, they should be investigated in detail for proper oil level, operating conditions and any other pertinent facts. Reports should be forwarded in the usual manner.

If you are personally present prior to the time the repairs are attempted on one of these failures and are able to insure that low lube level is not the cause, then it would be desireable to forward the complete rear axle assembly without it being disassembled. Each of you should be alert for one such example.

Additional changes to be incorporated along with the design change to relocate the filler plug include:

1. Filler plug on the 3-speed transmission will be changed from 1/2" pipe thread to a 7/8" - 18 plug using a nylon gasket.

2. The filler plug gasket common to both 3 and 4-speed transmissions, will be red nylon imprinted with a note "Trans. Fill Only - Check Oil Level at Axle Filler Plug".

3. Rear axle filler plug will be changed for 1/2" pipe thread to 3/4" pipe thread.

Extra copies of this letter are being forwarded to each Regional Service Engineer for distribution to Zone Service Managers.

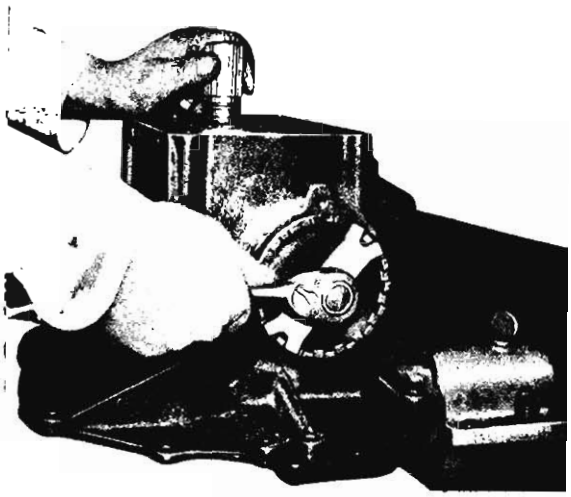
H A Bangsberg
Technical Service Department

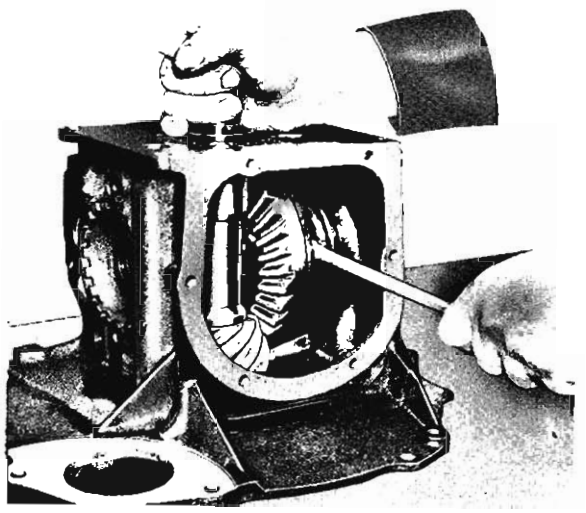
TRP:dz
cc: Regional Service Managers
Field Service Engineers

TOOTH CONTACT PATTERNS - REVISITED

Bob Ballew
1 Jan. 2002

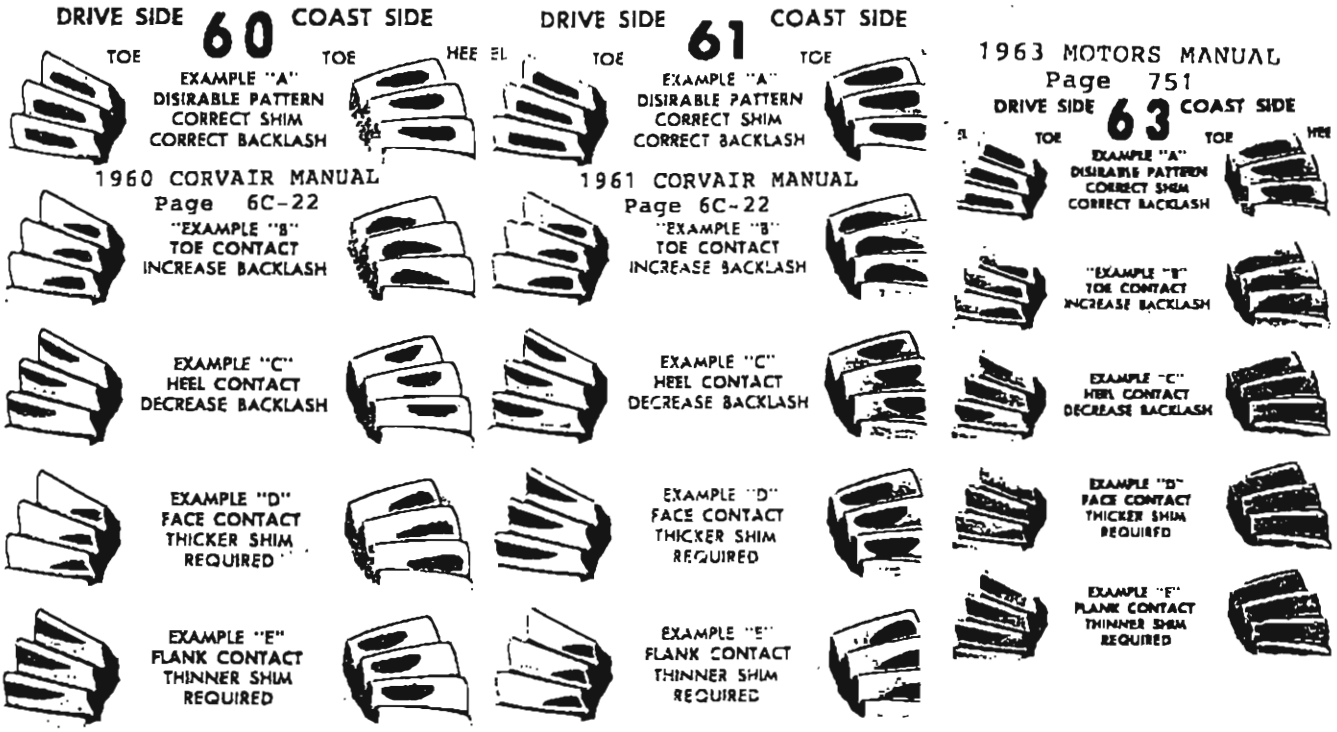
The first problem is how the repairperson views the ring gear. There are two ways to set up the differential housing. The first way is how our Corvair manual shows it with the rear (Large Flange) down either bolted to a Differential Carrier Holding Fixture #J-3289, or flat on the bench. (See Pictures) Of course none of us has the fixture, nor do we have a large hole in the middle of our work bench.

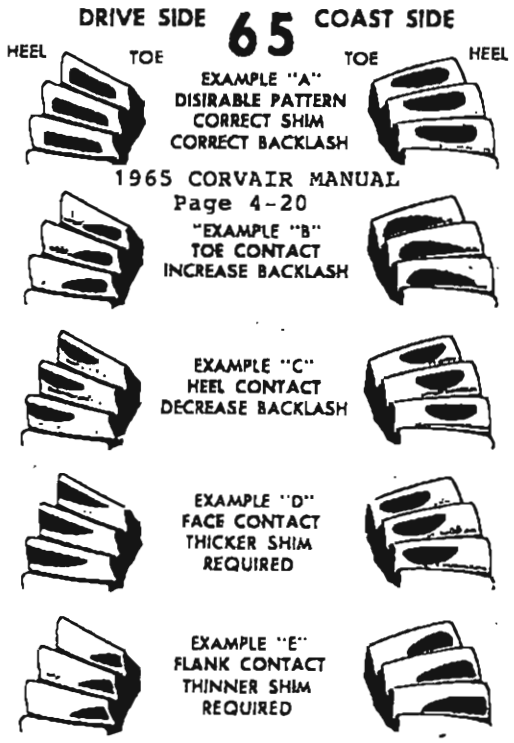




The second method is the one we folks without the hole or the fixture use. You turn your work bench vise clockwise a few degrees and lock it in that position. Lift up the housing and set it on the bench to the left of the vise and slide the flange into the vise jaws to hold it. Now as you look down into the housing, the ring gear is on your left. The fixture or hole method, has the Ring Gear on the right. With the vise system and the Ring Gear on your left, you must remember when setting up backlash or preload that left and right are reversed.

Now, there are various versions of what to do about adding or removing shims. It all depends on which manual you have. Now, if you only have the 1960 Corvair manual or the 1963 Motors manual it tells you one way, However if you only have the 1961 or the 1965 Corvair manual it tells you a different way to move the shims. If the only picture you have of the patterns is from the March 98 Communique, you get another version. Which one is the correct one?

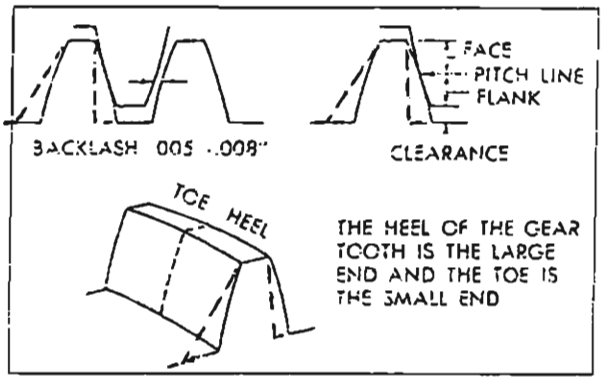




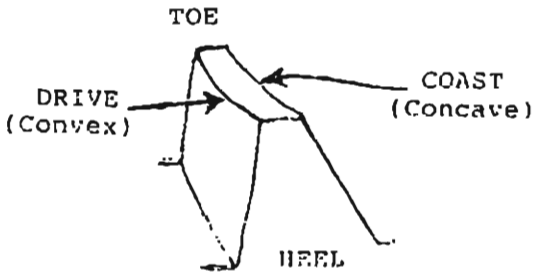
IT'S A PUZZLEMENT!!

WHICH ONE IS THE CORRECT ONE??

Ha! you're not going to stick me with that question. Let's look at another drawing which is in all the manuals and supposed to explain, Heel, Toe, Flank, Face, and Backlash. The drawings are shown with Generic teeth which bear no resemblance to real life Ring Gear teeth. So, for the novice, listen up, The DRIVE (Convex) side is 10° from vertical. The COAST (Concave) side is the slanted side 30° from vertical. (See my drawing on right) On the drawings in the rectangle, I have added dashed lines to show real life ring gear teeth shape. Notice the dashed lines are backwards from my drawing. Reason? Everything in the rectangle is from a Front Eng. car with a Ring Gear opposite from CORVAIR.



Ring gear teeth from a FRONT ENGINE car.



CORVAIR ring gear tooth.

Or, I should say, since we are the minority, WE are OPPOSITE all Front Eng. cars. Shown on the bottom of the page is a photo of a CORVAIR Ring Gear, lying teeth up on a bench. Notice COAST surface (White) shows on the left, and DRIVE (White striped) surface shows on the right. Further notice, painted tooth at 6 O'clock is the same shape as my drawing at upper right. Our Ring Gear turns counterclockwise. (What else?) Our pinion gear being behind the axle and at the single painted tooth, and turning counterclockwise as our engine, will turn the axle moving our CORVAIR forward. The rest of the world with their pinion gear in front of the axle and ring gear on the drivers side, turns things the other way to go forward. Our problem, we have inherited all their tooth patterns.

The CORVAIR Ring Gear shown flat on bench.

The FRONT Eng. Ring Gear is opposite in all details, and turns Clockwise. It is located on the Drivers side of the car.

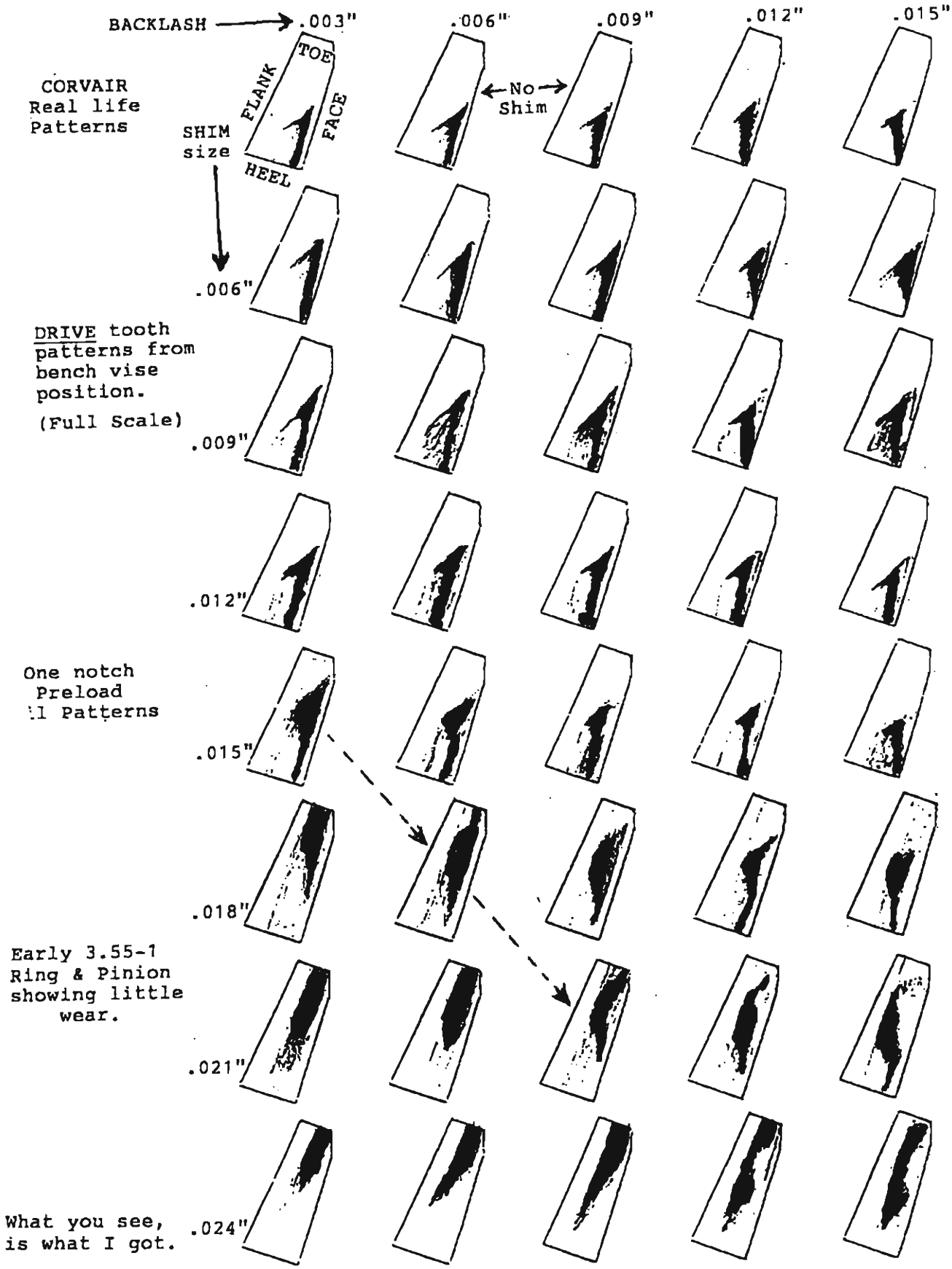
Now the question here is, should the patterns on Page 2 be reversed or just the titles be reversed, or both? Who can say with certainty that the patterns on the left is for the DRIVE side or the COAST side? Let's add another puzzle; as you look at your Ring Gear on the bench, notice the HEEL (Outer) end of the teeth are lower than the TOE (Inner) end. Now, look at the manuals drawings. They show the HEEL (Outer) end as the highest? Puzzling?

Well, the Author of the article in the March, 1998 Communique, came up with his solution to the problem of which side is Drive or Coast, just reverse the Titles, and since I don't know which of the Manuals Patterns he started out with, I'm not sure if he moved the columns of them over also. His drawings still show the HEELS higher than the TOES which ain't so in real life. He mentions that Front Eng. cars have their Ring Gears reversed from our Corvairs, that's true. If you have a ring gear from one of them and laid it flat on the bench, next to our CORVAIR ring Gear, you would see that the nearest tooth would have the DRIVE side opposite from our CORVAIR. I mentioned on page 3 that the Ring Gear from a Front Eng. car is on the Drivers side, whereas the CORVAIR Ring Gear is on the Passenger's side. (I'm going to ask a question and then answer it) Question? Why didn't they put the CORVAIR Ring Gear over there on the Drivers side also?? Since they had to machine an opposite one to move it, why move it?? You would still have the Pinion Gear behind the axle, which would now have an engine that would turn clockwise. (From the rear) It will run just as good that way?? So, Why move the darn Ring Gear over???

Why?? It's because of the crown in the road!! Almost all of our roads are higher in the middle to allow the rain water to run off which requires designers to compensate for that constant leaning to the right. Our little CORVAIRS with most of the weight in the rear are skitterish enough as is, without added weight over on the right with the leaning. How to move the engine weight over to the high side? (Left) Simple, move the Ring Gear over on the Passengers side of the differential and it will allow moving the Engine centerline to the left of the centerline of the Car, One and Three quarters inches!!! ⟵ this much ⟶

Of course, in so doing, it requires a Counterclockwise turning Engine. We have to push the back of the Ring Gear, UP, to make us go Forward. Elementary Watson!! 1 3/4" doesn't sound like much but we are moving the crankshaft, the P.G., diff. housing, Gen., Starter, Etc., that 1 3/4" further to the left. That results in a hell of a lot of weight helping the traction of the left rear wheel. They put the battery over there to help also.

On the next page is something I have wanted to do for a long time. Spend a few days changing shims and backlash, and come up with all manner of tooth patterns above and beyond the normal to see just what happens to the patterns. So here are 40 DRIVE tooth patterns for your perusal. Looks like .018" Shim and .006" Backlash is about right. Hope to do it again with New Gears. It's possible that New Gears will come up with patterns that look better than the ones I got from these used Gears. Although they didn't look worn, they might of been set up wrong for that short mileage.


BACKLASH
.003"
.006"
.009"
.012"
.015"
CORVAIR
Real life
Patterns
TOE
FLANK
FACE
HEEL
SHIM
size
No
Shim
.006"
DRIVE tooth
patterns from
bench vise
position.
(Full Scale)
.009"
.012"
One notch
Preload
Patterns
.015"
.018"
Early 3.55-1
Ring & Pinion
showing little
wear.
.021"
What you see,
is what I got.
.024"

Now a word about the size and shape of the Tooth patterns on page 5. I mentioned that I use the Bench Vise position for my Ring Gear tooth pattern work. As I look down into the Diff. case and turn the Drive side of the Ring Gear teeth back to inspect the pattern, what I see is the exact same size, shape and position of the Drive teeth. I can then draw the pattern more accurately in my true scale tooth outline than if I have to guess just where the pattern would be on a tooth outline a different size or at a different angle, or completely different shape.

Oh, by the way, if you are lucky enough to have the #J-3289 Holding Fixture or the hole in your bench, and you use that positior for your patterns, you can use these tooth outlines by simply turning them upside down. That is exactly what you will see when you look at your Drive tooth surface, the same size, shape and angle.

Some more interesting things about the patterns on page 5 is the directions the patterns go. According to the information from the book patterns on page 2, changing Shims is supposed to move you to either the Face or the Flank, or visa-versa. However, when I added Shims, the pattern went from the HEEL to the TOE, with only a very slight move to the Flank. As far as Backlash goes, the book patterns say, 'Toe Contact, Increase Backlash'. Where I used the thinner Shims, and added Basklash, there wasn't a great deal of movement. However, with the lower group with the thicker Shims, there was quite a bit of movement towards the HEEL, but that was only where the Backlash was up to .012" to .015".

Another interesting result, I have drawn a dashed line with arrows down at an 45° angle from the .015" Shim pattern, those three patterns with different Shims and Backlash, would meet most folks standards, if they were the first pattern they ran across. So it's not all cut and dried that there's only one pattern you could come up with. That 45° line runs kinda true for others.

Now, before we get to the mundane part about setting up a differential, here's an intriguing para. in our books, which most likely drives the novice repairperson up the wall.

RING GEAR AND PINION CONTACT PATTERN

Upon completion of the ring gear-to-pinion backlash adjustment previously described, a check of the gear teeth contact pattern should be made to insure gear life and minimize bearing noise from the carrier.

1. Thoroughly clean the ring gear and pinion teeth with solvent and air-dry.
2. Paint ring gear teeth only with a light and even coating of a mixture of iron oxide gear marking compound and axle lubricant of a suitable consistency to produce a contact pattern on the pinion gear.
3. While firmly holding the pinion with a rag to form a friction brake, turn the ring gear back and forth with a wrench (fig. 6C-52) on the ring gear mounting bolts until a definite contact pattern is formed on the pinion.

Bad pattern causes bearing noise ???

I'll buy that.

All of them ???

On the WHAT !!!

God help us, they said it AGAIN !!!

4. Inspect the contact pattern produced and analyze the results relative to the following data. Figure 6C-53 provides gear tooth nomenclature and figure 6C-54 illustrates the various contact patterns which may be experienced.

Note; Fig. 6C-54, 60-61 Books
65 book, Fig. 52, page 4-20

Okay, Let's analyze the contact pattern produced on the PINION, just like the last two para. has said. Now we are referred to a drawing of RING GEAR patterns! Do you get the feeling that the instructor writing this, hasn't the slightest idea what in the world he's talking about? At this point the novice most likely will go out and buy a Ford! Or maybe write an article on differential set up.

Of course we old hands of Corvair Manuals, are used to this. We know it's the contact pattern on the Ring Gear Teeth, not the Pinion that we are checking. (Hey, you don't suppose that this clown has got the Pinion Gear mixed up with the Coast side Ring Gear tooth patterns?) (Ya-know, where they show 'Coast Side Patterns' and call it 'Drive Side.') I think this guy that writes in our manuals, is the same guy that translates Japanese motor manuals into English.

Let's move on to TOOLS. No, let's check out something else in our books. I've got you conditioned to most anything now, so just one last fig. showing getting that Contact Pattern on the PINION. I didn't plan this, really? But I just happen to have that Book Fig. on the upper right on page 1. So, flip back.

This picture is in all our 60-61-65 Main Books. This is the operation on the bench with a hole in the middle. It's the procedure using a wrench on a bolt head and holding the Pinion Shaft to get a definite pattern on the Pinion Gear Teeth. The person who took the picture, took great pains to add perfect tooth patterns with his air brush on the Ring Gear teeth, and also on the Pinion Gear Teeth. (Shows better in the Books) However, if you look closely the Patterns on the Pinion Teeth are on it's Drive side, but the perfect patterns on the Ring Gear teeth are on the (You guessed it) COAST SIDE. In the picture the Drive Side of the Ring Gear Teeth, are the top three, don't show nothing, only a black shadow all across the surface. You don't suppose that this clown is trying to fool us with these perfect Patterns on the Coast side, to make it appear therefore the Drive side must be perfect too??? Remember the Ring Gear Teeth are supposed to be painted on the Coast side and Drive side also. "Where's The Paint?" "Where's the Pattern?"

Okay, now to Tools