901/902/911 Transmission rebuild video supplement

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Forward

These pages are intended to be a supplement to the transmission rebuild video that was made in early 2010. There is much information herein that many may find useful without the video and as such I have posted these up for free where ever I was allowed and seemed relevant. Please feel free to distribute these pages. However, changing the content, utilizing the content without giving due recognition, or utilizing the content of these pages in order to make a profit is not just seriously messed up, but also forbidden. Much of the information here are data that I have gathered from my experiences in rebuilding our style of transmissions. I have done well over 100 rebuilds with very few problems. Some of the information provided here is my opinion based on my experience. Please take it as such. I am hopeful that the information here will be of use to many. If there are missing or incorrect data, please feel free to contact me at MakeMy914Go@yahoo.com so that I may refine this document and make it as high fidelity and comprehensive as possible. Happy motoring ☺

Chapter 1 – "Do I even need a rebuild?"

What external things to inspect

It is usually a surprise to the bewildered owner of a poorly shifting transmission to find that the cause of the poor shifting is actually ***external*** to the gear box. The concept is fairly straight forward. The engine and transmission (drive-train) are solidly bolted together as a single unit, and they are suspended from the chassis with flexible rubber mounts. The shifter assembly is solidly connected to the body at the stick-shift (which is bolted to the floor in the cabin) and at the firewall bushing. This solid link to the body continues aft until it is connected to the transmission at the shift console (914). As such, any slop in the drive-train mounts, or the shift linkage, will cause the orientation between the drive-train and the chassis to change and subsequently the shift pattern location to shift making your shifting suck. All concepts below can be applied to 911/912 configurations, but since I do not have the same level of intimate knowledge of 911/912 anatomy past the gear box, I did not go into exact details.

So, with that concept in mind, here is a list of things to check before blaming the transmission.

****Engine mounts***

Both side and tail shift 901 configurations in the 914 (912 and 911 as well) have rubber mounts incorporated into the engine mount bar. The side shift 914 configuration has solid mounts from the bar ends to the chassis and rubber mounts between the engine and bar, the tail shift configuration is exactly the opposite. The two rubber mounts are intended to isolate drive-train vibrations from the chassis, but they can break causing the whole drive-train to shift. The common symptoms experienced when an engine mount fails are a "clunk" or "thump" when revving the motor or driving, and a shift pattern that continues to move around on you (gears are once in one place, then in another).

How to test your engine mounts; side shift 914:

Testing your engine mounts is pretty easy. First, realize that the side shift engine mounts are pressed between the engine and the engine bar. Thus, you need to lift the engine a little to see if the engine mounts are still in one piece. I have a method that I use and find to be pretty easy. First, jack the car up and place it securely on jack stands or ramps. Then, take a piece of wood and place it on top of the jack and lightly jack under the engine to see if the engine easily lifts away from the engine bar. You are not trying to lift the car with the engine; you are only trying to see if the engine is still attached to the engine bar. Repeat this on both sides of the engine to better isolate the two rubber mounts. It is OK it the engine lifts a little from the bar as that is just the rubber mounts yielding a little bit, but if the engine lifts very easy and any more than a small amount, consider changing your engine mount(s).

How to inspect your engine mounts; tail shift 914:

On the tail shift 901 in a 914, and 914/6 it is easy to check the engine mounts as they are located at the ends of the engine bar and are bolted to the frame. Inspection of these is pretty self explanatory and simply requires that one support the engine bar, pull the bolts, and inspect the rubber in the mounts. A good upgrade for these are the 911 engine mounts which tend to be cheaper than the 914 stock mounts, are solid rubber, and are overall better for enhanced stiffness and resistance to failure, without being too stiff.

****Transmission mounts***

Transmission mount failure presents as a changing or sloppy shift pattern. The transmission mounts are straight forward and easy to inspect. Just support the transmission, remove the bolts from the mounts, remove the mounts and inspect.

***Shift bushings, 914**

Shift bushings differ from side shift, tail shift, and '70-72 914s that have been converted to side shift.

***Side shifter**:*

Side shifters have the following major bushings:

- Firewall
- In the joint just aft of the firewall in the shift linkage
- At the side shift console where the rod passes through
- In the cup at the end of the shift rod

The majority of bushing issues are found when the firewall bushing deteriorates and disappears. Excessive looseness in any of the bushings will cause your shifting to suck. There are also bushings within the stick shift mechanism itself in that cabin, but they are not usually the culprit for missing or floating gears.

Tail shifter:

The tail shifter has the following bushings:

- Cup bushing under the stick shift in the cabin
- Firewall bushing (same location, different size than a side shifter)
- At the back end of the transmission where the rod mates up

Converted '70-72 to side shifter:

For those wishing to convert their early 914 to a side shift, the only special thing to mention is that you must use a conversion bushing at the firewall. The firewall hole where the shift rod passes through in these earlier cars is larger than the one for the side shifting later model cars, and the hole in the middle of the bushing is smaller for the side shift rod verses the larger diameter tail shift rod. Thus, only the adapter bushing will work. Many times I have seen where one has used the standard side shift bushing in an earlier car only to have it be very sloppy in the firewall hole. The conversion bushing is readily available currently (01/22/10) and inexpensive.

Cone Screws (side shifter only)

There are two cone screws to consider when your shifting gets crappy. One cone screw is located where the external shift rod joins the one sticking out of the fire wall. It is used to couple these two rods together and if it backs out the rods will have slop in them. The second cone screw is located at the aft most part of the external shift rod where it retains the shift cup. Again, if the screw backs out a little then play will be in the coupling and shifting will subsequently be affected. Cone screws come with a nylock deposit and should be replaced with new ones each time you remove them lest you suffer lost shifting. They are cheap, I am cheap, and I do it. I recommend against reusing a cone screw with loc-tite because it is common for the screw to strip upon extraction due to the loc-tite working too well, but since some of you will do this anyway, at least use the weak loc-tite so you have a chance of getting the damn thing out when you next need to.

Clutch cable

The clutch cable being too loose is probably one of the most common reasons that people's shifting sucks. If your cable is too loose then you will not be able to fully disengage the pressure plate from the clutch disk and you will keep power to the transmission. If it is really loose then reverse will grind when shifting into it from a standstill. There is no way that this should happen if the clutch is fully disengaged. To properly adjust your clutch, you need to tighten the cable until the clutch disengages at about 1/4 to 1/3 pedal travel (*See **figure 1** in appendix*). If the clutch disengages too early then it is too tight, too late then it is too loose.

****Clutch tube (particular to 914)***

If your clutch cable seems impossible to adjust, you may be suffering from a separated clutch tube. The clutch tube runs through the center tunnel and is welded near the front of the driver's side of the tunnel and to the firewall where the clutch cable exits. Often, one or both of the welds brake causing your tube to shift when you clutch in. This will disable your cable's ability to pull enough on your clutch and thus will not fully disengage your clutch. Repairs for this issue take many forms and are beyond the scope of this article. Searching www.914World.com , or other forums for information and advice on how to tackle this and other 914 related problems is a good start.

Adjusting your shifter

Concept:

Before you can easily adjust your shifter you need to conceptualize what is happening. I can only do so well with words and diagrams, but once you get the concept you will be surprised how easy it is to adjust the shifter perfectly in a very short amount of time.

For this explanation, reference figures 2, 3, and 4 in the appendix. Figure 2 is the conceptual depiction of how the shifter should be when aligned correctly. The black outline is where you would like the shift pattern to be, and is where the stick-shift actually can travel. The red lines represent where the shift pattern actually is. Stay with me, and make sure you get this concept.

Now a common issue is that people end up with only some gears, but not all. Refer to figure 3. You will notice that the red lines are to the right and up from the desired location of the shifter. In this setup you would only be able to select 1st and 3rd gears, but 1st would be near where 3rd should be and 3rd would be near where 5th should be. About now I hope you are having that "ah ha!" moment.

Adjustment:

To rectify this condition:

1. Select a gear. In using figure 3 it would be wisest to select 3rd. You can determine

that it is 3rd that you are selecting because there will be no gears past the middle (1st) and 3rd is the next over on the bottom. Also, you would have no upper gears.

2. Loosen the pinch bolt under the stick shift
3. Stabilize the shift rod in the tunnel so it doesn't move, this way you are only moving the stick-shift and not the rod, thus not changing the fact that the gear box is in third.
4. Move the shifter to where 3rd should be. Second and 3rd are the only gears to use as they lie on the plane of the spring plate and you can use the shifters spring plate to guide you to where 2 and 3 should be.
5. Tighten pinch bolt and see if you can get all gears.

The short answer is, put transmission into known 2nd or 3rd gear, then move the stick to where that gear is supposed to be.

Now use this concept on Figure 4. In figure 4 you would only have gears 1, 3, and 5 as R, 2, 4 would be out of reach of your current adjustment. To fix this scenario you would follow the same steps as stated above.

I hope this clarifies this simple procedure. It is a bit more difficult to explain in prose.

Inspecting a core transmission

So, you are considering buying a used transmission and the owner tells you that it shifted properly before it was pulled and stored. So what? Unless someone can provide you with irrefutable evidence that the transmission was in good shape or has had some work done to it, it is a core. Feel free to violate this rule at your own financial peril. But, the box shifted just fine by hand or in the car. I don't care. That and $3 will get you a beer at most bars, but it will not prove that your core transmission is any good. If you did not drive the gear box before you purchased it to check out how it shifted, then you can not verify the condition without pulling the stack. However, if it does not shift that doesn't mean anything either. More on that point later after rebuild. The output flanges should turn independently and together. If they do not turn independently, but do turn together, you may have a welded diff or a rare factory ZF, or TB LSD. Not likely, but I don't want to dash your hopes ;-)

Definite signs of concern include, but are not limited to:

- Drive shaft has much axial play
- Output shafts do not move at all
- Output shafts make a grinding noise when turning
- Current owner looks nervous and deflects your questions
- Etc.

A word on reading used transmission oil

A lot can be deduced from the oil you get out of a core transmission. However, you cannot rely solely on this method as it is easy for someone to change out the oil and then let it sit leaving the oil relatively clean. Giant, gold, or other metal chunks are concerning for bearing failure. Gold flake in the oil is often indicative of normal wear and tear on the consumable parts in the stack. Oil that is gooey or burnt is indicative of a neglected box and may mean lots of parts to be needed to rebuild. Lots of shavings on the magnetic drain plug are not a definite cause for concern as it is often due to normal wear and tear.

Chapter 2 – Do I need that? Myths and musings

This section is intended to educate you about some things that people do to the 901, my opinions on those things, how I have come to those conclusions, and to allow you to draw your own conclusion based on such.

Billet intermediate plate

This is a popular “upgrade” for many people whom believe themselves to have engines that are too strong for a stock 901. My question for the person considering this or any other “upgrade” for their 901 is, why? Find out if there is actual evidence of a problem occurring that the intervention you are considering has actually fixed. With the billet intermediate plate the claim is that they keep the bearing in the intermediate plate more stable than the lighter, stock magnesium alloy plate. By doing this the idea is that it keeps your input and output shafts from separating. From my own research through surveys of several 901 owners and operators, and rebuilding over 200 type 901/902/911 gear boxes, I can say that I have never seen the problem that the billet plate is supposed to solve. However, I have heard one firsthand account from a member of 914World.com that builds transmissions in Australia that he has switched to the billet plate due to the torque of one of his customer's engines constantly warping the bearing bore of the output shaft intermediate plate bearing in the stock plates. This is a data point of one and to me says that the vast majority of people do not need this sexy, yet expensive part. More likely, the cause of the shaft separation in the stack is due to failure of the forward pinion bearing which results in the loss of the part that pushes the pinion against the ring gear. This is also not very common.

Through bolting the intermediate plate/case/tail cone

This is a new one that I recently came across. This takes some of the studs out of the case that are used to hold the tail cone, intermediate plate, and case together and replaces them with bolts. The concept is that this keeps the case, intermediate plate, and tail cone from separating under extreme load. This does not make any sense to me as I have never heard of nor seen such a thing happen. The intervention makes sense, but the problem so far as I know does not exist. It is like claiming that your shoes are magic as they ward off saber toothed tigers. You haven't seen any tigers around you, have you? It must work.

Lubricants

Of all of the things I get asked questions about, lubricants for our gear boxes is at the top of the list. The main types I am asked about are the specialty oils (Swepco and Royal Purple) and regular old 80w-90 (dino oil). My logic is this; a vast majority of the boxes that I have rebuilt have been run for 30 years or more on regular dino oil. The boxes with the worst insides still lasted a few decades on good old dino oil. So, I would submit that dino oil is some pretty damn good stuff. Now, I have no evidence that using one of the specialty oils is bad for your gear box. I would bet that they are not, and those who do use them swear by them. However, it is often that just changing your oil is enough to net you some better gear box behavior if you have not done so previously.

A concern that I have regarding the specialty oils involves the detergents that these oils contain. Every box that I have rebuilt that had previously used one of the specialty oils have been incredibly clean inside and a pleasure to work on. However, that does not mean that there is a lack of dirt and debris in the box. Regular oil is not very detergent and as such grime and sediments tend to settle out of solution. This is actually a good thing as there is no filter in the 901 to strain the oil. With specialty oils, the increased detergency keeps the sediments and grim suspended in solution. This is not a desirable scenario in that instead of having these damaging agents settling out, they are retained in solution and cycled through the workings of the gear box much like a polishing compound. Changing your gear box oil every 12,000mi or 2 years as the manual recommends seriously negates these concerns. Past that point, it is up to you whether it is worth the large price tag to run specialty oils or good old 80w-90 GL5 dino oil. Perhaps you may wish to put some sort of filter around the breather port at the top of the case as well to control any contaminant influx. I have not done this, but it would be simple and make sense.

Stainless steel fasteners (and mag alloy cases)

If I hear one more time, from someone who heard somewhere about how using stainless steel fasteners will rot your magnesium alloy case, I am going to lose it. This blanket statement is not all wrong, but needs much explanation (cop a squat, it is gonna be a while).

The first thing you need to consider is galvanic corrosion which is corrosion that occurs between dissimilar metals. This is intended to be a brief overview of how galvanic corrosion happens, and why not all stainless steel is equal in its ability to corrode.

Why do I even care if SS fasteners corrode magnesium alloy cases? Because I have been using SS hardware on all of my rebuilds for at least a few years. I do this because the stock hardware, which are unique in that they are mild steel with helicoiled threads inside of them, does corrode to the studs and is a bitch to get off often requiring the removal of the stud to get the nut off. SS hardware is intended to prevent this event for a longer time, if not indefinitely.

All stainless steel is not the same! In a typical Galvanic chart (see appendix), metals are listed from more cathodic (positive), or less likely to be attacked, to anodic (negative), or more likely to be attacked. Notice in the galvanic chart that I have provided in the appendix that magnesium alloys are the most anodic and thus the most likely to be attacked. They are the wussy little kid on the play ground and everyone wants to take their lunch money.

Now, the stock fasteners were mild steel with the helicoiled threads inside. I do not know what material these threads are made out of or why they are used. I hope to know some day, but at the time of this writing all I have to go on is conjecture and opinions are like assholes. If you look at the galvanic chart you will see that there are several types of SS fasteners. The farther you get form the anodic metal you are working with, the more electrochemical difference you will have and the worse will be the corrosion. Mild steel and low-alloy steel are both 3 and 4 spots above magnesium alloy, respectively, and as such are not too bad of a choice. The stainless steel fasteners that I use are A-2, also known as 304, and are only 5 positions above mag alloy. They are considered “active” in that they naturally have a layer of chromium-rich oxide film that functions as the protectant. Not an issue, but you can see on the galvanic chart that there are considerably worse choices of stainless.

Corrosion protection (of mag alloy cases)

Many people love to clean up their gear boxes so that they look so pretty to the road kill as they take in their last glimpse of life. This is all fine and good, but you may actually be doing your gear box a disservice in cleaning all that road grime off.

As described in the previous section, mag alloy is very prone to corrosion. The cases came from the factory with a coating to prevent this, but the coating was only good for a couple of years and required reapplication. I would seriously doubt that many people have any of this factory coating still protecting their cases as it breaks down from just contacting air. The oil and grime that builds up on your case, although unsightly to the soon to be dead squirrel you just ran over, actually work to prevent corrosion by blocking access to the mag alloy by water and air. So, if you don't clean it, swell, but if you do, you need to coat it with something.

There are many techniques that are described ad nauseum in the various forums on how to protect your mag allow case. Pretty much, all ways work and have their plusses and minuses; it is up to you to choose what you are more comfortable with. Simply painting the case is better than leaving it exposed to the elements.

Media blasting your case

Warning, you may be about to really crap things up! If you take everything out of your case and intermediate plate, you can blast. However, if you try just taping things up real well and then blasting, you are more likely to end up with grit in the case that will degrade things and seriously shorten the life of your gear box. I prefer hot tanking things as there is no risk of the above badness.

Chapter 3 – Tweaking your gears and diff

Gear selection:

Considerations

What gears will work best for you depends on several factors: engine torque curve, HP, what the car will be used for. Ideally, you want to choose your gearing so that your engine RPM in every gear will be set up to extract the most use of the torque. For example, say you make peak torque between 4k-5k RPM. If you choose gearing that utilizes this band then you will get the best use out of your gear box. What is very good for those of us with 901/902/911 boxes is that the gears are almost all interchangeable with 2nd being the only one that would require a shaft swap unless you have a 904 shaft with removable gears.

Engine dependent gearing

The engine that is being hooked up to the gear box also determines how the gear box would best be setup. For instance, engines that make high torque at low RPMs, like V8s and large displacement Porsche 6 cylinder engines, require a taller set of gears than stock 4 cylinder engines which make their torque at higher RPMs (tall and small are slang terms that refer to how many RPM are needed to move the car. Small is 1st, tall would be 5th). As such, stock 1st gear in the 901 is useless and even dangerous to use with engines like V8s as it can cause damage if used. Stock 5th for the high revving /4 engine will also be too high for any engine that produces torque at low RPM and as such most people option to install taller gears in the 5th gear position.

Interpreting gearing

Porsche utilizes the alphabet to designate where gears lie on a continuum with "A" being the shortest stock gear, and "ZD" being the stock tallest.

- Stock gearing for 914/4, all years: A, F, N, V, ZD
- Stock gears for 914/6, all, and many early 911: A, GA, O, V, ZA
- Stock for most 912 5 speed boxes: A, F, M, S, X
- Stock for most 912 4 speed boxes: A, H, Q, X

*Note – the gearing for the 914/6 engine is a good example of how small tweaks to what gears you have make better use of the torque provided by the engine, and how the shorter 5th (ZA vs ZD) provides for better cooling through higher RPMs and better use of the 6 cylinder torque curve in most applications.

Intended usage of the gear box

How you intend to use your gear box is another important factor to keep in mind when you are choosing gears. A very popular and readily available gear selection for courses with lots of turns, limited straightaways, and with a 4cyl with a normal torque curve is A, F, M, S, X. The first two gears are stock for the /4 while the 3, 4, 5, gears are all closer together than stock and are shorter overall. The MSX setup would absolutely suck on a course with long and plentiful straightaways, or on a freeway to and from a course. The stock gearing is fairly decent overall for a mixed race course. Other than these two popular configurations, the sky is the limit (or your wallet). I wish for those of you reading this to keep in mind that me telling you what you will enjoy best in terms of gears is like me trying on a pair of pants and telling you that you will like them based on my experience. As such, take the advice here in the gearing section as just that, and see what works best for you. The best is to talk to those who race and see what they like and why.

Flipping gears

Flipping gears is done for two major reasons: 1) To gain a ratio that is not available in the normal A-ZD offering. 2) To make a gear ratio that one wants without having to shell out the money for the actual gears (for instance, a flipped "M" gear is the same as a ZA which is stock 5th on a /6 box). Flipping an "H" gear and sticking it into 5th to gain a taller gear than ZD is a very popular application used in V8 configurations because they produce torque at lower RPM and cruising at 3.5K-4K RPM at freeway speeds with a ZD 5th gear is not very enjoyable in a V8.

Limited slip differentials (LSD):

The main idea

LSDs are great when used correctly. They are not cheap so getting one just to get one is something I would recommend against. To understand what an LSD does one should first understand what the standard differential does. The differential's primary job is to allow the wheel on the inner side of a turn to turn slower while the wheel on the outside of the turn turns faster. For example, a left turning car will have the rear left wheel turning slower and the right rear wheel turning faster. The problem seen with a stock differential occurs when one of the rear wheels slips. It is at this point that the stock differential will transfer all power to the slipping wheel while the gripping wheel gets no power. This seems retarded, but in normal everyday driving this is a perfectly fine design and not problematic. On the track, when rounding a corner and your wheel starts to slip you lose power to the drive wheel, costing you time which is not acceptable in racing. It is this scenario that the LSD is designed to address. LSDs provide more power to the wheel with the grip thus keeping the power to the road around a slide or corner. LSDs come in two flavors that are addressed below.

Torque biasing (TB)

The quintessential version know to most people of a TB LSD is the one manufactured by Quaiffe. TB LSDs use a gear package inside the differential to divert power to the sticking wheel. This type of LSD is perfect for all applications except racing where the other type of LSD is superior. The TB LSD is inferior for racing because it is only working during acceleration (when torque is applied). This is what most people want in a street upgrade, but many racers do not like this on/off behavior.

Friction biasing (FB)

The stock LSD that came in some HB designated (case code on bottom rib starts with HB) 901 boxes was a FB type, designated as a “factory ZF” LSD. A FB type is constructed much like a positraction differential in that it uses a wet clutch comprised of several friction disks and pressure plates. The thickness of the friction disks and pressure plates sets the percent of torque bias, typically 40 or 80% (percent diverted to drive wheel in a slip) in our Porsche boxes. These are smoother than the TB LSDs, are more preferred by racers for their constant effect, but they do require periodic replacement of the internal clutch parts in order to work. Depending on how hard one pushes their car and how often, the FB LSD may need rebuilding once a season, or can last several years. Matt Monson of

Guard Transmissions has reported that many, in fact, last for several years and that the internal clutch pieces typically only require replacement at the time other transmission parts normally wear. The LSD has 4 friction disks, 6 pressure plates, and 2 wave plates or belleville washers in it. Each part can be purchased from vendors like Guard Transmission. The wave plates, the original parts that came with the LSD, tend to be in fragments by the time you rebuild the LSD. The belleville washer setup is considered to be a superior design and an upgrade to the stock wave washer and are not reported to be nearly as prone to fragmentation.

Welded differentials:

Don't do it!

I am still not sure why anyone would weld a differential. It is closer to an LSD than the stock differential, but when welded the differential no torque biasing in that the wheels always turn at the same rate. ALWAYS. This is freaking dangerous! Why? Picture that you are trying to turn, but you have a welded differential. Your car decides that it wishes to continue going straight (under-steer), nope, wait, now it wants to turn really fast (over-steer), nope, wait, now it wants to go straight again. Sounds like a recipe for disaster. I will not work on welded differentials because I don't trust them and don't want anyone's blood on my hands. Proceed along the welded differential path at your own peril.

Chapter 4 – Troubleshooting, care, and feeding of your transmission

Trouble shooting

***Note:** These diagnostic suggestions are all given with the expectation that there is adequate, clean 90w, GL5 oil in the gear box*

Reverse gear grinds:

Since reverse gear has absolutely no means of synchronization, having it grind when you are shifting into it is a sure sign that your clutch cable is too loose, or that some other force is causing the cable not to fully disengage the pressure plate from the clutch during shifting (clutch drag). This is a problem that needs to be addressed sooner rather than later.

Things to consider if your reverse gear suddenly starts to grind:

- Your cable is stretching and may be a about to break
- Your clutch tube has broken free of its supports inside that center tunnel
- Your throwout bearing arm bushing that goes between the fork and the ball pivot is badly worn, or gone.

Pops out of gear:

Popping out of gear is another one of those symptoms that is pretty specific. When you put the gear box into gear, and it pops out when you put power through it, there are two main things that it can be.

- Synchro band/synchro hardware inside the band is/are worn out or defective
- Shifter is misaligned.

Typically, if the shifter is out of alignment there will be subsequent gears popping out in the same plane (1-3-5, or R-2-4). The problem can result from a combination of these problems and, as such, a slight adjustment can sometimes buy you some time. But, you need to understand that the longer you wait, the more expensive the parts are gonna be to repair the problem as it begins to destroy your slider and dog teeth.

Not going into gear:

This is usually a different manifestation of the same problems that cause popping out of gear, so revue that section.

Grinds:

Grinding is generally a first sign that your box needs attention. The two main causes of this symptom are:

- Clutch cable too loose
- Synchro band worn out of limits

First off, check the clutch cable. Refer to my section on cable adjustment to see if your cable is correctly adjusted. If so, you should consider that your gear box hard ware is past its service life and your tranz needs to be rebuilt/repaired.

What causes the grinding sound???

Porsche gear boxes are designed with the gears always enmeshed with their partner. As such, the grinding is NOT due to the actual gears beating each other up. The grinding noise is caused when the slider that selects the gear fails to smoothly engage with the engagement teeth (dog teeth) that are on the gear. This engagement is facilitated by the synchronization band. The failure of these parts typically follows this progression: Synchro band → dog teeth → slider. The interesting aspect of this is that the cost of parts follows this as well. At the time that I am writing this the cost for parts are approximately as follows; synchro band $90, dog teeth $160, slider for 1st and R $500, slider for 2nd-5th $200. As you can see, the longer you do not deal with a grind, the more it will cost you in the end.

Whining:

Wining in a gear box that was previously quite can be an ominous sign. The usual causes in order of badness are:

- Low/no/dirty oil
- Dead/dying bearing

One needs to address this immediately as this is the beginning to the road of ruin. New onset whining indicates that something is not meshing up correctly or being lubricated adequately. These conditions can lead to ruin of parts that are too expensive to replace and, generally, to the purchase of another gear box to rebuild. Common findings in the tear down of one of these boxes are broken shaft bearings and galled pinion shafts. A galled shaft is not worth replacing since core transmissions are generally much cheaper than the parts and labor to do so.

Clutch will not disengage (clutch drag):

This section is intended to address causes other than the aforementioned clutch cable adjustment.

Often times when one uses a fly wheel that has been resurfaced, clutch disengagement will be sketchy at best. This main question is, has your fly wheel been resurfaced? If so, your clutch package is now farther from the throw out bearing.

When the flywheel has been resurfaced, material is taken off of the face which makes the flywheel thinner. As such, the clutch package (clutch disk and pressure plate) move closer to the engine and farther from the throwout bearing in the transmission bell housing. This change in the relationship of the parts causes the throw out bearing to have less distance in its push against the pressure plate. To rectify this issue, one only needs to add another washer under the pivot ball for the throwout bearing fork. Originally, there is only one washer and no sealant under the pivot ball. This will seal against oil leaks from that area provided the pivot ball is torqued down appropriately. When you add the second FLAT washer (no lock or split washers), you will need to put either a little Teflon tape, or other petroleum resistant sealant on the threads of the pivot ball as the two washers will no longer be able to prevent leaks. Shimming the pivot ball places the throwout bearing closer to the clutch package so that it regains its authority over the pressure plate.

Clutch slipping:

I figure that if your clutch is recently slipping, and you are reading this, that your clutch is too new to be worn out already and you have done your part to check the clutch cable and related issues with that. If after that you are still scratching your head about how your fairly new and healthy clutch can be slipping consider these few things:

- Contamination of the clutch package with petroleum goo
- Improperly machined flywheel

The main cause of a fouled clutch is a leak within the bell housing. The main sources are a loose pivot ball, input shaft seal leak on transmission, and crank seal on the engine.

Has your flywheel been machined recently? If so, consider that it may not have been done correctly. If the clutch disk face of the flywheel is machined down, and the shoulder of the flywheel (the outer edge) is not, then the clutch disk will have too much space to move in and the pressure plate will not be able to press it against the flywheel to correctly couple the engine to the transmission. This can be fixed, but requires the flywheel to be removed and re-machined.

Shifting has gone to poo:

If you experience a rapid change (moments to a week) in your shifting pattern or crispness, consider these:

- Bushings
- Cone screws
- Roll pins

The linkage has several bushings in it that can fail. When they fail, the orientation of the shift rod to the transmission changes and your pattern and crispness goes to pot. Inspect and replace as necessary.

In the side shift transmission there are two cone screws that couple the external shift rod to the internal shift rod and the shifting coupler in the rear shift console on the gear box. These need to be checked and replaced if they managed to work their way loose. Always use new ones, and don't put sealant or thread locker on them or you may be sorry later when you need to remove things without destroying them. These need to be tightened down all the way and the shafts should be made solid to one another.

There are roll pins to consider in all of the gear boxes. The roll pins are inside and outside and can either fail all at once causing you to lose all shifting, or can slowly fail causing the aforementioned issues. Roll pins are located in the following places:

Side shifter

- On the outside coupler in the arm sticking out of the gear box shift console*
- On the inside on the same part*
- On the internal shift rods

Tail shifter (914 and 914/6)

- On the inside of the tail cone under the bottom cover that is held on by 4x 10mm nuts*
- On the internal shift rods

The ones that are typical spots for failure are the ones with asterisks.

Lost shifting:

Check roll pins as stated above for any sudden loss of shifting.

General maintenance/Care and feeding of your transmission

Oil changing:

The service manual recommends that you change your gear box oil every 10,000mi. Sooner if you drive it hard or in dusty/dirty environments. If you use specialty oils like Swepco, et al, then you may wish to change your oil more often (see section on my musings about oil for reasons).

Clutch cable adjustments:

As your cable gets old it will stretch a bit. Checking the adjustment of it will prolong the life of your clutch and your gear box internals. New cables also stretch after initial usage so they will also need to be checked and adjusted soon after installation.

Shift linkage:

This is the connection to your gear box and as such it needs to be maintained. Inspecting the bushings and roll pins is a good idea on a scheduled time or mileage.

Appendix

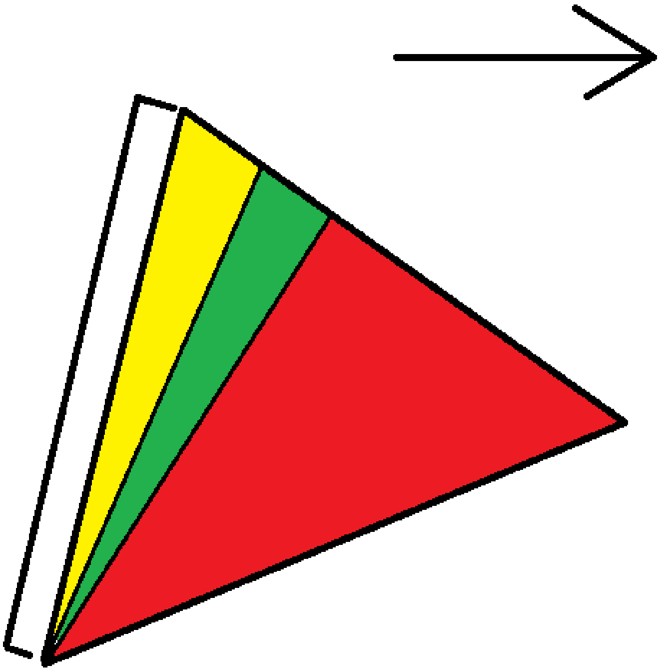

Figure 1. Clutch pedal adjustment

This is a graphical depiction of the clutch pedal travel, from left to right. The arrow is indicating where the pedal board is. The yellow zone of travel is considered too tight if your clutch disengages within this range. The green is perfect, and the red is too loose.

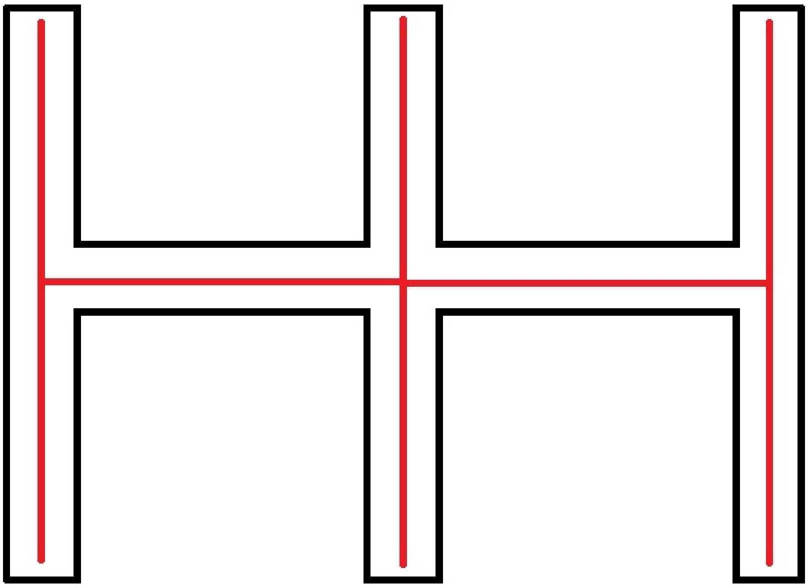

Figure 2. Shift adjustment

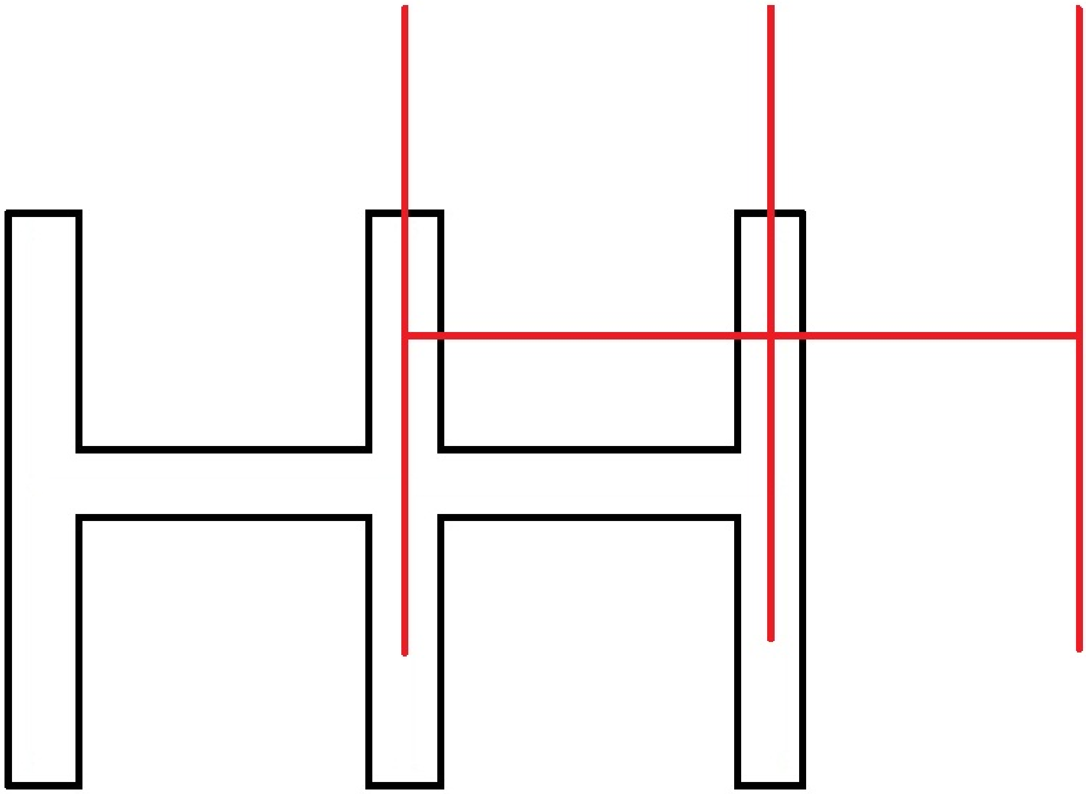

Figure 3. Shift adjustment

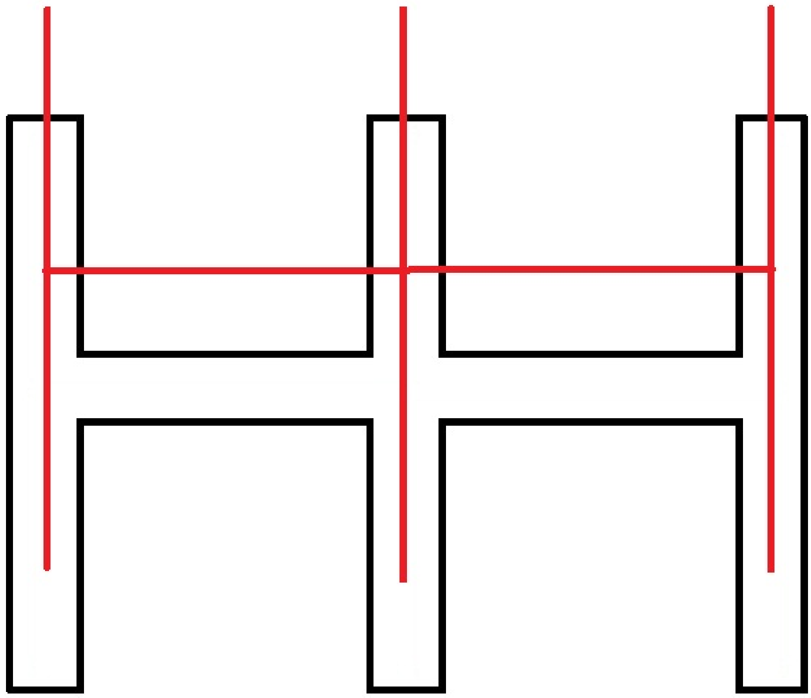

Figure 4. Shift adjustment

Galvanic chart

Noble (Cathode)

- Graphite
- Platinum
- Ni-Cr-Mo alloy
- Titanium
- Ni-Cr-Mo-Cu-Si alloy
- Ni-Fe-Cr alloy (type alloy 825)
- Stainless Steel Alloy"20"
- Stainless Steel type 316, 317 in passive state
- Nickel-Copper Alloy, type Monel
- Stainless Steel, type 302, 304,321, 347 in passive state
- Silver
- Nickel 200
- Ni-Cr alloy, type Alloy 600 in passive state
- Ni-Al bronze
- Copper-Nickel 70-30
- Stainless Stell, type 430
- Copper-Nickel 90-10
- Stainless Steel, type 410, 416
- Bronze
- Aluminium Brass
- Copper
- Tin
- Naval Brass, Red Brass
- Stainless Steel type 316, 317 in active state
- Al-Bronze
- Stainless Steel, type 302, 304 (A-2),321, 347 in active state
- Low Alloy Steel
- Mild Steel, Cast Iron
- Al-Alloys
- Zinc
- Magnesium

Active (Anode)