Subenews

Safety Alert Bulletin: Splined Shaft Failures

Introduction

Ever since **Bill Yamokowski's** post in July "Another one bite the dust" there has been a long series of posts regarding the need to inspect the splined shaft connecting the gearbox to the engine/flywheel assembly on all Eggenfellner Subaru engines. Other associated topics and concerns have been the replacement of the Solid Mass Flywheels on earlier engines and the impacts of torsional vibration to all engines. These are very serious issues for all Egg engine owners and should not be ignored. Each owner needs to study all the data being presented and determine a course of action that minimizes future flying risks. For some this might mean thorough examination of existing splined shaft assemblies, verifying alignment with special tools, replacement of flywheels, etc. Others may elect to do nothing. In either case it will be an individual decision.

I realize that with so many posts going back and forth on a range of topics it can be hard for members to digest all that's been presented. Therefore I decided to read through all the posts and organize them in a way that can help you make a decision on what to do. I will first start by repeating the background and analysis information I sent out by email on 8/17/12. Then I will copy some important comments and opinions from Ross Farnam and Al Wick that will be of value in your decision process. Finally I will cover the three issues of 1) splined shaft removal and inspection, 2) flywheel replacement, and 3) torsional vibration (TV) separately based solely on postings to date. After getting through all this material, you should have enough information to draw up your own plan of action.

Pete

Background

Roger Cosh reported shearing of splined shaft groves which resulted in an off-field landing in a soccer field (wife Julie piloting). Ref. Subenews NL # 14, July 2010.

Bill Yamokoski reported an off field landing due to same problem on July 24th in our Subenews forum Message # 8287 "Another One bites the Dust". His airplane flipped and was damaged. No serious injuries. He was our highest time pilot with 1,425 hours on his 2.5L Egg Subaru powered Glastar.

New member **Richard Snider** who purchased Bill Jaques's RV9A upon hearing about this splined shaft problem from Tim Coldenhoff decided to remove his gearbox and check the spline. In doing so the splined shaft split in two as he pulled the gearbox away from the engine mounting plate & flywheel.

Others in the group have been examining their splined shafts. At least one splined shaft has been through Non-Destructive testing (NDT) and proved to be okay. Another has shown clear visible wear. **Randy Russell's** splined shaft was very near failure. It was just a matter of time for him. See photos on pa. 4.

Mike McLane was shocked that after only 200 hrs and no noticeable thrum-thrum he found a tremendous amount of wear between the splined shaft and gear box. He's now going Lycoming. Other reports are coming in.

Bill Yamokowski's Splined Shaft
Note the worn ridges on right.

Bill's Splined Adapter Plate
Note the sheared ridges...

Analysis

Splined shaft failures are apparently caused by slight mis-alignments between the gearbox and the engine. Other factors may be involved.

Failures so far appear to be associated with the earlier engines (pre-2007) with the solid flywheels and earlier mounting plates with only 2 or 3 alignment pins.

There is no assurance at present time that the engines with the dual-mass flywheels and additional alignment pins are not subject to splined shaft fatique/failures due to other factors such as Torsional Vibrations and the 'thrum-thrum' vibrations that many are observing. More data needs to come in.

Editor's Note: After reviewing a draft of this safety report, **Mike Talmadge** offered the following important clarifications regarding alignment pins…

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The typical early installation had two 13mm diameter alignment pins between the gearbox and engine mounting plate. Later Jan settled on two more 10mm diameter pins. These are driven into the engine block and protrude through very loose holes in the engine mounting plate. These two pins are used in conjunction with the now-famous aligning tool and the pins in the gearbox to align the complete system.

There are folks who report having one or no pins in the system. These installations need to be looked at closely. I don't recall any gearboxes that were not at least aligned with the engine mounting plate via two pins. Somebody forgot something here. Maybe they have an installation as described in the next paragraph.

Jan also did a few engines using ½" diameter split pins between the upper corners of the engine block plate and the engine mounting plate. I have one of his Defiant engines and it was done this way. In this case, the 10mm pins we're using with the alignment plate were not used. They can be if the owner wants to remove the ½" split pins and install 10mm pins.

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Upon **Ross Farnham's** suggestion for more analysis in this area, member Michael O'Brien has volunteered to conduct a survey regarding our observance of the Torsional Vibration/ 'thrum-thrum' symptoms. I have shared your email address with Michael for this reason. For the safety of our group it is important that all flying members return this survey to Michael as quickly as possible. We really need to have this data to help further analyze the extent of the problem and perhaps identify which aircraft are more prone to these failures. The survey will arrive in your email soon, and will come from Subenews@comcast.net, so please make sure that this new address is not treated as spam. [**Editor's Note:** So far Mike has received 45 of the surveys back. More discussion on this topic is found under Issue # 3 'Torsional Vibrations' farther below in this document].

Eggenfellner on August 9th posted MSG # 34251 on his Subaruaircraft site regarding the solid flywheels: *"Good afternoon, Due to the recent failure of a splinedd shaft, we are now only supporting the change to a torsion damping flywheel. All solid flywheel installations are no longer airworthy. Some parts are available for the adaptation of this. The procedure will be documented by one or several builders working with me on this, for pictures, etc. Most builders are on a different forum. Jan"*

Members with the older solid flywheels are being forced to consider removing their propellers, gearboxes, engine mounting plates, etc., and replacing the solid flywheel with the dual mass flywheel. This is not a quick or simple procedure. The dual mass flywheel will need to be purchased from Subaru and modified to work with our engines. So far **Mike Talmadge** and **Steve Jakulski** (group members) have done this and have provided good knowledge on how to perform this task.

There is **NO** group buy for the dual mass flywheel being generated on our Subenews forum. See MSG # 8717 and **Mike Talmadge's** offer to modify the Dual Mass Flywheel for individual group members. **Steve Jakulski** has worked with Mike and others in our group to generate two pdf files showing the modification work. These files are attached and also available under the files section in our Subenews Yahoo! Group site.

Our Subenews group is taking orders for special alignment tools…see MSG #8674. **Tom Henry** and **Mike Creer** are coordinating this action. The tool drawing, fabrication and verification is being done by **Dick Tasker** with the help of **Michael O'Brien.**

Bill's GlaStar...before the crash

Do you have a Dual-Mass, Torsion Dampening Flywheel?

Some of our members do not know if they have the dual mass flywheel on their engines. One member wrote Jan that he had a non-turbo, yellow H6 with Gen3 PSRU and did not know if he had the dual mass flywheel. Jan responded with the following post on his own website:

Grab the propeller and turn it while looking at the starter ring gear. If you can move the propeller any distance (2-4") before the ring gear starts to move, you have a torsion damping flywheel and you are good to go.

There was continued discussion on our own Subenews site about how much travel one should have at the prop tip…to determine if you had a dual mass flywheel.

Randy Russell (Msg# 8905) thought the 2-4" was wrong in Jan's statement based on the 9/16" play discussed on Subenews.

Dick Tasker responded (Msg# 8906): I could believe this. When I was trying to get my spline shaft out, it rotated significantly before the actual flywheel moved.

Glenn Murray responded (Msg# 8908): The way I understand it is Jan's message is in reply to a question on determining whether a dual-mass flywheel is installed or not. The 2-4" propeller blade movement quoted (prior to starter gear movement) includes both the gear/spline lash and flywheel dampening mechanism whereas the '9/16" movement on this site' refers to gear/spline lash only. Glenn

Ross Farnham and Al Wick Comments

Ross Farnham (Posting 8/25/12) "Gearbox and Flywheel Concerns"

I have had numerous people contact me via email about the latest gearbox and flywheel issues so I decided to post a few thoughts here in hopes of saving some time replying to people individually.

My first observation is that we don't know exactly what is causing the failures. It could be shaft alignment, metallurgy, inconsistent or altered batches, TV or flywheel choice.

The second point is that solid flywheel engines are older and are more likely to have accumulated higher flight hours and cycles than dual mass packages- therefore more failures may be showing up now. I'll add there are quite a number of relatively high time solid flywheel packages that are working just fine.

Third, the TV characteristics of 4 and 6 cylinder engines are completely different and therefore not comparable.

I would agree that inspection of the splines and shaft is a very good idea as is ensuring proper lubrication and alignment of said parts.

Where am I going with this is? I see a knee jerk reaction where there are no solid facts available yet and I fear that many people will feel everything is fine when they make the switch to the dual mass setup and align things well. This may solve the problems but equally so, may not. Please don't become complacent here- understand you are still flying a very experimental package that has not been thoroughly flight tested or professionally evaluated from an engineering standpoint. Lots of things can go wrong so fly accordingly- leave yourself some options or outs.

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Al Wick

[Editor's Note: Al Wick Posted his thoughts regarding shaft alignment and TV in post #8907, as a response to Allen Fulmer who asked if the pilot shaft and bearing (part of the splined shaft arrangement) was really needed. Al has an interesting writing style...].

"That little pilot shaft bearing is the best asset you have on your plane. It's the only tool that tells you if your alignment is bad. It's a wonderful predictive tool that says:" Dude, you screwed up your alignment of the gearbox, adapter, flywheel." It will tell you this **long** before you experience a spline failure. What a tremendous asset.

So, What function does it actually perform?

Let's do a thought experiment here. Maybe this will clarify the alignment issues. If I stick a 6 foot long spline into the flywheel, then ask my mother-in-law to do chin ups from the end of that long spline. What effect does that have?

First, there are two points that see very high loads. Loads they were never designed for. The bottom outside edge of the spline sees all of my mother-in-law's weight (and she's pretty heavy). If I ran the engine with her hanging on to that six foot spline, eventually the outside edge of the spline adapter would wear. You'd be able to measure this with calipers if you had enough hours on the engine. So eventually you'd see a bell mouth shaped spline adapter.

Al Wick, cont'd

Simply because all the load is concentrated on that outside edge. Dual mass guys will see sloppy fit of spline.

My mother-in-law hanging on that spline also puts a huge side load on the pilot bearing. So I only need run the engine for an hour on the ground and that little bearing will melt the grease out of it.

So all poorly aligned engines will have pilot bearings that stick and lose grease. It will only take an hour or so of ground running for this to happen. Nice safety predictor. All spline failures caused by alignment will have greaseless pilot bearing, bell mouth shaped spline adapter due to side loads. You guys don't have to guess what caused the failures, you can measure it and make factual decision.

Let's talk about the few guys with good alignment. Those guys remove their redrive and have no difficulty removing spline. The pilot bearing looks virginal. Whoo hoo! Clear evidence that the psru is on the crank centerline. The spline will last forever, as it sees torsional loads along the entire length of the tooth. Not concentrated at outside edge.

Alignment tool:

Jan is a talented guy. But just like the rest of us, he has gaps in his knowledge. Clearly he does not have a clue on how to achieve consistent alignment engine to engine. If he'd only talked to any machinist, they could have steered him in the right direction. Clearly one of his "alignment tools" has a substantial error. The bell housing comes with two pins that are precisely located to crank centerline. If at all possible you should be using those to align mounting plate. I sure hope you are not falling into trap of assumptions and making all of your alignment tools off center. I don't know the details of what you guys are doing. How you verify dimensions. I'm concerned.

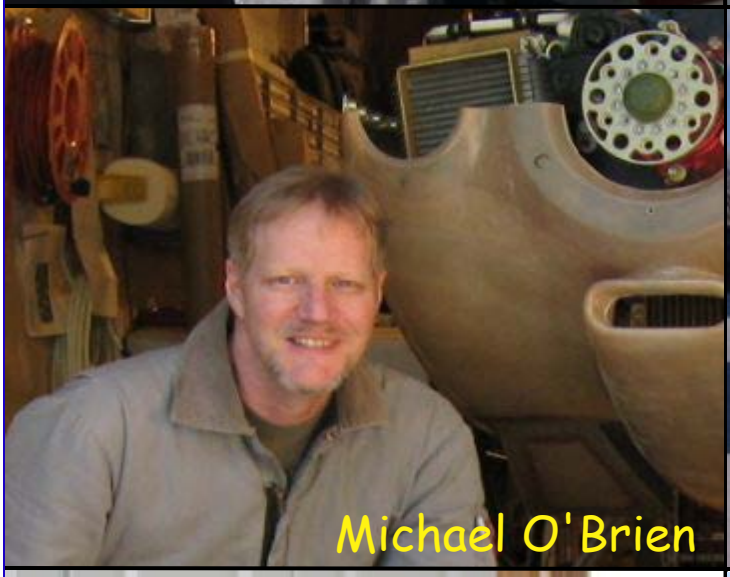
Randy Russell's Splined Shaft

The three photo's on this page taken by Randy Russell of his spline shaft and adaptor plate show how incredibly close he was to having an in-flight failure, similarly to Bill Yamokowski. Randy's past newsletter stories has him flying overs some far off desparately lonely country in search of game. His chances of survival would have been far worse than Bill's landing at a government managed site. Everyone in our group needs to do this spline shaft inspection. Hopefully your spline shaft and adaptor will look like that of George Adkin's (photos on page 8).

Main Contributor's to This Safety Alert Bulletin


Mike Talmadge


Mike's RV-9A


Michael O'Brien


Michael's RV-9A


Steve Jukulski

Steve's GlaStar

The above Subenews members were major contributor's to this report. Our group owes them a great debt of gratitude for their investigative work and the willingness to share what they've learned with us. Dick Tasker is credited for developing the alignment tool for our group and Mike Creer has been coordinating the group buy for this tool. Their pictures are on the back page. Tom Henry helped develop the initial Excel spreadsheet for the group buy. Don't have a picture of him. And athough I have a picture of Bill Yamokowski's GlaStar, I never did get a picture of him.

Issue # 1: Splined Shaft Check

It has been strongly recommended by several group members that everyone check the condition of the splined shaft periodically. An example of this being done properly is given by our own **Steve Murray** (RV8 with H6 – 245 hours on Gen3v4 gearbox). Posted on Subenews 8/26/12 in response to the group's torsional vibration (TV) survey being conducted by **Michael O'Brien.**

I inspected the splined shaft on my H6-RV8.
Aircraft Owner: Steve Murray
Aircraft has flown? (Yes|No): Yes
Total Hours on Aircraft: 345
Total Hours on (current) PSRU: 245
Engine model (Year, make): Early H6 (Black plate) probably 2004
PSRU (Make, version): Gen 3 Rev 4
Flywheel type (Solid, Dual-Mass, Other): Dual Mass
If noticable TV, what RPM Range(s) (None, or RPM values): none
Prop (Make, Number of blades): MT 3 blade
Prop Diameter: 72"
Prop backlash measurement at tip of blade (PSRU/splined Shaft free-play): 1"
Start Kickback: None
SDS ECU with Programmer (Yes|No): No (Stock Subaru ECU)
For SDS ECU, Timing at 500 RPM: N\A
Recent Inspection performed on splined shaft (Yes|No): Yes

Result of inspection of splined shaft: There was a small amount of gear oil on the back side of the gearbox. The back seal area was dry, so I think this is coming from the thru bolt head and case joint. I never have added oil, so the loss is not perceptible when using the front sight window.

No wear visible on the splined shaft, there was rust on both ends, Snap ring was not damaged. It is a light press fit between the pilot bearing and the pilot shaft on the splined shaft. This was confirmed by removing the female spline adaptor plate on the flywheel and putting the pilot shaft into the pilot bearing by itself. Due to this press fit, I needed to remove the adaptor plate bolts and pry on the adaptor plate. I do not like putting this type side load on the pilot bearing. In my opinion there is a slight down side to doing this inspection due to the prying and pulling needed to perform the inspection. The bearing seemed to be smooth running.

There was almost no perceptible play between the splined shaft and the flywheel splined adaptor. (I am embarrassed to say that I forgot to check the fit between the splined shaft and gearbox.) I coated the shaft liberally with anti-seize and reassembled. The gearbox slid back onto the mounting plate with hand pressure. I installed a magnetic drain plug and 14 oz Mobil one 75w-90 gear oil. Steve.

Steve Murray and his RV-8

Trouble Removing the Splined Shaft...

Editor's Note: Here is a series of posts originated by **Richard Tasker** after he experienced real difficulty in removing the spline shaft from the flywheel assembly. Some of you may experience the same problem and here's how he got the shaft removed based upon advice of others. I realized I could have easily summarized this rather than showing the original posts. However, I wanted all to see how the group is working together to help resolved these problems. This again is one of the benefits of having a tightly closed membership group focused only on these Egg engines.

Richard Tasker (8/26/12):
I just took my gearbox off in preparation for checking out the new tool and to add the recommended lubricant. Getting the gearbox off was pretty straightforward (once I removed everything else that was in the way). It slid off the splined shaft just fine (after I removed the starter which was in the way)

I cannot get the shaft out of the dual mass flywheel adapter plate. It moves in and out about 0.2" but won't come out anymore. I thought that it was binding on the adapter plate so I removed all the Allen bolts holding that to the flywheel, but it didn't help any. Now the plate moves freely in and out on the shaft and everything spins freely, but the shaft still won't come out any further. It seems like it is caught on something under the plate (not associated with the plate). I cannot slide the adapter plate off the shaft to see what is going on without disconnecting the mounting plate from the engine - which I will do if nothing else works. I don't remember exactly how it all went together so I was wondering if anyone who has the dual mass setup could give me a hint.

Above photo is a splined shaft in the splined shaft adapter which in turn is bolted onto the flywheel (behind the engine mounting plate) by 8 bolts. Athough this is not Dick's engine, this photo represents Dick Tasker's configuration when the shaft would not come out of the adapter. (Photo by George Adkins)

It almost seems like the shaft is jammed in the flywheel center bearing. I should note that the plane has not been flown. Thanks for any help, Dick Tasker

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Mike Talmadge response:
Dick, It sounds like the pilot shaft is stuck to the pilot bearing. The pilot bearing is pressed in from the ENGINE side of the flywheel, opposite to the standard way of doing it. Even removing the engine mounting plate won't help much here, except to make more room for prying. If you can get the splined adapter out far enough, you might be able to get about three prybar-like tools in back of it to pry it off of the bearing. Maybe aluminum wedges?

At this point, prying things apart while minimizing collateral damage seems like your only avenue. There is no way to get the flywheel off of the engine without removing the splined adapter.

What bothers me is that you are able to move the shaft in and out .2 inches. It seems that this might be due to the pilot stuck to the bearing and the bearing sliding in its bore. The later splined shafts are two piece affairs; a dowel pin (acting as a pilot shaft) pressed into a splined shaft. On the one I got from Jan, there were two showstoppers. First, the pin was too big to fit into the pilot bearing. It should be an easy slip fit. Second, the pin had about .006" runout relative to the spline. Considering how tightly the adapter and splined shaft fit together, this was sure to cause bad things to happen.

My first solution was to machine the pilot shaft, no easy feat because the pin was very hard (a standard hardened steel dowel pin), and add a sleeve to bring it back up to 12 mm. I finally decided that I'd remove the pilot altogether.

Just guessing…It sounds like your diagnosis is correct. With a bit of patience, I'm sure you'll prevail. Mike T.

Rick Snider
I had the same problem. I used a slide hammer and by grabbing it by the snap ring a few smacks later and it popped out. Rick

Dick Tasker (again)
Arrgghhh...The whole reason I was taking things apart was so I could do a quick check on the alignment tool before I sent it on to you. And now I cannot get the shaft out so I cannot do the check right now. I don't understand why this is binding now since it went in just fine when I first installed the gearbox. I also don't see why there is a pilot shaft and bearing in the first place. It is not like the shaft is going anywhere and it certainly doesn't need support at that end. It doesn't even spin relative to the bearing in normal operation!

I will see if I can find someone with a slide hammer as Rick suggested. I already thought that would be a good idea,

Spline Shaft Removal, cont'd

but, even with all the tools I have, I do not have one of those. Dick.

Glen Murray #8904
Dick, I ran into the same issue when trying to remove my spline. I applied LIGHT pressure on the back of the cir-clip with a small pry bar while tapping on the forward end of the spline with a rubber mallet at a
slight angle opposite the side where the pry bar contacted the cir-clip. Ever so slowly the spline walked out until it popped out. I was unable to determine what held it up but with the light pressure and tapping it did come out. Glenn Murray

Msg# 8912 (no name disclosed)
Dick, I just did my inspection this past weekend and had the exact same issue. Once I had removed the bolts from the flywheel spline adaptor plate I used and the open end of a "open end wrench" to pry under one side of the adaptor plate. I did not like to do this as it applies a side load to the bearing but I could not find any other method. I just pried a bit, rotated the adaptor plate around and pried more, repeat, repeat, repeat about 25 times and it finally came free. You will slowly see it start to pull out with each prying cycle. Good luck

Dick Tasker #8920
I was finally able to get the shaft out of the flywheel. Took me well over one hour of beating and prying (in addition to the hour or so yesterday)…. So long partly because I didn't want to damage anything. Once I finally got it out, I can see where and why it was binding. The pilot shaft is tapered on the end. Evidently when it was machined the section on the shaft just inside of the tapered section was slightly upset so that it is slightly larger diameter than the rest of the shaft. Needless to say, I will take a bit off so I can get it in or out easier the next time. Thanks for all the suggestions. I wasn't able to find anyone with a slide hammer I could borrow so I used the pry and tap method to eventually get it off.

Also, I received the sample alignment tool which seems to be fine with the exception that the holes are a bit under-sized for the pins. They are in the correct places. I am sending it to Mike Talmadge so he can also check it out since he was the one that came up with the spacing in the first place. We can just increase the hole size a bit on the drawing and I believe we are good to go - but I will wait to see what Mike says. Dick.

Mike Talmadge…Addendum (Msg# 8917)
Another side of this is that there is no possible way to adjust the alignment of the adapter relative to the flywheel with a dual-mass flywheel. There is also a very real chance that the splined shaft is not concentric with its pilot shaft. Over the small length between the pilot bearing and the tightly fitted splined shaft, a couple thousandths of an inch can cause pretty high side forces. A little trig will tell us that if we use the center of the adapter spline as a pivot point, the gearbox end of the splined shaft will run out almost three times as much as the runout between the pilot shaft and the splined shaft. Food for thought. Mike T.

Above photo is Bill Yamokowski's splined shaft, his splined shaft adapter, and his splined shaft pilot bearing. The left half of the shaft, which goes into the gearbox looks okay. The right end, which goes into the adpator plate has its spline stripped and worn down. It free-wheeled in the adaptor plate, causing the prop to stop producing thrust.

These two photos of George Adkin's splined shaft and adaptor show little or no wear... indicating good alignment between gearbox and engine.

Issue #2: Solid Flywheel Replacement

As referenced above, Jan Eggenfellner stated that he is no longer supporting the solid mass flywheels. Hence members of our group want to know what's involved in terms of cost and technical expertise in making this change. **Mike Talmadge** and **Steve Jakulski** have both made this changeover and have posted the information on our Subenews Yahoo! Group site. I will attempt to bring you up to speed by reiterating some of the posts here and by attaching Steve's "How to" file with photos to this email.

I should point out that some members in our group do not think replacing the solid mass flywheel is needed if proper alignment can be verified and inspection shows no unusual wear. Even so, members such as **Kelly Landrum** with his H4 supercharged engine has told me he is switching over because of a 'kickback' being experienced upon shutdown during the final engine rotation. He believes this cannot be good for the splined shaft or gearbox and thinks that even with proper alignment changing out to the dual mass torsion damping flywheel is a good thing.

The first thing you must do is to order the dual mass flywheel from a supplier. I heard there are several available if you Google the part number, which is 12345AA010. Steve got his from www.subarupartswarehouse.com for about $485 plus $50 shipping (it is heavy). After you get the flywheel you must remove the friction plate from it, drill out some rivets and precision tap some holes and then get a new splined shaft and splined shaft adapter plate as well as special screws/bolts for it. All this is not an easy and quick task for most of us, as you will learn by reading the detailed instructions below. However, another way to make the change is to order the new flywheel and have it sent directly to Mike Talmadge who has agreed to help us out be making the modifications to the flywheel for minimal costs. More on this below.

Here is the process for modifying a newly purchased dual mass flywheel (by **Mike Talmadge)**: Ref Msg #8811:

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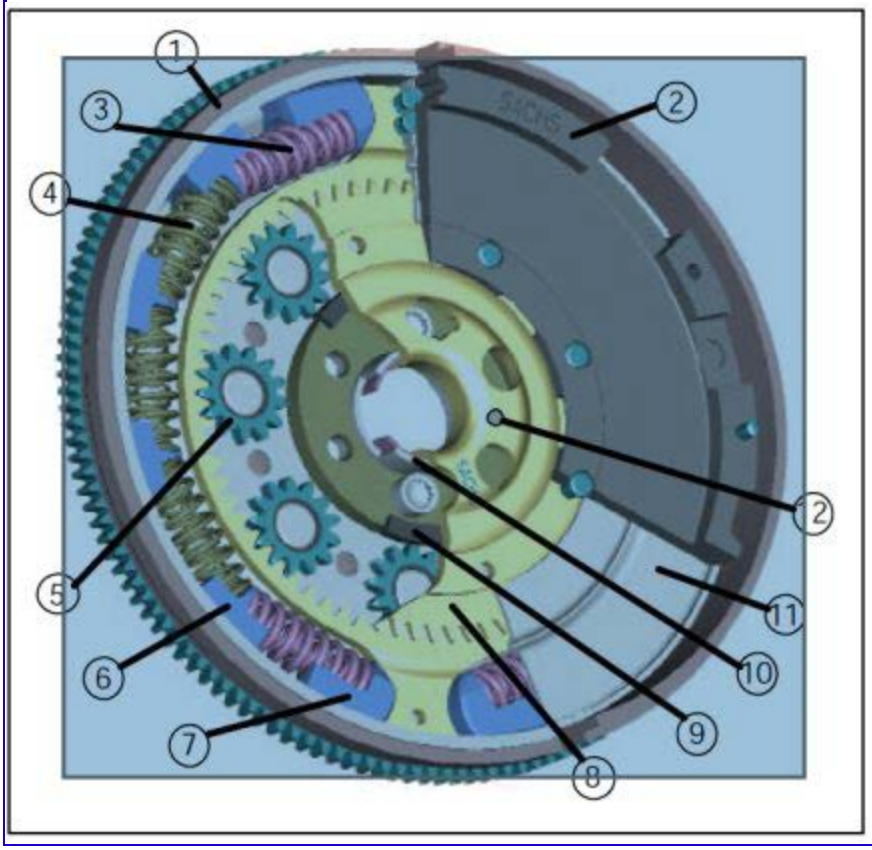
OK, here we go. CAVEAT: The last time I did this was a couple of years ago and I hope I don't leave out any steps. I guess that's why I'd like to do the operation while taking notes and pictures.

Use only high-speed steel, cobalt steel, TiN coated, or other high quality drills. Punches need to be high quality. Cheap stuff will not work here. You're gonna be really whacking these rivets.

1) First, you can locate the holes in question by laying the adapter plate you got from Jan on the flywheel friction surface. You'll find that the 8 holes in the adapter line up with the 8 rivets in the flywheel. These are the victims, er, the rivets to be drilled out. If there are little dimples in the center of the rivets, center-punch them to make them bigger. If no dimples, then, as accurately as possibly, center-punch the center of the rivets.



Dual-mass flywheels are installed in many modern vehicles to decrease noise and improve refinement on the move.

1 = **Primary flywheel** with starter ring gear
2 = **Secondary flywheel**
3 = Firm springs
4 = Soft springs
5 = Planet wheel
6 = Guide shoe
7 = Spring seat
8 = Ring gear
9 = Axial plain bearing
10 = Radial plain bearing
11 = Cover plate to retain the grease packing
12 = Hole for pin to prevent rotation

Flywheel Replacement...cont'd

2) Now, run a drill, about 1/8" diameter or so into each rivet about 1/4" deep. From here on, chip management is important. Keep chips from getting into nooks and crannies. Maybe masking tape, lots of vacuuming etc.

3) Here comes the guessing part. With a 9/32 drill, drill out the rivets deep enough to remove their heads. If a 9/32 drill isn't big enough to remove the heads, go up in size until you find a drill that will work. Once the heads are drilled off, go back to the 9/32 drill and drill deep enough to go almost all the way through the friction plate. DO NOT DRILL DEEPER THAN THIS!!!!. IF YOU DRILL INTO THE FLYWHEEL, YOU CAN STILL SAVE THE DAY, BUT YOUR WORK WILL INCREASE EXPONENTIALLY.

4) If it isn't already, support the flywheel on a couple of pieces of 2x4.

5) Look at the flywheel and be sure the rivets are lined up with the covers in the back of the flywheel. If not, you can turn things a bit to line them up. Now, as Jan says, use a big hammer and a quality pin punch, 1/4" is about right, to drive the remaining part of the rivets through the back of the flywheel. Don't use a center punch. This will only expand the rivet and make your job much more difficult. You will drive the covers on the backside out along with the rivets. No big deal, you're not going to put them back in anyway.

Sometimes the rivets might get hung up on the way out. Be careful here and don't try and drive them out if they're not lined up with the "exit holes"

6) You can now remove the friction surface. It's a tight fit in the flywheel, but a little persuasion will get it to see things your way.

Clean any chips out with a vacuum and maybe a pick or small screwdriver to get chips out of tight spaces.

7) If you haven't hit the sides of the flywheel holes with a drill, the holes will be the right diameter for tapping with a 5/16-**24** tap. Jan said 5/16-28 but he made a typo. 5/16-28 does not exist.

8) Jan thinks that the holes must be tapped squarely. I agree very much. If you have a drill press or milling machine available, and the table is large enough and square enough, you can do the job there, by hand, of course. It is most important that you use a high quality tap and a good cutting oil, stuff from Harbor Freight or Sears won't give you the thread profile you want...trust me on this. The best type of tap to use here might be a spiral flute gun tap. These taps curl the chip out of the hole rather than into the hole. It makes for easier chip control. If you are unsure of your ability here, get some knowledgeable help. You've come too far at this point to screw it up now.

9) During the tapping operation, keep chips under control and don't let them get anywhere in the flywheel works.

10) You're now at the point you thought you'd be at when you thought you wanted a dual-mass flywheel. Congratulations!

11) Now you need bolts to mount the flywheel to the crankshaft. The bolts taken from the solid flywheel are too long and the heads are too big. You'll also need bolts to attach the spline adapter to the flywheel too. Regular 5/16-24 socket head cap screw heads are too tall. They will interfere with the engine mounting plate.

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[Editor's Note: I've discussed the above bolt issue with Mike Talmadge as well has his offer to do the flywheel modifications for individual members. In my mind he is providing a very generous offer for our group. Here is the latest information he supplied me as of 9/2/12]

I now have the prices for the adapter plate to flywheel screws. ARP screws will cost $24.00 for a set of 8, including modifying. The ARP P/N is 741-0560. I like these; more wrenching area, more bearing area.

Alloy socket head capscrews will cost $10.00 for a set of 8, including modifying. These are what I've seen in Jan's deliveries.

Either type has to be modified to work with our application. This is included in the above price.

For those who might want to do their own mods, I can provide drawings and/or instructions.

Flywheel modification will be $40.00 to remove the friction surface, tap the 8 mounting holes, and check and make minor balance corrections. [**Editor's Note**: In Msg #8719 Mike wrote: : "*The flywheel is very thin, of course, so a static balance procedure will work well. A mandrel mounted on knife-edge ball bearings will indicate out of balance down to a couple of grams at the flywheel OD. By the way, the flywheel plus bolts, but not the adapter, weighs about 22 lbs. after mods."*].

The flywheel-to-crankshaft bolts from the solid flywheel cannot be used with the dual mass flywheel. Folks can purchase them from Subaru or I can supply them. I'll simply go the the Subaru dealer, buy them and charge whatever I pay for them. For folks who want to get their own, the Subaru P/N Jan provided is 800410020. I don't know what the local dealer charges for these things, but a quick internet search shows prices from $2.75 to $8.00 each.

Of course, shipping cost has to be added in. If I know it's coming, I can turn a flywheel around in a day or 2, including fasteners.[**Editor's Note:** Mike lives in San Marcos CA, about 30 miles north of San Diego, about 3 miles east of KCRQ (Palomar)]. His email address is mikerv9a@sbcglobal.net.

Comments on Tapping of the Dual Mass Flywheel

Randy Russell, Mike Talmadge and **Dick Tasker** had important comments regarding **Steve Jakulski's** write up of the tapping of the dual mass flywheel. (Report is attached) Here are their posts…

Randy Russell (Msg#8740)
I have found that the easiest way to tap correctly, is to use a drill press with the tap installed, and gently press the tap into position and TURN IT BY HAND for 3 or 4 threads. This gives the threads the proper angle to the surface. It is then fairly easy to remove the tap from the drill press and finish it by hand. The secret to a good thread is patience and cutting fluid, with frequent reverse direction turns to break off the metal turnings. I forgot to mention, the CORRECT drill size, not one that is pretty darn close. ;>) Randy.

Randy Russell (Msg#8836)
I followed the directions and everything turned out great. One thing to add…in my case, the depth for the 5/16" drill was 15/32" deep and this just avoided the flywheel. The rivets fell out with the ¼" punch. Your mileage may vary. Randy R. C-GYOO

Dick Tasker (Aug 26, 2:00pm PDT)
Steve, I just saw your upload of the tapping of the dual mass flywheel. The last picture shows a blue circle where you say you are planning on removing material.

DO NOT REMOVE everything within the blue circle!!! If you do you will have only one pin to align the gearbox to!!! The 13mm hole in the lower left is one of the holes for the two gearbox alignment pins. Leave that area intact!

Additionally, while your machinist friend has had enough experience and the equipment to tap the hole under drill press power, unless one knows exactly what one is doing and is knowledgeable regarding the machine capability, I would NOT recommend tapping the hole under power unless one has a tapping adapter. Better to get it all aligned and then turn the chuck with the tap in it by hand. It is exceptionally easy to break a tap if done under power. Dick Tasker

Steve responded…You are correct. Thanks for noting that. I am removing that picture from the file until it is determined just how the hole should be cut to allow the adapter to slide into place with that part of the plate surrounding the pin remaining... Steve

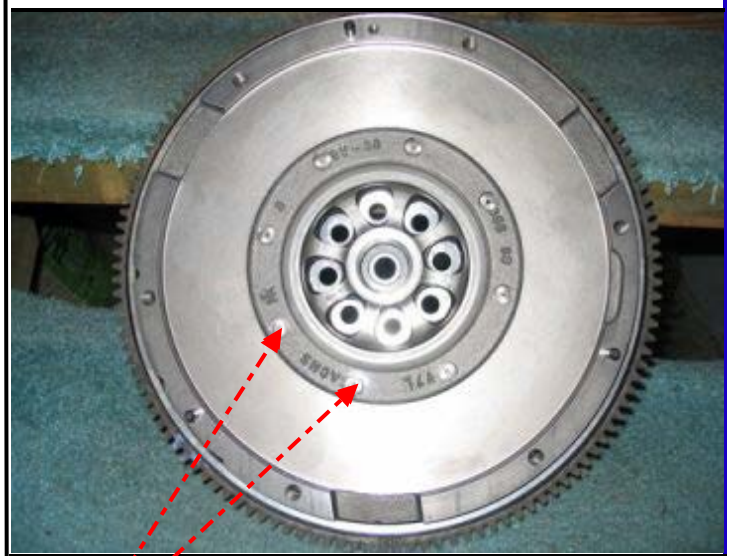
Mike Talmadge (Aug 26, 3:10pm PDT)
I looked at your tapping write up and was impressed. Everything looked right. A little hint. If you used a spiral flute gun tap, the chips would have come out the top of the hole, pretty much eliminating the need to remove tapping chips from the flywheel.

As Dick said, tapping under power is best left to those who do this a lot and have a very good relationship with their machine tools. Your work was done in a Bridgeport milling machine (or clone) which has a spindle brake, reversing switch, and a very slow spindle speed. None of this stuff is available on a standard drill press. One can hand turn the chuck to start the tap and then use the handle of the chuck key inserted into the chuck to finish the job. Just let the quill follow along.

Another hint might be to use caution while deburring. Remove only what you need to. This thing is pretty thin and we can use all the threads we can get. Still, nice work! Mike T.

NOTE TO ALL. Attached are two MS Word files developed by **Steve Jakulski** which describes how he did the flywheel change over. These pictures are worth a thousand words. Again, you can do the change yourself…or you can have Mike Talmadge do the mod for you. In either case you will have to order the dual mass flywheel (P/N 12345AA010) yourself ($488.55)…and you will have to order eight new bolts for mounting the dual mass flywheel to the crankshaft (Subaru P/N 800410020…$2.11 ea). See www.subarupartswarehouse.com

And you aren't done yet....
You still have to get the splined shaft, the splined shaft adaptor, and the 8 special bolts that hold the splined shaft adaptor onto the flywheel. Regarding the latter three items (shaft, adaptor, bolts) they need to be ordered directly from Jan Eggenfellner. According to **Kelly Landrum** (Ref Msg #8749) the cost of these from Jan is $500, i.e., $250 for the splined shaft and $250 for the adaptor plate. There is some uncertainty whether Jan will supply the 8 bolts needed to secure the adaptor to the flywheel. If he doesn't, then **Mike Talmadge** can supply the 8 bolts for you. This was discussed above.



This is the rear of the Subaru P/N 12345AA010 Torsion Dampening Flywheel. The eight inner rivets need to be taken out and the holes tapped for the spline adapter plate.

Question on Dual Mass Adapter Bolt Sizes

Steve Jukulski Msg# 8994
I believe you (**Mike Talmadge**) had made an earlier reference that the part you selected to use for attaching the dual mass flywheel adapter was an ARP bolt, part # 741-0560. Does that use a standard socket set, though with 12 side (point) instead of 6, or does it require a special socket?

Can you indicate what length was required and what obstacles had to be overcome with their use (what surgery on the bolt)? It looks like the flange on the bolt head would probably need to be ground away somewhat? Not sure what else? Also, do you know what surgery had to be used on the socket head bolt if used instead? Thanks, Steve

Mike Talmadge Response:
Hi Steve, If you use the ARP bolt, you need to turn the flange diameter down to .470" and cut the head height down to .240 The length of this part is 9/16". All you need is about 1/2", but they don't happen to make it that long. The wrench you need is a 12 point 3/8" socket, pretty standard stuff.

If you use a standard alloy socket head capscrew (AKA Allen head bolt) you need to cut the head height down from .313" to .240". The wrench here is a 1/4 hex wrench (AKA Allen wrench), preferably one that comes in a socket so you can torque it properly. You want to make sure the bolt is made by a reputable manufacturer. Lots of these things are made in china these days.

I like the ARP fastener because you get more wrenching surface, better bearing area, and a known high quality fastener. I hope this helps. Mike T.

Supporting the Engine during Engine Mounting Plate Removal

Steve Jakulski Msg# 8995
Does anyone have any recommendation on how to support the engine (GlaStar / H4) for working on the aluminum plate? I have an engine hoist but I can't see any good places to strap the engine. Steve

Mike Talmadge Response Msg# 8999
Hi Steve, Lots of questions!!! There doesn't seem to be a lot of choices here, but I ended up making a couple of aluminum straps from scrap, bolting them to some tapped holes in the top of the block, and lifting from there. You only need to pick up a couple hundred pounds, so some .060 material will work just fine. Once the load was off the mounting plate, I supported the engine from the bottom with a couple of sawhorses, a 2x6 and some wood blocks. You don't need anything too fancy here unless you're going to make a living at it.

I'm sure you could wrap a piece of decent rope around the engine and pull from there too. Just be sure you don't pinch anything. Once lifted, it's good to support it from the bottom for safety as well as ease of working. In any case, if there is a rear engine stabilizing mount, leave it attached, it makes things a bit easier.

Final note. The flywheel bolts are pretty tight and Jan Loctites them in, so break them loose before you raise the engine or remove the engine mounting bolts. It will make your life much easier. If you have a helper, he/she can immobilize the flywheel while you're grunting and groaning with the bolts....makes the job way easier. Happy hoisting! Mike T.

Spacing Changes Between the Engine Mounting Plate and the Engine Bell Housing

Steve Jukulski Msg# 8996
For anyone that may have made it this far. Is there any spacing changes needed between the engine fly wheel/adapter and mounting plate with the dual-mass flywheel modification? GlaStar/H4. Steve.

Mike Talmadge response, Msg 8998
Hi again, Steve, I ended up making a new batch of spacers .050" longer than the originals. The flywheel was a little close for comfort. I don't know of anybody else that has done this though. Something to keep tour eye on when assembling. Always something, huh? Mike T.

John Moody Response, Msg# 9001
FWIW I lost a couple of the spacers & had to get some made so I had to measure them - they were 0.550 in thick - for STi(H4) / black mount plate/ dual mass flywheel. John Moody

Mike Talmadge added: “The spacers for at least three H6 installs were also .550" thick”.

Torque Requirements for Bolts

Mike Talmadge was good enough to research the bolt torque requirements:

According to Subaru, the torque for the flywheel-to-crankshaft bolts is 60 lb-ft.

According to Jan, the torque for the adapter-to-flywheel (dual-mass) is 250 lb-in, about 21 lb-ft.

These numbers seem reasonable. I would not exceed the 250 lb-ft that Jan suggests though.

In addition, blue Locktite can be used to secure these bolts.

Issue #3: Torsional Vibration (TV)

Editor's Note: Most of you should know by now that **Michael O'Brien** is conducting a survey of currently flying group members regarding TV. Reference the report above by **Steve Murray.** About 45 of the 61 flying Subenews members turned in their surveys. The results were quite scattered and it is very hard to determine if a single factor might be a leading cause for TV. What Michael ended up doing was constructing a spreadsheet to help study and understand the survey results. I have attached his spreadsheet to this email for your review and information. From what we see no specific conclusions can be reached. These Egg engine conversions were not the product of a modern, high quality automotive production line. It was apparent that some gearboxes 'rattled' more than others…one rattled so badly (**Richard Reid**'s) that he refused to fly it. The gearbox, with its 1:2.01 gear ratio is very prone to harmonic vibrations. Engine configurations are different; propellers are different in terms of both type and degree of balancing, etc. It is no wonder that a root common cause for the 'thrum-thrum' /TV is difficult, if not impossible to identify.

However, Mike has done some further experimenting and has determined that the 'thrum-thrum' can be minimized (at least on his airplane) by changing a few things. Your results may vary. Here is his email on the subject. (Thanks Mike, great effort!).

Michael O'Brien (Msg# 8915)

This last weekend, during re-assembly of the gear box and prop after inspection of the splined shaft, I decided to try a few things to try to reduce or eliminate the TV that I've been feeling between 2100 - 2450 rpm. If you might recall, I had a G3V3 gearbox originally, and I did not have any noticeable TV. It wasn't until I had Jan upgrade the G3V3 to V4 that I then began to feel TV.

The following 4 changes were made in an attempt to reduce/eliminate TV (I know, make 1 change, then test...but I really didn't think anything would work, so I did a shotgun approach):

1. Drain/refill the Gearbox, but replace 2 ounces of the fluid with Power Punch Extreme Pressure Gear Oil Additive which can be obtained at your local Napa Auto parts store. I was interested in the anti-foaming quality, along with the potential to quiet things down a bit. The total fluid level in the PSRU is now 17 oz, of which 2 oz are this product.
2. The clearance between the prop bolts and the PSRU makes it very hard to fit a torque wrench (with a crows foot) in order properly torque the prop bolts. Plus, in the past, I've rounded over several lock nut flats with various crows feet adapters, which is a PITA when that happens. So, I removed (by hand, not power tool so as to eliminate heat xfer) about 1/4 " off of the end of the 6 prop bolts, then carefully filed the bolts to an equal length. The reason for this was so that I could fit a 9/16" box end torque adapter to properly torque the prop locking nuts. Torqued each nut to 80 ft lbs -- so much easier now!!! When the lock nuts are torqued, there's at least 3 threads showing on the end of each prop bolt.
3. I had always previously "clocked" the prop hub to the PSRU prop flange so the bolts always went back into their original position. This time, I purposely rotated the prop hub 60% (moved by 2 holes) on the PSRU prop flange just to switch things up.
4. Re-balance the prop to .03 IPS before the test flight. (I've always made sure the prop was balanced; however, the last balance was only to .05 IPS, so this last balancing was a bit better.)

The results were quite surprising! I feel/hear minor TV now only at 2250-2300 prop rpm range! The other rpm ranges are smooth! I'm very happy about this because I can live with not running in the 2250-2300 range.

Perhaps other more engineering types can provide any thoughts you might have on which of the above changes contributed the most to reducing the TV, and why? Feedback is always welcome!

Michael, N707SM, 2007 E6/200, Quinti 4-blade, G3V4 PSRU

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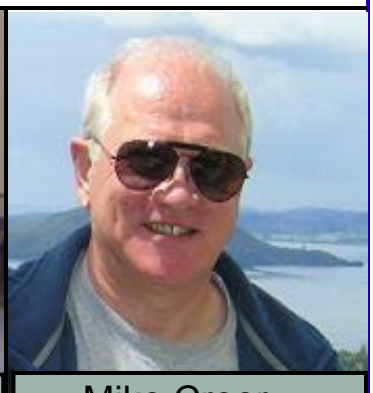
END OF SAFETY BULLETIN

Attachments:

1. Removing Dual Mass Friction Plate.pdf (Steve Jakulski)
2. Tapping Dual Mass Flywheel.pdf (Steve Jakulski)
3. Subenews_TV-survey.xls, (Michael O'Brien)

Dick Tasker



Mike Creer