Rav4 EV drive unit “Milling” noise repair.

I recently purchased a used Rav4 EV with 126,000 miles, which had very loud whine, and scraping sounds at low speeds.

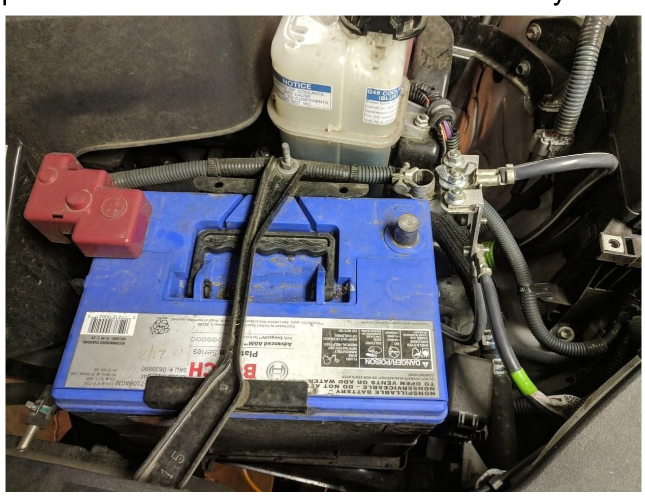
This uses an early Tesla drive unit, virtually identical to the 2013 vintage Model S drive unit, the main difference being the Rav4 has a parking pawl added, where the Model S does not need one.

Below I will discuss how I removed the drive unit and repaired it. Much of this repair is experimental, so proceed at your own risk.

The Rav4:

The rev. F drive unit:

Before exposing any of the high voltage connections on any EV, it is critical to disconnect the power. First I disconnected the 12V battery:



The HV battery disconnect is located under a cover under the passenger seat. Remove the cover, then remove the disconnect block, which I believe is also a pyrofuse.

Make sure to test any connections you expose for voltage before you put a wrench on it or touch it! Measure between the terminals, and between each terminal and the chassis.

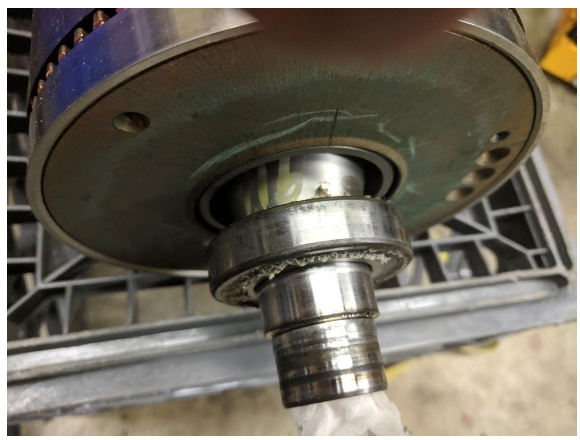

I won't go into details on how to remove the drive unit since it is described well in the factory service manual. This can be obtained on Toyota's website for a fee.

Here are my findings:

- The right side axle seal was leaking.
- The motor rotor coolant seal was leaking coolant into the motor housing.
- The motor rotor bearings had excessive axial play, which allowed the encoder wheel to rub against the motor housing.
- The gearbox pinion gear motor-side bearing had fretting damage, which caused the majority of the noise.

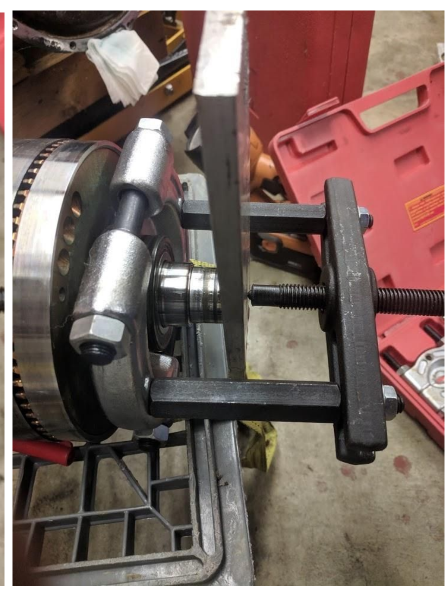
After removing the end cover, I found that the encoder wheel was scraping against the end cover. I believe this is due to axial play in the motor bearings. Here you can see marks left by the encoder wheel:


Motor rotor seal side bearing and seal surface. Notice the green discoloration on the rotor caused by the coolant leak.

This is the gearbox side of the rotor. Notice how bright that copper is!

The bearings can easily be removed with a standard bearing puller. You will need a block between the puller screw and the hollow shaft.



The rotor bearings are a hybrid ceramic bearing. After thinking about the engineering, I decided that this was the correct choice. One of the downsides, is that the only path left for any rotor voltages is through the gearbox bearing, which may be why it failed. I couldn't cross reference the part on the factory bearings to anything, so I found the closest bearing I could to the ones shipped from the factory.

Factory bearing on the bottom, new bearing on the top:

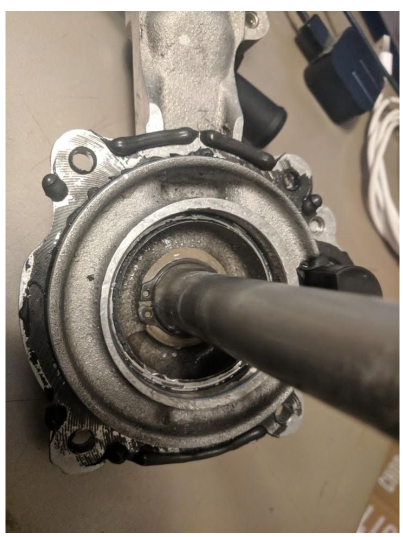
A 1.25" galvanized pipe worked for me to drive the new bearings onto the motor shaft:

The rotor cooling system is quite ingenious. Water flows into a tube in the center of the rotor, then presumably goes through passages internally, then is returned on the outside of that tube. Only one mechanical seal is required to seal the rotating motor shaft. Unfortunately for me, this seal had failed, and I could not find a direct replacement. The seal dimensions are 30x55x8mm. It is a double-lip teflon seal with an excluder. If you happen to know where I could get these, please let me know!

Due to the high surface speed, I do believe that a Teflon seal is the correct choice here. I did my best to find something suitable that I could buy off the shelf.

Here is the housing with the seal:

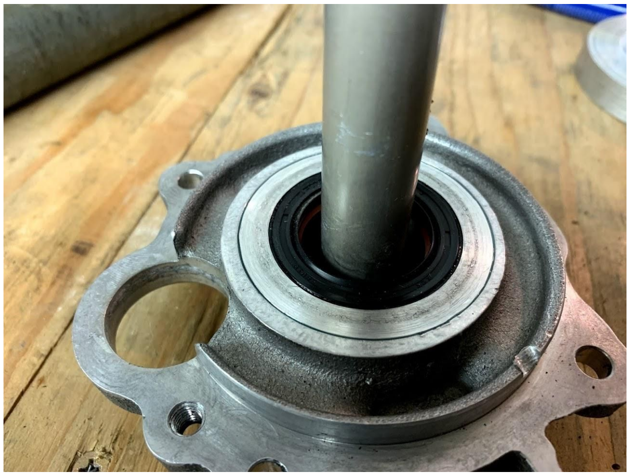
I had to get medieval to remove the old seal:



I found a teflon lined water pump seal for a snowmobile that had the correct 30mm shaft diameter. It is a Kimpex 09-113TS:

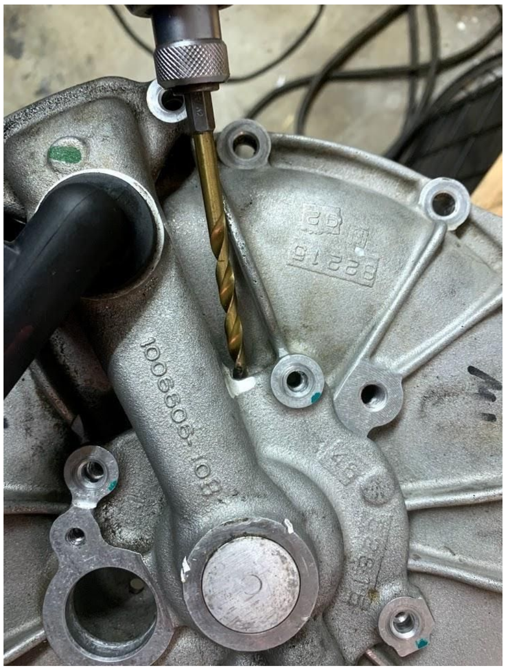
Unfortunately the new seal had a 42mm outside diameter, so I needed to make a spacer ring.

I used Permatex sleeve retainer to hold and seal the spacer ring into the housing, and pressed everything together:



Here’s the fun part, due to the way the motor is built, a leak at this seal will allow coolant into the motor, where I think it could pass through the power conductor passage into the inverter housing. I decided I’d rather dump the coolant overboard if it were to leak again. (which I anticipate it will, since I don’t think my replacement seal is as good as the original)

I drilled a hole into the housing to function as a drain, then plugged the vent into the motor with JB Weld.

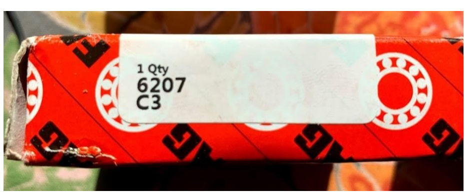


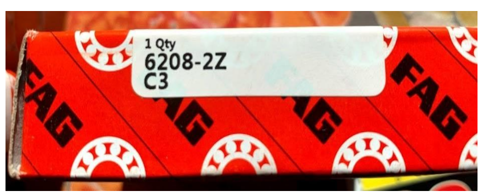
Gearbox Noise!

The pinion bearing shown here was in very bad condition. Based on the fretting pattern on inner surface of the outer race, I believe the failure was caused by electrical current flowing through the bearing while it was rotating. Tesla did attempt to mitigate this by adding a carbon brush ring between the motor and gearbox.

All bearings in the gearbox are C3 clearance. I would not recommend anything tighter due to the high RPM.

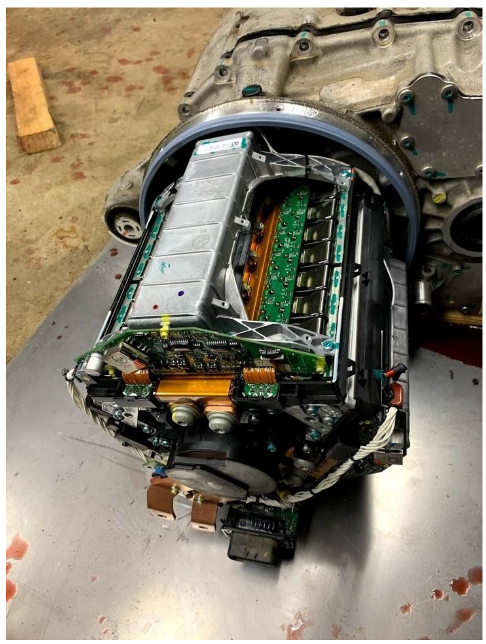
I chose to replace both pinion bearings. I couldn't get SKF bearings as fast as I wanted, so I settled on Schaeffler bearings from Amazon. The 6208 replacement was shielded, so I popped those off before installing.



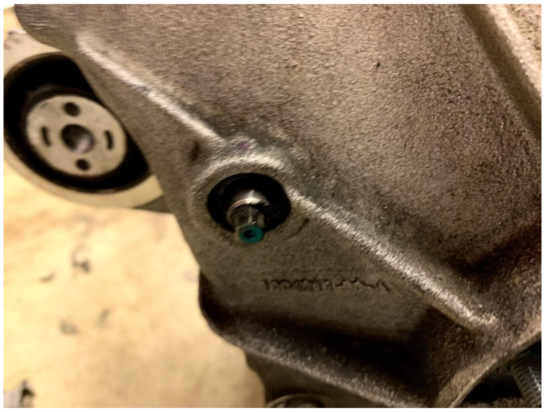


I used AISIN AB1207B1 sealant to re-seal everything. There are probably better choices out there.

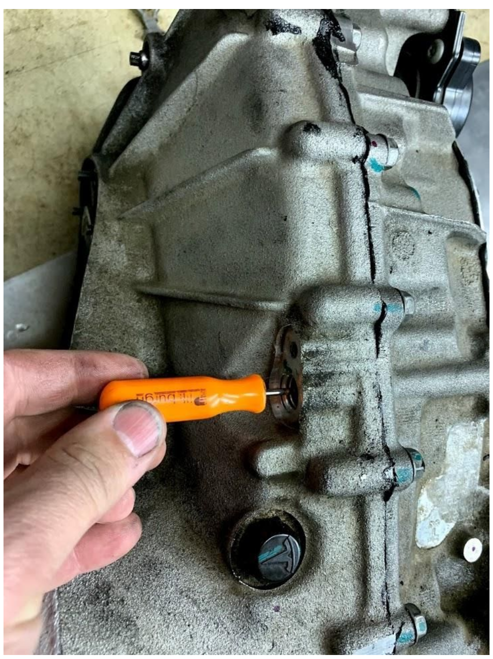
When disassembling the gearbox, watch out for the thermistor cable that goes between the case halves. I had to cut some zip ties in the inverter, and disconnect it from the PCB.

When reassembling the gearbox, make sure the parking pawl is disengaged. (picture shows it engaged) You can manually disengage it with a ¼” socket. If the case halves don’t go together easily, it’s probably the parking pawl.



Once reassembled, you will want to make sure the small coolant hole is clear of sealant. I used a pick to reach into the passage.



Replacing the axle seals was very easy. Just pop the old ones out with a pry bar, and hammer the new ones in with a large socket. Just make sure not to drive the new seals in too far, there are no stops inside the gearbox. The replacement seals are purchasable directly from Toyota. There are a few other external parts of the drive unit available from Toyota as well. The seal part number is 17292-0Z010.

If you are handy, there isn’t much to be afraid of with these drive units. My total cost was roughly $500 and a couple weekends of time.