

**MAIN ROTOR TRANSMISSION CHIP DETECTOR**

13 October, 2014 – In my second and last Helicycle I want to make everything better than the first one. That includes not only a transmission chip detector, but one for the tail rotor as well. The transmission is ready to accept an ADC chip detector. All you have to do is unscrew the plug in the bottom and screw the detector in! It's too bad that ADC went broke and those detectors are not available any more.

After much hand wringing and many hours on the Internet and the phone I decided to go with the detectors used on the Robinson R22. I'll give you the bad news first:

- MRGB Chip Detector    B566-1                    \$317.00
- O-Ring                    A215-017                    \$0.65
- Spacer                    A130-14                    \$10.25

Then there are the tools I needed but didn't have:

- Pitch Gauge to check threads on the detectors    \$45.05
- 3/4" Countersink to make O-ring groove            \$25.94
- 11/16" Tap Drill                                        \$24.20
- 3/4-16 Taper Tap                                        \$36.26
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Now that I've spent all the money for parts and tools, and my transmission is here, I can see if I can actually make this work. The first order of business was to have a chat with Blake and see if there were any issues that I needed to know about. Blake was not happy to hear my plan but he knows me by now, so he gave up without much of a fight. His main concern was the introduction of debris into the transmission, and also maintaining the preload on the bearings. He suggested making a support with a hole in the middle so the transmission could be pointed shaft side down. That would allow the bottom plate to be removed without introducing any unnecessary stress on the oil pump shaft or the internal O-ring. So that's what I did.

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Here's the transmission supported by the shelf with the hole in the middle and ready for the operation to begin.

Two of the AN4 bolts screw into the case and the rest pass through and are secured with lock nuts. When reassembling I need to secure those two with service-removable Loctite. In the lower corner of the picture you can see the plumbing that I removed from the transmission to avoid damage. All the holes were plugged with plastic protectors to prevent contamination. I need all this off for painting once I'm done here anyway.

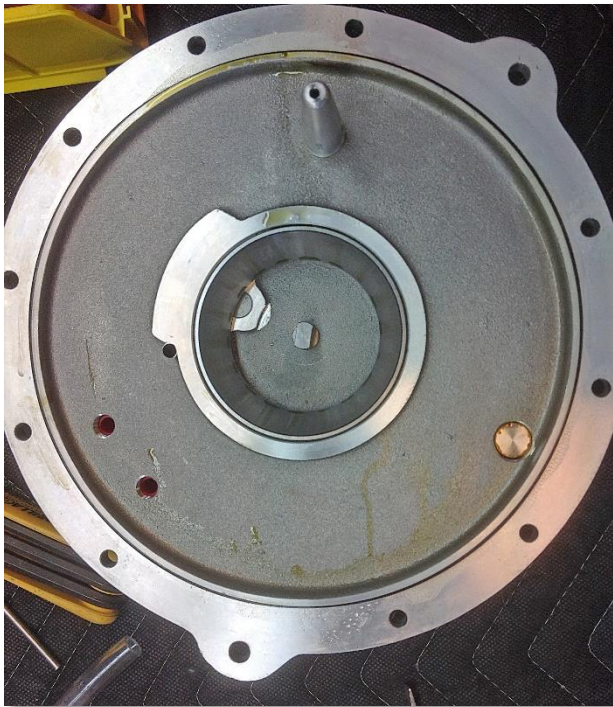


After removing the bolts and carefully working the bottom cover loose, I lifted it straight up and this is what I found. When Blake talks about preload he is talking about the tapered roller bearing at the top of the picture (bottom of the transmission.)

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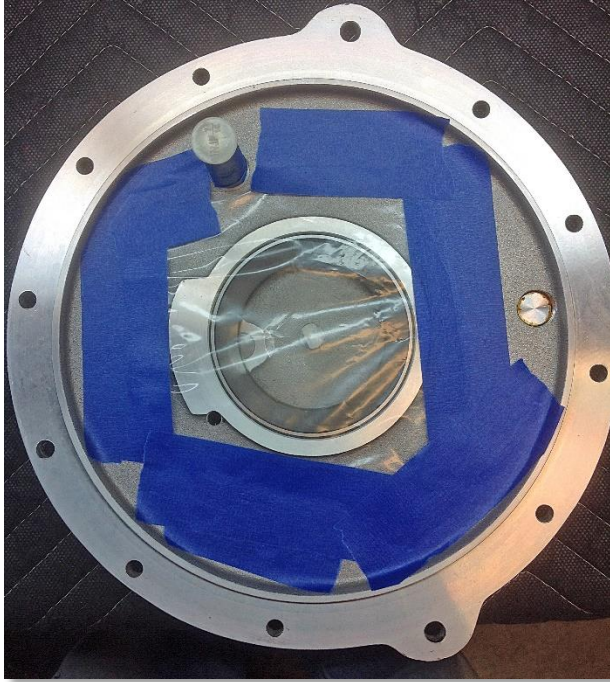
Here's a closer look at the pinion gear. When you consider that there is almost one hundred horsepower driving this little gear you can appreciate the engineering that went into the design of this transmission. As B.J mentions in one of his videos, the loads on a helicopter transmission are much more severe than on an automobile. I'm impressed!



After carefully covering the transmission to keep it clean, I moved to the bottom cover. You can see the very thin O-ring that goes around the circumference. I removed that and set it aside in a baggie along with the plumbing and hardware.

In the center you see the oil pump drive shaft. This has to be lined up properly when reassembling the transmission. It's also imperative that no debris gets into that central area where the tapered roller bearing goes. I also want to avoid dropping anything into any of the lubrication openings.

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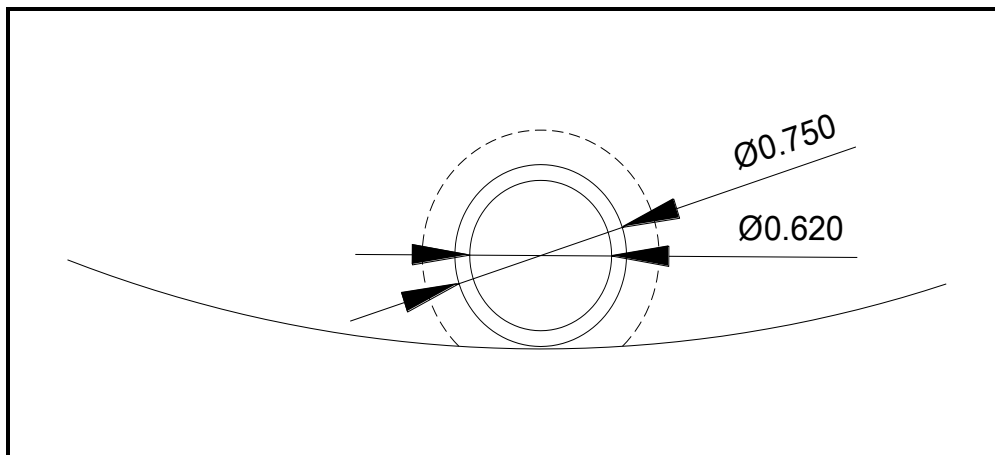
After tucking the transmission away I degreased the inside of the cover and sealed off all the sensitive areas to prevent contamination. Only the chip detector hole is exposed. Once I get going this side will face down so gravity should help me keep it clean.

OK -- so after spending something like \$475 on parts and tools, and tearing my brand new transmission apart, I should probably see if it will be possible to actually make this work...

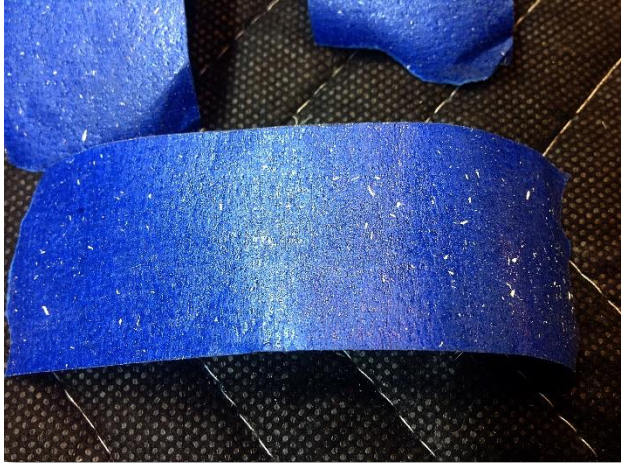


Here's a close-up of the existing chip detector hole. As you can see, there is almost no room to enlarge this hole without running into the outside raised area. When I'm faced with something like this I take measurements and draw it up in AutoCAD.

In the sketch below you can see that it looks like I can just barely enlarge that hole from .620 to .750 without chewing into the side of the cover. If I can I'll try to offset the new hole towards the center to give myself more room.



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One last comment before I start. In the process of degreasing the inside of the cover so the tape would stick I pulled up a lot of very small metallic particles from the rough interior of the cover. This is a good example of why you want to change the lubrication in the transmission, the engine, and the tail rotor gearbox after a few hours, and why it is important to tear the oil filters apart and inspect them. This is the sort of material that you'll find imbedded in the filter. You don't want this stuff circulating through your precision bearings.



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Before tearing into my new transmission I machined threads into this scrap of Delrin just to guard against any major mistakes. Now I know I have the size and thread pitch correct.

The next step is to start machining the transmission cover itself. Before I do that I'll clean up the area around my mill to minimize the chance of introducing any contamination into the cover.



Here's a picture of the chip detector. It has two sections and is called "self-sealing." When the removable section with the magnet is removed the spring-loaded valve I'm pointing to will close off the opening to prevent oil from pouring out all over your fuel tanks.

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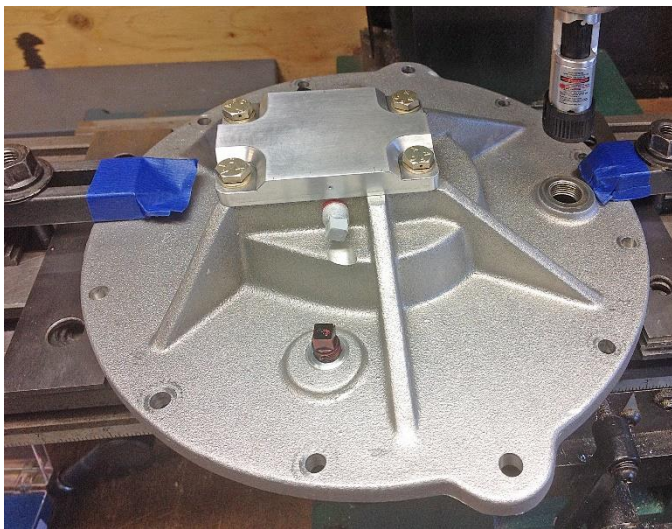


Here you see the removable piece with the magnet (red arrow) removed from the body. Notice that it is sealed with two O-rings. You can also see that the valve has now closed off the opening to prevent leakage.



OK. It's time to get to work...

I clamped the cover to my mill bed and used some precision flats to raise it off the bed to clear the lip. I used my laser to find the center of the existing hole and then I moved towards the center about .050 so the enlarged hole would remain clear of the lip.



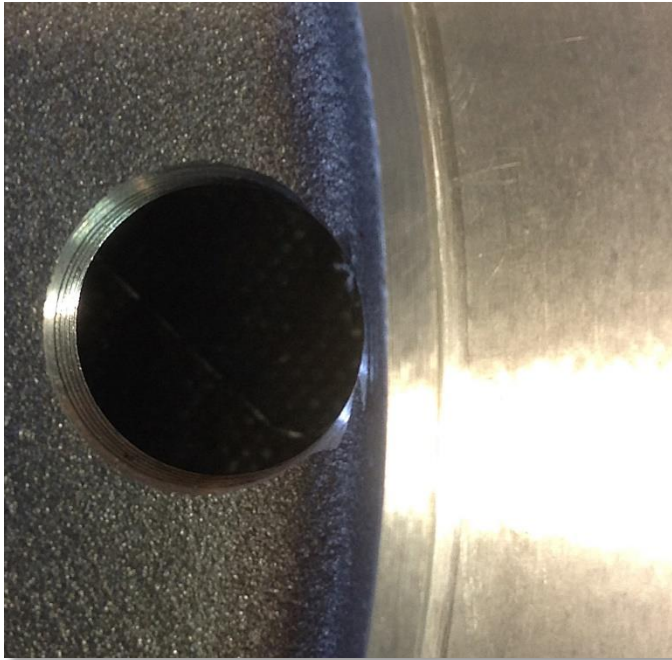
Here you can see the amount of offset that I used. Then I locked the bed down and used a variety of end mills and drill bits in successively larger sizes until I got to my final drill size of 11/16 which is the recommended size for tapping aluminum.

Being able to lock the location of that hole in relation to the quill and also precisely control the feed was essential and only possible with a mill. I'd hate to try this with a drill press.

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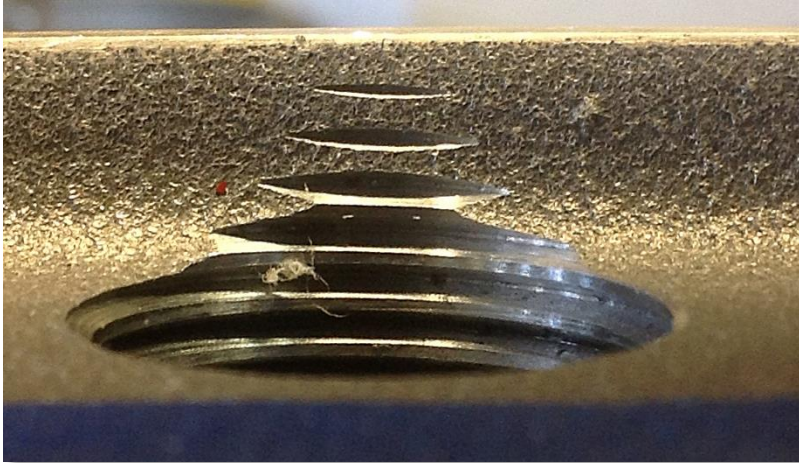


Once the hole was drilled and tapped I used this countersink to cut an O-ring groove. Again, this was made easy with a mill because I could take a .010 cut, pull the countersink out of the way, take a look, and then go back and remove a tad more material. The alignment remained locked in place during the whole operation.

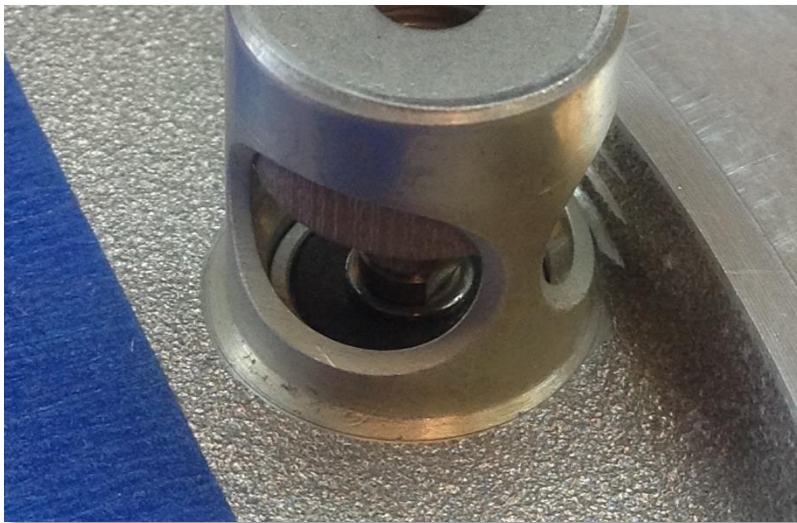


Here you can see why I needed to offset the hole. I'm right up against the rim.

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The tap just kissed the side of the rim, so that offset was just about right and definitely needed.



Here's the chip detector installed in the new enlarged hole. In this picture the transmission is right side up and you can see how the lubricant will be able to flow freely through the holes in the side of the detector. The magnet is just visible at the bottom of the detector.



Here's what the sensor looks like mounted on the underside of the transmission. To check it all you have to do is grab the little ribbed piece, push up, and twist to remove. The signal line mounts to the threaded screw. This is one of the very few components that will use the frame as a ground return.



**TAIL ROTOR GEARBOX CHIP DETECTOR**

In this project I'll be installing a Robinson tail rotor chip detector in the Helicycle T/R gearbox. Here's the Robinson part numbers:

- TRGB Chip Detector      B566-2                      \$220.00
- Packing                      MS28778                      \$3.25

I'll also need the following tools:

- 7/16-20 Taper Tap
- 25/64 drill bit for 75% threads in aluminum

**PREPARATIONS**

The first step was to check with Blake to insure that I wasn't getting into something that I couldn't deal with. Blake wasn't happy to hear that I was going to tear into the gearbox, but he assured me that a bunch of very small spring-loaded parts wouldn't come flying out of the gearbox when I started disassembly. That's always comforting to know.

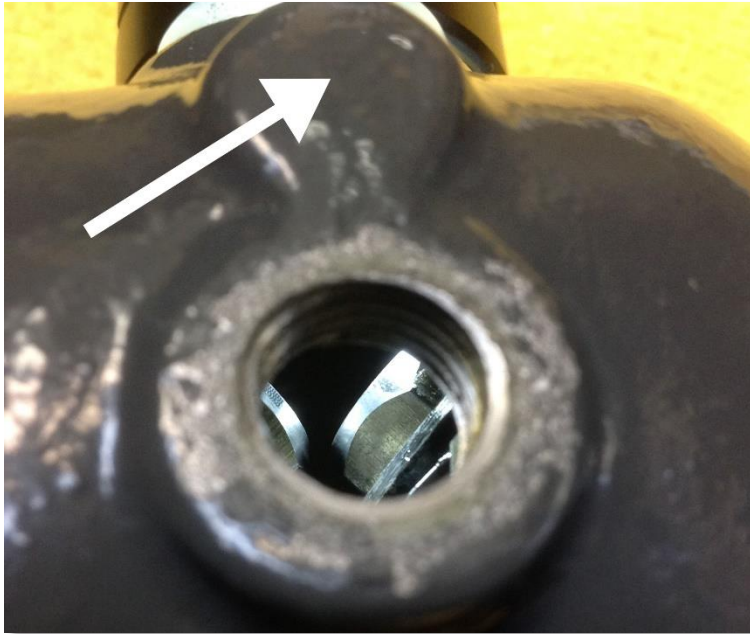
The first step was to disassemble the gearbox. I made a special effort to insure that the area was scrupulously clean. My main concern is the inadvertent introduction of debris into the gearbox.



The tail rotor gearbox consists of two subassemblies that are inserted into precision honed pockets in the case. After removing the mounting hardware I was able to remove both after some gentle pulling and twisting, mostly required to break the paint loose where the parts joined. I set the parts on this new microfiber shop rag, took this picture, and immediately put them into sealed baggies.

Since I have no intention of touching either subassembly, this will all go back in exactly the same configuration as before. I haven't touched the bearing preloads for example.

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Of course, before tearing into the gearbox I needed to have a plan and be assured that it would actually work. The folks from Scion that made the autonomous Helicycle for the Navy already did this particular modification, so I knew it would work, but to be sure I double-checked. The chip detector will be installed on this boss where the white arrow is pointing. Looking through the drain plug hole, you can see where the attachment bolts are located for the two gears. They are well clear of that area.

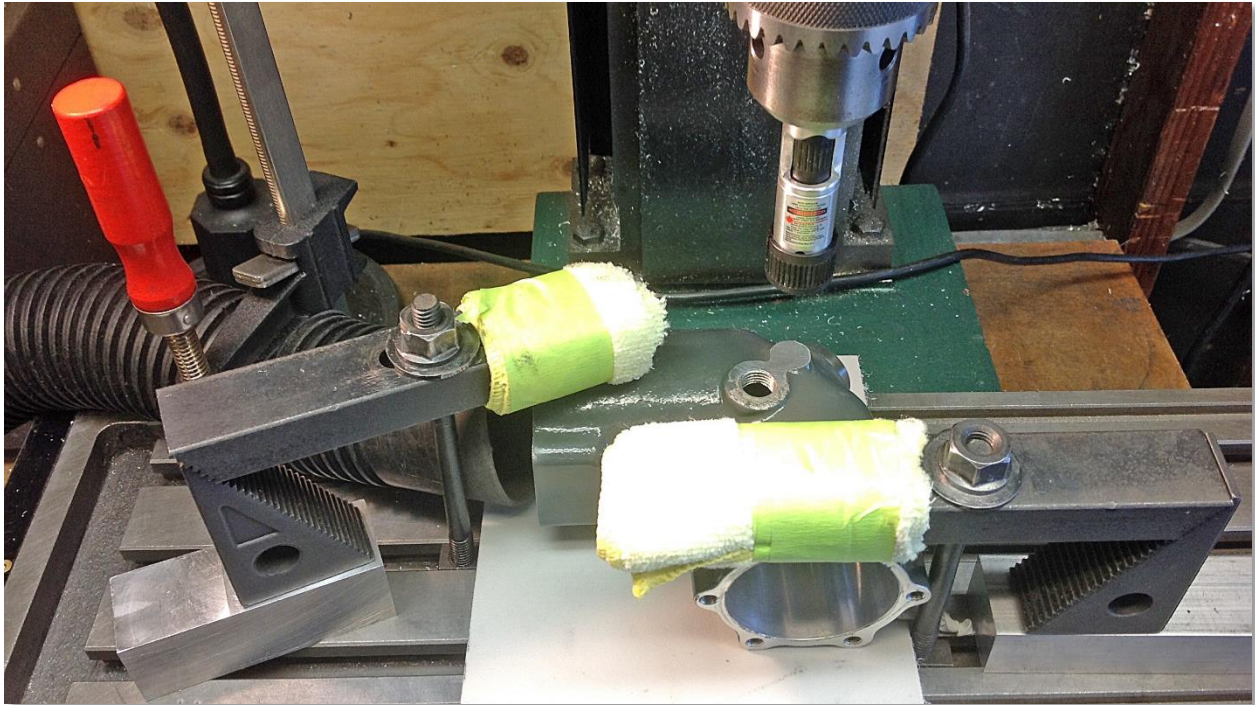


Here's the view of the gearbox interior looking in from one end. The hole that you see inside is the sight gauge.

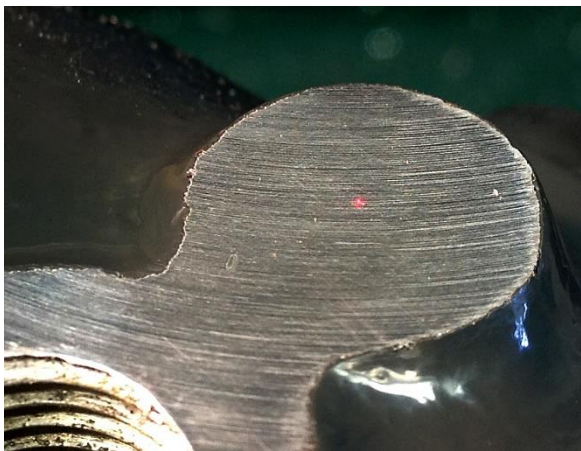
The two gear subassemblies are precision fits into this housing, with a metal-to-metal seal. It's imperative that nothing scratch or nick either surface. I'm also going to be taking special precautions to try to capture the debris that fall inside as I drill and tap the detector's mounting hole.

I started by carefully cleaning the interior with another new microfiber shop rag dampened with isopropyl alcohol. I don't want any oily residue to trap debris during machining operations.

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I clamped the housing in position being careful not to scrape up the paint. I also kept the clamping force to a minimum – just enough to secure the housing against movement. I don't want to distort it! Finally, I clamped my vacuum hose next to the opening on the left. My plan is to catch the debris that falls through the hole in the air stream before it has a chance to land inside the housing.



I surfaced the boss in preparation to drilling and tapping the mounting hole and used my laser center finder to eyeball the location of the hole (the small red dot.)

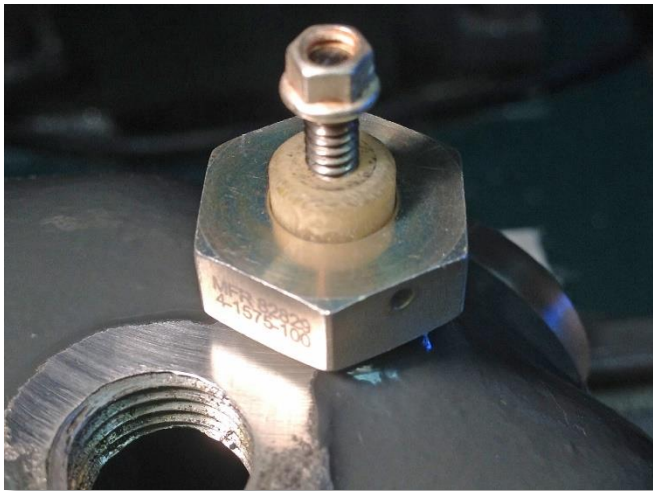
The drain plug is a pipe thread so it will jam into position and does not use an O-ring and doesn't need a flat surface. But the chip detector does. Once the hole is tapped I'll use a countersink to deburr the hole and machine an O-ring groove.

And since I'm only going to be able to do this once I wanted to make sure that 7/16-20 really is the correct thread size for the detector. I drilled and tapped test threads into a piece of scrap and screwed the detector in, just to be sure. To be safe I'll start with a center drill and work my way up to 25/64<sup>th</sup> very slowly and cautiously. Since the housing is only loosely clamped I don't want to apply any more force or torque to it than I have to.

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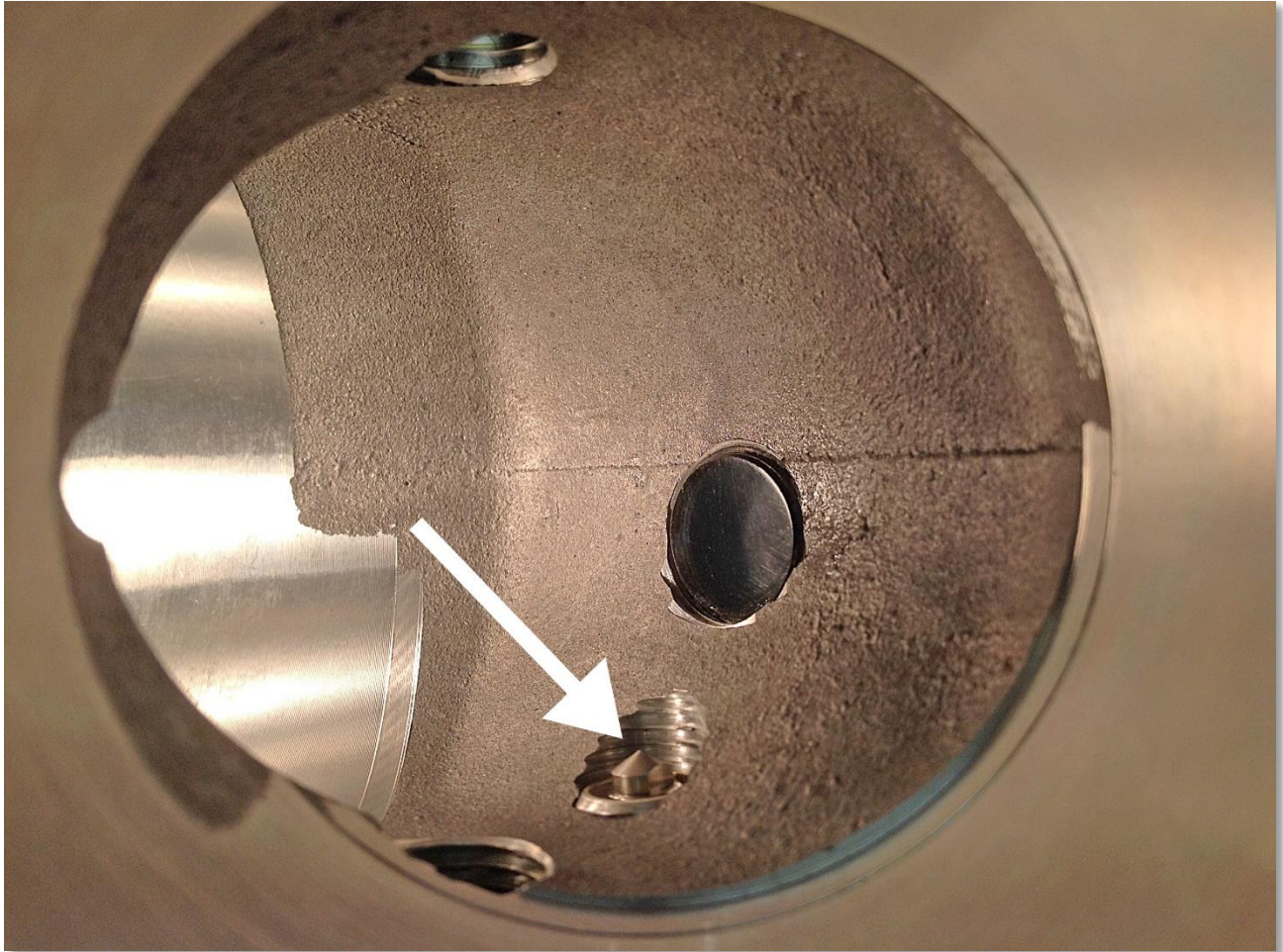
Here's the tapped and countersunk hole ready to accept the detector.



And here's the chip detector installed next to the drain plug.

Now that the detector is installed it's very important to make sure there are no chips or other debris inside the housing.

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Here's a look inside the housing. As you can see, the chip detector is completely out of the way of the gears (while arrow) and in a great place to pick up any ferrous material in the oil. To insure that the interior of the housing was completely free of contamination I washed it out in the kitchen sink with a few drops of dish soap and lots of hot water. Once it was completely clean I dried it with high-pressure air and reassembled it.

That's all there is to it. Now both chip detectors are installed and it's time for the next project...