

1. Introduction and Purpose

Hanging the engine is perhaps one of the biggest days in the life of a custom-built airplane. It is, however, one of the least illustrated or documented procedures for the home builder, including the RV series of aircraft. This article was prepared to address this need by providing an illustrated guide to mounting a Lycoming engine on your plan. When this procedure is followed, you should expect the engine to be hung in less than one hour. The 5 builders authoring this article have installed 4 engines on RVs within the last 4 months, each time learning subtle tricks decreasing our mounting time from just under one hour for our first one, to the case illustrated here which was completed in 37 minutes. We have documented every step with a digital camera and have labeled the photos for clarity. It should be obvious, however, that differences exist for every plane and every engine, and this article is simply meant to be instructional. We do not claim to be professionals and cannot be held accountable for the accuracy of this information or how you use it as you install your own engine.

2. What We are Installing, and Left vs. Right

The engine used in this illustration is a Lycoming IO-360 B2B. It is shown in the top right photo as delivered in May, 2001. This engine was custom built for me (Jim Norman) by Aero Sport Power. A group of Tampa builders have come to my house to help install it on an RV-6A, however this exact sequence has been used to hang similar IO-360s on the other author's RV-6, RV-6A, and RV-8A. The experience discussed in this article is primarily from the others in the group, I just happen to be the guy who is putting this combined experience on (electronic) paper. When we discuss the Left side of the engine, it will be the side that is on the left when seated inside the cockpit of the plane.



Figure 1. Engine Hoist

3. Items Needed to Get Started.

It will be very difficult to mount an engine by yourself, so don't try. Get at least one more person, and ideally 2 helpers. They don't need to know anything about airplanes, but it sure helps if they know the difference between a socket wrench and a boxed-end wrench.

Additional items needed are shown in Figures 1, 2, and 3, and are described here:

Engine Hoist (or Block & Tackle). You can rent this in any town about \$20/day.

Mounting Bolts and rubber Engine Mounts. The ones shown were bought from Vans. Each mount consists of 2 black rubber biscuits which are subtly different, an inner cylindrical rod which prevents over compression of the rubber, and one big washer. Note that the four engine mounts are identical,



Figure 2. Engine Mounts and Bolts.

and you need to buy four. They come individually. You will mount the top ones differently than the bottom ones, but none the less, each set is identical. The bolts are close tolerance and are very high quality. They are expensive, but do not cheat here. The bolts come as a set of 4, with 2 being slightly longer than the other two. The difference in length is only the width of a washer. The longer bolts will be used on the bottom and therefore allow for the use of an additional washer if you have some engine sag with time. The bolts come with two more big washers (slightly smaller in diameter than the one which came with each rubber set) four castle nuts, four cotter pins, and a handful of AN970 washers. There are extras of these (little) washers and are to be used as needed under the castle nuts to get the castle nut where it is appropriate for placement of the cotter pin.



Figure 3. Lots of Refreshments.

Tools.

Appropriate wrenches and sockets, and a punch (which will be used as a drift pin if it is needed).

Van's drawing number SK-90A. Read it now, and read it several times during this operation. Take it out of the binder and tape it to the side of the plane.

Refreshments. If you're going to get some buddies to help out, you better have a well stocked refrigerator preferably in the garage so they don't have to walk very far. This important concept is illustrated in Figure 3, and has proven to cut down significantly on mounting time ($p < 0.05$).

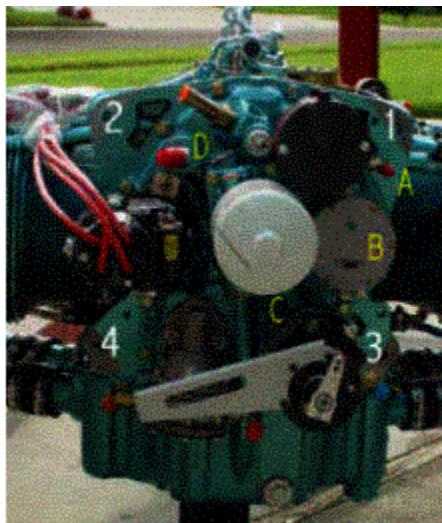


Figure 4. Engine Preparation.

4. Preparing the Engine

Prior to hanging the engine, there are a couple of things that should be done, and one or two that must be done. In Figure 4 we show the rear of my (JN) engine which has been labeled for some important preparation points

The white numbers show the order in which we will be installing the mounts and bolts. The top right is number one followed by top left, then bottom right and bottom left.

The yellow letters show some of the installations on the accessory case. Letter A is the most important. This is the fitting which will provide a measure of oil pressure. This fitting is nearly impossible to get to after the engine has been mounted, so put it in first. This fitting is a special fitting made for this application and is bent 45 degrees and has a restriction outlet that prevents

total immediate oil loss if there is a hose failure down stream. A small hose fits to this fitting that subsequently attaches to a pressure transducer. Importantly, this fitting must be oriented a specific direction or it gets in the way of the mount and/or you can't get your hose on. It is to be pointing down toward the ground and back toward the rear of the airplane. If you have it aimed toward your right main tire you will be fine.

The following are less important, but are shown for clarification. Letter B is the Hall Effect Sensor Module for a Lightspeed Engineering Plasma CDI Ignition system which has been mounted in place of the right magneto. This can be mounted later fairly easily, but it is easier to do prior to mounting the engine. Do not, however, have any of the wiring systems attached. Letter C is showing an oil line fitting which goes to the oil cooler. This is easier to put in prior to mounting the engine. The counterpart fitting to Letter C is shown as Letter D; it also will connect to the oil cooler. This is not necessary to put in prior to mounting the engine on the airframe, but its not in the way either, so put it in if you have it. Note that this engine has the prop governor and cable bracket attached. This can be done later, but it is considerably easier to do prior to hanging the engine, and it lets you look inside the black box to see what is happening in there. Also note that this engine has a vacuum pump mounted This also can wait until later, but it is a bit easier to do prior to the engine being hung. However, note that the vacuum pump does NOT have its inlet and outlet fittings attached (yet). If you are going to mount the vacuum pump before you mount the engine, you need to mount the vacuum INLET pipe first, otherwise you will have to remove the pump to get this fitting on since the motor mount top cross piece will prevent you from screwing this inlet pipe in. These two vacuum pump fittings stand a chance of hitting the motor mount top piece as you align the engine at the very beginning so be careful not to bend them, scratch the paint, or crack the pump itself when you are first getting started. Our recommendation is to screw the inlet into the vacuum pump and mount the pump prior to mounting the engine, leaving the vacuum outlet fitting until later. However, mounting a vacuum pump is not difficult, so there is no need to fret about this issue, and certainly no need to wait for a vacuum pump to arrive prior to mounting the engine. Finally, you will note in these pictures that the fuel injection has not been bolted onto the bottom intake. Typically Lycoming engines are shipped with the carburetor (or fuel injection) detached from the bottom to make the entire system smaller and therefore cheaper to ship while also decreasing the likelihood of damage to these sensitive parts. Do not fret this issue. You will install this later when it is easier.

5. Aligning the Engine to the Motor Mount

The first real step is to get the engine picked up and aligned with the engine mount on the firewall. This is quite easy. The only tricky part is to keep some of the accessories just discussed from getting banged up. Figure 5 shows us getting things aligned, with guys on each side making sure the pretty paint doesn't get scratched (on the engine or the mount), or that the vacuum pump doesn't hit the cross piece of the mount.



Figure 5. Aligning the Engine.

6. The First Bolt

The first bolt/mount to be installed is the Top Right. Putting this bolt in is not hard at all and can be completed in about 30 seconds. Before you put it in completely, put the rubber biscuits in BOTH top mounts. Don't worry about the bottom rubbers yet cause if you try to put them in, they will fall on the floor so ignore the bottom rubbers for now and just put the tops in place. Refer now and frequently to Van's drawing number SK-90A. In this picture, the engine is on the left side of the page and the motor mount on the right. As noted briefly above, one of the tricks to this installation is understanding that the slightly thinner mounting rubber biscuit is made of a harder rubber, and is to be mounted in compression while the airplane is sitting on the ground. This means that the thinner rubber biscuit is next to the engine at both bottom positions, and on the rear of the airplane's engine mount (closer to the firewall) at the top two positions. The thick washers will always accompany the thinner, harder rubber biscuits. The big trick at this phase: Tighten this bolt all the way snug (don't get out the torque wrench yet, but tighten this bolt). This pulls the engine toward the right side so that the top left mount will come into alignment Figure 6 shows the top right bolt installed and tightened down.

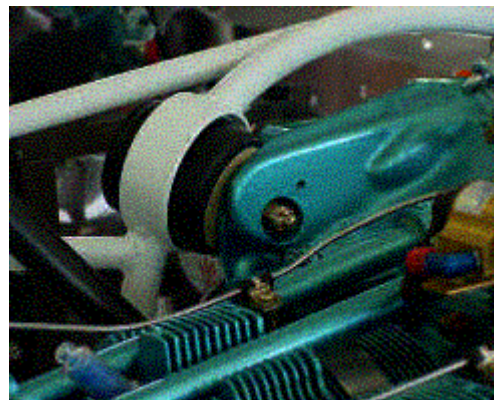


Figure 6. The First Mount and Bolt.

7. The Second Bolt

The second bolt to be placed is the Top Left. You should already have the rubbers in place, and this is not much harder than the first bolt. Figure 7 shows this taking place. Note that the engine hoist is still holding ALL of the weight of the engine. When installed, tighten this bolt all the way just like you did the Top Right bolt. If there is any trick to this bolt, it is that the first bolt was tightened down and the engine hoist is used to manipulate the engine up and down a bit while you push on the engine a little from side to side. This should not be hard.

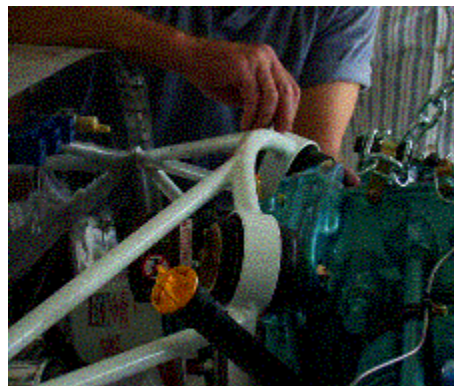


Figure 7. Installing the Second Bolt.

8. The Third Bolt

The third bolt is the Bottom Right. This is starting to get a little tougher and now you are going to have to use the engine hoist a little to help align things. First, pick up on the engine a little to allow you to put in rubber biscuits in both bottom mount cups. Remember, now we are putting the harder, thinner rubbers next to the engine, and they are each accompanied by one big washer which goes up against the engine block. The trick here is that you may have to loosen one or both of the bolts you just tightened (the top two bolts). Take a look and see what lines up and experiment a little with loosening the top right bolt a little first allowing the engine bottom to swing a little to the left. Once this bolt gets in, you must tighten it down all the way. The fourth bolt is the hardest, and it won't go in if the right bottom bolt is not tight. Another thing to note is that the first two bolts went in without much

trouble. But the third and fourth bolts will need some encouragement from other tools. We recommend that you do not use a hammer to help the bolts into their respective holes. Instead, try screwing the bolt into place once it is well lined up, allowing the threads to help pull the bolt into its final position.

9. The Fourth Bolt.

The fourth bolt is the Bottom Left and its shown in Figure 8. Once again, be careful of how your biscuits are placed. This is likely the only place that you MAY need a drift pin to help align the hole in the rubbers with the bolt hole in the crank case. **The drift pin is NOT to be used to move the engine! You can't move the engine with a drift pin, so don't try!** Its only purpose is to help you shift the rubbers a little. Since the rubbers are actually rubber, they will give a little if you pry them, but don't try to pry them from outside (levering against the engine block), but rather simply stick the drift pin through the back of the mount through the rubbers and into the threaded hole in the block (remember, just use a hole punch or Phillips screw driver for your drift pin nothing fancy. Again, pry the rubbers from the inside metal part only, and only if you have to. We have only had to use this drift-pin technique twice on four engines, but it is helpful. Once you have it aligned, then use another screwdriver on the outside to hold the biscuit in position (levering a little against the block) and insert the bolt. Do NOT pry against the rubber so that you damage it. Also, placing this bolt will most likely require that the other three bolts are tightened down FIRST. The amount that the other three MAY have to be loosened a little bit has varied slightly on our four recent mountings, but start with the assumption that the first three bolts are to be tightened all the way prior to getting the fourth bolt started.

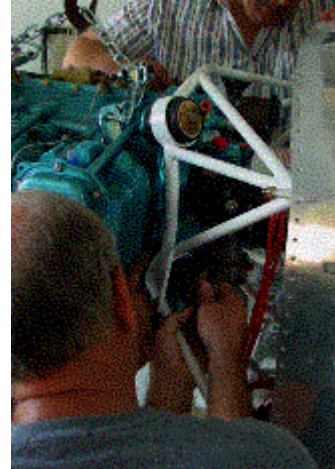


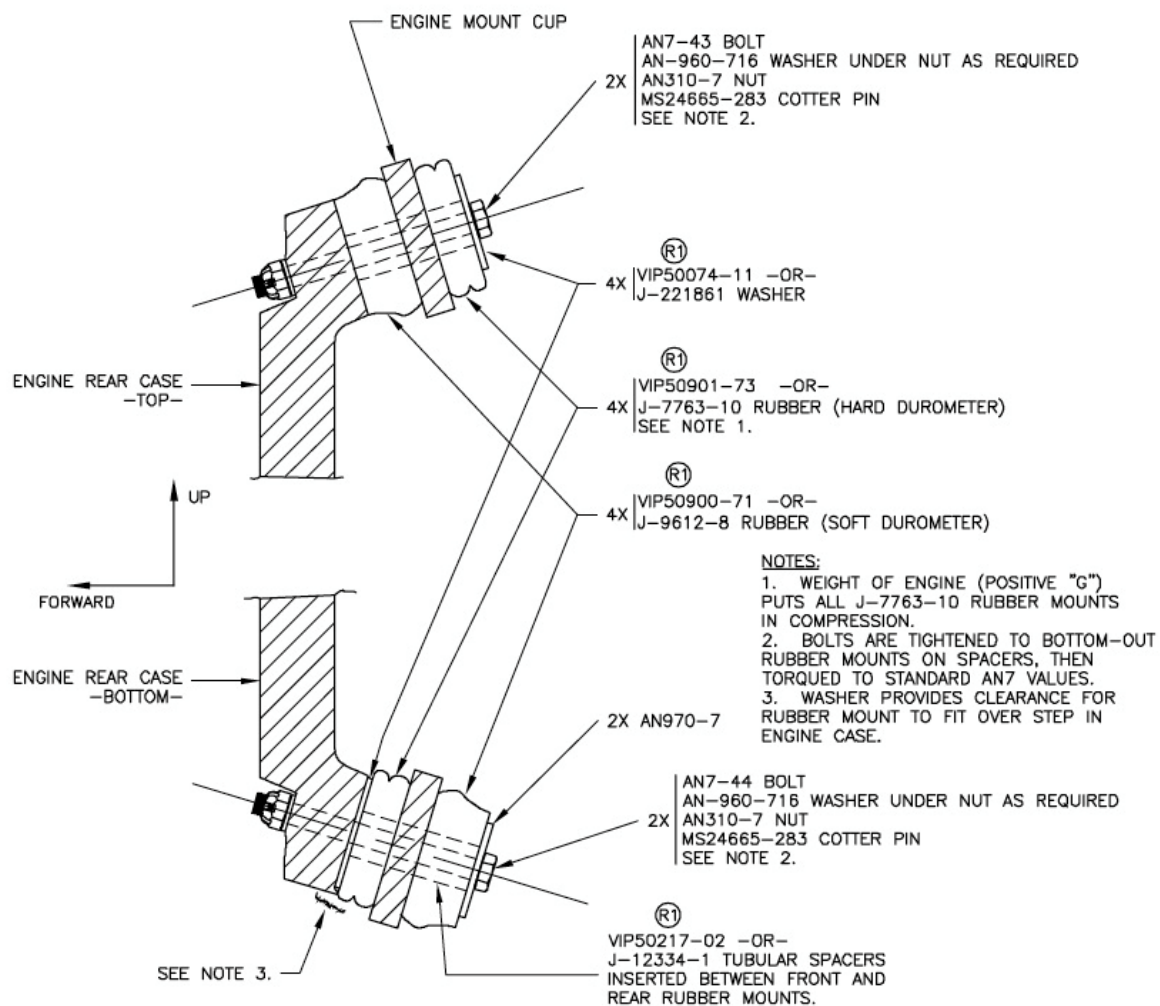
Figure 8. Last Bolt.

10. Remove the Engine Hoist.

Now you're done. Stand back, take some photos, and have a refreshing drink. The builders who have provided the expertise for this article are pictured here. The guy with the big letter A on his shirt is me, Jim Norman (RV-6A); Doug Gardner is letter B (RV-8A); C is my dad; D is James Samonsky who has helped build parts of all of our planes; E is Scott Reviere (RV-6A); and F is Don Hughes (RV-6). Note that everybody has a bottle of refreshment.



The Authors.



(R1) TYPICAL INSTALLATION OF
DYNAFOCAL MOUNTING KIT