

## **EAA Chapter 166 - Construction Corner Article**

*Jack Hilditch May 19, 2006*

### **Engine Building Seminars at Mattituck**

You might ask yourself “why would I want to go to an engine building seminar? I have no interest in building. I’d rather be flying.” If this sounds like you, welcome to the crowd. Curiosity, however, is one thing that separates those of us who like to build and fly from the general flying public. We want to know more about what we fly and how it works, so we seek out seminars like Mattituck’s. The tenor of this piece is not technical. My intention is to convey what an excellent resource the Mattituck seminars are.

### **Background**

Many of us are familiar with internal combustion engine basics. At some point in our lives we probably worked on one type of engine or another. Maybe changing the oil on a lawnmower or replacing a fan belt on our first car was as far as we went. That’s OK. More mechanically inclined readers may have taken their ‘wrenching’ to a higher level by building or modifying a car or two. It doesn’t matter what level of mechanical ability you possess. Knowing something about how your engine works, and what preventive maintenance it requires, will make you a more informed pilot. That is where seminars like Mattituck’s really shine. They take much of the mystery out of aircraft engines for those of us who are not gearheads or professionally employed in aviation maintenance.

### **The Basics**

One of the classic engines from my youth was the air-cooled, horizontally opposed VW. It was inexpensive to buy, simple to maintain and parts were cheap. If you ever worked on a VW motor, the similarities between it and a typical four cylinder aviation engine will be clear. If you did not have any experience with them, fear not. A boxer engine is simple to understand and easy to work on. If you need a little reassurance, grab a friend who is familiar with the type and dig in. You might ask “if working on one of these engines is so easy, why can’t anyone repair them and why do they cost so much for a TBO rebuild?” The answer is in the details.

### **The Details**

Overhauling an automotive motor is far less particular than overhauling an aircraft motor, and for good reason. If an overhauled car motor stops working, you pull over to the side of the road and figure out what went wrong. At altitude, a broken motor is far less forgiving, no matter what caused it to either stop working or run roughly. That fact substantially ramps up the level of care and quality control required in an overhaul. It means that simple dye checking may not suffice to determine whether the integrity of a casting is sufficient to warrant returning it to service. It also means that much more detailed records must be kept on each piece installed on, or in, a motor. It means that ADs and SBs must be considered and implemented. For example, I can’t remember the last time an automobile manufacturer required replacement of crankshafts because the metallurgy was flawed. Aircraft accident records narrowed recent engine failures to the metallurgical composition in a series of crankshaft casting failures. Airplanes fell out of the sky when those engines failed. That’s why we count on companies like Mattituck to

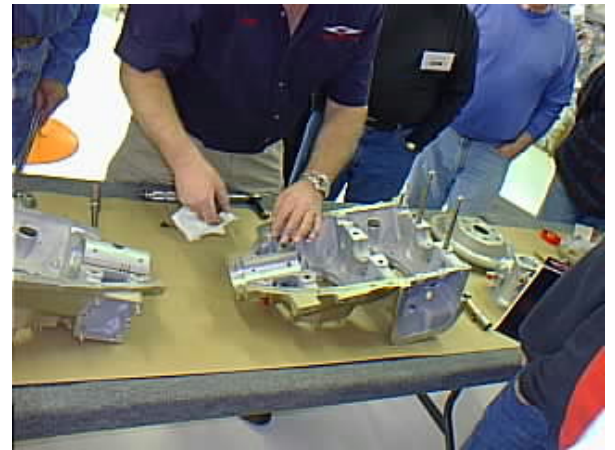
maintain such a high level of quality control when they overhaul our engines. It is for the same reason we should attend their seminars so we can learn from the masters.

### **What goes on at a Mattituck Seminar?**

To put it simply, they take an array of parts, laid out sequentially on a long table, and assemble an engine from scratch during the course of an eight hour day.



The air-cooled, opposed, or boxer aircraft engine design has been around for more than 50 years. It is mature, well tested, simple and a generally solid machine. These engines develop power at low RPM and usually provide reliable service if cared for according to manufacturer's guidelines. They typically have four or six air cooled cylinders that mount independently to a crankcase. The case splits down the middle into two main banks. It has the usual cylinders , pistons, rings,



connecting rods, wrist pins, tappets, gears, seals, and bearings. Each cylinder has a pair of valves to let fuel in and exhaust out. The engines also have a fuel system, a lubrication system and an electrical system, those are the basics. Putting the pieces together perfectly so the engine runs reliably, given the environmental extremes we subject them to, is where the magic comes in.

### **The Mattituck Experience**

Attending a Mattituck seminar is a more than just a day in the engine shop. In a recent trip, organized by the Meriden chapter, the day started with a very early meeting at a bus stop in Cromwell before heading to New London for the Orient Point ferry. While flying to Mattituck might be fun, a sunrise crossing of the Sound takes you to another world and sets the stage for a terrific day. I spent quite a few years at sea so I am biased on this. Any time I get the chance to watch the sunrise from a deck and hear the gulls, I grab it.

If you take nothing else away from a Mattituck seminar, remember that **attention to detail is mandatory**. Mattituck makes that policy abundantly clear to its employees and customers. They are not kidding! Everything connected to engine building or repair, particularly with aircraft engines, relies on attention to detail and cross-checking. You should make that your mantra as well. It could keep you alive. As you watch the engine

being assembled, and listen to the narration, you will see the Mattituck assembler practice what he preaches. Mattituck and other reputable engine shops are strict about this because they know our lives depend on the engines they build for us. When you work on your own engines, remember to follow Mattituck's example. It comes from years of experience. Here are a few points they emphasized during the seminar:

- Strictly adhere to the manufacturer's published tolerances, torques and clearances.
- Follow the manufacturer's assembly steps carefully because there may be particular steps that must be sequential in order to not damage the engine.
- Resist the temptation to say "that's pretty good" and **DO NOT CUT CORNERS!**
- Practice detailed record keeping.
- Check for ADs& SBs on parts and document compliance.
- Photograph each stage of the process in detail and place some kind of reference in the photograph, like a ruler or legible note, if applicable. This will add scale or placement information to the record so you can better understand it at a later date.
- Use a friend or fellow builder as a second set of eyes to review your critical stage checks.

Remember, the engine you build is what will keep you flying. For example, as you perform some task, try placing a check mark beside each step in the manual when you finish it. This will ensure that each step has been completed sequentially and make a good record for your quality control inspector and FAR Part 91 documentation. Every reputable engine rebuild shop requires a second pair of eyes to review whatever work was performed. Each step must also be documented. The purpose is to verify that nothing was overlooked before submitting the engine for inspection and sign off.

Think of engine building as a dead reckoning exercise where some waypoints can be confused with others unless you check them off as you pass. If you place sequential checkmarks on your sectional, or in your overhaul manual, you can be reasonably sure that you have passed the last waypoint or completed the previous task.



*Howard Linker Photo*

08:30 Parts laid out on the table in front of the group ready to begin assembly.

## Building the Engine



Crank mounted vertically on a stand. Connecting Rods & Caps are numbered sequentially. Don't mix and match them. Some engines use Connecting Rod Bolts that are designed to stretch until they reach a specific length rather than a torque setting. The IO-360 uses this type of bolt, **DO NOT REUSE THESE WHEN REBUILDING. THROW THEM AWAY AND PURCHASE NEW BOLTS.**

Visualizing the relationship between parts is easier when the case is mounted vertically. At times, having a second pair of hands available is not only useful but required. This frees you up to do the tightening while your helper holds pieces in position. Crankcase assembly is one of those times.



Sequence the pieces correctly, check for clearances, lube where necessary and do not force anything. 'O' ring damage, silk thread displacement or case damage may require disassembly to resolve oil leaks or worse so be methodical and careful. Do it right the first time around and remember the old carpenter's rule "measure twice, cut once."

Tighten the case bolts in the recommended sequence and to the required torque specifications.



Rotate the crank so the number one piston is at top dead center. This will help orient gears and aid in timing as you progress.

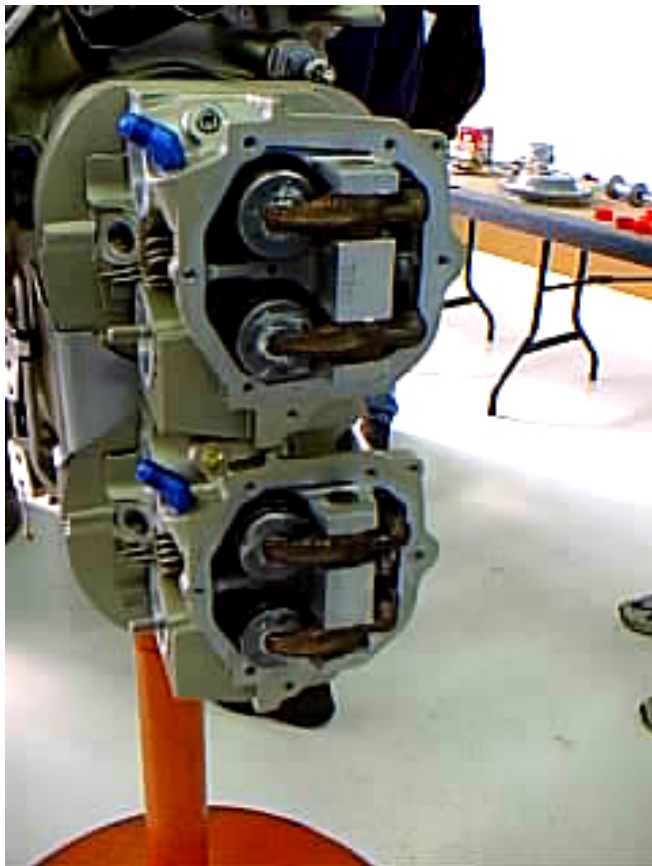
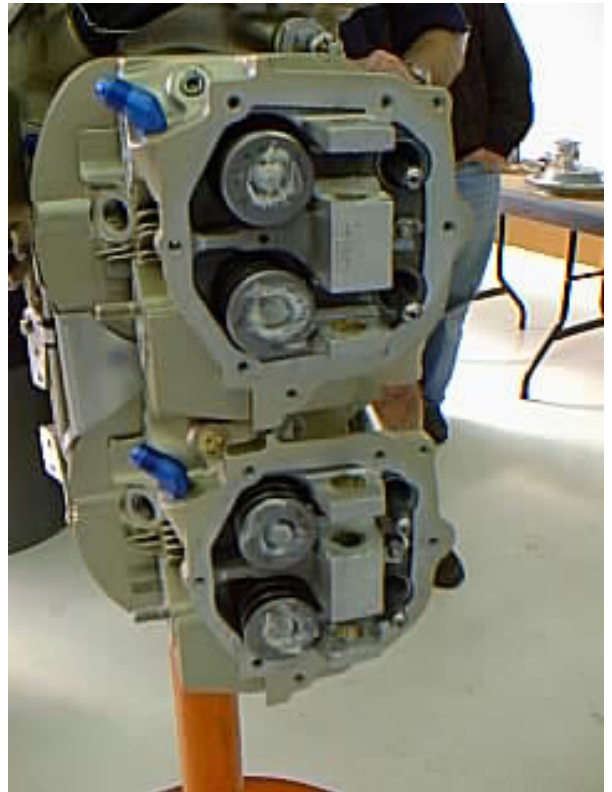
Check Piston Skirt size to Cylinder diameter. Number the pistons and cylinders to place in original positions (pistons in cylinders and cylinders to engine position)



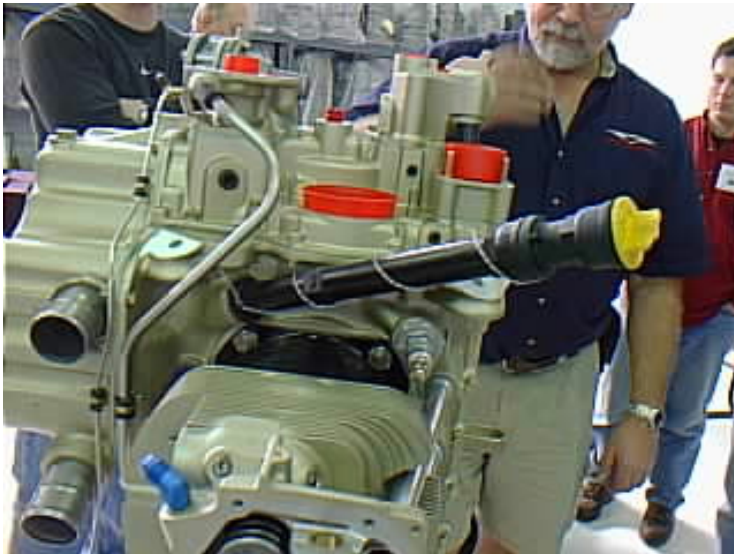


Don't mix & match lifters and pushrods. There are specific tolerances and if a combination falls outside the acceptable parameters, select another rod.

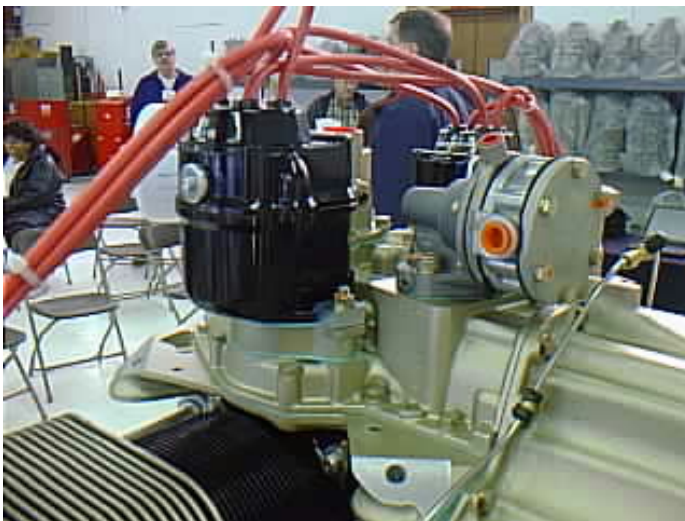
Drive tappet clearances must be checked with a 'Go-No Go' gauge.



Remember that snap rings are rotated 90 degrees from openings like the one shown here that retains the tachometer drive shaft.



Make sure the safety wiring is wrapped in the correct direction to prevent loosening, as illustrated on this oil filler tube.



Magnetos in place and timed.



17:00 The TMX-360 is assembled and ready for the test cell.



*Howard Linker Photo*

### **Summary and Addenda**

A tremendous amount of material is covered in the one day session. It is difficult to absorb and remember everything you see in such a short time. It is worthwhile to note that Mattituck has DVDs on the subject available for sale. The DVDs cover rebuilding of several engine models. These DVDs, while not a replacement for overhaul manuals, parts manuals, or experience, are quite handy reference materials and a good addition to your aviation collection. You can find the DVDs on line at:

[http://www.aircraftspruce.com/catalog/bvpages/vid\\_mattituck.php](http://www.aircraftspruce.com/catalog/bvpages/vid_mattituck.php)

Another good resource for Lycoming Engine information is the Lycoming group on Yahoo. That group is very active and can be reached at this URL:

<http://groups.yahoo.com/group/lycoming>

Mahlon Russell, a long time Mattituck manager, can be found on the Yahoo group or contacted directly by email at: [mahlon\\_russell@teledyne.com](mailto:mahlon_russell@teledyne.com) He has always responded promptly and has a wealth of engine knowledge that he is quite willing to share.

### **The Antique Car Museum.**

In a building behind the Mattituck shop is the private antique car collection owned and restored by Parker Wickham, the founder of Mattituck Aviation. When I first heard about the invitation to visit the museum, I thought it might be a 'yawner', but I was definitely wrong on that one. I've been visiting car collections for many years and often find one or two unusual vehicles in each of them. This collection has more than its share of unusual cars including one built by Jim Bede, the BD4 & BD5 designer.

<http://www.autocycles.org/compare.html> The car is reminiscent of an aircraft fuselage built in much the same fashion that Messerschmitt built their post war trikes

<http://www.microcarmuseum.com/tour/messerschmitt-kr200-58-bg.html> It looks like it came right off an aircraft assembly line. Here are a few shots from the museum.

