

JM-14 Turbine Engine Build Guide

Prelude

This guide is intended to provide easy to follow instructions for the assembly of the JM-14 Jet Engine. Below is a picture of the assembled engine, with call outs to externally visible features and some standard nomenclature. The engine runs on a 2-cycle fuel/oil mixture (described in detail in the Turbine Engine Specifications.)



Figure 1: External view of assembled engine.

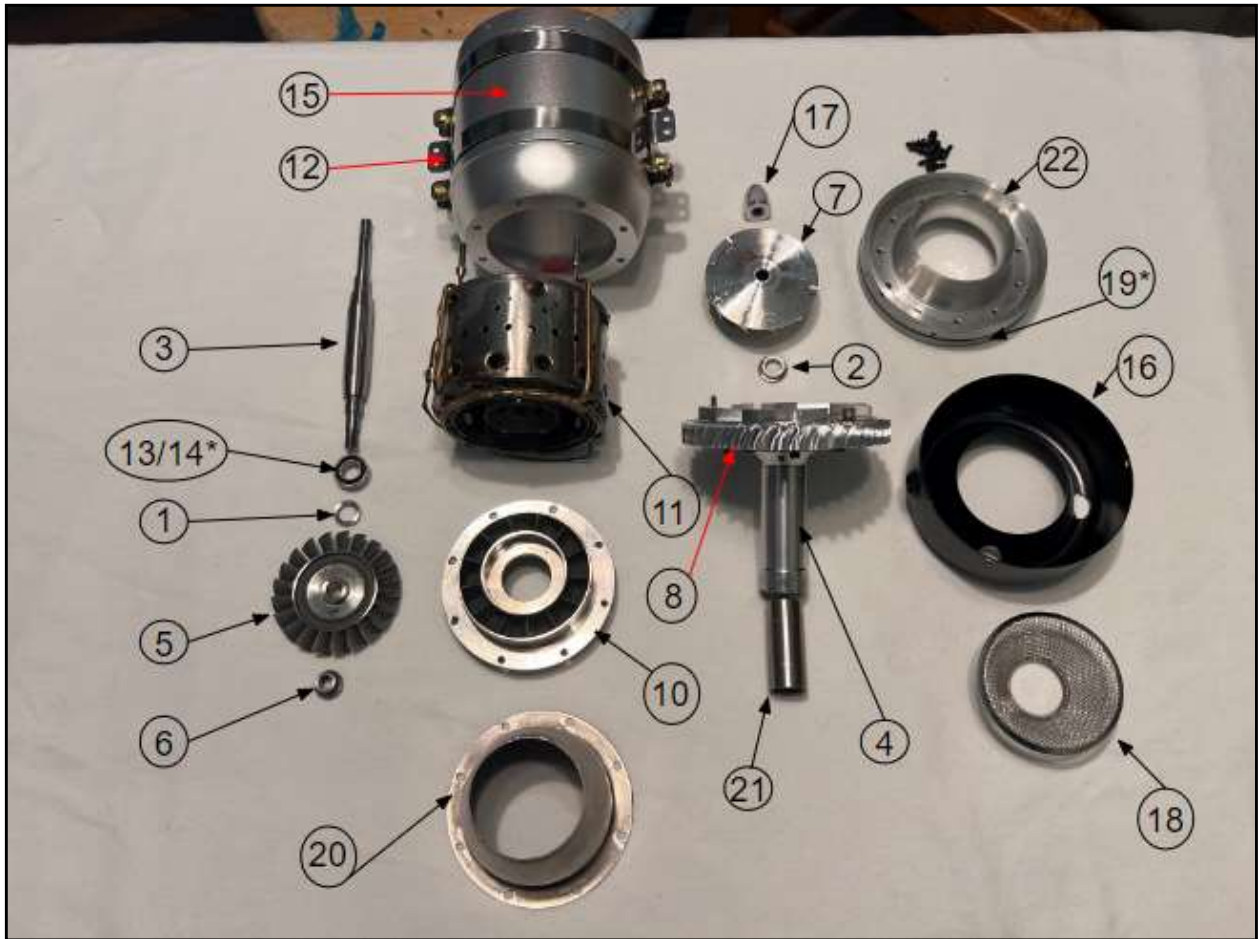


Figure 2a: Exploded view of engine parts. (Red arrows are solely for visibility)

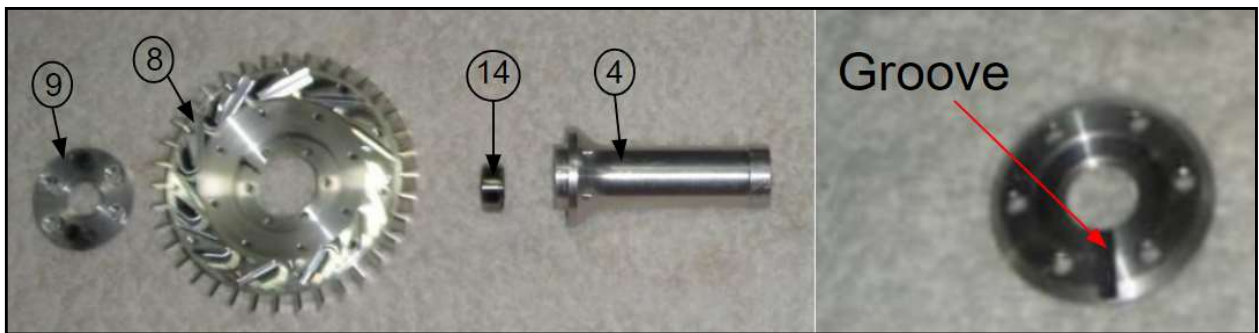


Figure 2b: Exploded view of engine parts. (Red arrows are solely for visibility)

JM14 Kit Contents:

1. V-shaped spacer
2. T-shaped spacer
3. Turbine shaft
4. Diffuser housing
5. Turbine
6. Turbine nut (regular-shaped nut)
7. Compressor
8. Diffuser
9. Diffuser Plate
10. NGV (Nozzle Guide Vanes)
11. Combustion chamber
12. Mounting straps (2)
13. LYB Bearing (Bearing A)
14. GRW Bearing (Bearing B)
15. Engine casing
16. Cowling
17. Compressor nut (bullet-shaped nut)
18. FOD (Foreign Object Debris) filter (wire mesh screen)
19. Large green O-ring
20. Tailcone/Nozzle
21. Preload tube
22. Inlet

Additional Equipment & Supplies:

1. Semi-permanent Loctite Blue Threadlocker
2. Machine oil (3&1)
3. Hex key (N mm)
4. 12 mm socket
5. 12-point box wrench (8 mm)
6. Leather work gloves (recommended)

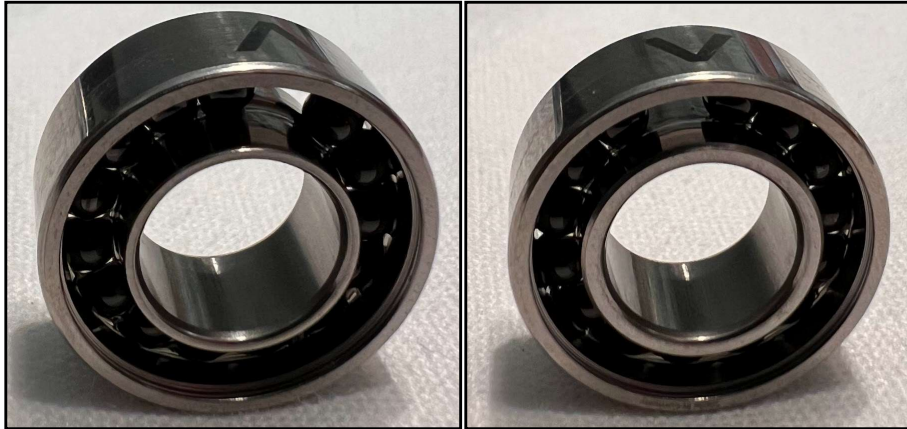


Figure 3: Image of bearings. Notice the slightly smaller gap where the ball bearings sit on the “pointed” end of V side (right).



Figure 4: Image of the turbine assembly parts laid out in order of assembly from aft to fore. Aft face of turbine shown here.



Figure 5: Above are the V-shaped and T-shaped washers. Notice the chamfered edge on the V-shaped washer to the right.

IMPORANT NOTE:

FAILURE TO FOLLOW THESE INSTRUCTIONS WILL DAMAGE BEARINGS. DO NOT APPLY PRESSURE ON INNER RACE FROM

THE THIN SIDE OF BEARING!

The bearings included in this kit are angular bearings so they must be inserted a specific way or damage to bearing will occur.

Each bearing has a thick center race on one side and a thin center race on the other side.

The thick side must face outwards towards turbine/compressor wheel.

And the thin side must face inwards towards the center of engine. An improperly inserted bearing will not rotate freely, and cause drag.

Excessive pressure on thin side of bearing while assembling your engine may cause inner chase and ceramic balls to disassemble

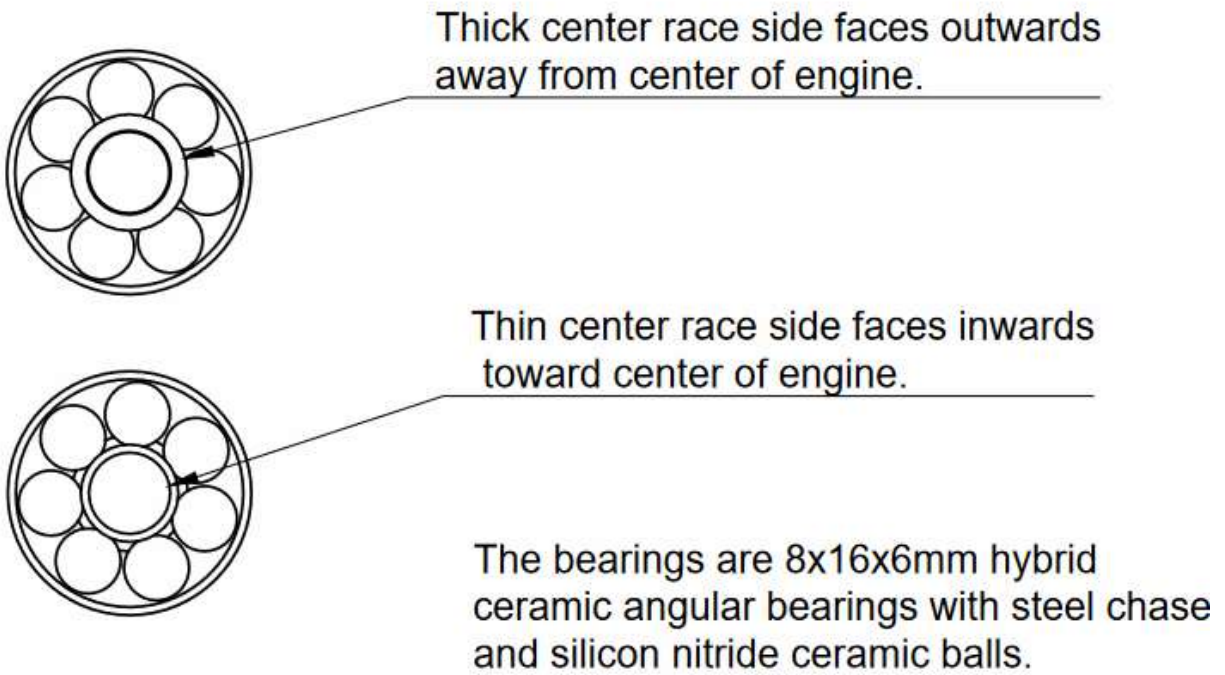


Figure 6: Further clarification on bearings (reference the JM50 build, information is relevant for JM14.)

1: Assemble turbine shaft

- 1.1: Slide the bearing onto the shaft from the aft. The face with the larger gap (see figure 3) points toward the forward end of the shaft.
- 1.2: Slide the V-shaped washer onto the shaft from the aft.
Note: Chamfered end points forward into the bearing.
- 1.3: Slide the turbine blade onto the shaft from the aft.
Note: Cut-out marks are on forward face..
- 1.4: Fasten the nut onto the shaft with the 8 mm 12-point box wrench. It is okay if it is not very tight, as it will be tightened more after the compressor is attached in step 4.2
Note: The nut is left-handed. Tighten in reverse fashion (right loose, left tight). **Do not use loctite.**



Figure 7: Completed turbine assembly

2: Assemble diffuser

- 2.1: Slide the pre-load tube into the aft end of the diffuser housing. This will be a tight fit. You will notice the pre-load tube is spring loaded.
- 2.2: Slide the bearing into the fore end of the diffuser housing. Face viewed in Figure 3 (right) should point in the fore direction.
- 2.3: Place the diffuser plate on the fore end of the diffuser. There is a groove that the lubrication line will slide into. Reference Figure 2b (right)
- 2.4: Place a drop of blue loctite onto each black bolt. Fasten the black bolts through the diffuser plate into the shaft housing.

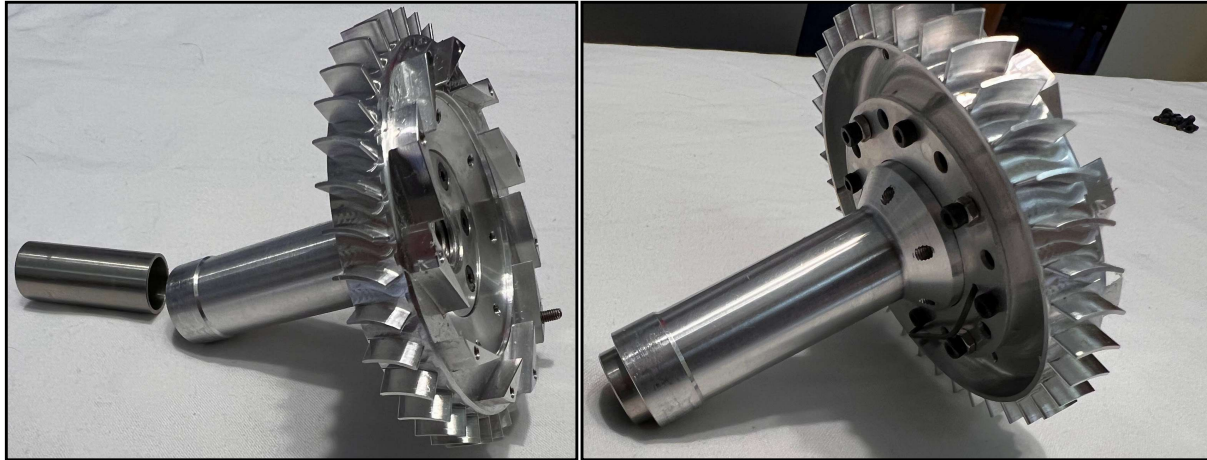


Figure 8: Completed diffuser assembly (right) prior to compressor integration. Tube (left) slides into shaft on aft end of assembly.

3: Main Integration with Combustion Chamber

3.1 Slide the shaft on the diffuser assembly through the combustion chamber. Make sure the fuel, lubricant, and start gas lines line up with the appropriate through-holes. The through-holes are slightly larger than the similar looking bolt holes as seen in Figure 8.



Figure 9: Through holes for fuel/oil lines of combustion chamber (right).

IMPORTANT: Bearings will bind under heat/stress without a wave spring and damage will occur.

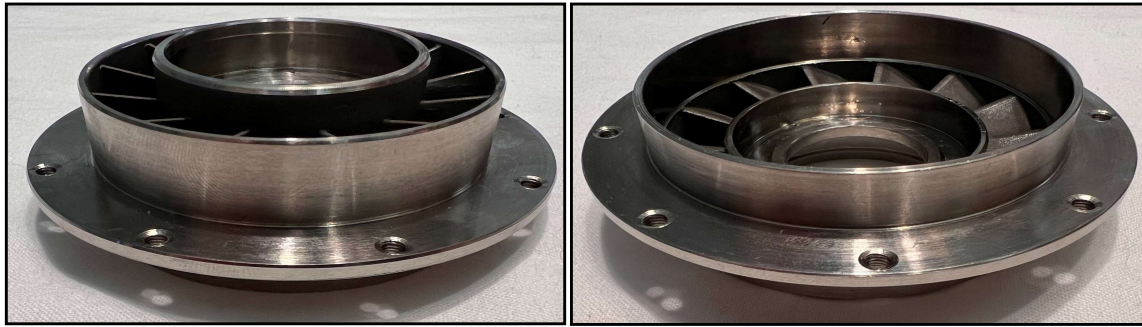


Figure 10: Forward end up (left). Aft end up (right).

3.2: Place the NGV into the combustion chamber with the deeper-recessed end pointing aft (Figure 9, right).

3.3: Slide the turbine shaft forward through the NGV and the diffuser housing.

4: Compressor Installation

4.1: Using work gloves, push the compressor onto the fore end of the turbine shaft. This will be a very tight fit.

Note: Though the compressor is not threaded, it may be helpful to rotate the compressor during fitting to overcome friction between the compressor and the shaft.

4.2: Fasten the bullet-shaped nut onto the turbine shaft with the 12 mm wrench, just tight. **DO NOT** overtighten (the nut is left-handed, so “lefty tighty”). At the same time, tighten the turbine nut completely using the 8 mm 12-point box wrench.

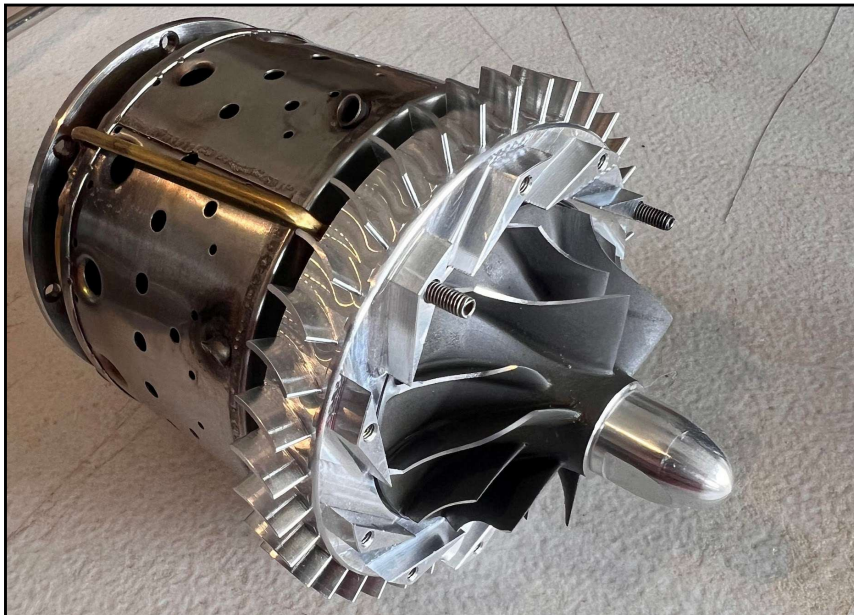


Figure 11: Compressor with bullet-shaped nut installed

4.3: Fit the large green O-ring around the inlet groove.

Note: You may need to use a small amount of machine oil to fit the O-ring onto the inlet.

4.4: Place the inlet over the compressor.

4.5: Fasten the inlet to the diffuser using the 2.0 hex wrench and small black hex screws with black rubber washers.

5: Fit Check

5.1: There should be no scraping or any contact of the blade surfaces with the housing for the compressor or the turbine. If there is contact, the engine will not start. Any contact is a sign that a component is misaligned because the tolerance is very tight.

5.2: A strong puff of air from the lungs or compressed air source should cause the compressor and turbine to spin.

Note: Do not continue until compressor/turbine are spinning freely with no sounds of contact.

6: Body Assembly

6.1: Slide the casing housing over the aft end of the engine assembly past the green O-ring. (O-ring visible in Figure 11.)

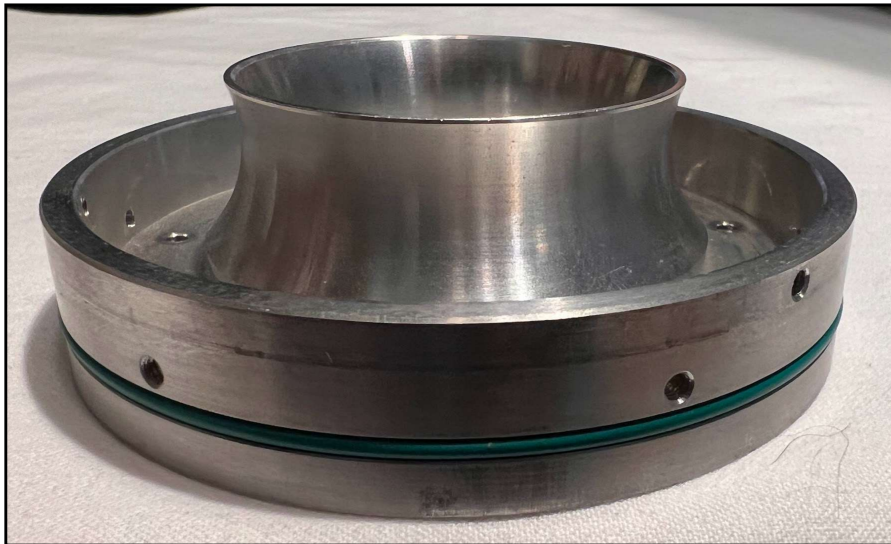


Figure 12: O-ring installed on inlet.

6.2: There are 3 sets of screw holes that will need to be aligned before installing fasteners. These are the radial screws that secure the casing to the inlet, the glow plug holes on combustion chamber and casing, and the axial holes on the aft end of casing that align with the NGV holes. Fine adjustments can be made by using hex wrench to align the glow plug hole (Also helps with aligning the NGV holes).

6.3: Use the silver 2.0 mm hex screws to fasten the radial holes of casing to inlet, and the 2.5 mm silver hex screws to fasten the nozzle/tailcone to the aft end of casing.

6.4: Install the fluid fittings as shown in Figure 12.

Note: Notice the location of the Flow Restrictor in the photo. It is important that this piece is in the correct location as it meter the lubrication to the bearings. It should come as a small separate piece of tube, with the restrictor already inside. The needle end of the restrictor points toward the lubrication fitting.

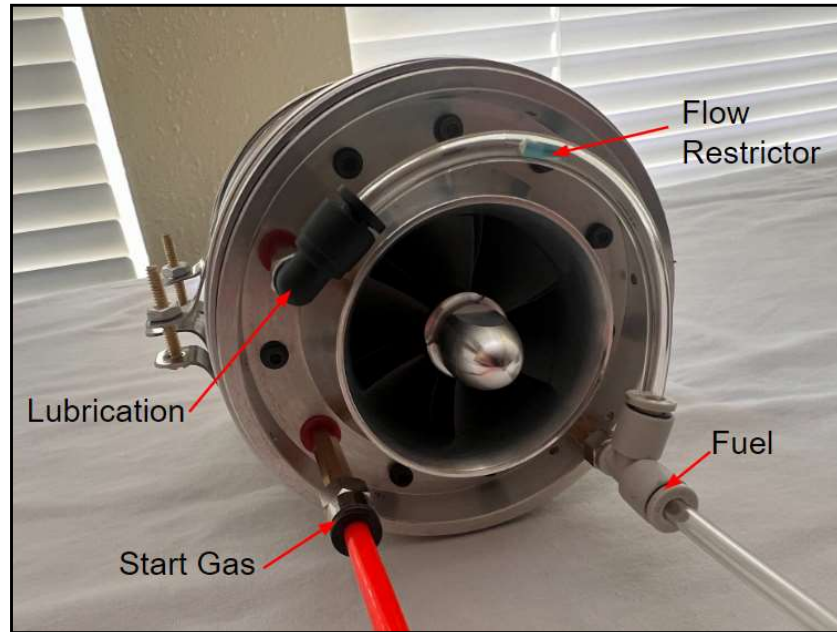


Figure 13: Fuel/Oil fittings installed. Orange line is for start gas.

6.5: Place the FOD filter over the fore end of the inlet. This filter fits loosely inside the cowling.

6.6: Place the cowling over the fore end of the engine. There are 2 holes in the cowling for the start gas and fuel fittings to go through. The fitting on the side of the cowling is used if the hall effect sensor is installed.

6.7: Fasten the silver screws through the cowling with the 2.0 mm hex wrench. These holes may prove difficult to align, a few pieces of masking tape along the seam where cowling meets the casing could also be used.

6.8: Gently bend each mounting strap around the combustion chamber housing so that it forms a semicircular shape. Bend the bolt holes 90 degrees in the opposite direction. This can be done by hand or with the aid of needle-nosed pliers. A vice is helpful for this step, if available, but not required.

6.9: Place the mounting straps on opposite sides of the combustion chamber housing. Hardware for securing the mounting straps will need to be provided by the end user.

6.10 Take the glow plug out of the packaging, note that in the interior there is a small electrical coil. Get a pair of fine tweezers or a needle, and extend the coil out by 2 mm. This will help with ignition of the fuel air mixture inside the combustion chamber, by giving the coil more surface area to interact with the fuel.

6.11 After extending the coil, insert the glow plug into the combustion chamber, with the coil facing in. Some alignment adjustments can be made with 2.0 hex wrench to allow for successful insertion.

6.12 Finish integration of the glow plug by rotating with the 8 mm box wrench until the interface of the glow plug is flush with the exterior of the engine.

Congrats! Your engine is now fully assembled and ready to be integrated into a full test setup.

If you have any questions or concerns related to this procedure please contact MiniJets:

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minijetengine@gmail.com

Safety Notes

Take note that this engine is not a toy. This is a no kidding turbojet engine. This engine should be handled with the utmost respect and care. Contained inside this engine during operation is a lot of energy both in heat and mechanical form that is capable of extreme personal and property injury and damage. Do not operate this engine under the influence of alcohol!

The following guidelines should be read carefully followed.

1. Always keep a CO2 or similar fire extinguisher close when starting and operating the engine
2. Use proper personal protective equipment to include ear and eye protection!
3. Keep loose clothing and loose material away from the intake of the turbine and away from the rear of the turbine.
4. Always operate your engine in open air away from confined spaces as the engine exhaust contains gases which can cause asphyxiation.
5. Do not touch the engine while it is running. Turbines rotate at a very high rpm and the engine casing and exhaust can reach very high temperatures. Ensure anything affected by heat is kept well clear of the engine and exhaust during operation.
6. Never use the engine near to sources of flammable gases, liquids or materials.
7. Keep spectators, children and animals well away from the starting area at least 25 feet away.
8. Ensure proper use and disposal of fuels for they are hazardous to the environment and they are flammable. Use proper and correctly marked containers for all flammable substances used for the turbine's operation. It is a good idea to use fuel proof gloves when handling fuels.

Turbine Engine Specifications

Outer Diameter: 90 mm

Length: 165 mm less starter

Weight: 850 grams less starter

Approximate thrust: 12 lbs at 160,000 RPM

Idle RPM: 43,000

Min Sustain RPM: 30,000

EGT @ max rpm: Approximately 680 °C

Consumption: @ max RPM about 6-7 oz per min

Fuel / oil: Kerosene / J-A1 + 4-5% oil (Mobile Jet Engine II is recommended, do not use standard or 2 Cycle oil.)
(Good Rule of Thumb is 1 fl oz (~30 ml) of oil per 24 fl oz of fuel in the two cycle mixture).

First Manual Test Notes/Suggestions:

1. Diesel fuel is recommended for your first run. Pre lube bearings by adding a little fuel with throttle prior to running. Do not pool fuel in engine. Blow air to clear residual fuel prior to starting process.
2. Set engine up in a secure stand. Use an air compressor to spool engine up to RPM. A leaf blower may not put out enough air and you could potentially overheat your engine.
3. Use a 12v RC fuel pump and an voltage attenuator for throttle.
4. Use a propane valve for propane start throttle control. Open propane valve with low RPM and light rear of engine using a torch.
5. Once lit open propane more and slowly bring RPMs up with compressed air while heating engine with propane for aprox 45-60 secs. Be sure to add liquid fuel soon as that is your bearing lubrication.
6. Once liquid fuel is added engine should spool up RPMs. SHUT OFF PROPANE & KEEP BLOWING AIR into engine until engine is at running temp and rpms.
7. Find the sweet spot of compressor wheel for max rotation. Listen to engine and get those RPMs up. Too much flame out the back is a sign of too much fuel or not enough RPMs