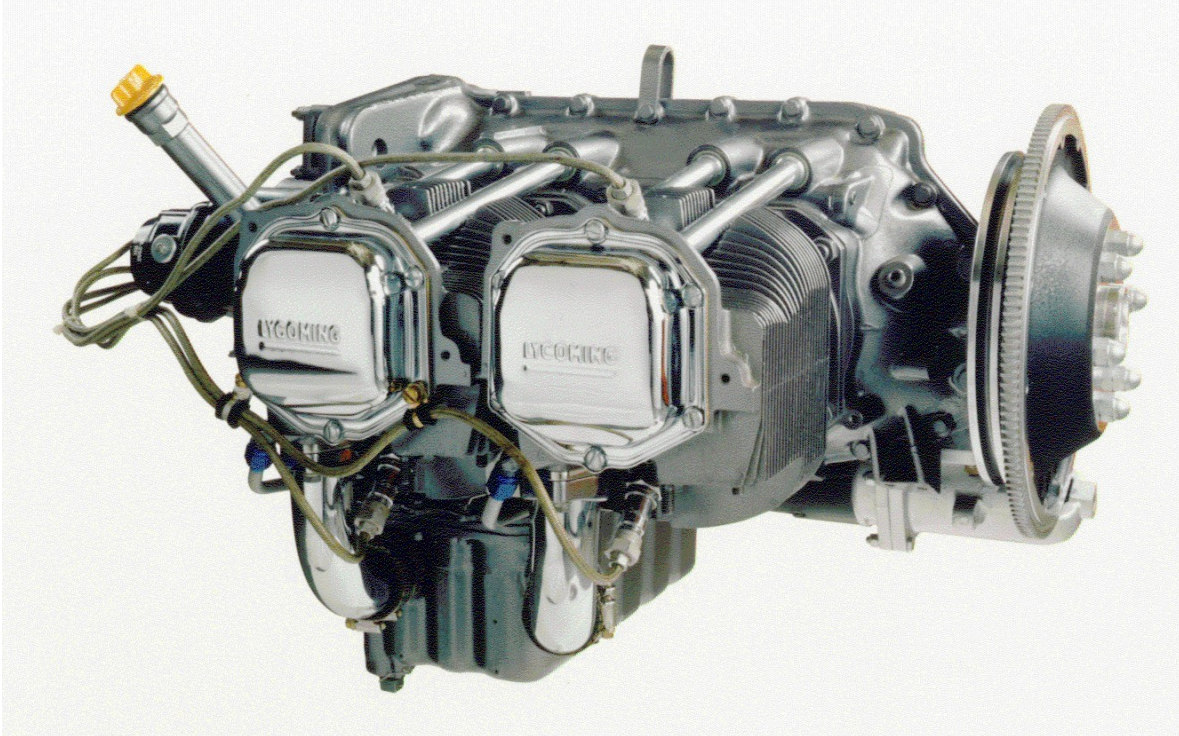


ENGINE INSTALLATION

The SAFARI uses a modified, aircraft type 4 cylinder, 4 stroke, air cooled conical mount engine. Handling your new engine is much easier with an engine stand, hoist adapter, and hoist. Plans of each are included in this manual, if you choose to build your own. If you prefer, they are available from the factory.



CONVERTING YOUR ENGINE FOR VERTICAL OPERATION

The parts needed to modify the engine from a horizontal position to vertical are included in your Engine Conversion Kit.

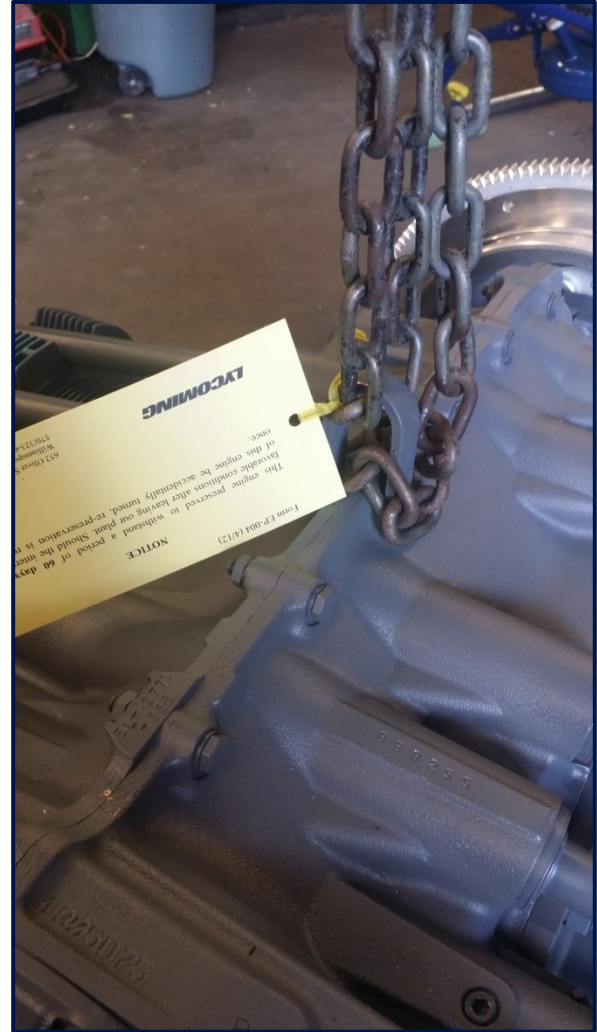
In order to mount the engine vertically, the oil system must be modified to an external sump system. The engine manufacturer's sump is replaced with a cover plate and oil suction hose. A drain hose is installed on the engine where the prop governor drive usually mounts. The valve covers are modified to allow oil to drain back into the sump, which will also be installed.

If the Safari factory has installed the sump cover on your engine in order to return the transport sump to the engine manufacturer, all residual oil has already been drained.

AN913-1D 1/8" plugs will also be installed into the location of the valve cover drain tubes. The dipstick plug will be installed. Safety wire this plug.

The Packing List accompanying your Engine Conversion Kit will indicate that these items are already installed.

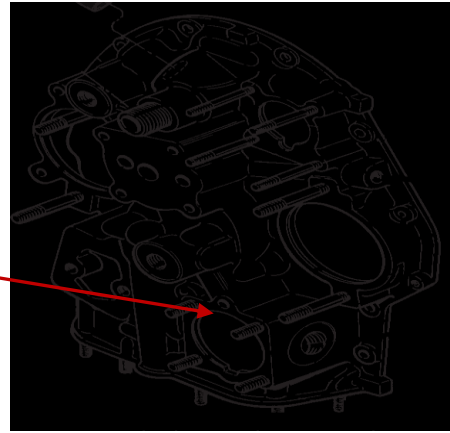
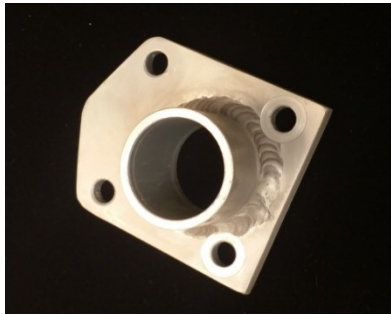
- ☞ Remove the engine from the shipping crate, taking care to pick it up by the lift hook installed on the engine at the manufacturer. The engine will lift out of the crate in a horizontal position.



These tasks can be done after installation of the engine, but are easier done while the engine is horizontal:

- ☞ If you sourced your own engine, remove the valve cover drain tubes and install AN913-1D 1/8" plugs.
- ☞ If you sourced your own engine, remove the engine oil dipstick and install the plug supplied in your Engine Conversion Kit.
- ☞ Remove the cover from the prop governor pad and install the drain flange supplied in the Engine Conversion Kit in its place using the bolts used by the engine manufacturer.

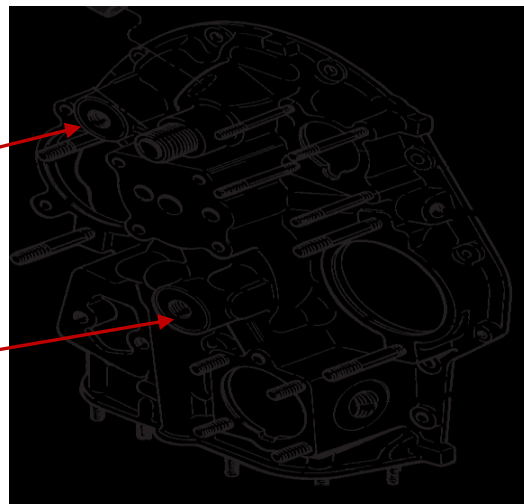




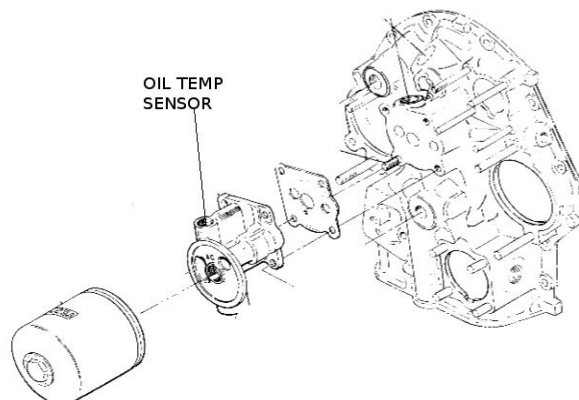
- Remove the plugs from the locations shown for the two oil cooler connections and install AN844-8D hose end fittings from your Oil Cooler Kit. Use plumber's tape on the threads. They should point roughly towards the 7:00 position when viewed from the rear (bottom) of the engine.

OIL COOLER RETURN

OIL COOLER OUTLET



- Inside your Instrument Kit is a separate box containing the Quad Gauge Kit for oil pressure, transmission temperature, oil temperature and AMP. Remove the 399S9 oil temperature sender from the kit and install it in the base of the oil filter housing and safety wire it. Plumber's tape is not used on these threads. Leave the wires rolled up for now.



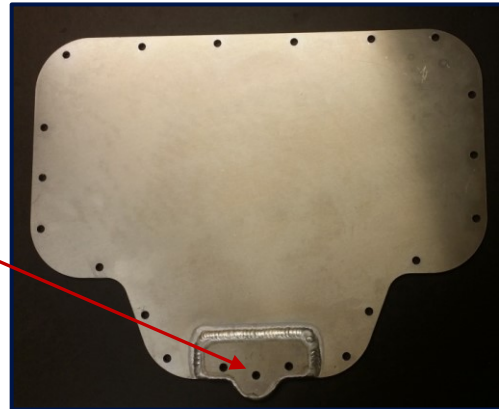
- ☞ Fit the two lower baffles of the Engine Cooling Shroud to the engine while it is still in the horizontal position. While this appears to be out of sequence, it is far easier to fit these pieces correctly while the engine is horizontal. Leave them on the engine while it is being moved into a vertical position.
- ☞ While it is suspended, attach the engine stand to the back of the engine using the bolts on top of the engine stand. The engine should be maneuvered into a vertical position resting on the engine stand using a strap attached to the prop flange, or lots of help.



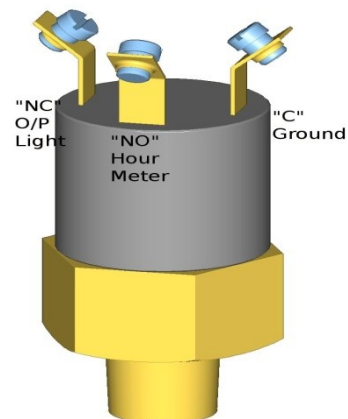
At this point, refer to Section 12 Engine Cooling Shroud. The engine shroud should be test fit onto your engine, and this is time to do it. Several pieces of the engine shroud must be painted and installed on the engine before the engine is mounted into the airframe.

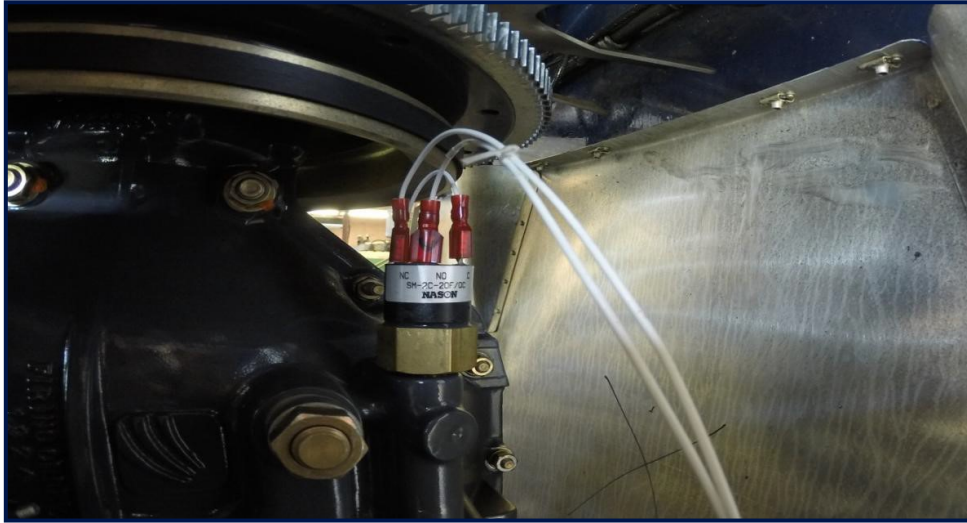
- ☞ Remove the sump cover plate that was installed on your engine at the Safari factory. If you sourced your own engine, see the notes later in this manual. As you remove the bolts, note where the particular bolts are located. The bolts are not all the same length, and some have nuts to secure them. Others are bolted directly into the engine case. Be sure you do not attempt to install a bolt into the engine case that is too long. Continued tightening of a bolt that is too long can damage the engine case beyond repair.

AN842-10D FITTING



- ☞ Drill a $\frac{45}{64}$ " hole at the bottom center of the sump cover plate in your kit.
- ☞ From the side with the doubler welded on, tap the hole with a $\frac{1}{2}$ " NPT tap deep enough so that when threaded properly, the supplied AN842-10D fitting will thread in almost completely and point to about 7:00 (down and to the left when facing it).
- ☞ From the engine side (without the doubler) trim the protruding part of the fitting with a hacksaw or grinder, being careful not to damage the sealing face where the gasket will make contact. Use a file to make precise adjustments.
- ☞ Remove the fitting, apply thread tape and reinstall to the same position. The oil suction fitting should not protrude through the cover plate.
- ☞ Apply a small amount of silicone RTV around the gasket surface on the sump cover plate paying particular attention to the area around the oil suction fitting. Allow the sealant to set before installing the cover plate.
- ☞ Remove the plug that was installed by the engine manufacturer and install the oil pressure switch at the location shown. Make sure the contact label is easily visible when installed. See the photo below.





While the engine is on the engine stand is a good time to install the magneto wiring. It is much harder to install this wiring after the engine is installed. Directions are found in Section 7, Page 12.

The engine conversion from horizontal to vertical will be completed with the installation of the engine oil system and the machined valve covers provided with your Kit.

The rear firewall should already be installed on the cabin before mounting the engine. Return the cooling fan and clutch drum to the crate.

The flywheel must be removed from the engine before transfer into the frame.

IMPORTANT - regardless of what type of ignition system you have, it will require some kind of reference for engine crankshaft position.

On magneto systems, this comes from the magneto drive gear in the accessory drive. For electronic systems, this could come from a direct crank sensor mounted under the flywheel, magneto gear sensor or some other source. Setting the ignition to fire at the appropriate time in the combustion cycle is known as “timing the engine”.

The flywheel is marked in several locations with relevant positions in regard to engine timing; however, these can be difficult to see with the engine mounted vertically. Before the engine is installed, take the time to mark the flywheel with the required reference marks to make timing easier in the future.

The flywheel “Top Dead Center” (TDC) location is marked on the flywheel as “0”. There is usually a line extending top to bottom through the “0”. On most prop flanges, the flywheel will only go on one way because one of the flange inserts is slightly larger. It fits into one slightly larger hole in the flywheel. Your prop flange may or may not have this indexing insert, so make sure the flywheel goes back on the same way it comes off.

- ☞ Note the position of the flywheel on the prop flange and mark the “0” index insert on the flange. Use an enamel paint or other permanent and durable marking material.
- ☞ Remove the flywheel from the prop flange, and locate the timing marks on the bottom side of the flywheel. Most electronic systems use 0°. Magneto systems use 20° or 25°.
- ☞ Mark the appropriate position on the top, bottom and ring gear. The starter will be contacting the ring gear, and may wear away all but the marking on the bottom of the gear tooth.
- ☞ On dual ignition systems (one standard magneto and one electronic magneto) mark both positions.

INSTALLING YOUR ENGINE

CAUTION

- * Before continuing, be sure the device used for hoisting the engine has been tested and is capable of supporting the full weight of the engine and hoisting adapter. Use weights rather than the engine to test the capacity if needed.
- * Ensure the hoisting device can be moved while under load as well.
- * Ensure all personnel involved in the engine transfer operation are familiar with the following safety guidelines prior to proceeding.
- * Never place any part of your body between the engine and the frame.
- * Never place any part of your body between the engine and the floor when the engine is in transit.
- * Always guide the engine during transit to avoid bumping the frame.
- * Always make sure the engine will clear all obstructions prior to changing directions.
- * Always make sure personnel are clear before lowering the engine.

Have the (4) AN8-41 engine mount bolts, (8) AN960-816 engine mount washers, (4) AN310-8 nuts, (4) AN380-3-4 cotter pins and (8) engine mount vibration absorbers ready to install.

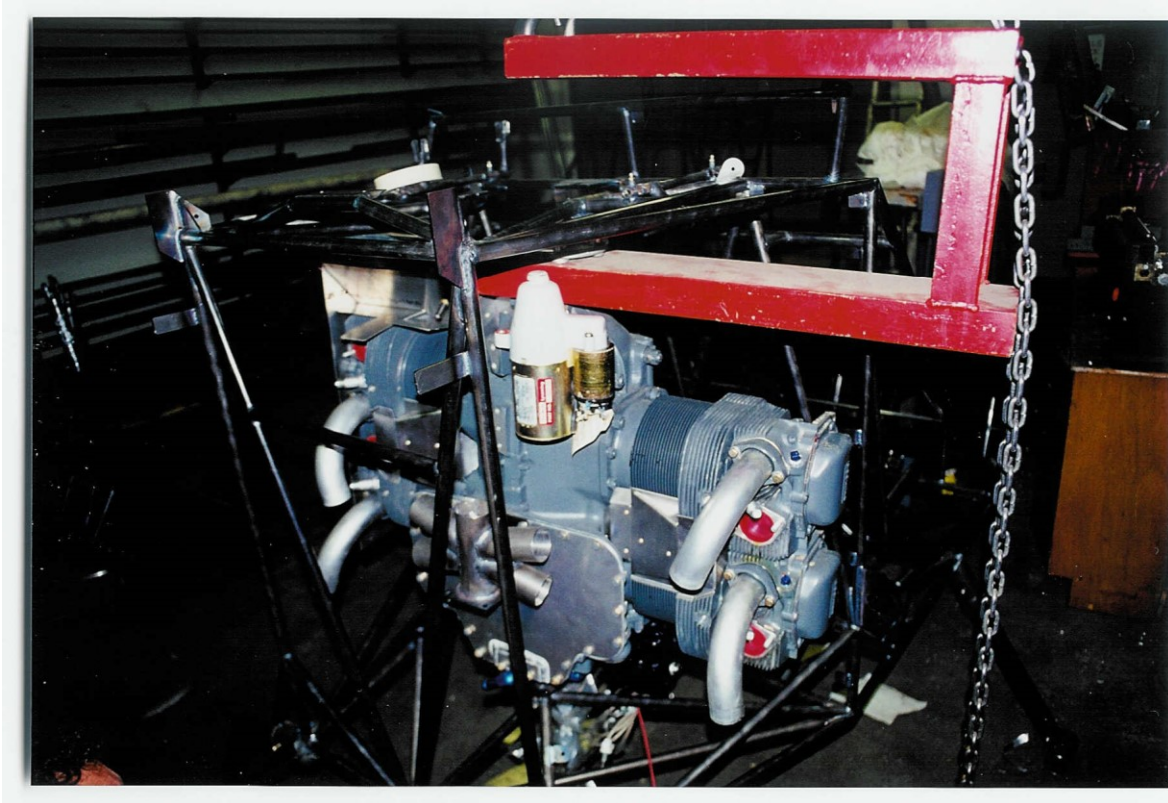
The order of installation, top to bottom is:

- * Bolt head
- * Washer
- * Absorber
- * Engine block
- * Absorber
- * Frame
- * Washer
- * Nut

An alignment tool will make things go much smoother once the engine is positioned in the frame.

NOTE: Additional washers may be required to level the engine in the frame.

A light coat of petrolatum (Vaseline) or silicone grease on and inside the absorbers may make installation easier. Do NOT use regular grease as this may cause them to break down prematurely.



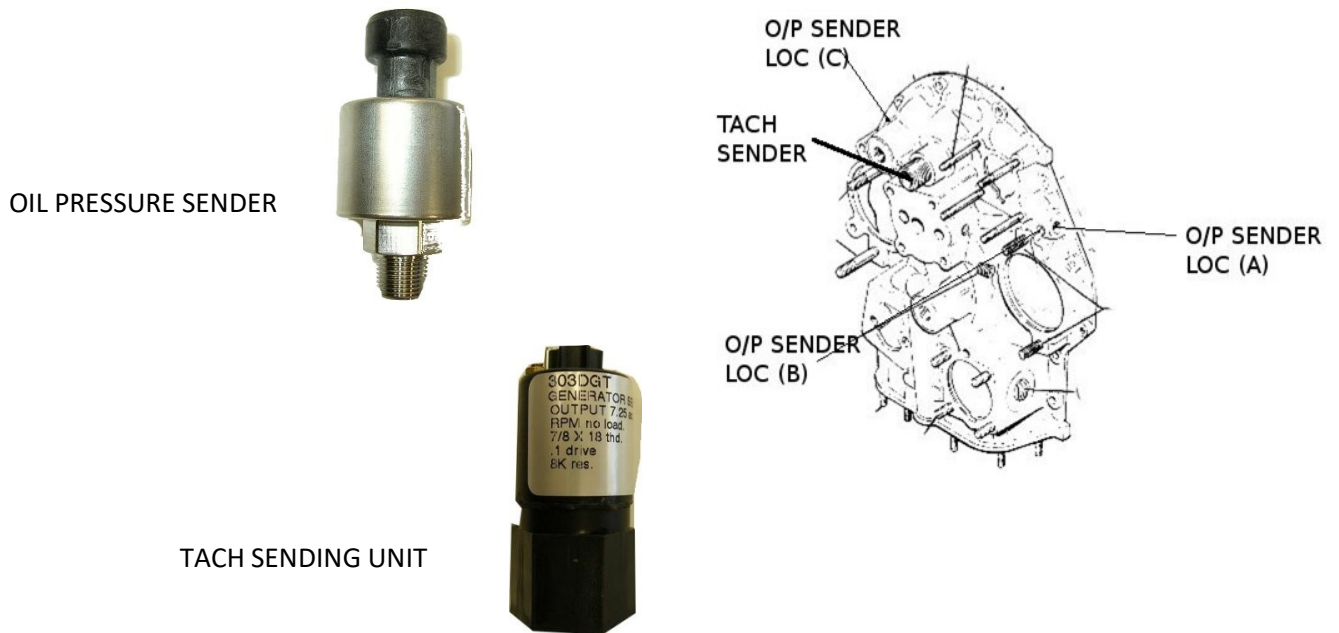
- ☞ Ensure the frame is positioned in-line and within reach of the hoist. Approximately 4 feet of travel is required.
- ☞ Attach the hoisting adapter under the prop flange of the engine. (See notes regarding builder supplied engines for information about installing engines with flywheel mounted direct crank sensors.)
- ☞ Attach the hoist to the hoisting adapter and slowly take out the slack.
- ☞ Carefully lift the engine until it is clear of the stand and slightly above the lower mount points in the frame.
- ☞ Move the engine into position in the frame, being careful not to pinch the shroud between the frame and the engine. Before lowering the engine, ensure all wires and hoses are clear and properly routed.
- ☞ Place all four absorbers on their respective mounting points. Install one bolt and upper absorber as a guide and carefully lower the engine.
- ☞ Do not place the full weight of the engine on the frame until all bolts are lined up. When all bolts are in place, lower the engine until the hoist adapter is not carrying weight. Loosely install the lower washers and nuts.

- ☞ The engine must be on the same plane as the airframe. The frame must be leveled, and the engine leveled to the frame. Using whatever type of level you have available, adjust the position of the frame to level front to back and side to side.
- ☞ Now level the engine at the prop flange. Additional washers may be needed under the engine.
- ☞ Remove the hoisting adapter, and check the engine for level at the prop flange again.
- ☞ Tighten the nuts until they are just snug, and make any minor adjustments to the level of the engine using the nuts. Be careful not to over tighten them. The absorbers should not appear “pinched”.
- ☞ Cotter pin the nuts.
- ☞ If you have used additional washers to level the engine, you may find that the AN8-41 bolts are not long enough to extend past the nut adequately. If this is the case, contact the factory for longer bolts. The bolts provided with the Kit will serve to keep the engine positioned correctly while you continue the project.

COMPLETING THE ENGINE AND INSTRUMENT WIRING

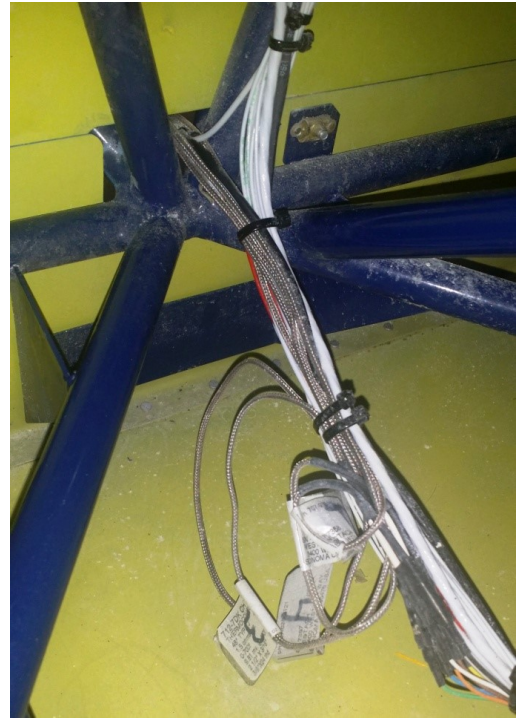
Once the engine is positioned in the frame and the alternator, starter, intake and carburetor are installed (carburetor installation instructions are found in Section 18 Fuel System Installation), wiring can be completed for the instrument senders that were installed before the engine was integrated, and additional instrument senders can be installed and wired.

- ☞ The engine oil temperature sender 399OT that was installed earlier at the base of the oil filter has two wires exiting the sender. One is connected to wire I from Group One and the other will connect to the Z wire from the Group One bundle. At this point, leave that wire to be spliced along with other sensor ground wires.
- ☞ Install the oil pressure sender in one of the locations shown. Use plumber's tape on the threads. A 45° 1/8" male/female fitting is provided in your Engine Conversion Kit in case it is needed to avoid interference with the magneto or shroud. Connect the red wire to J and the white wire to K, both from the Group One bundle. The black wire will be connected to Z.



- ☞ Remove one of the tachometer sending units and small drive tang from the Engine/Rotor Tachometer Kit provided in the Instrument and Electrical Kit. Use a small amount of grease to hold the tang in place, then thread the tachometer sending unit onto the engine. Attach the red wire of the engine tach harness to the #2 pin on the tach sender. Attach the black wire to pin #1.

- ☞ Remove the four CHT probes from the CHT Gauge Kit in the Instrument and Electrical Kit and install them into the cylinders, following the instructions provided with the gauge. Route the CHT probe cables down each side of the engine to enter the cabin through the lower center bulkhead opening.
- ☞ Connect each CHT cable to the correct wire of the CHT harness (from the instrument panel) just inside the cabin. Consult the instructions provided with the CHT gauge to match the correct sensor cable and harness wire. Loop the longer cables and secure them to avoid tension on the connectors.



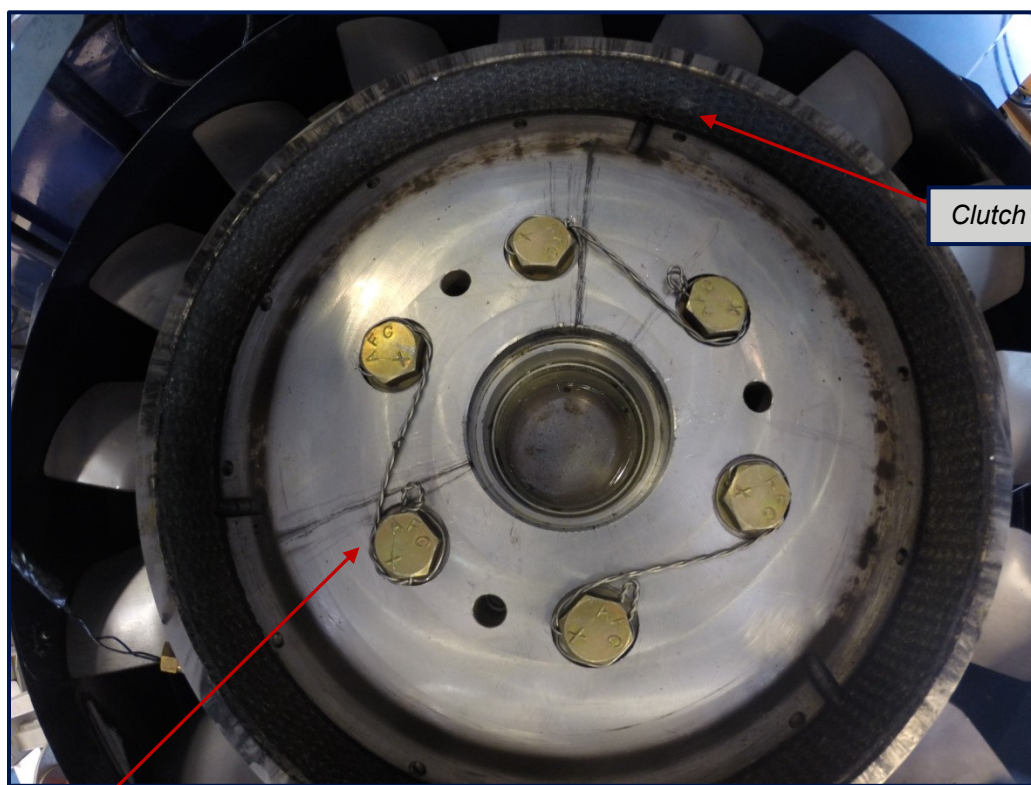
- ☞ If the carburetor temperature sender (installed on the carburetor before installation) has small silver tips on the wires, cut these off so that it can be spliced. Connect one wire to C from the Group One bundle exiting the cabin below the co-pilot's seat. The remaining wire is the third ground wire that will be connected to Z from the Group One bundle.
- ☞ Gather the ground wires from the carburetor temperature sender, oil temperature sender, and oil pressure sender. Crimp the 3 ends into one side of a blue butt connector, and secure the Z wire from the Group One bundle into the other end.
- ☞ The oil pressure switch wiring is completed by crimping a red female terminal to a short piece of 20 gauge wire and sliding it down over the C terminal on the switch and attaching to one of the screws on the engine for a ground. Use the same type of connector to connect the NC terminal to the D wire, and the NO terminal to the V wire.
- ☞ Attach the 64" white cable that you routed through the hole in the co-pilot's side of the cabin to the big lug on the starter using the nut provided on the starter.
- ☞ Terminate the wire which begins at the starter relay on the solenoid board with a ring terminal, and secure it to the smaller lug on the starter.
- ☞ Wire F is terminated with a blue female spade connector, and plugged into F on the alternator.
- ☞ Wire N is installed the same way on the N connection on the alternator.
- ☞ Wire 15 is terminated with a ring terminal and connected to the lug on the alternator using the hardware provided with the alternator.

- ☞ Ground the engine to the frame with the 5” white cable provided with the solenoid board. One terminal should be attached under the head of one of the bolts used to attach the oil sump plate. The other terminal should be attached to the grounding tab welded onto the frame. Use a wire brush to remove the paint from the tab to ensure a good connection. Thread an AN4H-5A bolt with an AN970-4 washer under the bolt head through the ring terminal, and secure with an AN960-416 washer and AN365-428 vinyl lock nut. Safety wire the bolt head.



INSTALLING THE FLYWHEEL, FAN AND CLUTCH DRUM

- ☞ Replace the flywheel on the prop flange, aligning it using the identifying marks you made on the flywheel before it was removed.
- ☞ The clutch drum and fan were already assembled when they were placed in the shipping crate. Remove them from the crate again, and place the assembly on top of the flywheel, aligning the bolt holes in the clutch drum to the holes in the flywheel. The clutch drum can be installed wherever the holes align.
- ☞ Use the AN8H-20 Bolts and AN960-816L washers to secure the clutch drum. Verify that you have all thin washers. Tighten the bolts in a star pattern to make sure the clutch drum is seated evenly. Torque to 28 ft/lbs. Safety wire the bolts as shown below.



Clutch drum lining

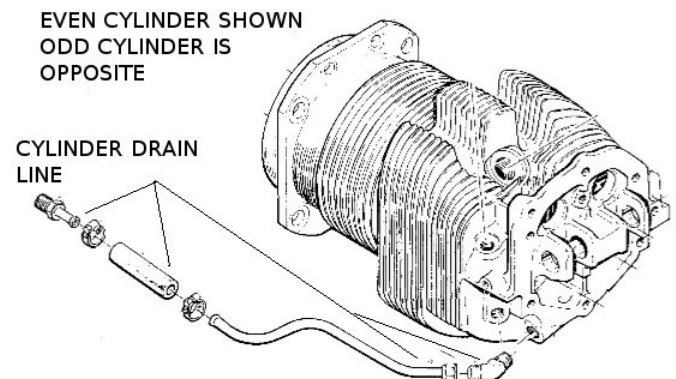
Clutch drum bolted to flywheel

NOTE: The following information may be useful if you have provided your own engine. If using a new factory engine, it will not apply.

Remove the fuel pump taking care not to damage the gasket. Using the gasket as a template, fabricate a cover for the fuel pump mount pad, using 0.125" aluminum plate or better. Clean the gasket surface of the accessory case prior to installation.

Install the cover plate and gasket. If installed, remove the engine crankcase vent nipple. If the nipple is pressed in, it must be plugged with a short piece of hose, a plug and hose clamps (This is common on older O-320 engines). If a threaded nipple was removed, install AN913-4D plug from kit with plumber's tape on threads. Safety wire the plug. O-320 engines may use AN844-6D fittings.

Remove 4 cylinder drain lines and fittings then install 8 AN913-2D plugs in cylinder heads and crankcase. Use plumber's tape on the threads.



Picture 5.10: Cylinder Drain Removal

NOTE: If the engine is equipped with a direct crank sensor under the flywheel, modification of the engine hoist adapter must be made to avoid damaging the sensor. Contact the factory for details.