Chapter 14 Fuel System

14.1 Introduction

This chapter includes installation of the fuel lines up to the firewall and the gascolator. Chapter 21 *Firewall Forward – Continental IO-550N* completes the fuel line installation. All the parts needed for this chapter are included in your kit.

The fuel system of the Lancair ES can be thought of as segmented.

- First the fuel runs through flexible lines from the wing tanks to the fuselage.
- Next the fuel is routed through flexible line forward to the fuel selector which is mounted between the pilot and copilot on the floor.
- Fuel from the selected tank then moves to the electric fuel pump mounted aft of the firewall.
- From the electric pump, the fuel is pushed into the gascolator where any water will settle to the bottom of the gascolator and not reach the engine.
- Then the engine-driven fuel pump draws fuel out of the gascolator, decides how much the engine needs, and supplies only that amount to the intake manifold. Using the fuel injected Continental IO-550, the engine will return unused fuel to the wing tanks through smaller return lines.

The fuel system described is for the Continental IO-550. Other engines may require modifications to this chapter, but the basic concept of fuel supply and return are essentially the same.

Note: Fuel lines have changed from 3/8” (9 mm) to 1/2” (12 mm). Older kits may still have the 3/8” (9 mm) hoses.

Steps to Completion

First, review Chapter 2, 2.3.I *Working with Braided Hose* on page 2.25.

- Drill holes in the fuselage, within the wing fairings, for routing lines.
- Measure and cut the flexible fuel lines.
- Install the lines from the fuselage to the wings.
- Install the fuel selector valve.
- Drill holes in the forward seat support for the fuel lines.
- Connect the flexible fuel lines running from the wings to the fuel selector valve.
- Install the electric fuel pump
- Connect the electric fuel pump to the fuel selector valve.
- Run the fuel return line from the firewall to the fuel selector valve.

14.2 Parts List

Fuel supply lines

Item	Part Number	QTY	Description
1)	FU7-2A	2	Finger strainers for fuel supply lines from wing
2)	RS3002		Steel-braided hose for fuel supply lines (#8)
3)	RS1003	4	Fitting (size #8) straight end
4)	RS1017	2	90° elbow fitting
5)	6061T6-.500x035		1/2" (12 mm) dia., .035" (0.09 mm) wall, aluminum tubing
6)	AN818-8D	4	Fitting nut, coupling
7)	AN819-8D	4	Fitting sleeve, coupling

Fuel return lines

Item	Part Number	QTY	Description
1)	RS3000		Steel-braided hose for fuel return lines (#4)
2)	RS1001	4	Fitting (size #4) straight end
3)	RS1015	2	90° elbow fitting
4)	AN833-4D	1	Bulkhead fitting
5)	AN924-4D	1	Fitting nut, bulkhead

Other fuel system parts

Item	Part Number	QTY	Description
1)	PH-250	3”x 3”	Phenolic base for fuel selector
2)	597-A	1	Fuel selector assembly with fittings - AN822-8D (2) for fuel supply line to fuel selector - AN822-4D (2) for fuel return line to fuel selector

Other fuel system parts (Continued)

Item	Part Number	QTY	Description
3)	MS24694-S100	4	Screws
4)	AN365-428A	4	Locknuts
5)	Rubber hose		2’ (600 mm) of rubber hose
6)	Zip ties		For securing the rubber tubing to the fuel lines
7)	~~5456~~ 5455-00-1 (12 volt) ~~5457~~ 5457-00-1 (24 volt)	1	Fuel pump
8)	4042	1	Fuel pump mount (optional)
9)	C5315 x 8 x 6	2	Fittings for fuel pump
10)	229-4-1	1	Hose elbow fitting
11)	MS27769-1D	1	Plug
12)	5052-.25x035		1/4” (6 mm) aluminum tubing
13)	44-NSR		1/4” (6 mm) Nylo-seal tubing
14)	~~5416K23~~ 145-0008		Hose clamps
15)	229-4-1	1	Optional fuel boost pump

14.3 Construction Procedures

14.3.A Making and Installing the Wing to Fuselage Lines

The fuel lines are connected using stainless steel braided hoses. These hoses connect the fuel tanks in the wing to the fuselage's bulkhead fittings.

Before you start working on the fuel lines, make sure you review the techniques for working with braided hose. You need to know how to cut the hose and how to install fittings on the ends of the hose. Review the information in Chapter 2, 2.3.I *Working with Braided Hose* on page 2.25.

In addition, keep the following recommendations in mind as you work on the fuel lines.

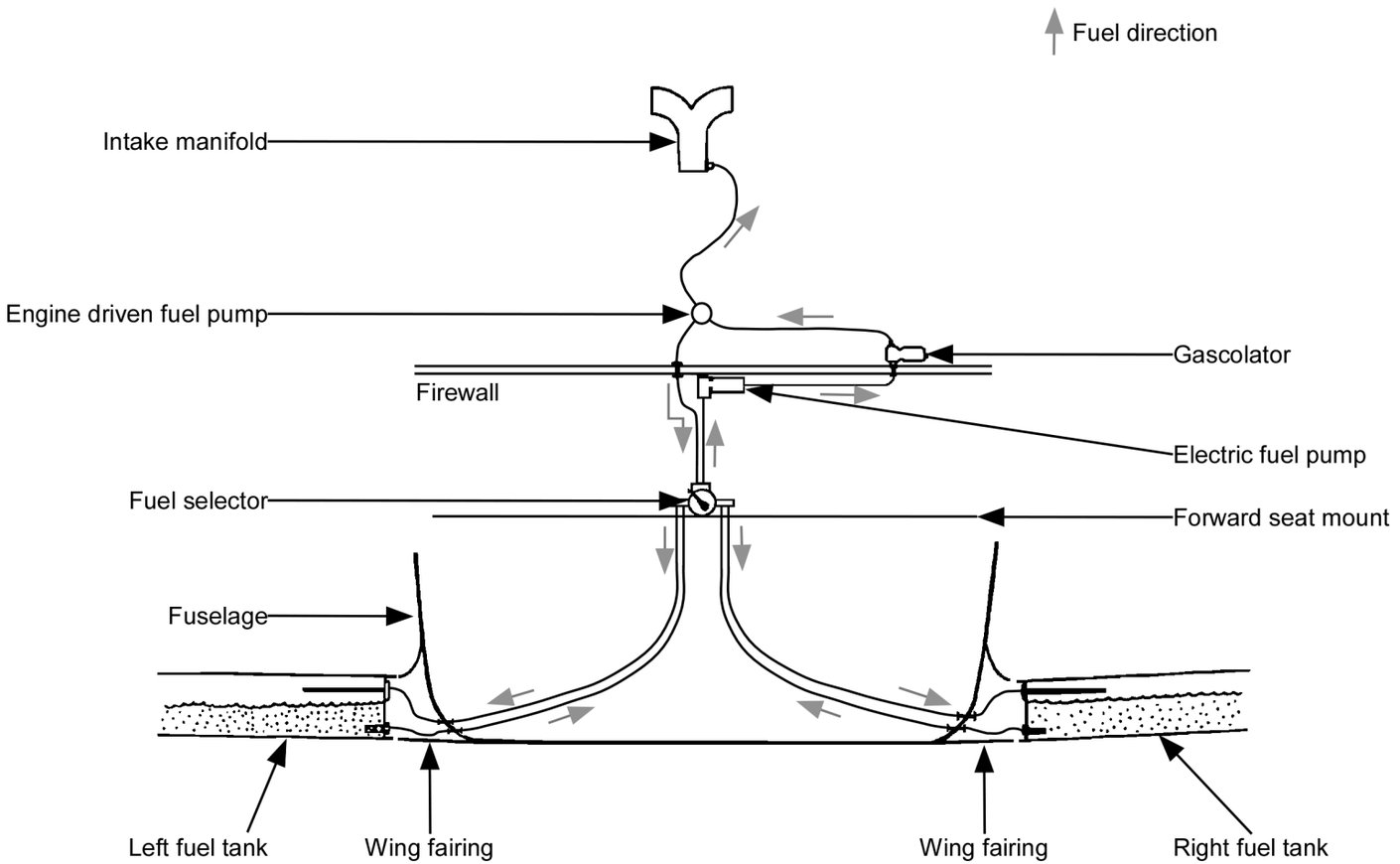
Measuring and working with braided hose:

- The length of the hose is determined by measuring from the very tips of the flared ends of the fittings. Try to measure along a smooth arc between the fittings to avoid kinking the hose from over bending. Subtract about 1/2" (12 mm) from the measurement to find the actual hose length.
- There are no absolute rules in hose measurement.
- Try to avoid kinking the hose.

Fuel lines and sealing compounds:

- Do not use any type of sealing tape in the fuel system. Teflon tape has the potential for breaking loose and running into the engine.
- Flared-end fittings do not require any form of sealant.
- Pipe-thread fittings should be sealed using a teflon based sealant paste. We recommend Loctite 592 Teflon sealant.
- When applying the sealant paste, start approximately 1-2 threads back on the fitting to avoid contamination of the fuel.

Figure 14.3.A.1 Fuel system schematic



Drilling the Fuselage Openings for the Fuel Lines

The fuel and fuel return lines enter the fuselage in the forward section of the wing fairing, in front and below the aileron control tube hole.

You will insert the fuel lines; one from the fuel to the engine, and the other for fuel returning from the engine. The fuel supply line travels through 1/2” (12 mm) braided hole from the bulkhead fitting up to the fuel selector valves and then to the electric fuel pump.

Steps...

1. Drill the holes for the fuel lines in the locations shown in Figure 14.3.A.2.

   Use a 7/16" drill for creating the holes.
2. Cut four 3” (75 mm) pieces of rubber hose from hosing slightly larger than the fuel lines.
3. Cut lengthwise through each 3” (75 mm) piece so it is no longer a continuous, circular piece.

   You should be able to open up the 3” (75 mm) piece and slip it on the fuel lines.

Finger strainers. If you haven't installed the finger strainers (FU7-2A) into the inboard end of the wings, do so now. Refer to Figure 14.3.B.3 to see the finger strainer.

Installing the Fuel Lines through the Drilled Holes

Steps...

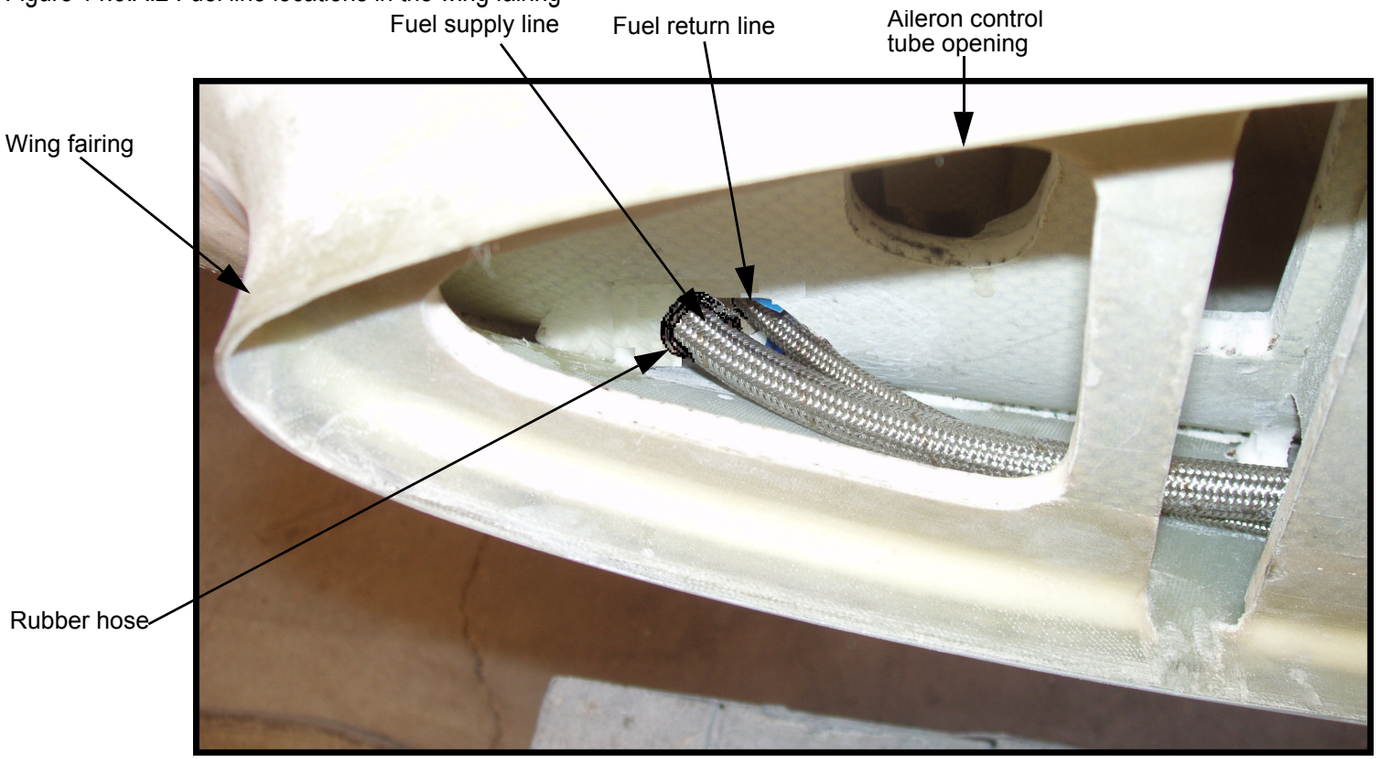
1. Measure the stainless steel hose and cut two of each. Use RS3001 for the fuel return lines and RS3000for the fuel supply lines. Cut two of each.

   Length These lines will run from the fuel selector, between the front seats, to the connections on the inboard end of the wings. Make sure you leave extra length for when you need to remove the wings. You will need enough to slide the wing out so you can reach in and disconnect the fuel lines.
2. Place each piece of rubber hose around each fuel line.
3. Slide the rubber hose into the hole in the fuselage.

   The rubber hose protects the fuel lines from chaffing against the edges of the holes in the fuselage.
4. Use a zip tie on each side of the fuselage wall, around the rubber hose. Snug the zip tie so the fuselage line is secure inside the rubber hose.

   Make sure you have left the correct length of braided hose on each side of the zip tie before you snug the ties.

Figure 14.3.A.2 Fuel line locations in the wing fairing



14.3.B Installing the Fuel Selector

The fuel selector is mounted on the floor of the cabin between the pilot and copilot seats.

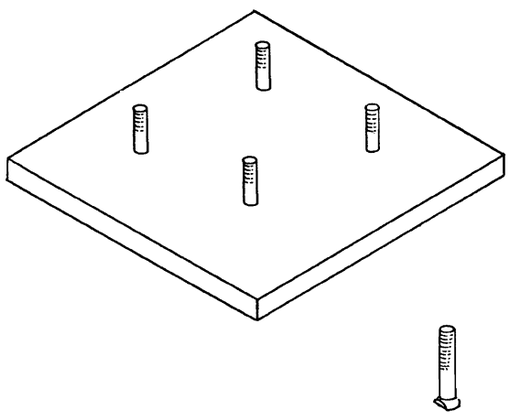
Steps...

1. Cut a piece of 1/4" thick phenolic, 3-1/2" x 3-1/2" (90 x 90 mm).

   This will be the mounting base for the fuel selector.
2. Mark the fuel selector mounting hole locations onto the phenolic base using the base of the fuel selector.
3. Drill 1/4” (6 mm) diameter holes through the phenolic at the marked locations.
4. Countersink these holes on the bottom to accept four screws (MS24694-S100).
5. Grind the four screws (MS24694-S100) so each one has a flat section on its head.

   This will prevent the head from rotating when used as a stud.

Figure 14.3.B.1 Fuel selector mounting base



6. Use epoxy/flox to bond the four screws you just modified.

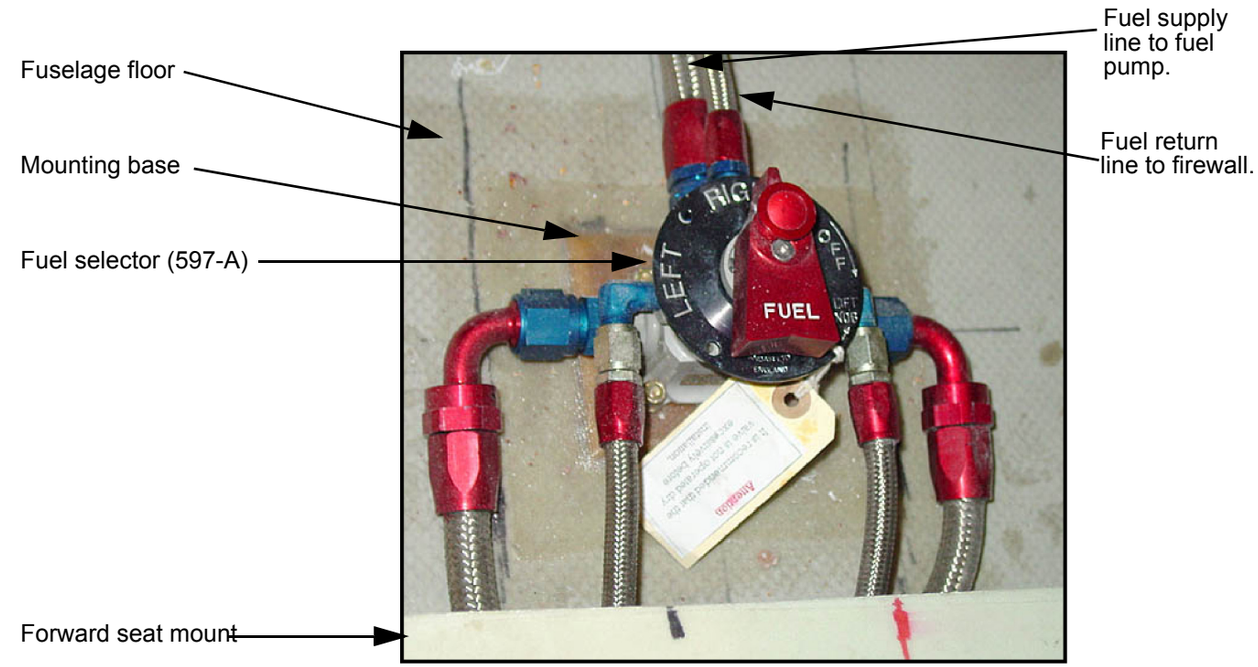
   Tip: Make sure the epoxy/flox does not get on the threads of the screws. The threads must be clean.
7. Locate the fuel selector and mounting base so the center of the handle is forward of the forward seat mount.

   The fuel selector can be mounted up to 7" (180 mm) forward of the forward seat mount or you can mount the selector closer to the forward seat mount.
8. Sand the bottom of the phenolic mounting base.
9. Install the mounting base by bonding it to the fuselage with epoxy/flox.

   Tip: Remember to sand and clean the fuselage where you are bonding and glassing.
10. Reinforce this bond with 2-BID, overlapping onto the fuselage 1" (25 mm) around the phenolic.

    The BID will have to be cut to fit over the mounting studs.
11. Secure the fuel selector to the phenolic mounting base with locknuts, AN365-428A.

Figure 14.3.B.2 Fuel selector on the mounting base



Finishing the Fuselage to Wing Fuel Lines

Follow this procedure for the left wing fuel lines and then for the right wing fuel lines.

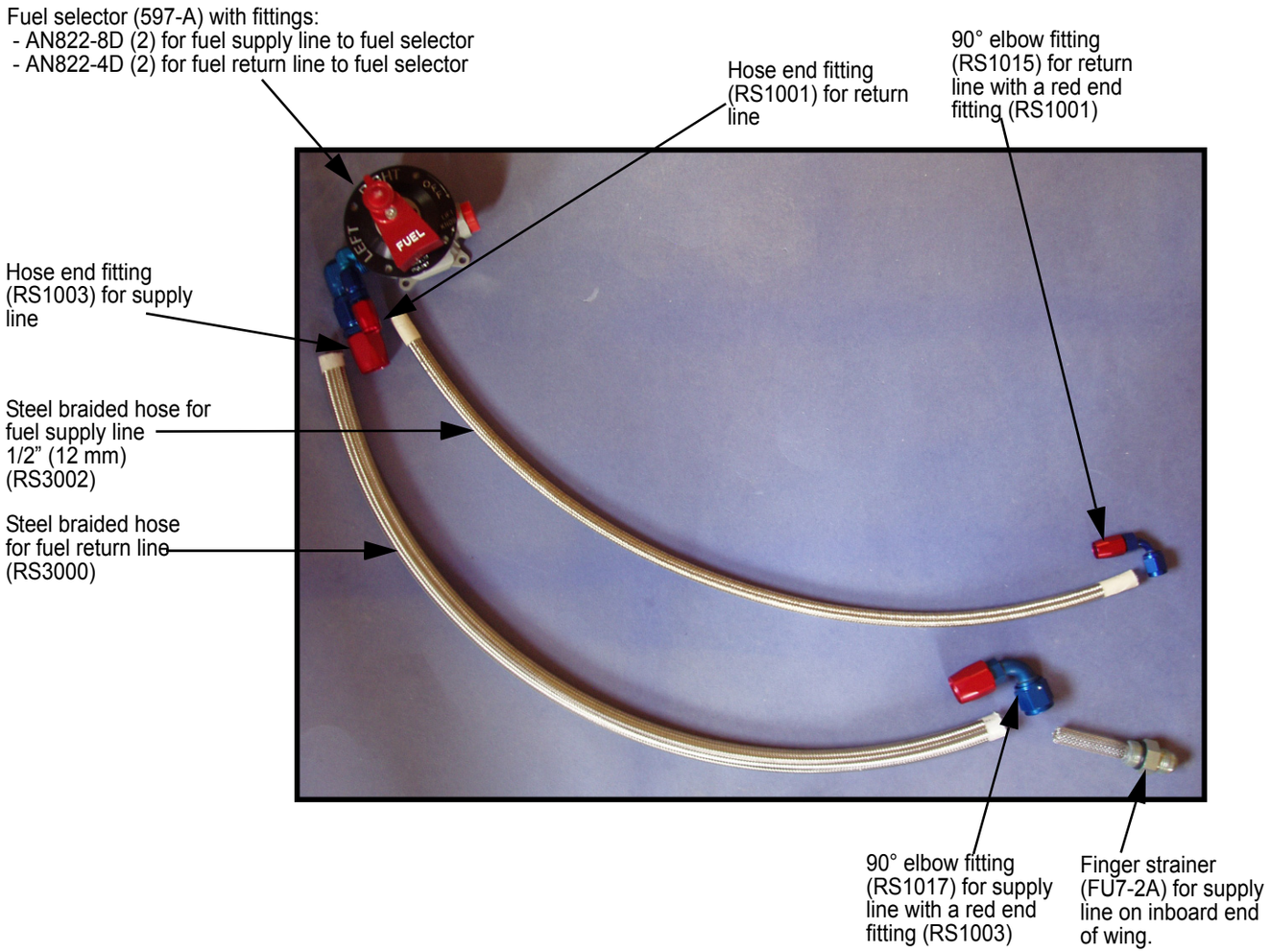
Steps...

1. Put a hose end fitting (RS1003) on the end of the steel braided hose for the fuel supply line on the wing fairing end.
2. Connect a 90° elbow fitting (RS1017) to the end of the supply line.

   WARNING: DO NOT use pipe sealing compound on flared threads!
3. Put a hose end fitting (RS1001) on the end of the steel braided hose for the fuel return line on the wing fairing end.
4. Connect a 90° elbow fitting (RS1015) to the end of the return line.
5. Grind entrance holes through the forward seat mount for the fuel supply and fuel return lines.

   Forward Seat Mount – Grind two holes, one for the lines to the left wing and one for the lines to the right wing. Each hole needs to be large enough to accommodate both the fuel supply and the fuel return lines.
6. When you are satisfied with the size and shape of the holes, remove the core and fill with micro. It is perhaps best to wait with this until you have made a trial fit with the fuel lines.

Figure 14.3.B.3 Fuel line connections for the selector valve and the inboard end of the wings



Tip: The fuel supply line on the forward side of the selector has an O-ring and does not require any pipe sealing compound on its threads. All other fittings in the selector should have sealing compound applied to their threads as discussed earlier in this chapter. See *Fuel lines and sealing compounds:* on page 14.3.

Routing the Fuel Lines in the Fuselage

Using the flexible hose lines that you inserted through the fuselage openings, route the fuel supply and return lines are in the fuselage as follows:

- Aft from the fuel selector through the holes you drilled in the forward seat support.
- Between the forward seat support and the shear web bulkhead to the holes you drilled in the fuselage side in *Drilling the Fuselage Openings for the Fuel Lines* on page 14.4.

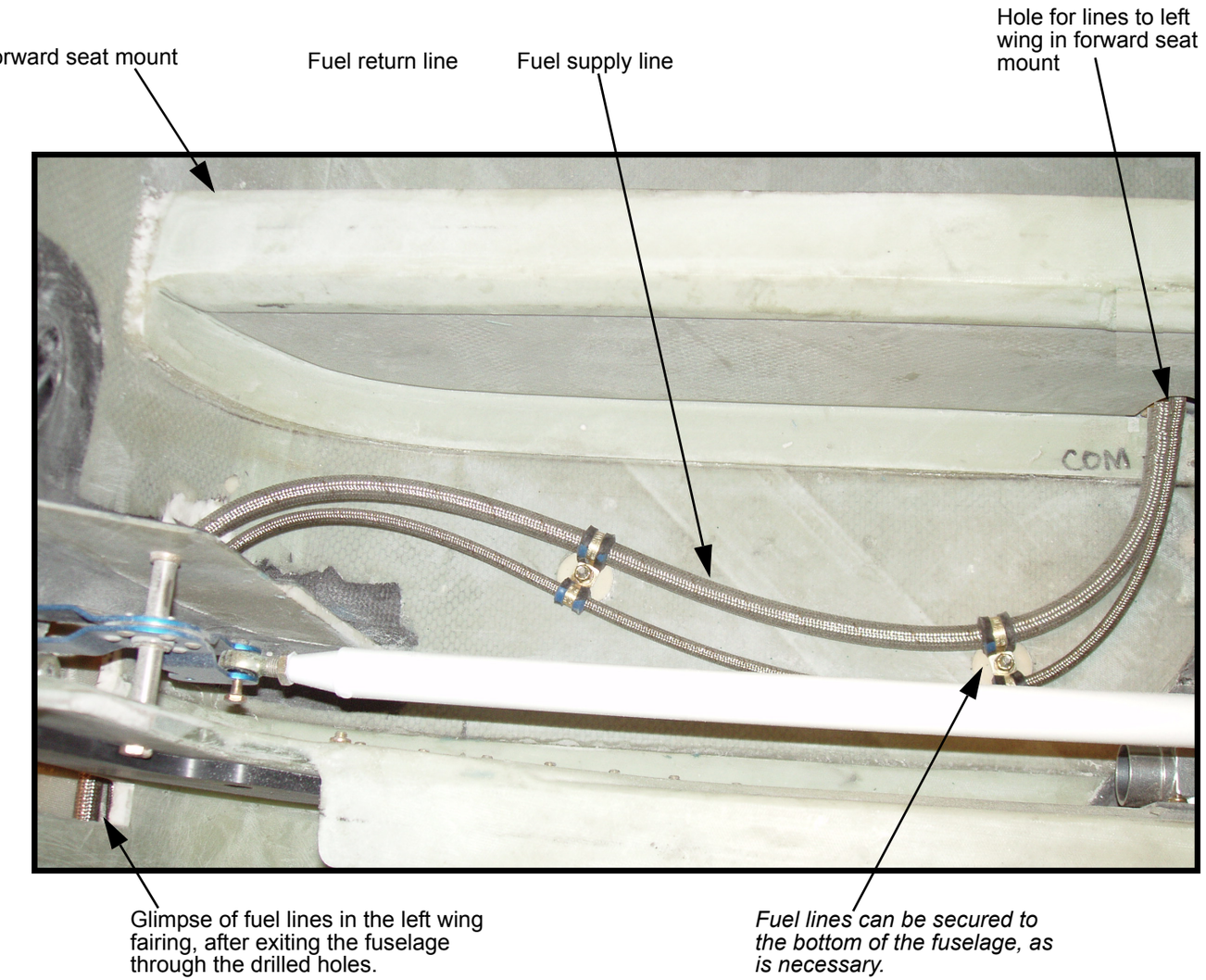
You can also refer to Figure 14.3.A.1 Fuel system schematic to review the routing of the fuel lines.

This completes the fuel fittings and hoses between the wing and the fuselage. The braided stainless steel hoses are extremely resistant to kinking, but we recommend that you double check each line.

Maintenance tip

The flexible hose connections need to be disconnected at the wing when the wing is installed or removed. If you are maintaining your ES, please drain the fuel before you disconnect the hoses from the bulkhead fittings.

Figure 14.3.B.4 Fuel supply and return lines aft of the forward seat mount



14.3.C Installing the Electric Fuel Pump

From this point in the installation, your fuel system can vary to accommodate your specific engine. This manual will describe a fuel system tailored to the Continental IO-550 engine.

The electric fuel pump is centered on the aft side of the firewall, saving valuable firewall space and protecting the pump from heat.

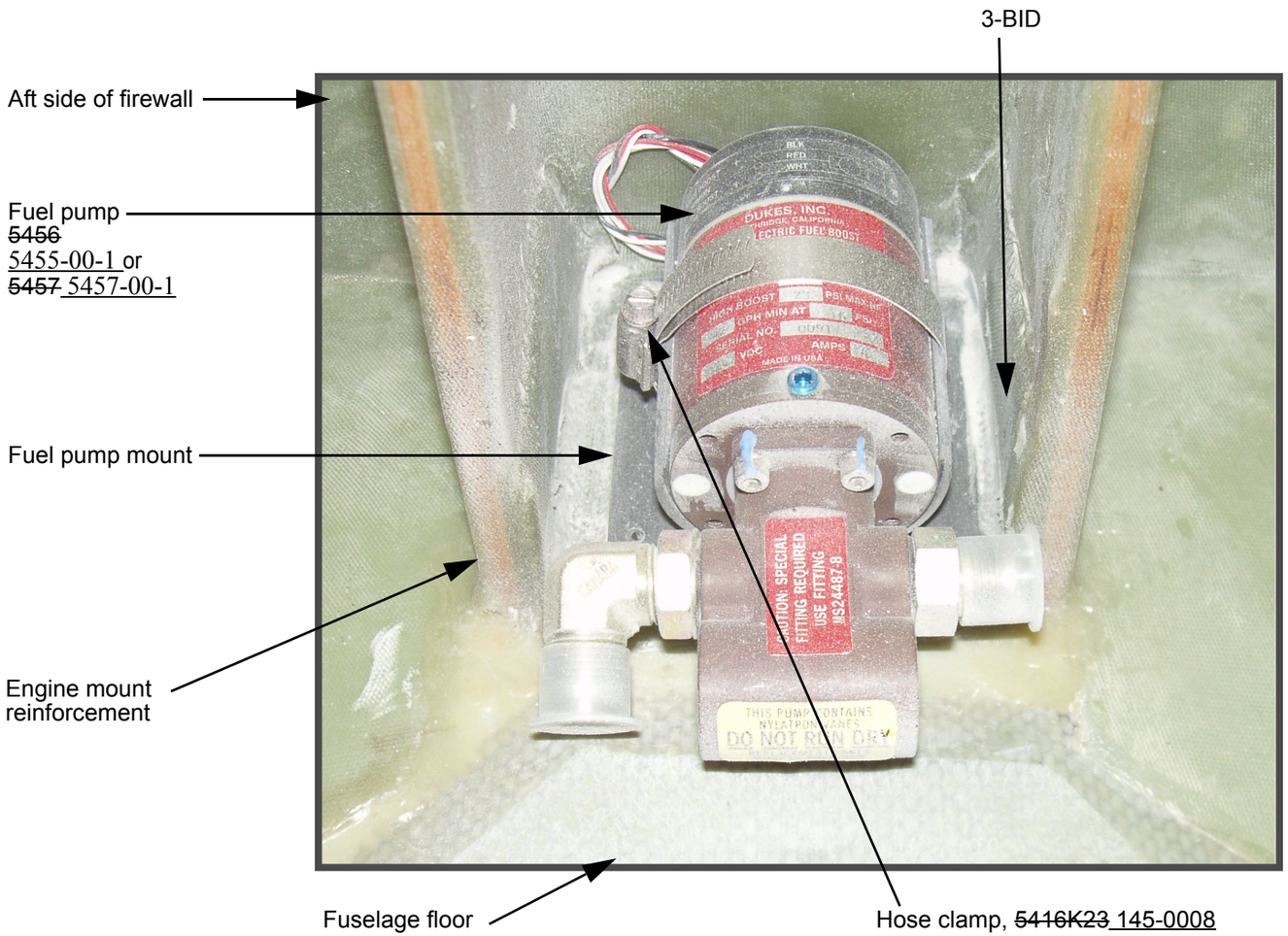
The Dukes, two stage electric fuel pump, is the recommended brand. This pump has a high boost for priming the engine (and for emergencies) and a low boost for maintaining consistent pressure to the engine driven pump. At high altitudes (12,000 ft. +), the electric fuel pump generally runs on low boost to pull the fuel from the wing tanks forward to the engine. An engine "surging" can result from laboring the engine at altitude without the low boost position. In the event of an engine-driven fuel pump failure, the high boost pump is used to force the fuel past the engine-driven fuel pump.

The Fuel Pump Mount

The fuel pump is mounted using a new part from KCI. Order the following depending on the fuel pump you are installing.

- ~~5456~~ 5455-00-1 for the 12-volt fuel pump
- ~~5457~~ 5457-00-1 for the 24-volt fuel pump

Figure 14.3.C.1 Mounted fuel pump



Locating and Securing the Fuel Pump

The picture on this page, Figure 14.3.C.2, shows the recommended method of positioning the fuel pump.

Steps...

1. Position the fuel pump and mounting bracket centered between the rudder pedals and aft of the firewall as shown in Figure 14.3.C.2.
2. Secure the bracket to the fuselage with a thick epoxy/flox mixture along the bottom.
3. When the flox has cured, reinforce the bracket/fuselage joint with 3-BID.
4. Coat the threads of two C5315 x 8 x 6 fittings with teflon impregnated pipe compound for sealing.
5. Thread a fitting into each end of the fuel pump.
6. Secure the fuel pump to the mounting bracket.

Venting the Fuel Pump

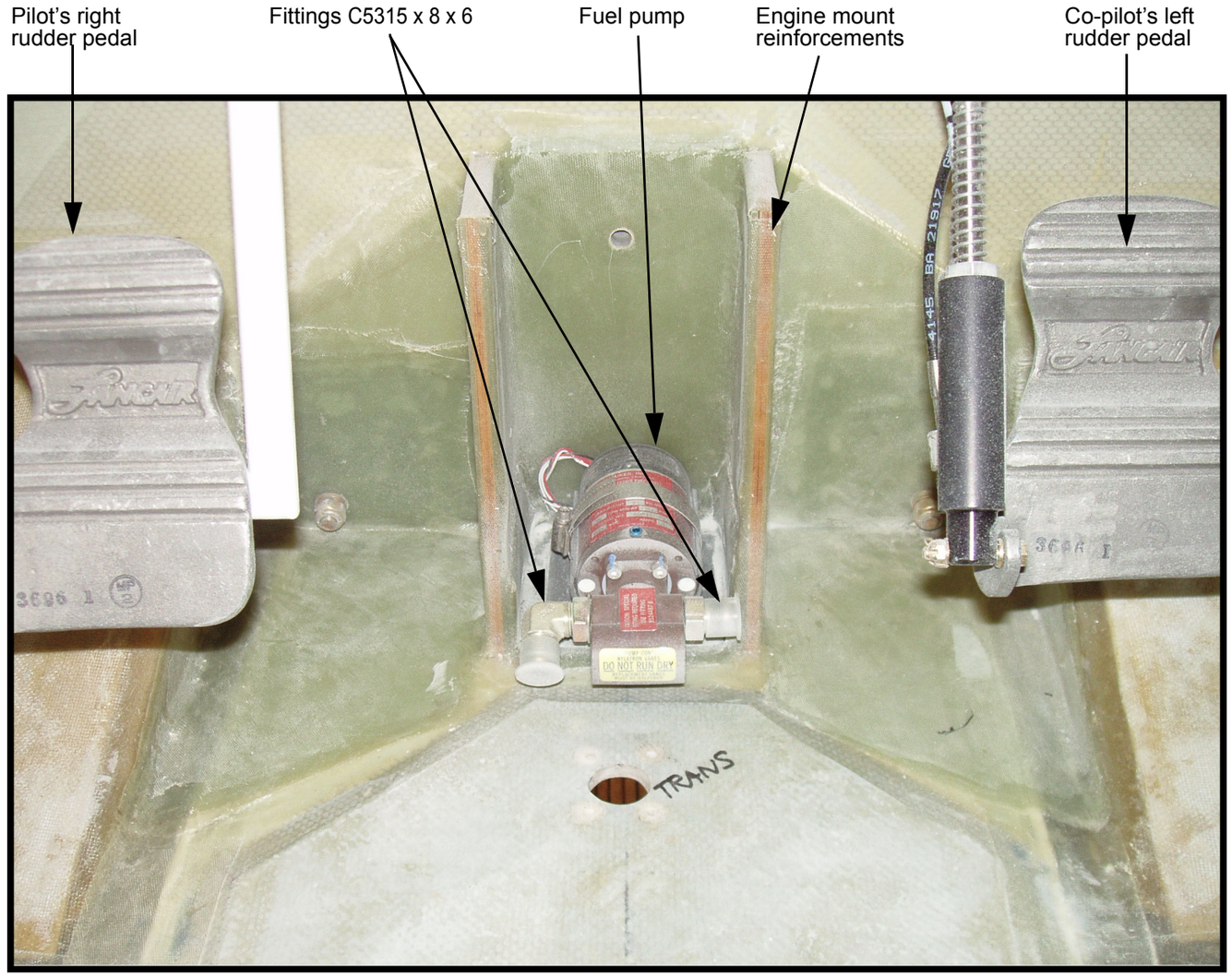
Steps...

1. Thread a 229-4-1 hose elbow fitting into the inboard vent hole of the fuel pump.
2. Cap off the outboard vent hole with an MS27769-1D plug.
3. Vent the pump outside of the cabin.
   - Use epoxy/flox to pot a 2" (50 mm) length of 1/4" dia. (6 mm) aluminum tubing through the bottom fuselage shell.
   - Connect the aluminum tube to the 229-4-1 fitting with 1/4" dia. Nyla-seal tubing (44-NSR).
   - Secure the tubing at each end with a hose clamp.

Exact lengths and position of the aluminum and plastic tubes are not critical since this is just a safety vent. The Fuel Pump Kit includes all required fittings and hoses.

Note: If you use a boost pump (229-4-1), it requires a vent to the outside. Note the two vent ports on the lower part of the cylindrical body. Either one can be used for the vent and the other must be plugged.

Figure 14.3.C.2 Locating and securing the fuel pump bracket to the fuselage



Connecting the Fuel Selector to the Fuel Pump

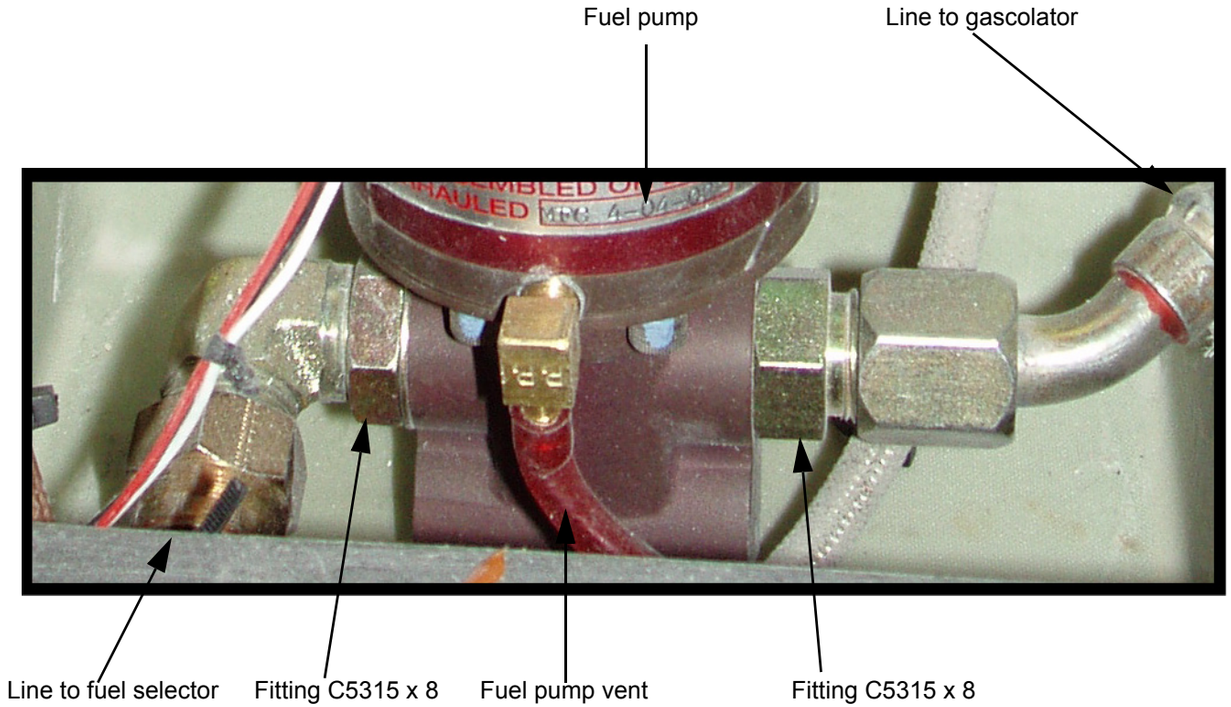
Now you will complete the fuel pump's connections.

Steps...

1. Route the fuel supply line coming from the fuel selector to the electric fuel pump using 1/2" (12 mm) dia., .035" (0.09 mm) wall, 6061-T6 aluminum tubing.
2. Use AN818-8D nuts and AN819-8D sleeves at each flared end of the 1/2" (12 mm) tube.
3. C5315 x 8 fittings are used in both forward and aft ends of the fuel pump.

The line to the gascolator will be completed in *Chapter 21 Firewall Forward – Continental IO-550N* in *Connecting the Gascolator* on page 21.37.

Figure 14.3.C.3 Fuel selector to fuel pump and gascolator



14.3.D Installing the Fuel Return Line to Firewall

Unused fuel flows back from the firewall to the fuel selector valve through a 1/4" (6 mm) dia. aluminum tube. This tube is connected to the lower, forward fitting of the fuel selector valve and a bulkhead fitting on the firewall.

Steps...

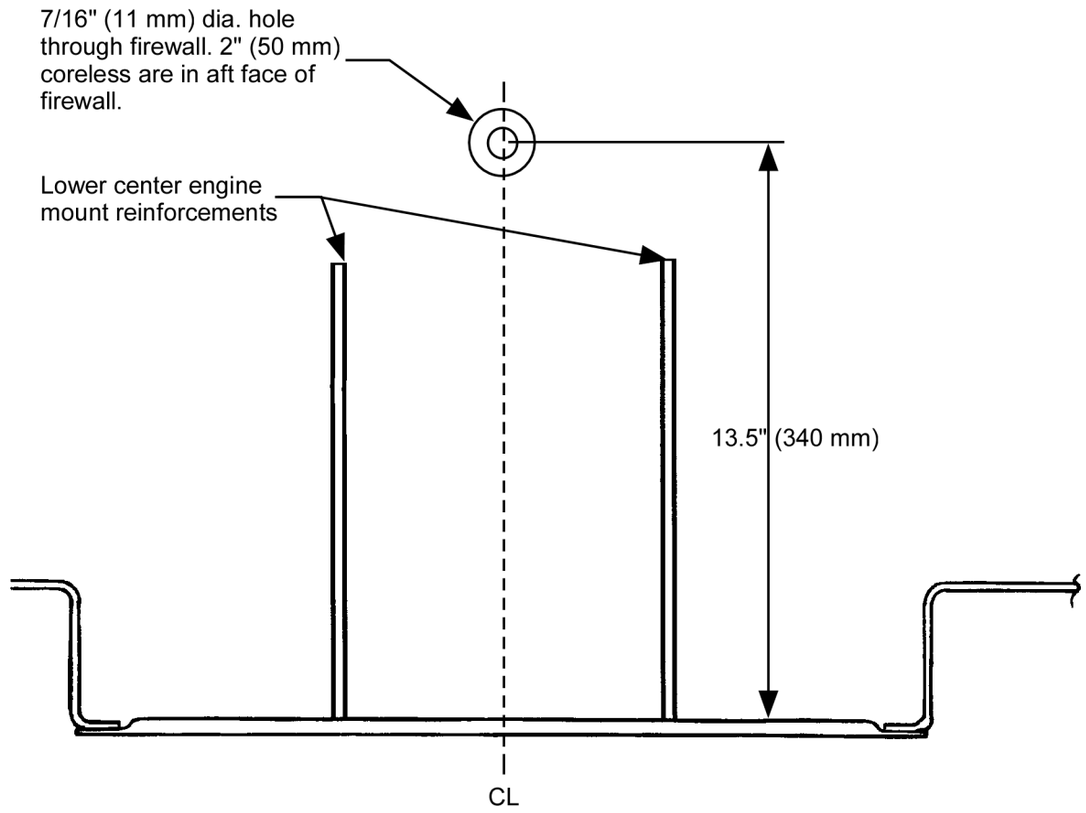
1. Find the location on the firewall for creating a hole for the bulkhead fitting.

   Location parameters:

   - Approximately 12-14” (300-350 mm) above the fuselage floor,
   - Between the engine mount reinforcements. See Figure 14.3.C.1 for their location.
2. Cut out a 2" (50 mm) diameter section of the firewall's aft laminate and core.
3. Sand and clean the circular cut out area and the surrounding laminate in preparation for BID.
4. Apply a 4-BID patch to the circular cut out area, overlapping 1" (25 mm) onto the original aft laminate all the way around. Use a thick epoxy/micro mixture to radius the exposed core areas underneath the BID.
5. When the 4-BID has cured, drill a 7/16" diameter hole in the center of the coreless circle.

   The hole needs to accommodate an AN833-4D bulkhead fitting.

Figure 14.3.D.1 Fuel return line – firewall to the selector

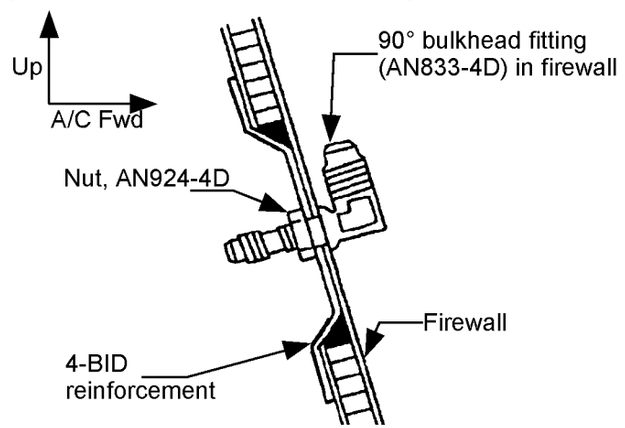


6. Secure the AN833-4D bulkhead fitting to the firewall with an AN924-4D nut.
7. Bend a 1/4" (6 mm) dia., .035" (0.9 mm) wall, 5052-0 aluminum tube to connect the AN833-4D bulkhead fitting with the lower, forward AN816-4D fitting in the fuel selector.
8. From the fuel selector, route the tube as follows:
   - Forward past the instrument panel,
   - Around the nose gear tunnel,
   - Along the lower right corner of the tunnel,
   - And up close to the firewall to the bulkhead fitting.

   Refer to Figure 14.3.C.3 to get an idea of the general routing of this tube.
9. Flare each end of the tube.
10. Use AN818-4D nuts and AN819-4D sleeves to connect the tube to the fuel selector and the bulkhead fitting.

    See Figure 14.3.B.3 for the connection location on the fuel selector valve.

Figure 14.3.D.2 Parts for bulkhead fitting



This completes the fuel lines aft of the firewall. In Chapter 21 *Firewall Forward – Continental IO-550N* you will complete the fuel lines forward of the firewall.

Figure 14.3.D.3 Bulkhead fitting in the firewall and tube routing