
25. Engine cowlings

The upper and lower engine cowlings are trimmed to fit together and fit into the joggle at the front of the fuselage for mounting. The cowlings are held together using countersunk screws through Tinnerman washers into anchor nuts mounted to the lower cowling. Attachment of the cowlings to the fuselage is also by means of similar screws and anchor nuts.

The only trimming that should be required is for the removal of the flat area at the rear of the air outlet ramp in the lower cowling and the shark gill type outlets in the upper cowling. The latter outlets ensure no hot air can collect around the battery and other components that will be mounted on the footwells.

Installation

Mark a line on the upper cowling 13mm ($\frac{1}{2}$ ") away from and parallel to the horizontal edge. Mark the centres for the holes to join the two cowlings together according to the drawing in figure 1.

Place the two cowlings together and hold them with clamps or adhesive tape then try them in place on the front of the fuselage.

Trim the bottom edge of the top cowling if necessary so that both cowlings can sit snugly in place then drill through the centres with a 3.2mm ($\frac{1}{8}$ ") drill. Use clecos through some of the holes to hold the cowlings together.

Set the fuselage up to be level and position the cowlings into the joggle at the front of the fuselage. Using the cowling split line as a reference, set the cowlings level and ensure the dimension to the split line up from the fuselage joint line is equal both sides.

To ensure that the cowlings are set straight ahead, use the reference centre lines, which can be found on the fuselage and cowling mouldings at 254mm (10") intervals. The centre of the propeller hole should be at the same height above the fuselage joint line as the split line of the cowlings.

Trim the rear edge of the cowlings if required to ensure a good fit to the fuselage then mark a line, on both cowlings, 13mm from and parallel to their rear edges. Mark the hole centres according to the figure and drill through with a $\frac{1}{8}$ " drill and use clecos to hold them in place.

Enlarge the holes joining the two cowlings together to 4.8mm ($\frac{3}{16}$ "), except for the rearmost hole each side, and install MS21047-3 anchor nuts (14 in total) to the inside of the lower cowling with TLPK33BS countersink rivets.

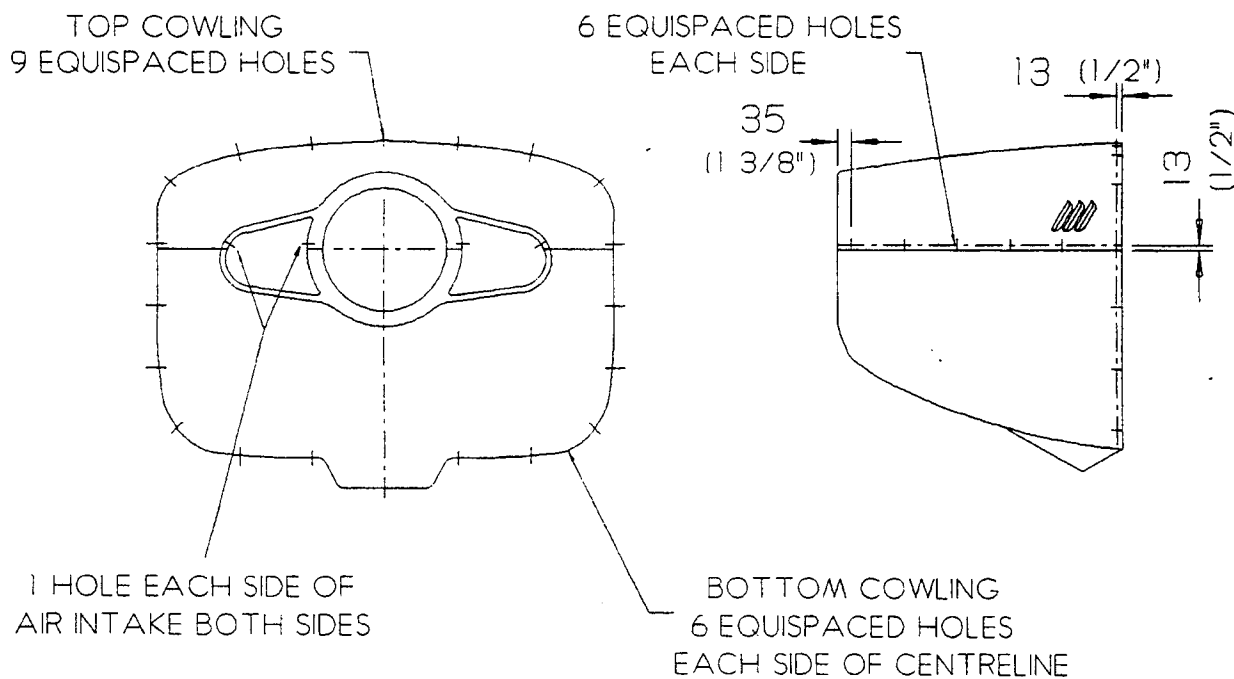
The remaining holes should also be opened to 4.8mm and MS21047-3 anchor nuts installed to the inside of the fuselage using countersink rivets. As the thickness of the fuselage where the anchor nuts are to be located will vary depending on their position a selection of 3.2mm diameter countersink rivets are provided. Use the shortest rivet that you can for attaching each anchor nut into the fuselage.

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Countersink the outside face of all the holes of the upper cowling and the rearmost holes only of the lower cowling, except the upper rear holes, to allow the Tinnerman washers to lie flat against the cowling surface. The cowlings may now be fitted using the AN507C-1032R12 screws.

Shorter MS24693-C272 screws may be used for joining the two cowlings together and these may be long enough to be used in some places securing the cowlings to the fuselage however, note that the lower inboard screws need to be longer than the rest.



Engine Controls

The Rotax 912 has two independent carburettors, one each providing a fuel/air mixture to one pair of cylinders.

The only mechanical controls required for the carburettors are throttle and choke.

Although there are two independent throttles and chokes, there is only one throttle and one choke control in the cockpit.

Throttle Control

A single lever, protruding through a slot in the top of the wheel well beside the landing gear retraction lever, provides the pilot with throttle control. The lever is mounted and pivots in a fibreglass housing fixed to the underside of the wheel well, and operates two separate cables.

Throttle Lever Housing

To make the throttle lever housing, first make a former, using scrap styrofoam, according to the drawing in figure 1.

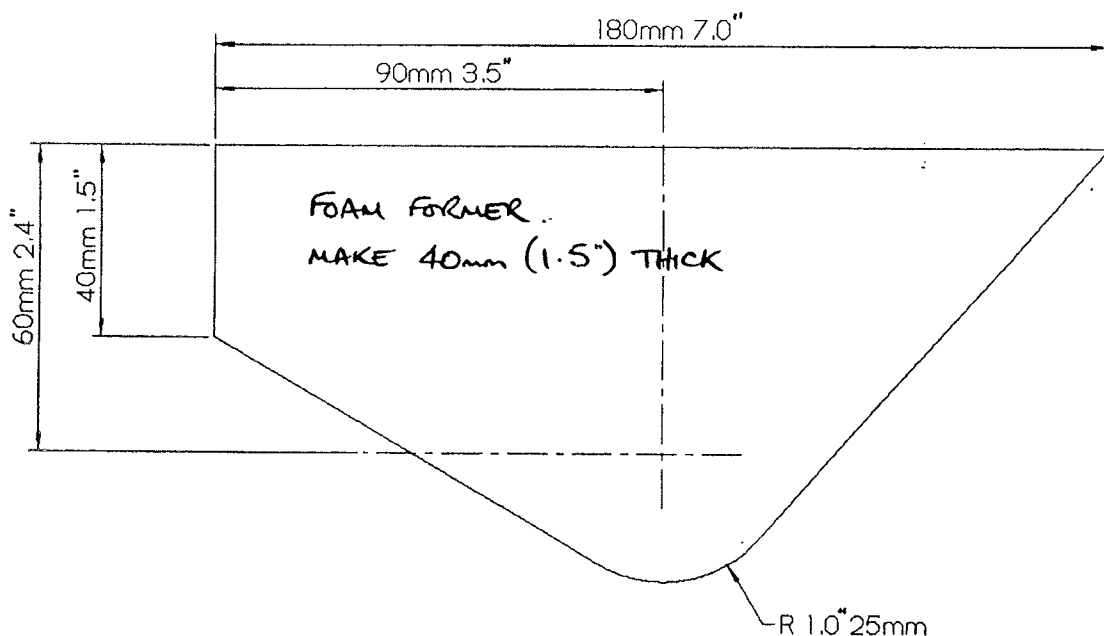
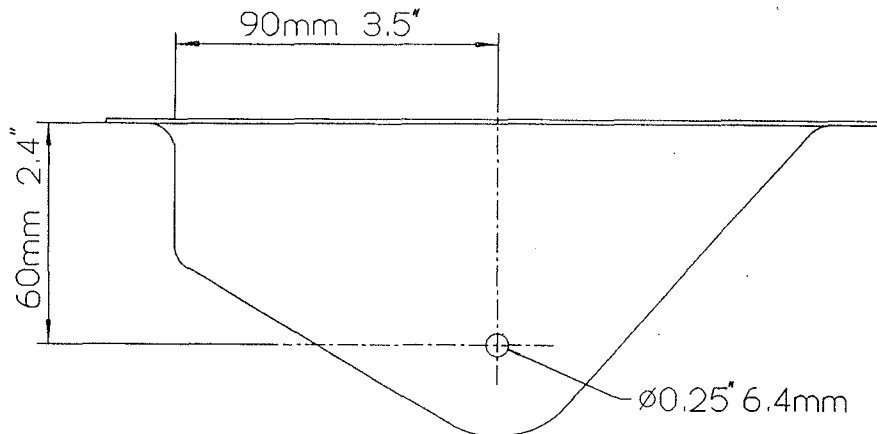


Fig 1. Former for throttle lever housing.

Set the former upside-down onto a sheet of plastic on a flat surface then lay up 4 plies of 'bid' over it and onto the plastic to form a flange of at least 25mm (1") all around. Cover the whole layup with peel-ply and allow to cure.

After cure, remove the peel-ply and carefully mark out and drill the 1/4" hole right through the housing. See figure 2.



Open up the hole on the starboard side of the housing to allow a socket through. Then remove the foam and trim the flange to approximately 20mm (3/4"). If you find a few pieces of foam left in awkward areas, they can be removed by dissolving them in petrol.

Drill two 4.8 mm holes in the flange for mounting bolts. Drill also the two 1/4" holes for the throttle cable outers in the flat front face of the housing.

Assembly

Install the cable outers through the two holes in the housing and clamp them in position with the nyloc nut with an AN960-10L washer each side of the fibreglass.

Assemble the two cables to the throttle lever according to figure 3 ensuring the end fittings are free to pivot. Thread the cables into the cable outers, then install the lever into the housing as shown in figure 3, adjusting the lever friction as desired. The friction should be sufficient to prevent the carburettor throttle lever spring from opening the throttle automatically, and this can be done after final assembly.

Installation

Mark out and cut out the slot for the throttle lever on the top of the wheel well. By positioning the front of the throttle box 380mm (15") aft of the firewall you will avoid the mainwheel.

Position the throttle lever assembly on the underside of the wheel well and, checking that full throttle lever travel is achievable, drill through for the mounting bolts holes.

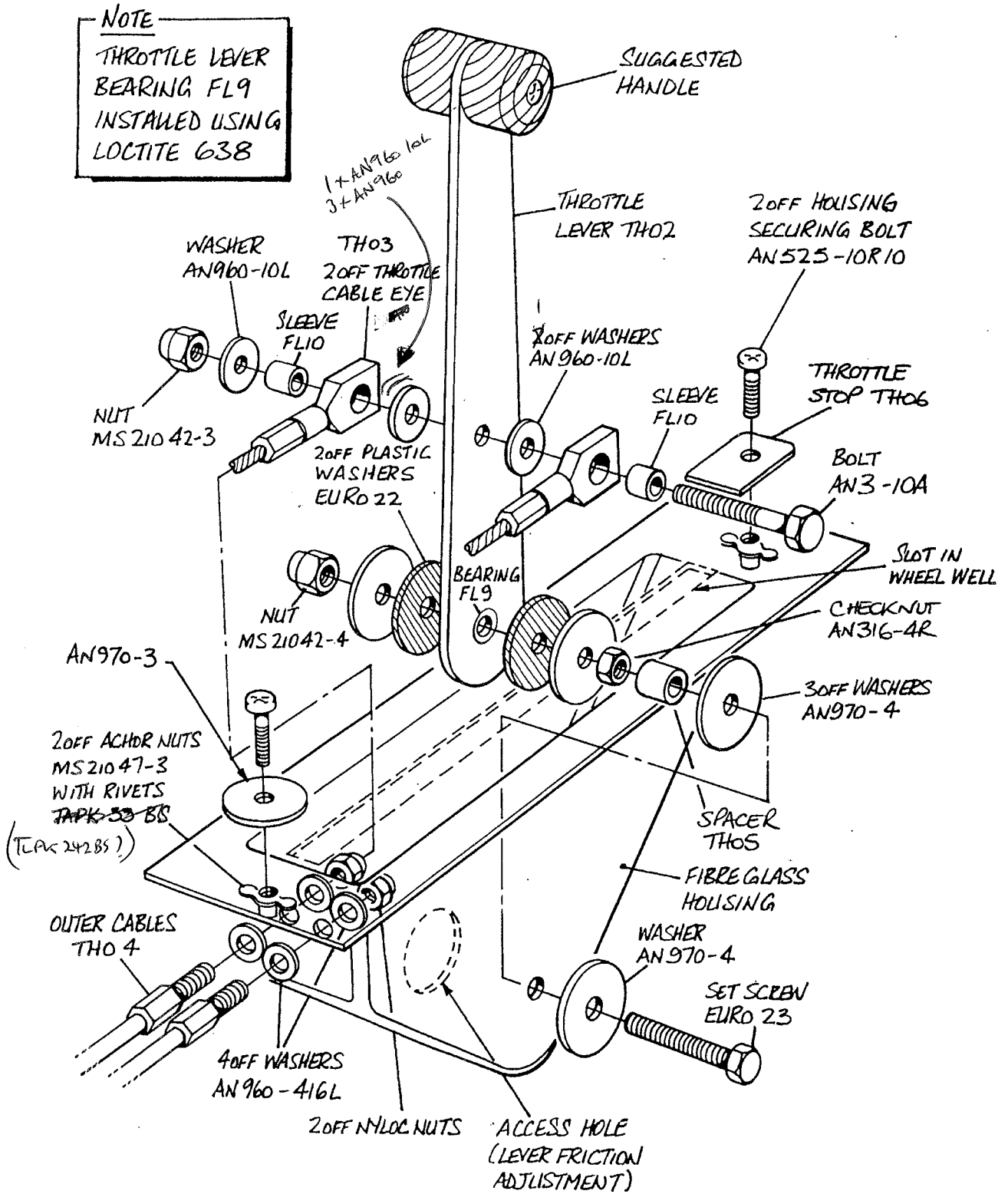


Fig 3. Exploded diagram of throttle lever assembly.

For ease of installation install an MS21047-3 anchor nut to the underside of the housing's flange at each end using TLPK 424 BS rivets then, using AN525-10R10 bolts with AN970-3 washers, secure the housing in place.

Finally, make a handle from wood or any other suitable material for the top of the throttle lever to complete the installation.

Slot the throttle cables through the gap between the firewall and the upper mounting members of the landing gear frame, securing them to the frame with tie wraps to prevent chafing.

Remove and discard the straight cable-outer receptacle provided on each carburettor and in its place insert the throttle cable. Use one check nut each side of the bracket to clamp the cable-outer in place.

Insert the cable itself into the nipple on the carburettor throttle lever, which is sprung to its full open position. Setting the throttle lever in the cockpit back about 2-3cm (1") from its full forward position, screw both nipples tight on the cables. Check for full throttle movement, making any adjustments as required, then seal the open hole in the throttle lever housing to prevent anything thrown up from the wheel from entering.

Choke Control

The two choke control cables are swaged together into the choke operating knob but run in separate outer sleeves which are swaged into a housing.

Installation

Remove the choke plate from the instrument panel and drill a 13mm ($\frac{1}{2}$ ") diameter hole in its centre for the cable outer assembly to go through.

Push the threaded portion of the cable-outer housing through the hole and clamp it in place with the lock washer and knurled nut.

Note : As it can be difficult to insert the two cables into their respective outers, remove the plastic knob instead leaving the cables installed when mounting the outer to the plate.

Decide on convenient locations for the cables to emerge from the firewall to enable easy runs to the 90° angled choke cable guides mounted on the carburettors then drill $\frac{1}{4}$ " holes right through. Push the cables through these holes, routing one to each carburettor.

Reinstall the choke plate into the instrument module. Push the cables into the carburettor cable guides and secure the cables to the choke levers using the solderless nipples. Ensure that the choke knob is fully in and the choke levers are fully down at the same time and that full choke movement can be achieved.

Squeeze silicone RTV around the cables where they come through the firewall and secure them with a cable tie to the engine mounting frame to prevent them from chafing.

Choke control

The choke cable, provided with the engine installation kit, is best installed on a detachable panel, sited immediately above the central tunnel. This small panel can then be left in place, with the cables attached, when the module is removed.

A hole cut according to figure 2 will accept this arrangement, if required.

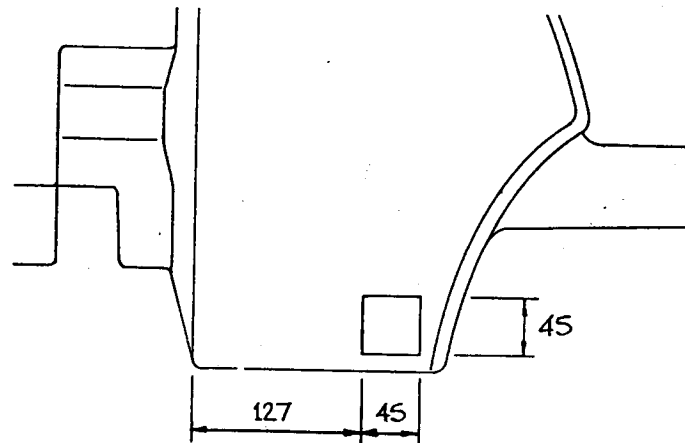


Fig 2. Choke control aperture if required.

Step 6

Make a mounting plate from 2-3mm light alloy, or a similar thickness of glassfibre laminate, for the choke control. The plate should fit behind the aperture in the panel. Attach MS21047-3 anchor nuts to the back of the plate with TLPK424BS countersunk rivets, having drilled the rivet holes with a $\frac{1}{8}$ " drill and countersunk each hole. Use AN526C10-32R8 screws to fasten in the plate.

Engine installation

Preparation

Before starting work on the engine installation read this manual and the Rotax 912 installation manual. There are some delicate parts attached to the engine, notably the ignition triggers, which require care in handling. Instead of installing the engine mounting to the aircraft then trying to position a heavy engine onto it, the engine mounting should be attached to the engine first. Before this is possible, however, re-arrangement of some of the installed components is required.

1) Water pump housing

Situated at the lower rear of the engine is the water pump. Four 45° angled pipe fittings are screwed into the housing, two each side, and fixed in position using Loctite. These two pairs of pipe fittings require repositioning slightly to allow the engine mounting to pass between them. Disconnect the rubber hoses and undo five socket head cap screws to remove the water pump housing from the engine.

If the gasket remains attached to the housing, carefully remove it. Remove also the rubber O-ring under the inlet fitting.

The Loctite will soften after heating to 250° to 300°C (480° to 570°F) and so allow the pipe fittings to be turned slightly. Don't try to turn them before softening the Loctite as they will distort and crack easily.

Use a hot air gun to heat the housing around each fitting in turn then rotate them to the new position. Be patient when doing this and do not apply too much force, they will give eventually. See figure 1. The Loctite will harden upon cooling.

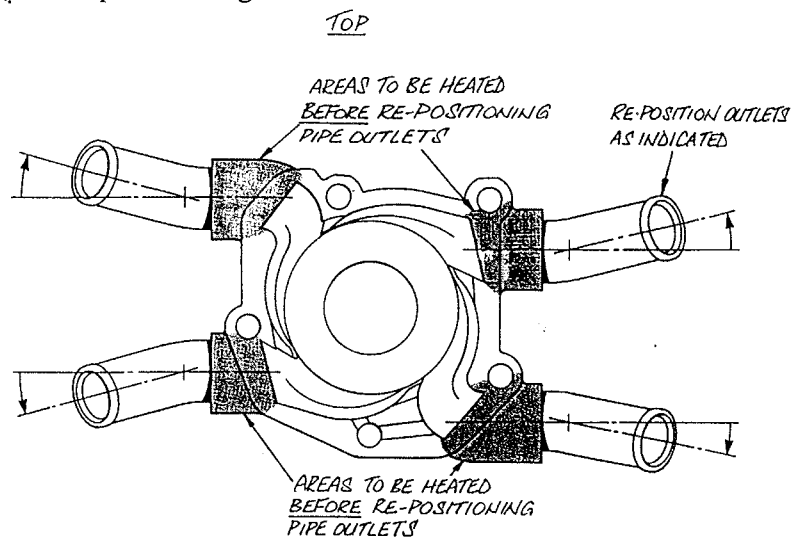


Fig 1. Positioning of water pump elbows.

Reinstall the water pump housing to the engine, replacing the gasket and the inlet fitting with its O-ring. Do not overtighten the bolts as they are screwed into holes tapped into the aluminium engine block.

2) Ignition box

The ignition box is mounted to the top of the engine on rubber vibration mountings. The rearmost rubber mounting is bolted to a bracket attached to the engine block.

Refer to figure 2 and remove the rubber mounting together with the upper bracket from the bracket which is bolted to the engine block. When removing the bracket, cover any holes in the alternator to ensure that loose objects cannot fall in. Re-install the bolt to the ignition box support.

Now bolt the rubber mounting to the other side of the support, leaving it loose until you have installed the engine mounting. To remove the remaining bracket, it will be necessary to undo the bolts retaining the two ignition triggers and cable clips. Take care not to bend the trigger base plates whilst you do this otherwise the trigger gap will be altered and affect the running of the engine.

Discard the bracket and its bolt and reattach the triggers and cable clips.

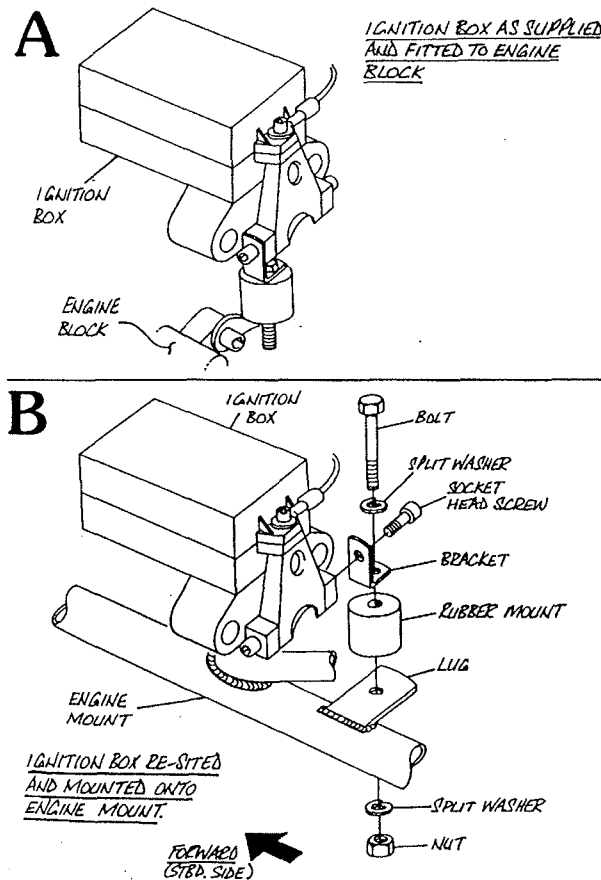


Fig 2. Rearrangement of ignition box shock mounting.

Engine mount fitting

If any of the four rear engine mount bolt holes have bolts already in them, remove them. Orientate the engine mounting with the engine according to figure 3 at the end of this section.

Carefully move the engine mounting into position from the back of the engine to align the four sideways orientated bolt holes with the mounting holes in the engine block.

Before you have aligned the holes, insert the Port upper bolt into the engine mounting bolt hole. This bolt will come into slight contact with the cooling fins of the adjacent cylinder, but it would be impossible to install the bolt after the two holes are in line. Install the long bolt into the Starboard upper bolt hole. This bolt screws into the port half of the engine casing.

Lastly, install the two lower bolts then tighten all four bolts.

Re-attach the water hoses to the water pump housing, arranging the hose clamps for easiest access, and bolt the ignition box shock mounting to the lug on the arm of the engine mounting.

Engine installation

Mount the engine to the landing gear frame using the rubber mountings. See figure 3.

To check the orientation of the engine, *first fit* the engine cowlings. The centre of the propeller hub should be in the centre of the front opening of the cowlings. To adjust the position of the propeller hub within the cowlings front opening shim between the landing gear frame and the appropriate cup washer using AN960-516L washers. In order to ensure that the split pin is correctly positioned relative to the castellated nut it will be necessary to use at least a total of 4 washers on each bolt. Any washers that are not needed to act as positioning shims should be placed immediately under the nut. Make a note of where and how many shim washers are used for later reference.

Note: *The 4 AN5-40 mounting bolts must be tightened fully to compress the rubber anti-vibration mounts (MT04) onto the steel spacers (MT03).*

Caution: *It should be noted that before the two ignition leads which come from the ignition box are earthed, the ignition is "live". It would be a sensible precaution to fit the magneto switches before further work is carried out on the engine, or at least temporary earth leads connecting the ignition wires to the engine casing.*

Washers & position:
4/0

LANDING GEAR MOUNTING FRAME LG01
3/1

CASTELLATED NUT-AN310-5
SPLIT PIN MS 24665-153

FIREWALL

ENGINE MOUNTING FRAME-MT01

ENGINE

* ADD WASHERS AN960-516L HERE (AS REQUIRED) TO ENSURE ENGINE ALIGNMENT.

NOTE:
* APPLICABLE TO EACH MOUNTING POINT (AS REQUIRED) FOR CORRECT ENGINE ALIGNMENT.

RUDDER PEDAL ARRANGEMENT OMITTED FOR CLARITY

CAP WASHER-MT02
'LORD' RUBBER MOUNT-MT04
1/4

TOP STARBOARD SOCKET HEAD CAP SCREW-M10x130

SOCKET HEAD CAP SCREW-M10x55 (3OFF)

SPACER-MT03

'LORD' RUBBER MOUNT-MT04

CAP WASHER-MT02

BOLT AN5-40

SOCKET HEAD CAP SCREWS

FIG.3 INSTALLATION ENGINE FRAME

Exhaust system

The exhaust system is the last item which requires permanent installation onto the engine; however, it is required to be temporarily fitted now to ensure clearance is maintained between it and various other parts.

Provision for taking hot air for cabin heat is provided in the form of a heat exchanger attached to the front of the expansion chamber. 2" diameter inlet and outlet stubs are provided for attachment of customer supplied air hose.

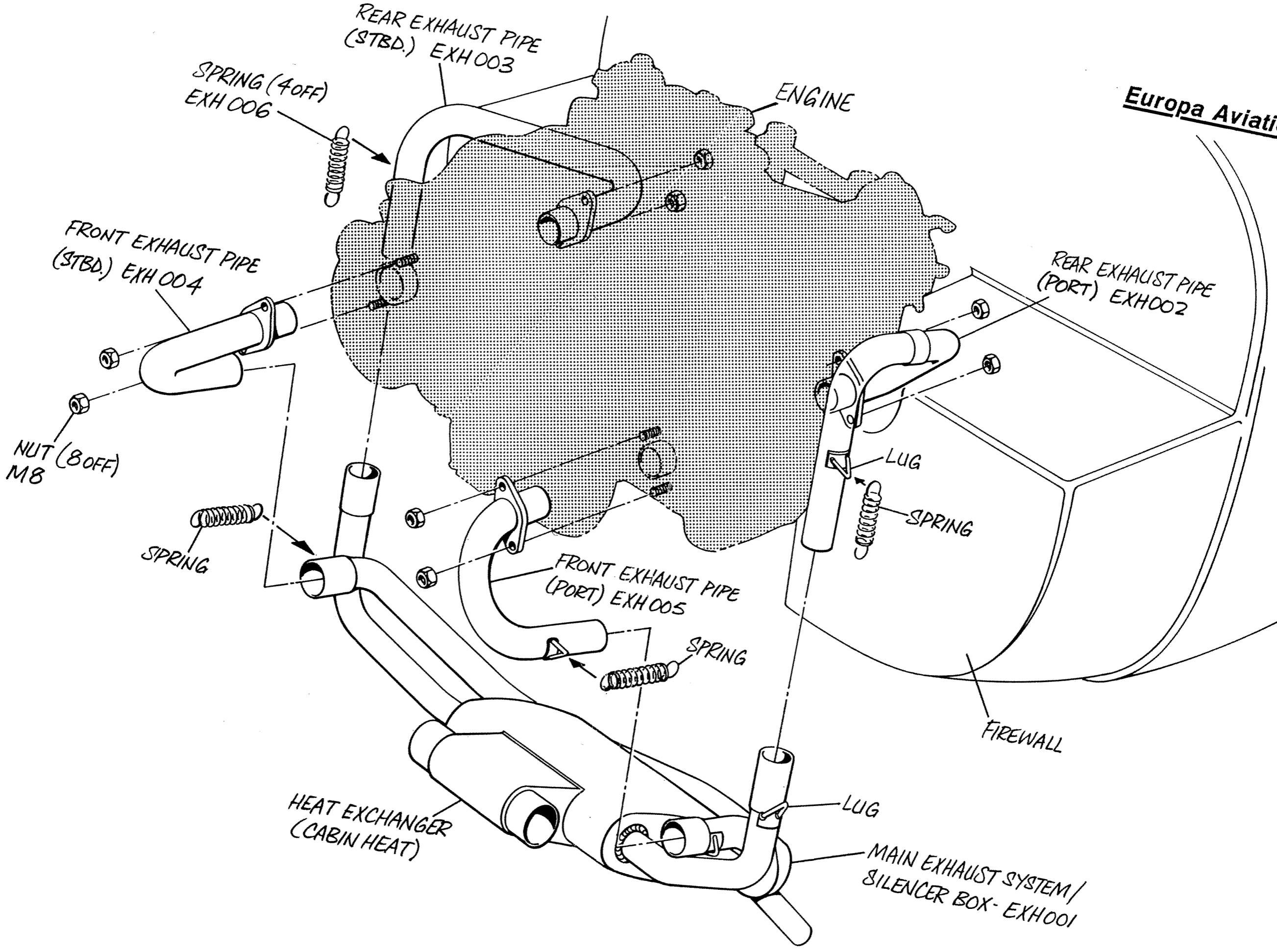
Installation

Refer to the figure overleaf for the exhaust installation.

Remove and discard the stub pipes that are located in the four exhaust ports. Locate and loosely bolt onto the engine the two rear pipes first and slide the exhaust silencer assembly up onto them. No jointing compound is necessary.

Next, push the two front pipes into the silencer assembly and rotate them around to locate into the front exhaust ports.

Attach a retaining spring to each of the four pipes then tighten the nuts attaching them to the engine.



REAR EXHAUST PIPE
(STBD.) EXH003

ENGINE

SPRING (4OFF)
EXH006

FRONT EXHAUST PIPE
(STBD.) EXH004

REAR EXHAUST PIPE
(PORT) EXH002

NUT (8OFF)
M8

SPRING

LUG

SPRING

FRONT EXHAUST PIPE
(PORT) EXH005

SPRING

FIREWALL

HEAT EXCHANGER
(CABIN HEAT)

LUG

MAIN EXHAUST SYSTEM/
SILENCER BOX - EXH001

EXHAUST SYSTEM

Radiators

Two radiators connected in series are used to cool the engine cooling fluid. The port radiator has attached behind it an oil cooling radiator.

Lugs and pins are attached to the radiators to provide means of location and attachment to the lower engine cowling. See the figure at the end of this chapter.

Fasten the lower engine cowling to the fuselage and trial fit the radiators in position behind the air inlets. Trim the rear lip of the air inlet as required to allow a clearance between the radiator and the exhaust.

Temporarily fix each radiator in position relative to the lower cowling and make up mounting lugs from 3mm plywood to fit underneath the radiator's attaching lugs and underneath the radiator at the locating pin. The upper lugs should be positioned to align with the bottom of the cowling joining flange joggle to set the vertical position of the radiator. As a guide to positioning the radiator, the 4th horizontal radiator coolant tube from the top should be approximately in line with the cowling split line.

It may be necessary to trim away part of the air intake lip on the starboard side to ensure adequate clearance between the starboard radiator and the front starboard exhaust. It is permissible to file the frame of this radiator locally to increase clearance from the exhaust.

Attach the plywood mounting lugs to the cowling with dabs of 5 minute epoxy to check they are located correctly.

Make the lower lug with the hole for the radiator's pin already in it and position it on the cowling with it located on the radiator.

Drill through the radiator lugs and the mounting lugs with a 4.8mm drill, inserting an AN3-5A bolt in each hole before drilling the second hole.

Lay up 3 plies of 'bid' at +/- 45° on each side of the plywood lugs extending onto the cowling at least 2-3 cm (1"). Cover the whole layup with peel-ply and leave to cure, trimming at the appropriate time.

Position an MS21047-3 anchor nut at each hole in the four upper lugs. Drill through the plywood mounting lugs with a 2.4mm (3/32") drill to mount the anchor nuts and install the anchor nuts to the lug underside with TAPK36 BS rivets, having countersunk the holes in the plywood lugs first.

Install the radiators using the AN3-5A bolts with AN960-10L washers under the bolt heads.

Hose installation

Inlet Hose

The inlet hose is the longer pre-formed hose with two 90° bends in it. On the rear face of the water pump housing at the base of the rear of the engine is the water inlet. Connect the short straight end of the inlet hose to the inlet pipe so that it runs up the port rear side of the engine, outside the engine mount, then forward over the top and connect the other end to the top of the port radiator. Use hose clips to secure the ends in place.

Link Hose

Cut a piece of hose to run between the two radiators routing underneath the gearbox and connect it using number 1 hose clips.

Outlet Hose

The outlet hose is the pre-formed hose with a 180° bend in one end. Connect the outlet hose to the expansion bottle with its curved end and the other end to the top of the starboard radiator using number 1 hose clips. Run this hose as low as possible to avoid air locks.

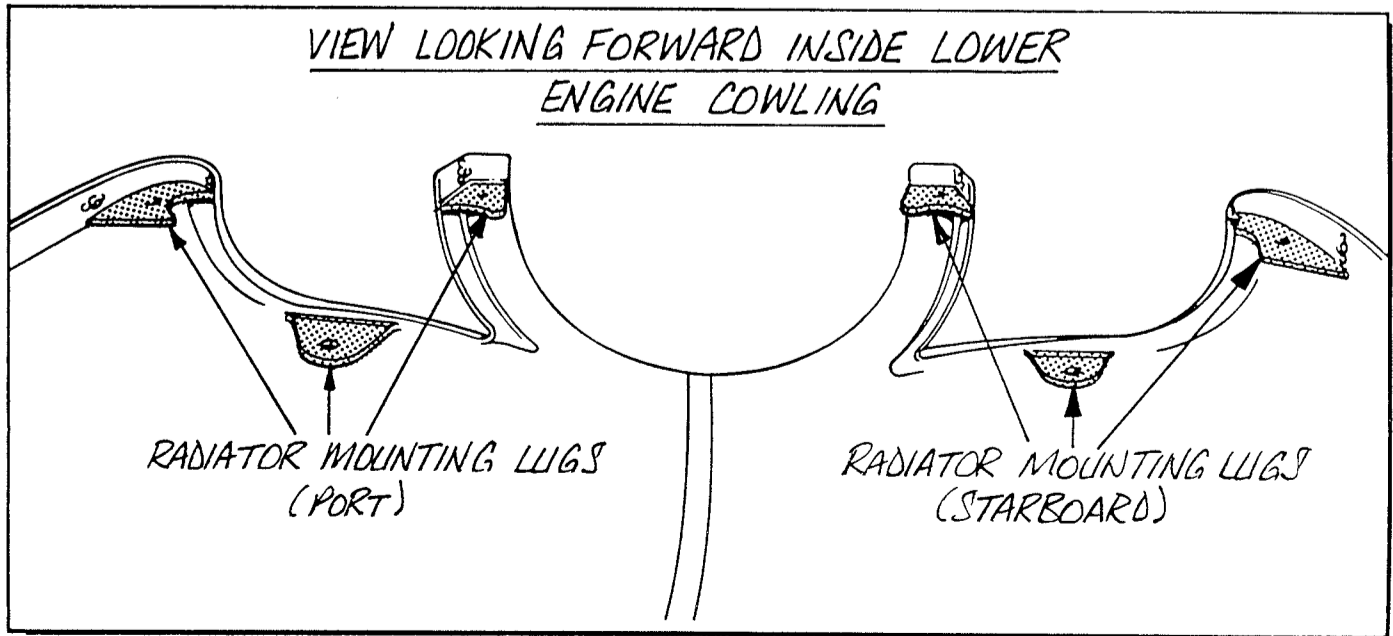
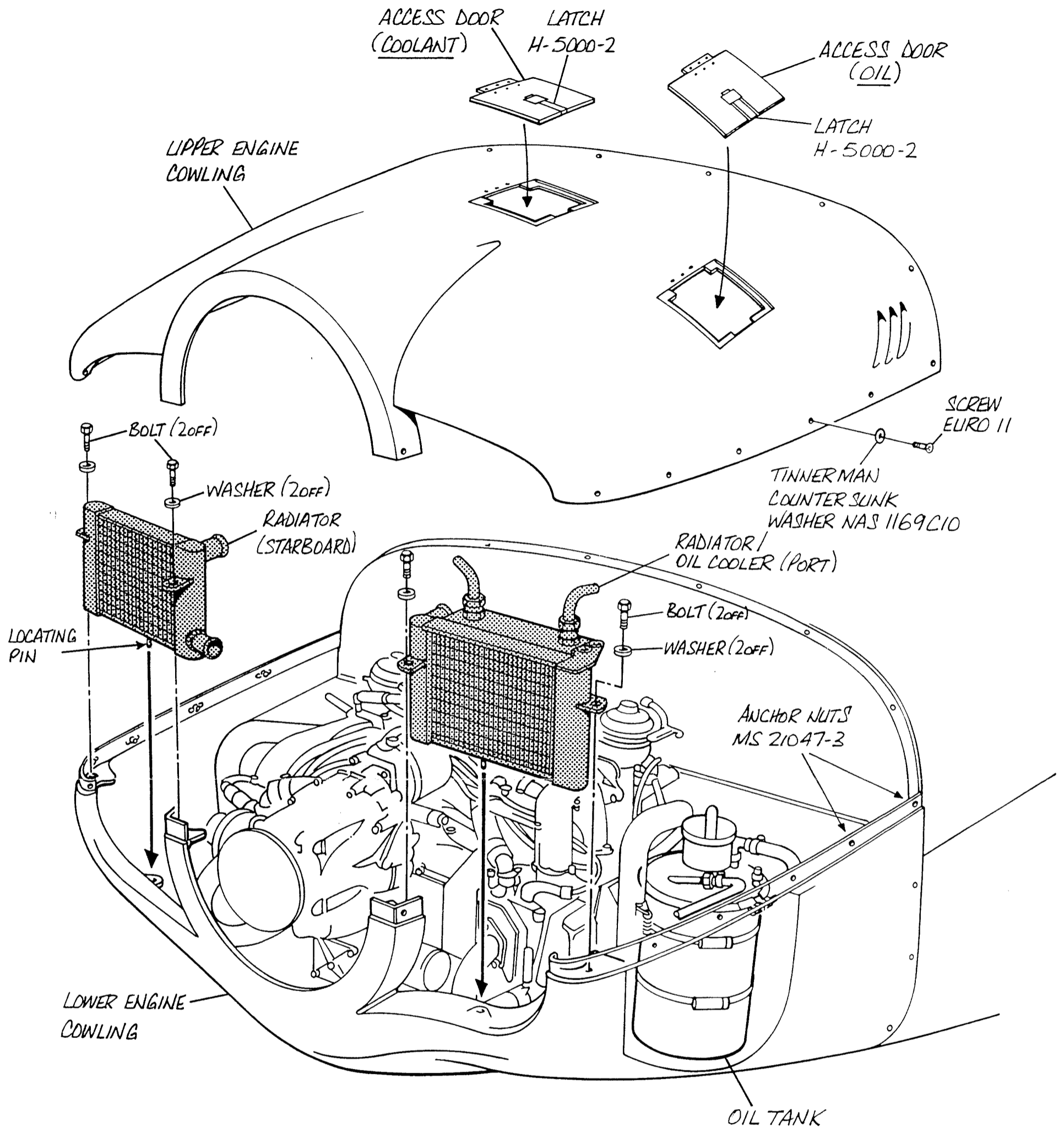
Coolant

The recommended proportions of ethylene glycol and water are:-60% ethylene glycol - 40% water.

This mixture ratio is quite important for effective cooling, and also for corrosion and icing protection, so don't guess at it. Keep some ready mixed coolant in a container for topping up as required.

Further information on coolant can be found in the Rotax engine installation manual.

The capacity of the Rotax engine / Europa radiators and pipes is 3 litres.



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Oil Tank

Oil Tank Mounting Bracket

The oil tank is to be mounted to the front of the port footwell using a steel bracket. To make the mounting bracket first mark out and cut out the steel sheet LB01 according to the drawing at the end of this chapter. Next, bend the central wide portion into a curve to match the outside of the oil tank. This can be accomplished by running the metal backwards and forwards across the corner of a wooden bench whilst applying a bending force on it.

Finally, bend the lugs each side of the curved portion so that the two narrow flanges can sit flat against the footwell front face. See figure 1.

Bending can be done by clamping the steel between lengths of wood in a vice. Try to avoid a sharp bend radius, a 10mm (3/8") radius is ideal.

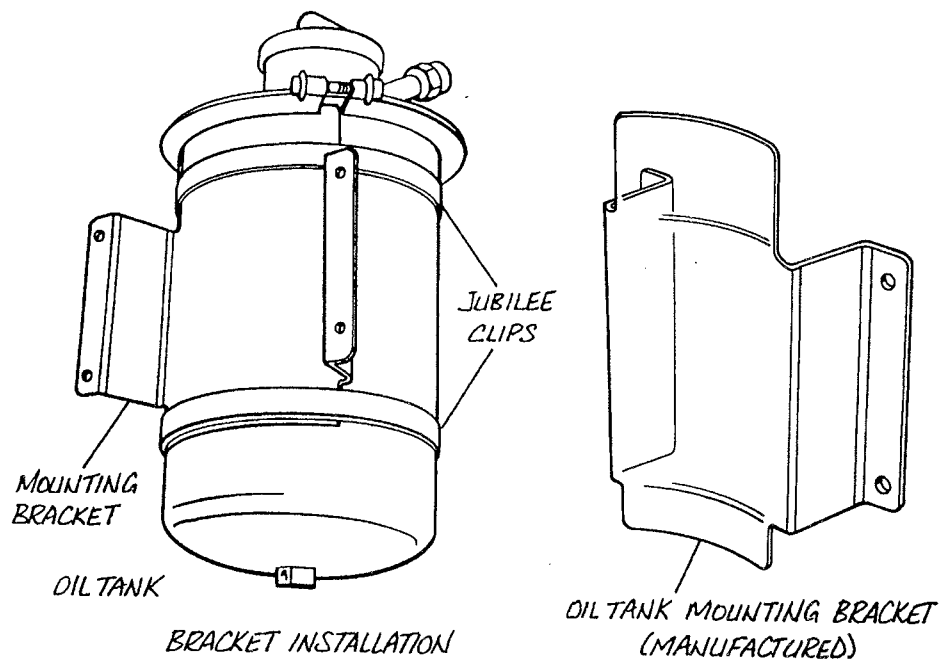


Fig 1. Oil tank mounting bracket

Bracket installation

Arranging the bracket with the longer lug fitting under the oil tank lid, fasten the bracket to the tank using the two number 6X size jubilee clips. Keep the clamps away from the radius of the bracket.

With the exhaust system and lower cowling in place position the oil tank and bracket onto the front face of the port side footwell. Move the tank away from the exhaust pipe until the bottom of the tank is within about 10mm from the cowling. See the figure at the end of the radiator chapter.

Drill through the bracket into the forward surface of the port footwell and bolt it in place using AN525-10R40 bolts and MS21042-3 nuts with AN970-3 large area washers on the inside to spread the load. 8

Oil tank installation

Reinstall the oil tank to its mounting bracket and orientate it so that the oil tank return fitting, which is identified as the pipe which enters the tank at a tangent, is pointing to port. The tank outlet fitting will be at the rear.

Screw the two 90° elbow fittings to the tank fittings, arranging the tank return fitting to point forwards and the tank outlet fitting to point outboard and slightly forwards, avoiding the oil filler neck.

Hose connections

Oil tank return

Push a length of oil hose onto the return fitting at the front of the tank, routing it between the oil filter and the engine. Connect its other end to the banjo hose fitting situated underneath the engine. Orientate the banjo fitting as required and wire-lock it.

Oil engine inlet

The oil inlet runs from the oil tank outlet fitting via the oil cooling radiator to the oil pump, located at the lower front of the engine, so two lengths of oil hose are required.

Oil tank outlet to oil cooler

Firstly, screw the two 90° hose fittings onto the oil cooler. The inboard fitting should be pointing towards the gearbox and the outboard fitting should be angled towards the starboard rear of the engine compartment. Leave them loose until the hoses have been fitted to allow for final alignment.

Connect a length of oil hose to the tank outlet fitting, attaching the other end to the outboard fitting of the oil cooler.

Oil cooler to oil pump

Attach a length of oil hose to the remaining fitting on the oil cooler and connect the other end to the oil pump, routing it over the gearbox. Use P-clips to hold the hose as required.

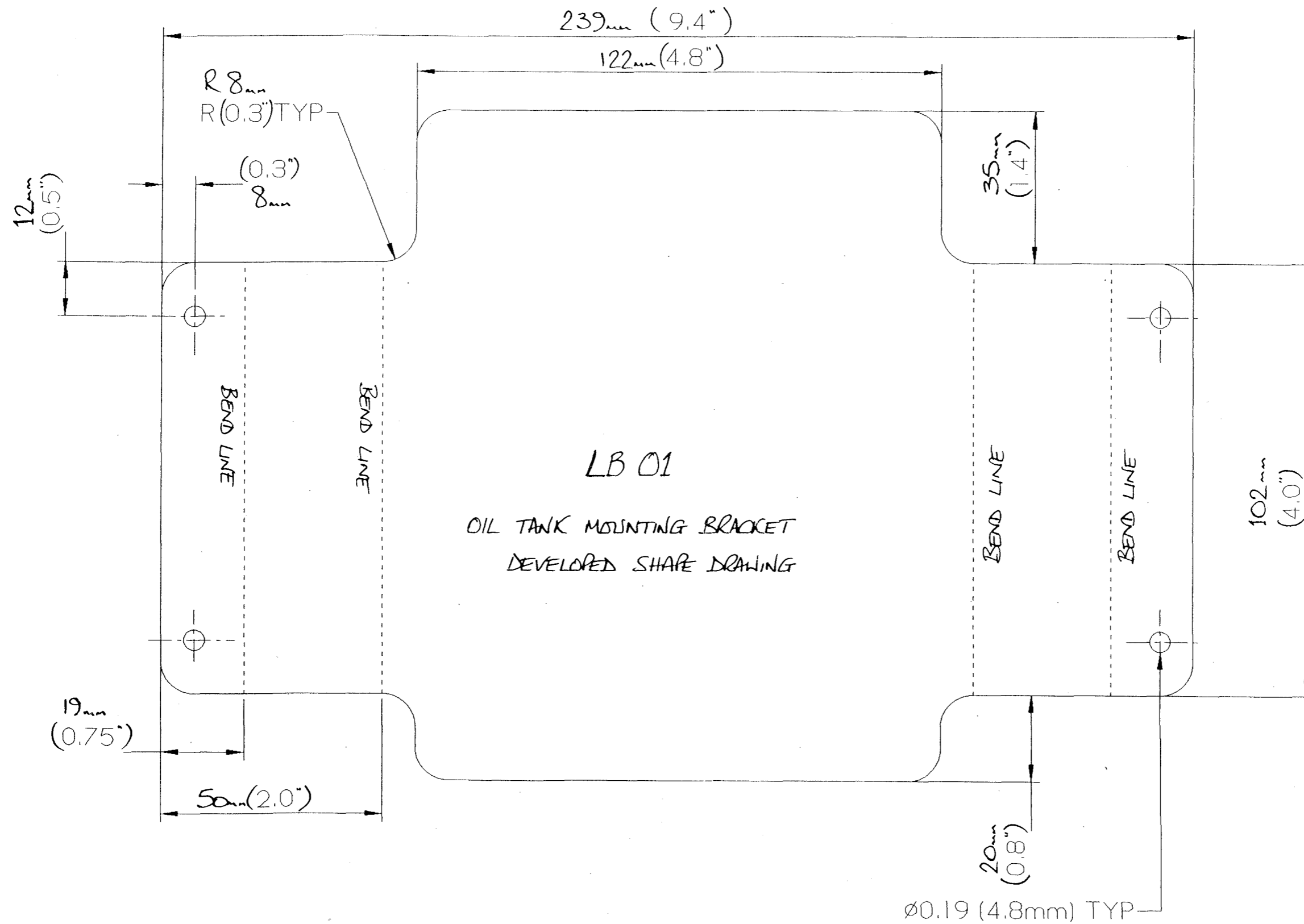
Use hose clips to secure each hose at both ends and don't forget to tighten the elbows and banjo fitting in place.

Oil tank vent

The vent from the oil tank allows an oil mist to escape to atmosphere. It is not unusual to run the vent line to the bottom of the cowling, however if you do this, don't position the end of the tube such that it will be in the airstream whilst flying. This could cause low pressure at the end of the tube to suck more oil from the tank than it should.

Another consideration is that the oil mist will tend to coat the fuselage if left to vent freely. To avoid this you can run the vent line into a collector bottle before it goes to atmosphere, however, no bottle is provided.

There is an internally threaded tube in the oil tank cap which is not required for the 912 engine. A taper threaded plug is provided which should be screwed in place using Loctite 243.



Fuel System

The installation of the fuel system described in the fuselage manual takes the fuel line as far as the fuel selector valve. After the fuel has passed through the fuel valve the line connects to an in-line filter which is transparent and so aids visual detection of contamination. From the filter the line runs forward to the electric pump inlet. The electric pump is pilot activated. From the electric pump the fuel line type changes from fabric braided to steel braided as it routes forward through the wheel well and so is subject to impact from stones, etc. thrown up from the main wheel. This line is connected to the inlet of the engine driven mechanical fuel pump located at the front of the engine. The line connected to the fuel outlet port of the mechanical pump runs aft and separates into two lines to feed each carburettor.

Installation

Electric fuel pump

The electric pump SS501 is to be mounted on the 3mm plywood bulkhead situated behind the tyre.

The pump should be positioned at approximately 45° to the horizontal with the inlet pointing to the lower corner of the tunnel. Position the centre of the pump approximately 10cm (4") from the floor and drill two 1/4" holes for the mounting bolts.

Screw the fittings FPA903A into the electric pump and, whilst the pump is not installed, either solder extension wires to the existing ones or attach connectors for later use. Mount the fuel pump using two AN4-6A bolts with an AN960-416 washer under the head, MS21042-4 nuts with AN970-4 washers against the bulkhead.

Fuel overflow tubes

It is important that the small bore tubes fitted to the top of the carburettor air inlet terminate at a position having the same pressure as the inlet air. Failure to do this will almost certainly result in rough running. If the tube is taken to the bottom of the engine cowling, then a nick or small hole must be made at an appropriate place to make the tube pressure the same as the inlet air.

