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## 13. Flying controls

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This section covers the installation of the pitch and roll control systems into the cockpit module before its bonding into the bottom fuselage moulding.

The aileron quick-connect system will also be installed and rigged with the wings attached to the cockpit module.

### Preparation

If work space is limited certain components can be made before the cockpit module is required (e.g. push-rods). Get all the parts required for each operation to hand and ensure they are clean.

For those parts being bonded, ensure they are clean, dry and adequately abraded otherwise a good bond will not be achieved.

### Aileron Controls

- ☐ **Parts and tools required (hardware not included)**
- ☐ 2 x CS01, CS02, CS03, CS04, CS05 (1 1/4" dia x 26" steel tube), CS06, CS07 and CS08
- ☐ Araldite 420 adhesive
- ☐ Drill
- ☐ 3.3 mm & 4.8 mm drill bits
- ☐ 2 1/8" hole saw

### Step 1

#### Control system assembly

A control stick is provided for both occupants but the assembly of only one side is described. The first part of the control system to be assembled is the control stick's fork CS02 to the bush CS03, the front Tufnol bearing CS04 and aileron torque tube CS05.

To check that all parts fit each other before bonding and riveting, push the CS03 bush through the front bearing CS04 then slide the control stick fork CS02 onto the bush. The clearance between these parts may appear to be excessive, however this is intentional to allow for tiny glass beads in the Araldite 420 adhesive which act as spacers ensuring correct glue line thickness.

The Tufnol bearing's main hole will require chamfering to remove the lip that may have been produced during boring and to clear the radius on the CS03 bush. Next push the torque tube CS05 into the bush from the flanged end until its end lines up with the end of the bush. See figure 1.

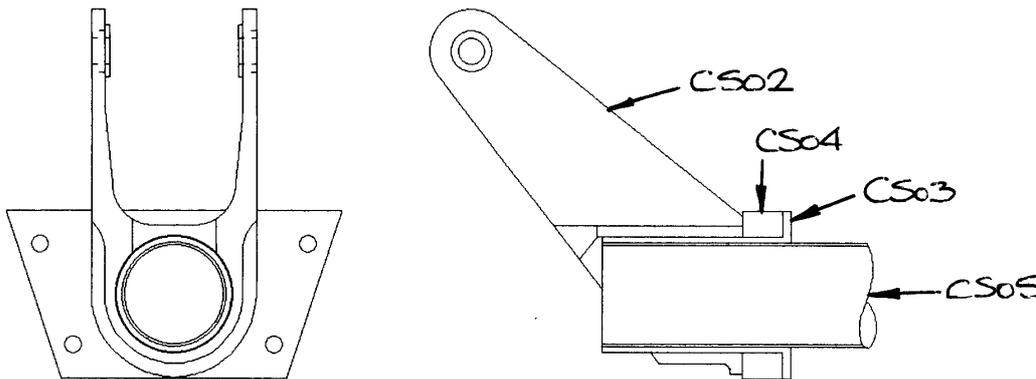
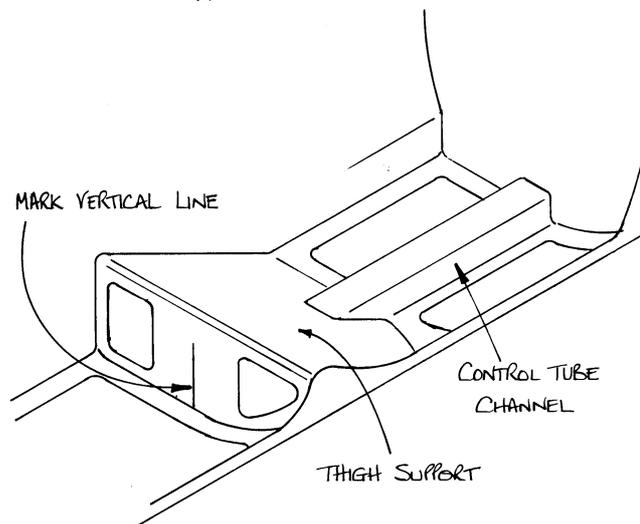


Fig 1. Section through control stick fork.

## Step 2

Mark a vertical line on the front face of both thigh supports which corresponds to the centreline of the control tube channel in each seat. See figure 2.



DETAIL OF COCKPIT MODULE SHOWING PORT SIDE SEAT PAN

Fig. 2 Marking centre for control tube

**Note:** The centres of the two control tubes should be set to 66.65 cm (26.25") apart.

Using a  $2\frac{1}{8}$ " diameter hole saw cut a hole in each thigh support with the centre on your marked line, keeping the hole saw against the cockpit module's floor so the bottom of the hole is in line with the lip of glassfibre.

Now set the cockpit module upside down on supports to place it at a suitable working height to make life as easy as possible. Two trestles will suffice, one crossways in the baggage area, the other supporting the central wheel well. Be careful not to exert any force onto the rear bulkhead to avoid damage.

Having temporarily assembled CS02, CS03, CS04 and CS05 together, pass the tube through the  $2\frac{1}{8}$ " hole in the cockpit module's thigh support. To allow CS04 to fit in the correct position you'll find its shorter, bottom edge will need filing to accommodate the radius of the moulding. Mark the bush flange outline on the bearing and radius the areas each side. Adjust the  $2\frac{1}{8}$ " hole as required to clear any moving parts.

**Note:** CS04 does not fit flat against the thigh support's front face. The gap will be taken up with a floc pad on installation.

The base of the front bearing CS04 (now uppermost as it's upside down) must be as close as possible to the base flange of the cockpit module to place CS02 as close to the cockpit floor as possible without it actually touching. To set and maintain this position, place a temporary shim in the control tube tunnel under the aileron torque tube CS05. Refer to figure 6.

Separate the parts then clean and scuff sand the end of the tube that fits into the bush and the bores of CS02 and CS03 and the outside of CS03 in preparation for bonding.

Mark out, centre punch and drill three 3.3 mm diameter holes through *each side* of CS02 as shown in figure 3.

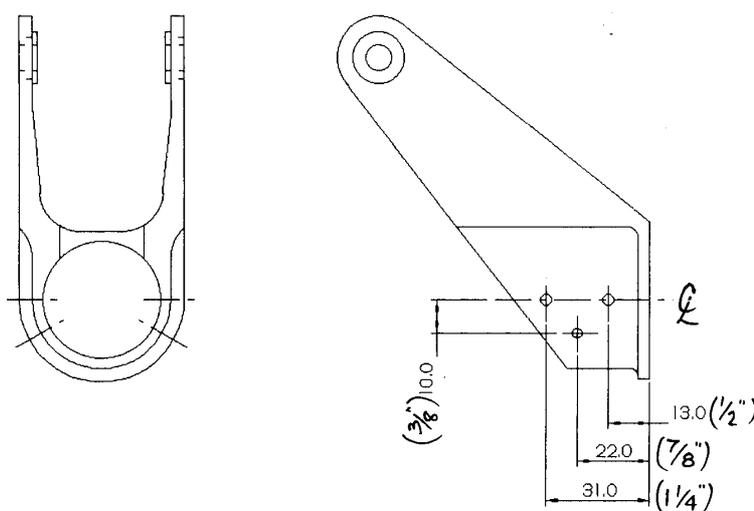


Fig 3. Rivet pattern in control stick fork CS02.



Prepare a small mix of Araldite 420 adhesive.

Push the CS03 bush through the CS04 bearing first, apply the adhesive to the bore of the stick fork CS02 taking care not to allow any adhesive to get near its bearing face.

Hold CS02 lightly in a vice or other support so the bearing face is uppermost. Apply grease to the bearing faces then slowly push the CS03 bush and CS04 bearing into CS02. The bearing should be able to revolve without excessive force. Don't squeeze the parts together too hard; a small amount of clearance will ensure freedom of movement will remain.

Wipe away any excess adhesive and leave to fully cure, which may take half a day

### Step 3

#### **Aileron torque tube**

After cure, remove the sub-assembly from the vice.

Place the CS05 tube into the vice vertically and *lightly* clamp it with one end sticking out sufficiently so that, with the stick fork sub-assembly placed onto it, the unflanged end of the bush coincides with the end of the tube. Refer to figure 1. Since there is some clearance between CS03 and CS05, ensure that the two components are parallel and that the clearances are the same at both ends when bonding them.

Mix a small quantity of Araldite 420 adhesive and coat the bore of the CS03 bush. Slide the assembly onto the tube, wipe away any excess adhesive and allow to fully cure.

After cure, drill right through CS02, CS03 and CS05 with a 3.3 mm drill using the pre-drilled holes as a guide taking care not to elongate them in the process. Install a TLPD 440 BS pop rivet in each hole.

## Step 4

### Rear bearing

Position the CS08 crank in position on the outside of the flange of the CS07 bush, as shown in figure 4, ensuring the large hole is concentric with the bush's hole and the crank bends away from the bush. Drill four holes, using a 4.8 mm drill bit, through the bush using the holes in the crank as a guide but taking care not to elongate them in the process, and install an AN525 10R12 bolt, MS21042-3 nut and AN960-10L washer in each hole as you go.

The part of the bush flange that extends below the crank should be removed in line with the bottom line of the crank to give greater clearance between it and the fuselage moulding.

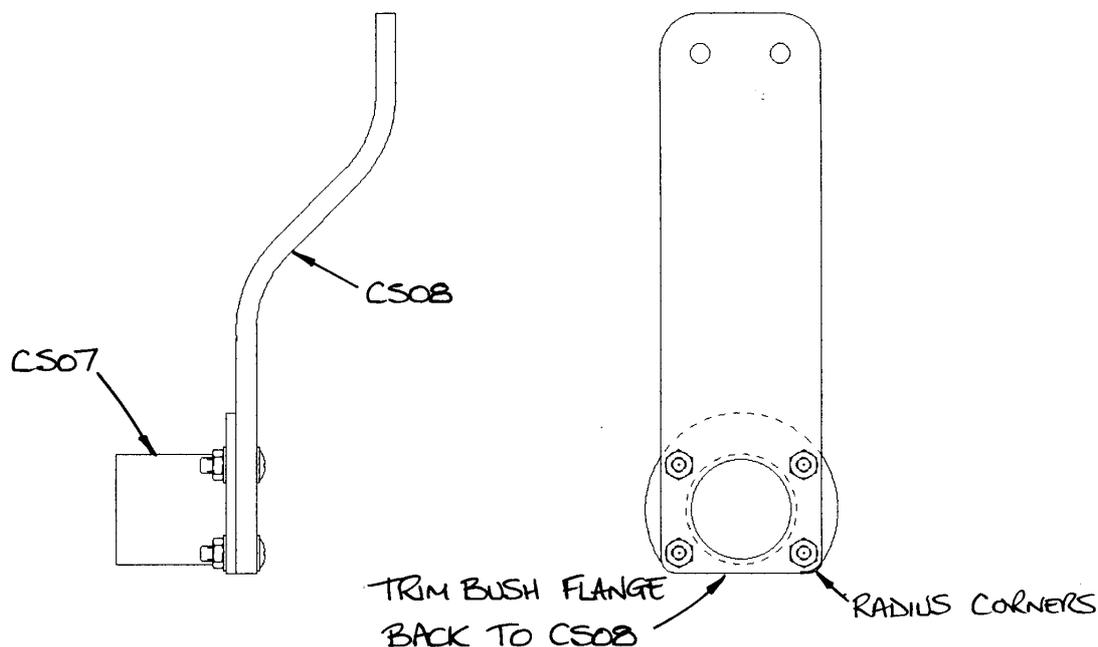


Fig 4. Aileron crank attached to bush.

Cut the corners off the CS06 Tufnol bearing as shown in figure 5. This gives clearance and, of course, saves a bit of weight. You can go even further by radiusing the corners, in fact you will find that you'll have to remove quite a lot of the bottom edge when you fit them.

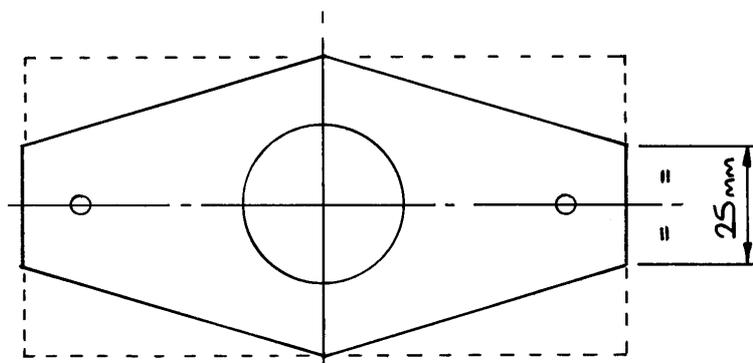


Fig 5. Rear bearing CS06 cut for better clearance.



Place the control tube assembly into the cockpit module through the 2 1/8" hole (remember the temporary shim in the channel) and slide on the CS06 Tufnol bearing and the CS07/CS08 sub-assembly. See figure 6.

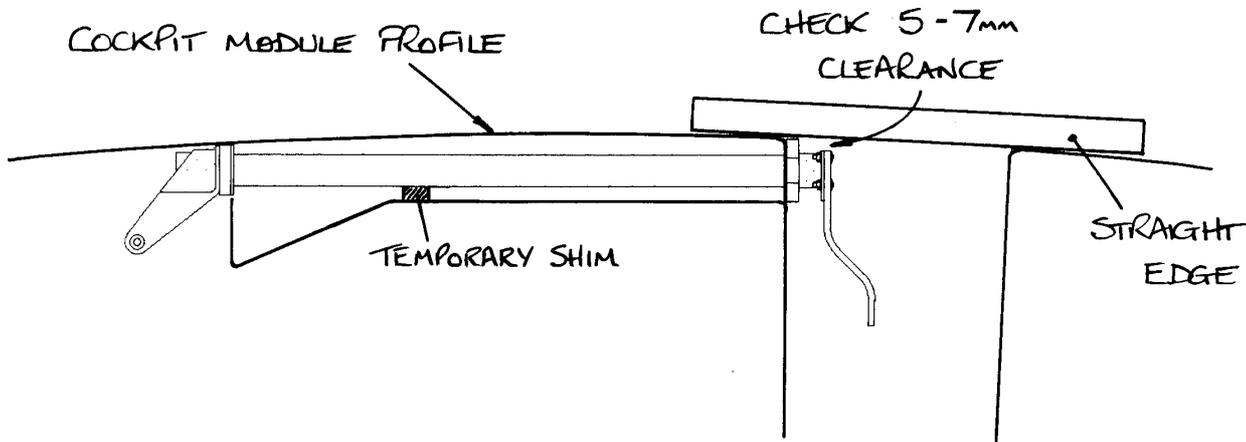


Fig 6. Section through cockpit module showing controls.

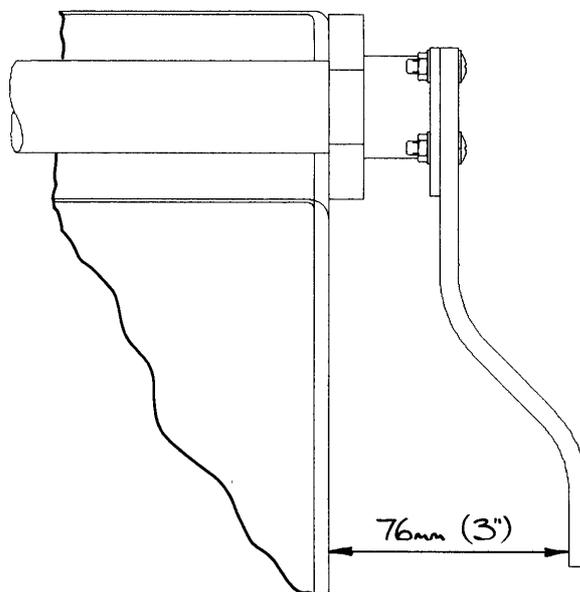
Check that the CS05 tubes are 66.65 cm (26.25") apart, the bearing CS04 is against the front of the thigh support and, making sure that there is between 5 and 7 mm of clearance between the bottom of CS08 and where the fuselage floor will be by placing a straight edge across from the seat back to the baggage area floor, drill through with a 4.8 mm drill using the four holes in CS04 as a guide.

Temporarily locate the front bearing in place with a couple of AN3-11A bolts, the bolts going through the Tufnol bearing first, with AN970-3 large diameter washers under MS21042-3 nuts. Remember, CS04 doesn't sit flat against the thigh support. See figure 16.

Maintaining the positions of the front and rear Tufnol bearings, drill through the cockpit module with your 4.8 mm drill using the pre-drilled holes in the rear bearing as a guide. The temporary shim can now be removed. Bolt the bearing to the cockpit module using two AN3-11A bolts with AN970-3 large diameter washers and AN960-10L washers under MS21042-3 nuts. See Figure 17.

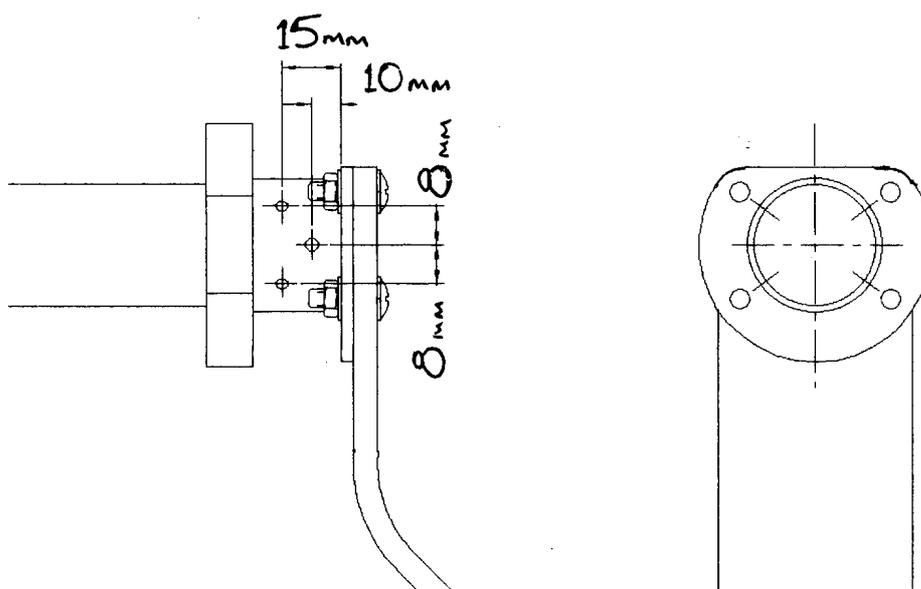
## Step 5

Set the CS02 fork to be vertical to orientate the CS05 tube then set the CS08 crank to also be vertical and therefore in line with CS02. Making sure that the front bearing is against the cockpit module, position the end of CS08 to be 76 mm (3") from the cockpit module as shown in figure 7.



*Fig 7. Setting up CS08 crank before drilling rivet holes.*

Drill through the bush CS07 in the positions shown in figure 8 on both sides, 3.3mm diameter, 6 holes in all. Disassemble the parts to remove any swarf then reassemble them with Araldite 420 adhesive and, after cure, rivet them together using six TLPD 424 BS pop rivets.



*Fig 8. Rivet hole pattern for rear bush.*



## Step 6

### Bearing installation

Remove the bolts locating both front and rear Tufnol bearings and slide the control assembly out of the way to give you access to scuff sand the front face of the thigh support and the rear face of the front bearing. Scuff sand also the rear Tufnol bearing's front face and the areas of the cockpit module which it contacts.

Prepare a small quantity of dryish flox and apply it to the edges of both front and rear bearings, making sure none gets near the central hole and sticks the whole lot solid. The main purpose of the flox is to provide a pad onto which the bearing can sit flat when the bolts are tightened up.

Apply grease to the rear bearings then position all the bearings, installing their bolts but not fully tightening them at this stage. The bearings must be square to the main shaft to avoid them binding. Tightening the bolts before the flox is hard will pull them out of square. Allow the flox to *fully* cure then tighten the bolts.

## Step 7

### Push-rods

Make up the aileron control cross link-rod CS12 using the ½" x 0.035" wall thickness steel tube supplied as detailed in figure 9 using two AN490HT8P end fittings and four AN470AD4-10 solid rivets. Screw on two MW4 rod-ends with AN316-4R check nuts.

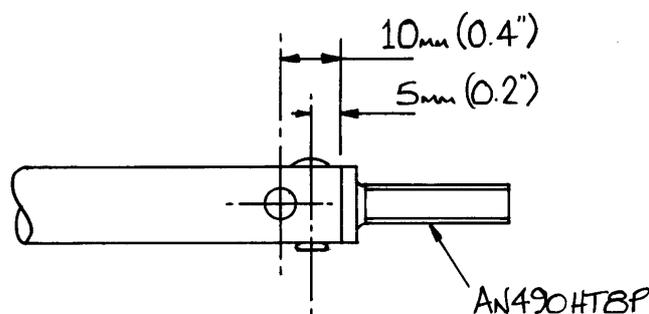


Fig 9. Typical push-rod end fitting attachment method.

While you're in push-rod making mode, make up the two short aileron quick-connect push-rods, using the ½" x 0.035" wall aluminium tube CS13, according to figure 9. Cut the tube into two 9 cm (3 ½") lengths.

One end of these will be attached to the vacant hole in each CS08 crank and the other end will be connected to the, yet to be installed, quick-connect bellcrank.

Other push-rods which will be required shortly are the two pitch push-rods which run through the aileron torque tubes. Make these up using the 64.75 cm (25.5") long 5/8" diameter x 0.035" wall thickness steel tubes (Part no. CS11). Install the end fittings as shown in figure 10 and screw on MW5 rod-ends and AN316-5R check nuts.

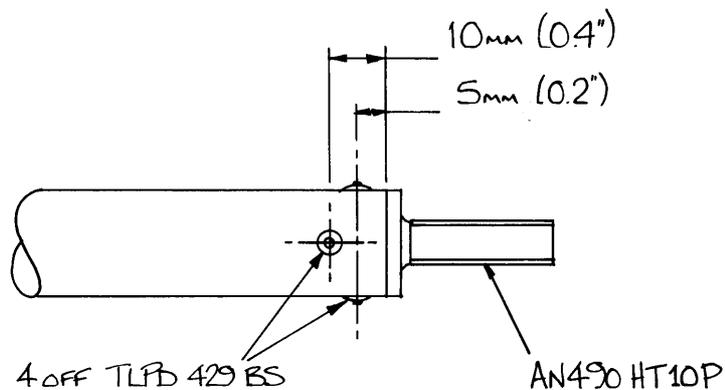


Fig 10. Installation of pitch push-rod end fitting.

### Step 8

Fasten the aileron cross link-rod to the inboard holes of the CS08 cranks according to the section in figure 11 adjusting its length so the cranks are parallel. See also figure 12.

Attach one end of the short link-rods to each of the CS08s in the same manner.

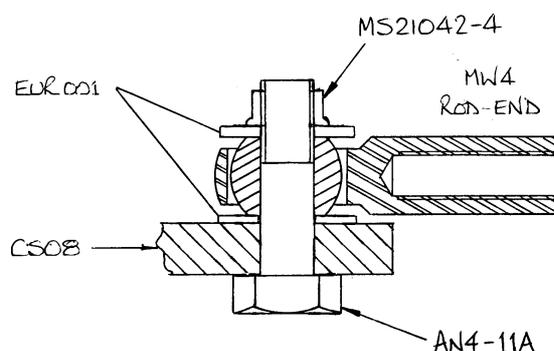


Fig 11. Section through CS08 and rod-end.

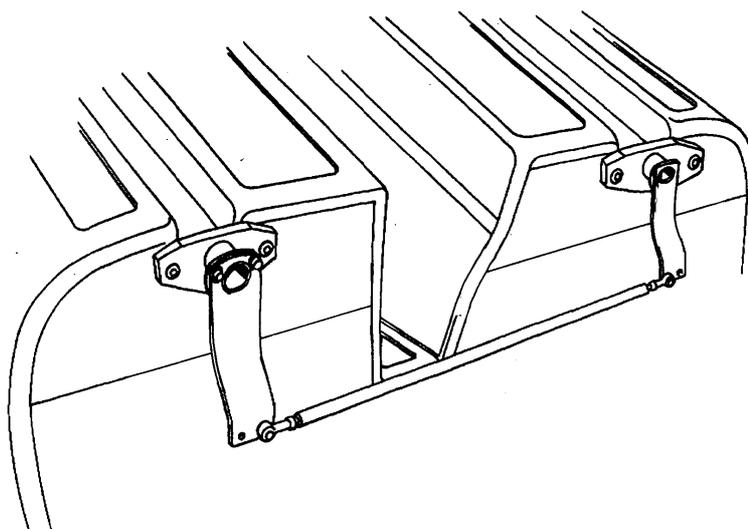


Fig 12. Aileron link rod CS12 attached to cranks CS08 .

## Step 9

### Control column

The 38 cm (15") long 1" diameter steel cranked tubes CS16, pushed into the bottom fitting CS01 with the Tufnol tube spacer CS16B form the control columns. If any of the parts don't fit each other easily, sand the bore using an abrasive flap wheel in your drill until it's sliding fit. The bottom of the control column is the short straight end. You can make a type of flap wheel (see figure 13) using a piece of metal rod with a slot cut in one end and a piece of fabric backed abrasive material held in the slot. You may have to sand the end of the tube a little as well as it can be difficult to remove material from the bottom of the bore.

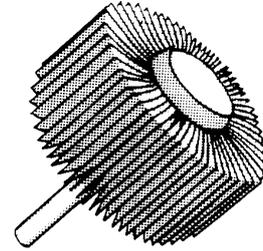


Fig 13. Flap wheel.

With the control column and spacer tube fully down against the shoulder in CS01, orientate the column such that the tube cranks aft and slightly inboard so that there is equal space between it and each of your thighs. Carefully drill through the existing hole and through the parts with a 1/4" drill, drilling each hole individually. Install an AN4-17A bolt, MS21042-4 nut and AN960-416L washer. (The nut and bolt could be substituted on the passenger's side by a pip pin to facilitate quick removal if required.)

**Note:** To avoid possible elongation of the holes in CS01, spot the centre of the hole using the hole in CS01 as a guide first then drill the hole through the tube and control column separately.

Slide the pitch push-rod into the aileron torque tube then install the control column assembly using an AN5-23 bolt through the pre-bushed pivot hole and an AN960-516L washer under an AN310-5 nut. Install also a MS24665-153 split pin but don't bend it until you're ready for final assembly.

**Hint:** When bending split pins to hold castle nuts there are two recognised methods. One method is to bend the split pin so that its legs run lengthwise to the bolt but this leaves its sharp ends exposed. The best and highly recommended method is to wrap each leg around one of the nut's castellations, putting the sharp end into one of the gaps. You may have to trim the split pin a little to make a neat job.

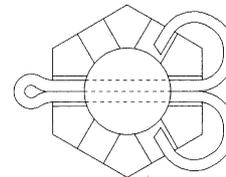


Fig 14. Recommended split pin bending method.

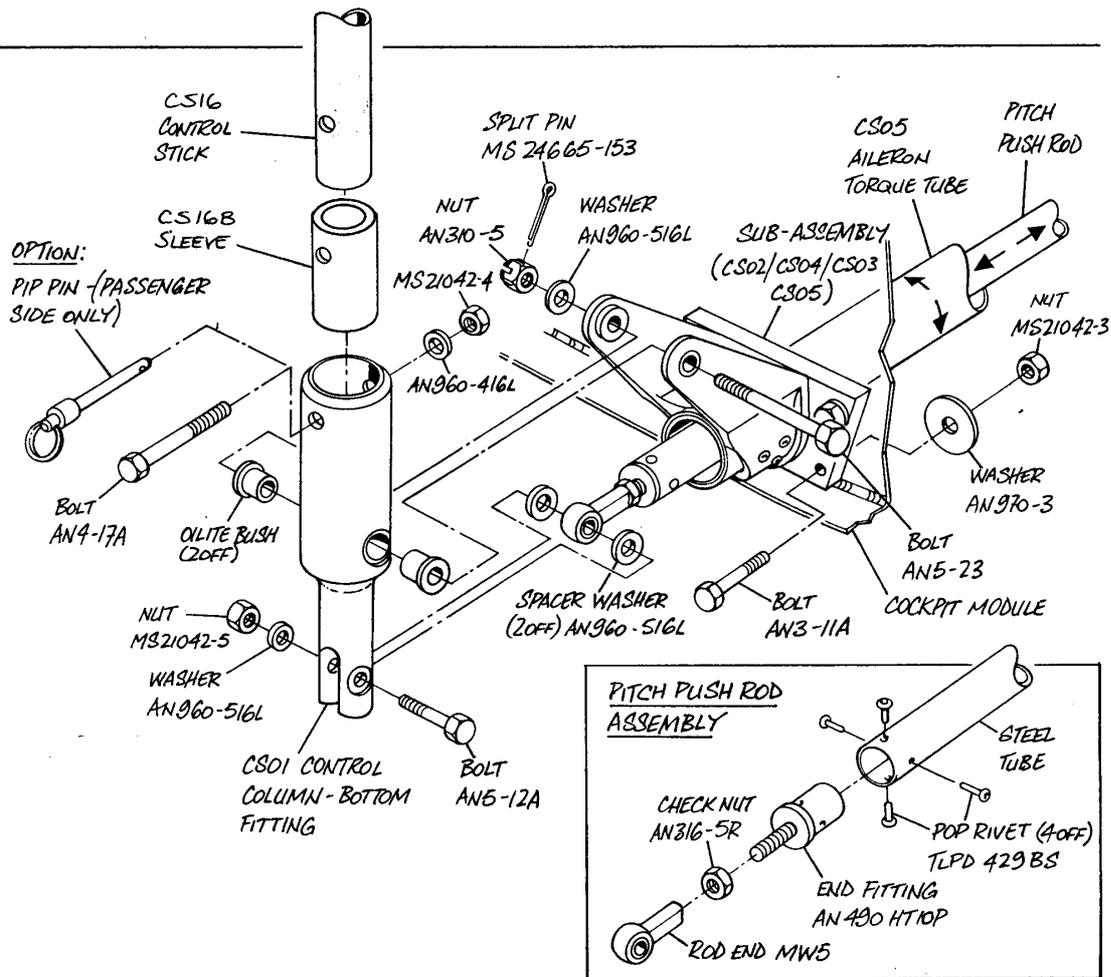
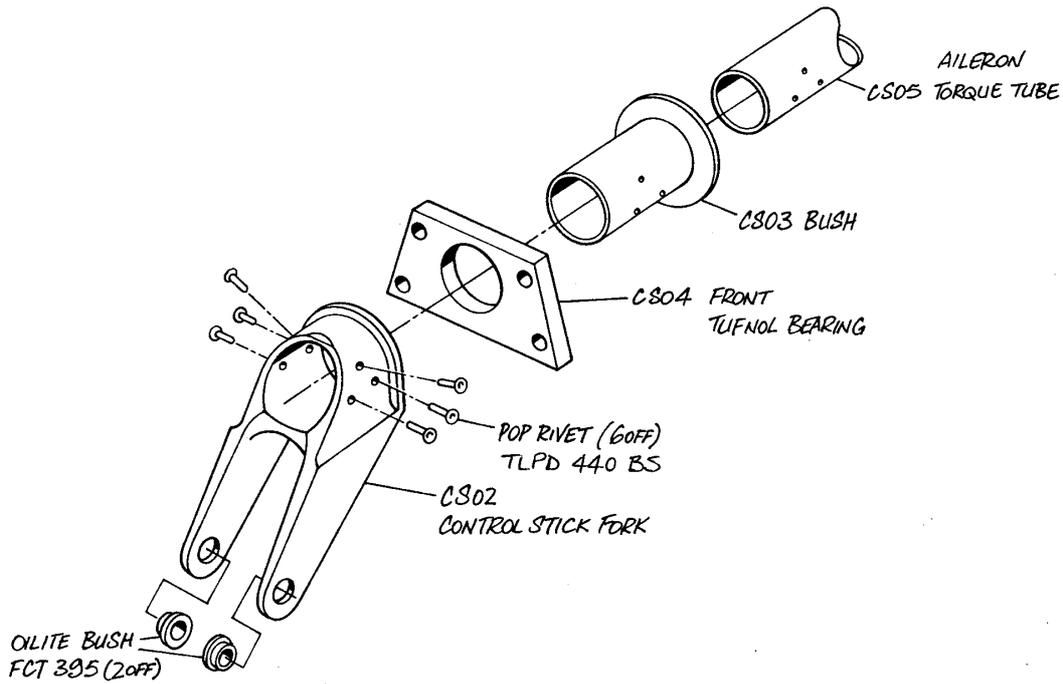
Connect the pitch push-rod to the bottom of the control stick with an AN5-12A bolt, MS21042-5 nut with an AN960-516L washer under it. Use an AN960-516L washer each side of the rod end's ball to act as a spacer.

### Control stick movement

Before progressing, check that the minimum control movement that can be achieved without interference, is 22.5 cm (9") fore and aft and 28 cm (11") laterally as measured at the top of the control column.

**Note:** The neutral position of the control stick is not when it is vertical. Neutral is when the stick has moved approximately 1/4 of the way back from fully forward.









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