

# Instruction Manual

## Modeling the Fokker Dr.1, Tri-Plane

Instruction Manual & Prototype by Dr. David G. Ullman, 2013



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**Model Airways Kit No. MA1040**

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# Building the Fokker Dr.1, Tri-Plane

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## Technical Details

Scale 1:16,  
Length 14 1/8"  
Span 17 3/4"  
Height 7 1/4"

Kit design, Sheets, instructions, and prototype model by David G. Ullman, 2013

## History

The Fokker Dr.1, Tri-Plane is probably the most famous fighter of WWI. It is known as the plane flown by Manfred von Richthofen, the Red Baron, who is credited with 80 victories before he himself was shot down and killed. Von Richthofen's first victory came in September 1916. A majority of his early victories were in various models of the Albatros (the Albatros D.Va is also a Model Airways kit). He only flew the Dr.1 from September 1917 until his death in April 1918, accounting for the last 20 of his kills.

In July 1917 the German military signed an agreement with Anthony Fokker, the Dutch airplane designer, for building 20 Tri-planes. The first of the 320 Tri-planes built entered service in August 1917 and the last ones taken out of service in June 1918. About 280 were destroyed in combat and many were also lost during training. It was a hard airplane to fly, but those who mastered it were deadly. By the end of the war only about 20 Dr.1s remained. Of these, two survived until WWII in German museums. They were lost during that war. Thus, there are no original Dr.1s, nor are there a complete set of drawings.

The Dr.1 was small airplane, 18' 11" (5.77m) long with a span of only 23' 7" (7.19m). Its empty weight was a mere 895lb (405 kg). It was powered by many engines, primarily the Oberursel UR II engine which was a copy of the French LeRhone type 9Ja. This was a rotary with 9 cylinders that spun around the stationary crankshaft producing 110 hp (84kw). What made the Dr.1 such a good fighter was that it could climb to 3000 ft (about 1000m) in less than 3 minutes. It had a ceiling of 19,000 ft (over 6000 m) and it was highly maneuverable with a very high roll rate. It was difficult to fly and only the best pilots could manage it. Those that did tame it liked it and were effective with it. The Dr.1 appeared too late in the war to have much effect on its outcome.

One challenge designing this kit is the lack of original Dr.1's or complete drawings of their parts. Every Dr.1 seen at an air show or in museum is a replica built from one of a number of sets of drawings that have been developed from the pieces and photographs that survive. Every effort has been made to develop a kit that is as accurate and as realistically possible based on this material.

## Before you Begin

### Suggested tool list:

- Xacto blade holder and #11 blades
- Single edged razor blades
- Small needle nose pliers
- Small end cutters
- Small diagonal cutters
- Plato Model 170 Shears (optional, but good for removing photo etched parts).

## **Disposable materials that will be needed:**

- Cyanoacrylate adhesive
- Cyanoacrylate un-cure
- Cyanoacrylate insta-set (accelerator)
- Liquid Nails Metal Projects LN-203 or other 5 minute epoxy (LN-203 is especially good on the materials in this kit)
- Disposable fingernail files - fine
- 220-320 sand paper
- Paper towels
- Clothespins
- Toothpicks
- Cotton swabs
- Masking tape- low tack
- Small touch-up paint brushes
- Small rubber bands

## **Paint**

In general water based paints (i.e. Acrylics) do not stick well to the metal used in this kit. It is suggested that only enamels be used. Further, clean (with soap) and sand all metal surfaces to be painted with very fine sandpaper or Scotch-Brite™.

- Semi-gloss or matte spray finish
- German Silver Metallic, Model Master Custom Spray Enamel, 2914 (this closely matches the casting's color).
- Italian Red, Model Master Custom Spray Enamel, 2919
- Semi-gloss black
- Dark gray

## **Working with the Sheets and parts**

There are five sheets of drawings that support this instruction manual:

- Sheet A: General side view and top view of the model with sections through the front of the fuselage
- Sheet B: Front view and fuselage details
- Sheet C: Wing Layouts
- Sheet D: Layout of tail surfaces, ailerons and landing gear; and various other details
- Sheet E: Engine Details

Some general suggestions:

- Copy the wing and other surface layouts if you want to preserve the original Sheets.
- Cut tubing by rolling it under a blade (it can be a used one as it doesn't have to be real sharp). After it is well creased, the tube can be snapped off. Make it slightly too long and file off the deformation made by the blade.
- Always wash and sand all metal parts before you glue to them or the glue won't stick very well. Epoxy works best on metal.
- Put puddles of glue on scrap paper and apply with toothpicks. Both are cheap. Never touch the bottle to the model.

### **A. Preparing cast parts**

Most parts are cast from Britannia a common casting metal that is very similar to pewter. The fuselage parts are cast in zinc as it is stiffer than Britannia. Britannia can be easily trimmed with a hobby knife. When gluing these metals, wash and clean the surface with Scotch-Brite or fine sand paper. They can be painted with any common, oil based hobby paint.

There are over 50 turnbuckles on the Dr.1, mainly in the fuselage. To make rigging easier, drill out each end of each turnbuckle with a 1/32" drill (.9 mm).

### **B. Cleaning laser cut parts**

Laser cutting is a great process for making very accurate basswood and plywood parts that fit together well. The downside is that it leaves a char or ash residue that can be easily spread by touching and discolor your finish. Best is to wipe it off before removing parts from the sheet with a paper towel. If it won't wipe off, use very fine (320) sandpaper. When removing a part from the sheet do the same to the edges. Best to lay a paper towel on the work surface and draw the part edge across it repeatedly, then lightly sand the edge. Be sure to throw away paper towels and sandpaper often as the black residue will get on other parts. Make sure you keep your hands clean or your fingers may track the char to the surface of the parts.

### **C. Preparing stock wooden parts**

Sand strips of wood with 220 or extra fine sandpaper prior to using.

### **D. Glue**

Glue wood parts with cyanoacrylate (super glue). To apply, put some drops on a paper pad and use toothpicks to apply to the model. When the material on the pad gets stiff or hardens, tear off top layer of pad and work from fresh sheet.

Best is to use epoxy for metal parts. Liquid Nails Metal Projects LN-203 or other 5 minute epoxy is best. Mix small batches on paper with a toothpick and apply. LN-203 comes in dual syringe that ensures the proper ratio.

**NOTE:** BEFORE GLUING ANY METAL PARTS WASH AND ROUGHEN THE SURFACE WITH A FILE OF FINE SANDPAPER.

### **E. Part Number Scheme**

All parts have two letters followed by a number. The first letter signifies the assembly on the airplane:

E = Engine  
F = Fuselage  
L = Landing gear  
T = Tail  
W = Wings

This second letter signifies the manufacturing process used to make the part:

C = Cast metal  
M = Metal bar or tube  
O = Other miscellaneous parts  
P = Photo etched metal  
S = Wood strips  
W = Wood (laser cut)

The one or two digit number is an identifier which is not necessarily continuous. For stock parts, the Model Airways standard stock number is also given. This is of the form WPXXXX.

## STAGE 1: BUILDING THE WINGS

Layout drawings for all three wings are on Sheet C. Instructions for the Bottom Wing are detailed first. The Mid and Upper wings are very similar in construction to the Bottom Wing and only details that differ from it are covered.

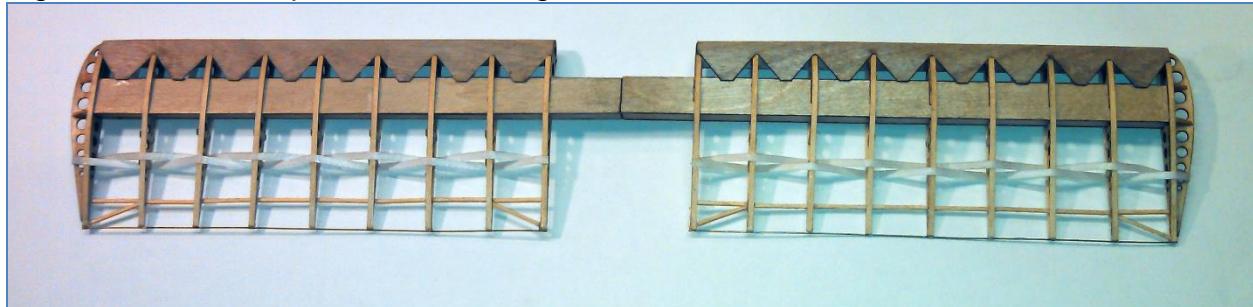
Anthony Fokker and his chief designer, Reinhold Platz, used a single box beam as the spar in each of the wings. These are so rigid that they allowed them to use no external wire bracing on the wings, lowering the aerodynamic drag. The structure used in this kit closely follows that used by Platz. The directions describe how to make one half. Both sides are identical and fastened together only at the spar as described in the directions.

### A. The Bottom Wing

#### Bottom Wing Parts List

Part #	Name	Count	Material
WW1a	Bottom wing spar: top	2	1/32 laser cut plywood
WW1b	Bottom wing spar: bottom	2	1/32 laser cut plywood
WW2	Bottom wing spar front	2	1/32 laser cut plywood
WW3	Bottom wing spar rear	2	1/32 laser cut plywood
WW4	Wing rib	16	1/32 laser cut plywood
WW5	Bottom/mid tip rib	2	1/32 laser cut plywood
WW6	Bottom/mid tip rib doublers	2	1/32 laser cut plywood
WW7	Bottom/mid wing tip	2	1/32 laser cut plywood
WW8	Bottom wing leading edge	2	1/64 laser cut plywood
WW9	Spar connector	2	1/32 laser cut plywood
WP3726	Rib stiffener	stock	1/64" x 1/16" (1.6 x .4 mm)
WP3600	Rear spar	stock	.031" square (1 x 1 mm)
WP2527	Rib and leading edge bracing tape	stock	1/16 in white Ribbon
WP3600	Trailing edge brace	stock	.031" square (1 x 1mm)
WP498	Trailing edge	stock	.015" dia wire (0.4mm)
WP3607	Spar spacer and tip braces	stock	1/32" x 1/4" (.8 x 6 mm)
WP3726	Rib caps	stock	1/64" x 1/16" (1.6 x 0.4 mm)
WP3658	Leading edge mold 1	stock	1/4 x 3/4 x 12" (6.4 x 19 x 304 mm)
WP104K	Leading edge mold 2	stock	3/16" Al rod 10" long (5 x 254mm)
WP3625	Tip skid	stock	3/32" square (2.4 x 2.4 mm)
WP3	Rear tip skid mount	2	.010" (.25 mm) Photo etched Al

Figure 1.1 The Complete Bottom Wing



## 1. Main spar

The main spar on the Dr.1 is essentially a box-beam. The top and bottom members have slots facing forward to receive the forward half of the ribs. The difference between the top (WW1a) and bottom (WW1b) is that the slot for the root rib is canted out at the bottom to clear the landing gear, thus the slot in the bottom is further outboard. To build this spar cut .40 inch (10mm) long spacers from 1/32 x 1/4 inch (.8 x 6 mm) and glue at three positions along spar bottom (Two shown in Figure 1.2). Their exact locations are not critical as they only act to provide guides to keep the front and rear square to the bottom while gluing them in place, but keep the inboard spacer outboard of the first rib as shown to the left in the figure. Before gluing ensure that the ribs fit in the slots and lightly sand the slots as needed.

Glue the spar front (WW2) and rear (WW3) to the bottom making sure the slots are aligned (See Figure 1.2). The rear spar notches are offset for the root rib so it is canted out at the bottom to clear the landing gear strut. Glue on the top. Mark inside the spar to note the root relative to the tip. Check that the ribs fit in the slots and that the root rib is canted outward at the bottom.

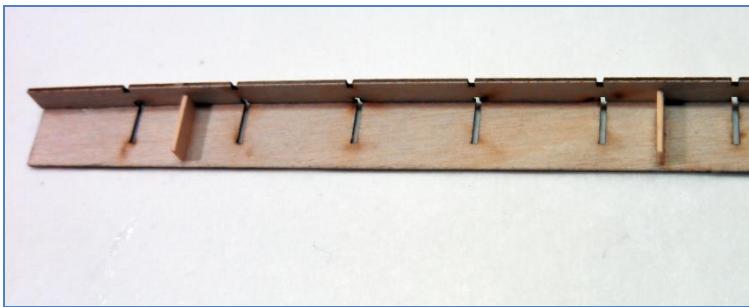


Figure 1.2 Bottom Wing Spar Details

## 2. Wing ribs

There are eight ribs (WW4) on each side of the bottom wing, not counting the tip rib (WW5). Each rib (except the root rib) has stiffeners on both sides as shown in Figure 1.3. These are cut from the 1/16 x1/64 inch (1.6 x .4 mm) strips. On the root rib only put stiffeners on the outboard side.

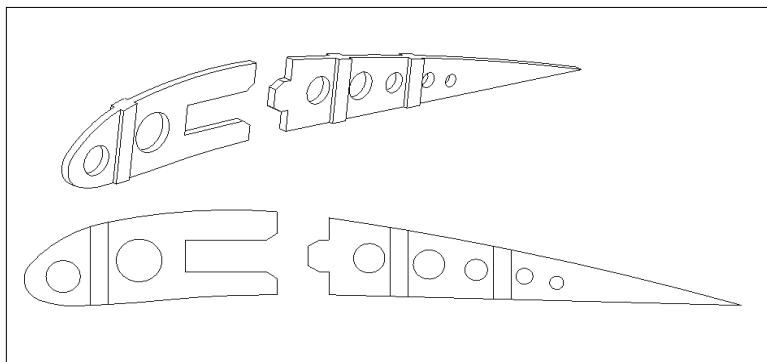


Figure 1.3 Wing Rib Details

The easy way to add the stiffeners is before the ribs are removed from the sheet as show in the photograph, Figure 1.4. Glue strips of stiffener to both sides of the ribs and then cut on the laser cut lines, on both sides, to free the ribs from the Sheet. Then clean off the carbon residue and sand the stiffeners to match the rib out line as needed.



Figure 1.4 Rib Stiffener Details

Pin the spar to the drawing with 1/64 inch (.4mm) spacers underneath as shown in Figure 1.5. The wing ribs fit in spar slots. When gluing, be sure the rear ribs touch the building surface at the trailing edge and the front ribs do so at the lowest point on the leading edge. Do not worry that the ribs do not reach all the way to the trailing edge on the drawing. The cap strips will make up this difference.



Figure 1.5 Building the Wing Detail

### 3. Wing Tips

The tip rib assembly is made up of three laser cut parts: the Tip Rib (WW5), Tip Rib Doubler (WW6) and Wing Tip (WW7); and some custom fit Tip Braces as shown in Figure 1.6. First, glue the Doubler (WW6) to the Tip Rib (WW5) and these to the end of the spar. Then, glue the Wing Tip (WW7) to the Tip Rib, warping it as shown in the figure and on Sheet C. A simple way to do this is to glue the front quarter first, and after it dries pull the tip down carefully and glue it in place. Add the Tip Braces cut from 1/32 x 1/8 inch (.8 x 3 mm) stock as shown.

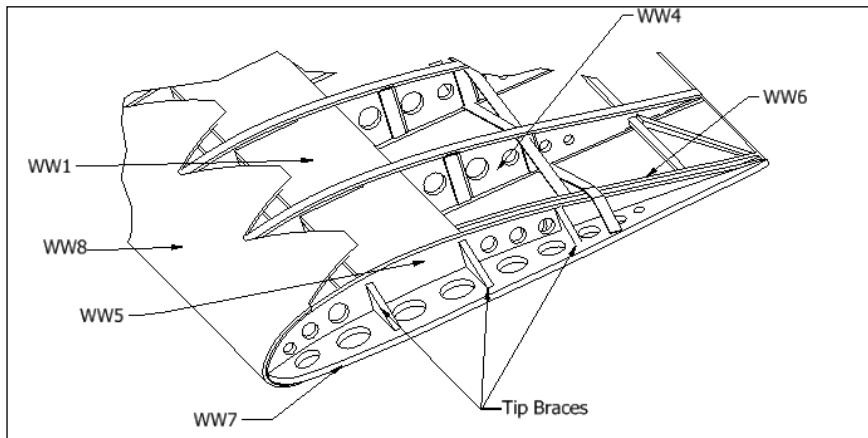
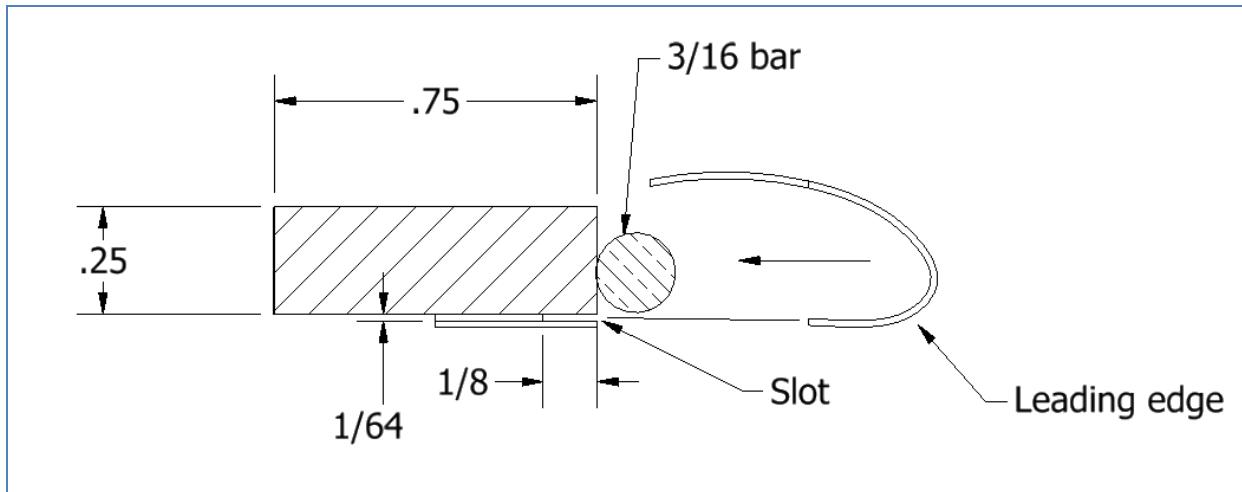


Figure 1.6 Wing Tip Details

### 4. Leading Edge

The leading edge (WW8) is made from 1/64 inch (.4mm) laser cut plywood. The actual Dr1 had a warped plywood leading edge as is used here. To prepare each leading edge (six in all for the three wings) first make a jig from the supplied piece 1/4 x 3/4 inch (6 x 18mm) basswood, a 3/16 inch (5mm) rod and some scrap 1/64 inch (.4mm) material. Glue together as shown in Figure 1.7 leaving a 1/64 x 1/8 inch (.4 x 3.2mm) slot as shown to hold the bottom of the leading edge. Then each leading edge can be formed by soaking the blank for at least  $\frac{1}{2}$  hour in water then slipping the straight edge of the blank in the slot and slowly working the Sheet around the bar, carefully bending it and clamping with clothes pins or small clamps as shown in Figure 1.8. Alternately, you can take two pieces of wood, 9" long to bridge the entire length of the leading edge and clamp these to get a more even pressure. Be very careful forming the plywood and work it around the rod slowly or it may break. Rolling it on the work surface is also helpful.

You may want to practice with some scrap, bending parallel to the grain of the outer layers of the plywood. Let it dry overnight.. Either glue in place or leave it in the jig as it may slowly uncurl if left un-glued for too long. Be careful to make a left and a right leading edge.



Figures 1.7 Leading Edge Jig



Figure 1.8 Leading Edge Clamped on Jig



Figure 1.9 Leading Edge Gluing Detail

Glue the leading edge to the spar/rib structure. First, remove the structure from the building board. Glue the top (the Vee edge) of the leading edge to the top of the spar as shown in Figure 1.9. The leading edge tabs should only overlap about 1/32 of an inch (.8 mm). Be sure each rib aligns with the Vee notches as shown. Best to start gluing at the two ends and, once you are sure of the alignment, glue all the other leading edge tabs to the spar. Then glue the bottom of the leading edge to the ribs being sure the leading edge is pulled tight against them. Clothes pins help here. Best to start gluing at the middle ribs and work outward.

While the wing is off the building board sight down the ribs and make sure they are all aligned. Trim the leading edge to match the root rib.

## 5. Final wing details

5.a. Bottom rib caps: Each rib has a 1/64 x 1/16 inch (.4 x 1.6 mm) cap on the top and the bottom. Begin with the bottom caps and glue them first at the back of the leading edge. When set, glue them along the remainder of the rib. Leave the bottom caps about 1/8 too long when

compared to the trailing edge length seen on the layout drawing. Glue on the root rib's cap strips so they only extend outboard (inboard flush with the rib).

5.b. Trailing Edge: The bottom cap strips provides a platform for the attachment of the trailing edge wire. This assures uniform mounting and a straight trailing edge. Glue .015 inch (.4mm) wire to each rib. Trim the bottom cap strips flush with the rear of the trailing edge.

5.c. Top rib caps: Add the top cap strips. You will have to bevel them slightly at the front to mate with the leading edge. Trim even with the trailing edge. Sand the front top to be plane with the leading edge with very fine sand paper. This should be minimal and be careful not to sand the leading edge plywood as the top veneer is very thin.

5.d. Rear spar: The Rear Spar is made of .040 inch (1mm) square stock cut to length to fit between each rib. It is best to reattach the wing structure to the drawing and cut some 1/64 inch (.4mm) spacers from scrap to hold the spar pieces the correct distance off of the building board. Glue the spar pieces in place as shown on Sheet C. Don't glue on the trailing edge braces quite yet.

5.e. Trailing edge braces: At the root and tip there is an angled brace (shown on Sheet C) that holds the trailing edge taught. They are made of .040 inch (1 mm) square stock. Cut and glue into position from the rear spar to the trailing edge of the root and tip ribs.

5.f. First finish: Finish the wing with a couple of thin coats of clear semi-gloss or matte spray before doing the next steps.

5.g. Lower leading edge bracing: On the original Dr1, the lower lip of the leading edge is tied to the spar with pieces of tape, woven material much like a wide ribbon. On this model 1/16 inch ribbon is used. Cut pieces of ribbon to 3/8" inch (10 mm) long or slightly longer. Glue them on as shown in Figure 1.10 between each pair of ribs.

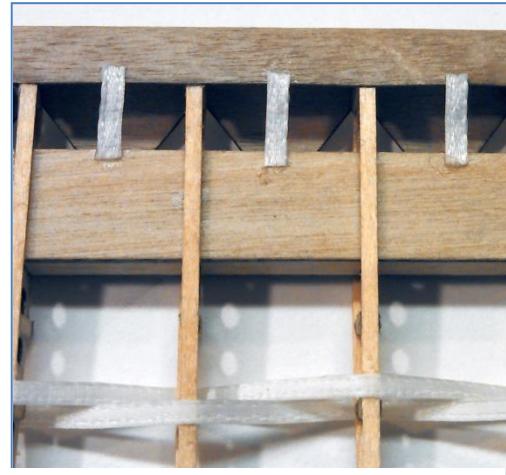


Figure 1.10 Rib and Leading Edge Bracing

5.h. Rib Twist Bracing: To keep the thin ribs from twisting, ribbon is woven between them as shown in Figures 1.1 and 1.10. Rib twist bracing is made from the same ribbon as the Lower Leading Edge Bracing. Best to cut a single length (about 18 inches (46cm long), glue one end directly over the rib stiffener on the root rib (either on top or bottom) and then weave it through to the tip. Pull it taught, making sure it is straight and then glue to each rib. Then, wrap the ribbon around the tip and follow the same procedure back to the root. Coat both the leading edge bracing and the rib twist bracing with clear finish or thin cyanoacrylate.

5.i. Connect the two wing halves together: Ensure that the ends of the spars are flush and aligned. Make sure the root ribs are at least 1.77 in (44mm) apart at spar. Insert and glue the Spar Connectors (WW9) to the front and rear of either wing. Then slide the other wing on and glue in place.

5.j. Tip skid: The lower wing has an iconic tip skid. This is made from 3/32 square (2.4 mm) stock 2" (50mm) long. Sand to shape. Paint dark brown.

Paint the Rear Tip Skid Mount (WP3) black and wrap it around the skid, twist it 90deg and glue to the back of the spar just inboard of the tip rib. Trim to length.

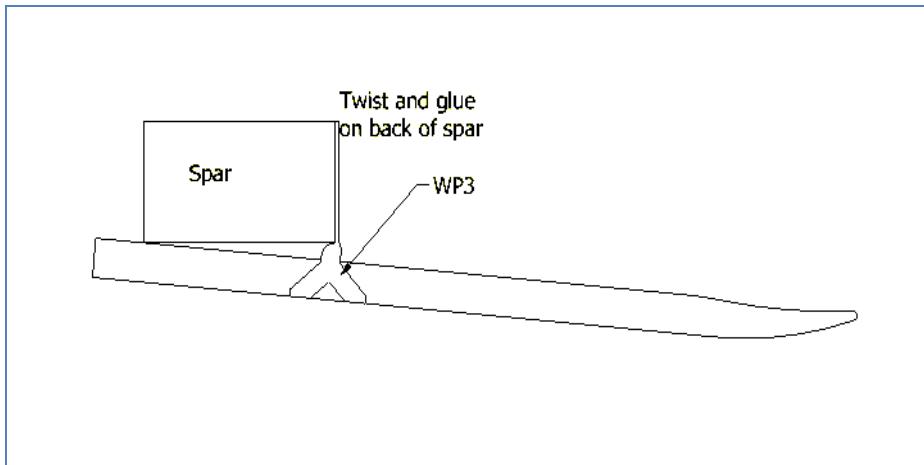


Figure 1.11 Tip skid detail

5.k. Final Finish: Finish the wing with a couple of thin coats of clear semi-gloss or matte spray being sure that the ribbon material is well wetted.

## B. The Middle Wing

### Middle Wing Parts List

Part #	Name	Count	Material
WW10	Middle wing spar bottom/top	4	1/32 laser cut plywood
WW11	Middle wing spar front	2	1/32 laser cut plywood
WW12	Middle wing spar rear	2	1/32 laser cut plywood
WW4	Wing rib	14	1/32 laser cut plywood
WW13	Middle root rib	2	1/32 laser cut plywood
WW5	Bottom/middle tip rib	2	1/32 laser cut plywood
WW6	Bottom/middle tip rib doubler	2	1/32 laser cut plywood
WW7	Bottom/middle wing tip	2	1/32 laser cut plywood
WW9	Spar connecter	2	1/32 laser cut plywood
WW14	Middle wing leading edge	2	1/64 laser cut plywood
WW15	Middle wing root trailing edge	2	1/32 laser cut plywood
WP3726	Rib stiffener	stock	1/64" x 1/16" (1.6 x .4 mm)
WP3600	Rear spar	stock	.031" square (1 x 1 mm)
WP2527	Rib and leading edge bracing tape	stock	1/16 in white Ribbon
WP3600	Trailing edge brace	stock	.040" square (1 x 1mm)
WP498	Trailing edge	stock	.015" dia wire (0.4mm)
WP3607	Spar spacer and tip braces	stock	1/32" x 1/4" (.8 x 6 mm)
WP3726	Rib caps	stock	1/64" x 1/16" (1.6 x .4 mm)

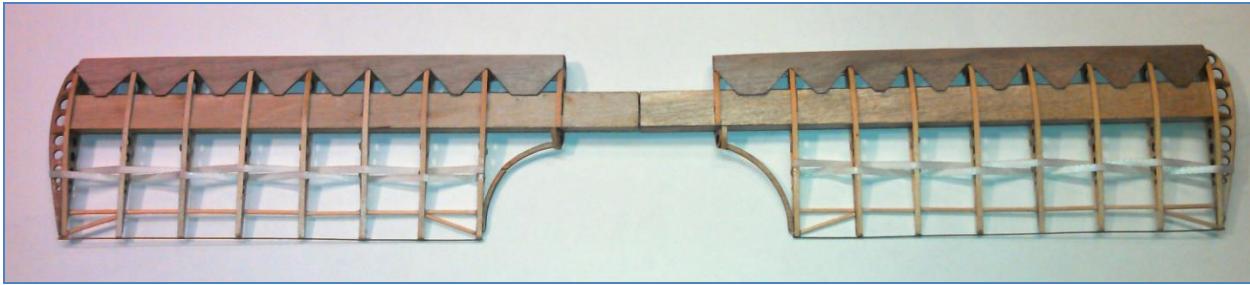


Figure 1.12 Middle Wing Completed

The Middle Wing is constructed the same as the Lower Wing, with the following exceptions:

- The spar top and bottom are the same (WW10) and the middle wing front is WW11 and rear is WW12. Be sure when building the spars that the slots in the Spar Rear (WW12) are oriented correctly. Also, be sure to build a left and right spar.
- The rear part of the Root Rib, WW13, is canted outward at the top to clear the Top Wing Strut (Figure 1.12).
- The inboard notch in the trailing edge, WW15 is glued to the root and first rib as in Figure 1.13. This notch was to allow the pilot to see forward below the nose, essential in a dog-fight.
- Be sure to make a left and right leading edge (WW13).

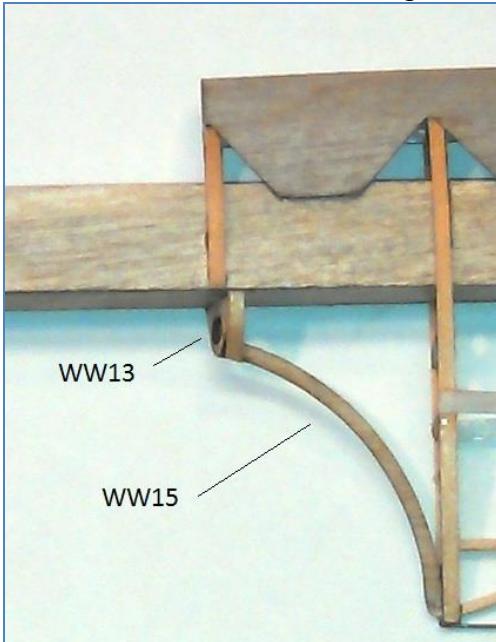


Figure 1.13 Middle Wing Root Detail

### C. The Top Wing

The Top Wing is similar to the other wings but has ailerons.

#### Top Wing Parts List

Part #	Name	Count	Material
WW16	Top wing spar bottom/top	4	1/32 laser cut plywood
WW17	Top wing spar front	2	1/32 laser cut plywood
WW18	Top wing spar rear	2	1/32 laser cut plywood
WW4	Wing rib	8	1/32 laser cut plywood

WW19	Top outer wing rib	12	1/32 laser cut plywood
WW20	Top tip rib	2	1/32 laser cut plywood
WW21	Top tip rib doubler	2	1/32 laser cut plywood
WW22	Top wing tip	2	1/32 laser cut plywood
WW23	Top wing leading edge	2	1/64 laser cut plywood
WW9	Spar connector	2	1/32 laser cut plywood
WP3629	Aileron spar	stock	3/32 x 1/4 (2.4 x 6.4mm)
WW24	Aileron spar braces	8	1/64 laser cut plywood
WW25	Aileron center spar braces	4	1/64 laser cut plywood

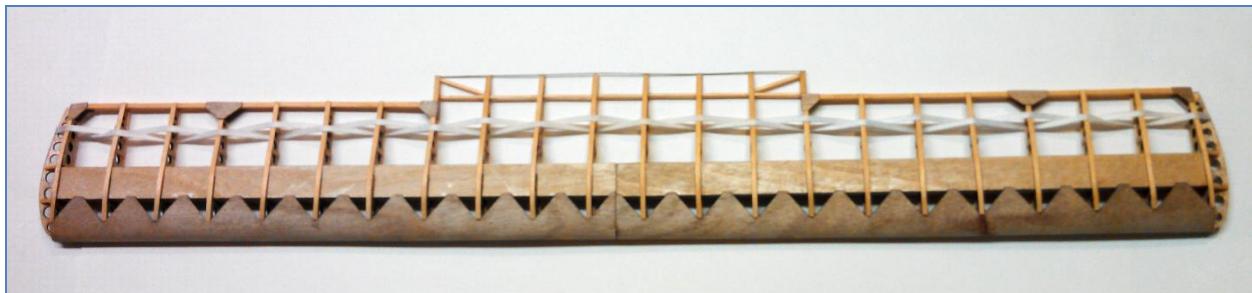


Figure 1.14 Complete Top Wing without Ailerons

## 1. Top Wing Basic Structure

The top wing basic structure is the same as the other two wings with the following exceptions:

- The spar top and bottom are the same (WW16) and the top wing front is WW17 and rear is WW18. Be sure when building the spars that the slots in the Spar Rear (WW12) are oriented correctly matching the top and bottom. Also, be sure to build a left and right spar.
- On each half, the 4 inner most ribs (WW4) are the same as on the other wings. The 6 outer ribs (WW19) and the tip ribs (WW20 – 22) are shortened to leave room for the ailerons as shown in Figure 1.14.
- The top wing leading edge is WW23.
- The Aileron Spar is made from 3/32 x 1/4 inch (2.4 x 6mm) stock carved as shown Sheet D. Easy way to carve this is to wrap fine sandpaper around a ¼" (6mm) rod. While building the Top Wing put 1/64" (.4mm) spacers under this spar.
- The Aileron Spar Braces (WW24) and the Aileron Center Spar Braces (WW25) are added at each end and center of the spar before adding the cap strips as shown in Figure 1.15 and on Sheet C. Position them so they align with the cap strips.
- The rib twist bracing (ribbon) can be added in one piece starting at the bottom center and tacking at the tips until you are sure it is well aligned.

Then go back with thin cyanoacrylate and wick it through each place it is in contact with a cap strip. Finish with clear finish or thin cyanoacrylate.

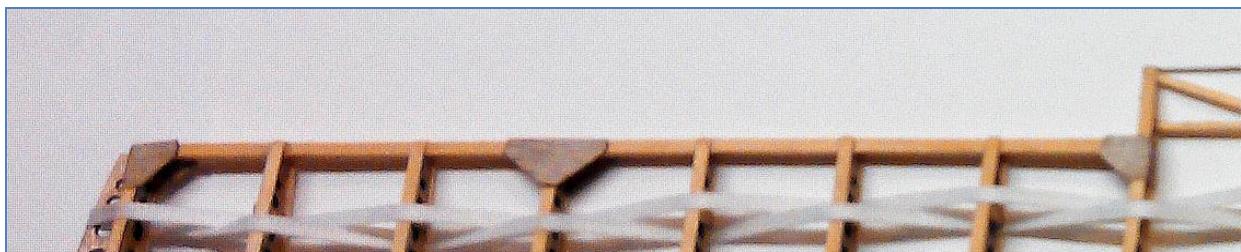


Figure 1.15 Tip section of top wing

## 2. Ailerons

Part #	Name	Count	Material
WP127K	Aileron front spar	stock	1/8" (3m) Brass tube
WP160K	Aileron rear spar	stock	1/32" (.8 mm) Brass rod
WP4	Aileron root rib	2	.020" (.5 mm) Photo etched brass
WP5	Aileron main rib	12	.020" (.5 mm) Photo etched brass
WP6	Aileron counterbalance rib	2	.020" (.5 mm) Photo etched brass
WP7	Aileron tip rib	2	.020" (.5 mm) Photo etched brass
WP8	Aileron control horn	2	.020" (.5 mm) Photo etched brass
WP498	Aileron trailing edge	stock	.015" dia wire (0.4mm)
WP0976	Hinges	stock	Copper tape
WP9	Outer aileron pulley housing	2	.01 (.25mm) Photo etched Aluminum
WP10	Inner aileron pulley housing	2	.01 (.25mm) Photo etched Aluminum
WC1	Aileron pulleys	8	Cast Britannia
WP160K	Pulley axels	stock	1/32" (.8mm) rod

The ailerons are shown in Figure 1.16 (painted) and on Sheet D (to scale). Begin with the front spar. It is made from a 1/8" (3mm) brass tube, 6" (152mm) long. Using a hammer and file, flatten the outer end as shown until it is flat at the tip.



Figure 1.16 Completed Aileron

Bend the Aileron Rear Spar (1/32" (.8mm) brass rod) to shape as shown on the Sheet D. With both spars on the Sheet, epoxy the ribs (WP4 -7) and spars as shown. Alternatively the ribs can be soldered to the spars. WP7 may need to be trimmed to fit. Add the trailing edge (.015" (0.4mm) wire and control horn (WP8). Paint silver.

Attach the ailerons to the wing with three bands of copper tape 1/8" wide by 1 1/2' long (3.2 x 38 mm) wrapped around the structure two times for strength, see Figure 1.17. The copper tape comes 1/4 wide. Slice it down the middle for all hinges.



Figure 1.17 Aileron Mounted to Wing

### 3. Aileron pulleys

Two pulleys guide the lines to each aileron for control. Here we make and install the pulleys, but the actual stringing is near the end, in Stage 7 (see Figure 7.4). Each guide is built from a body of folded aluminum (WP9 – 11), pulleys (WC1) and axels (from 1/32" (.8mm) rod). Figure 1.18 shows the outer body (WP9) which is the same on both sides and the left (WP10) inner body as folded. WP11 is essentially the same as WP10 but folded as a mirror image.. Put two pulleys in the outer body and one pulley in each locations on the inner body. Glue these in place on the top wing at the locations shown on Sheet C and being sure that they are equidistant from the top and bottom of the spar so that the cables can pass around the pulleys and through the forward hole in the wing ribs. The cables will be strung in Step 7, one of the last activities.

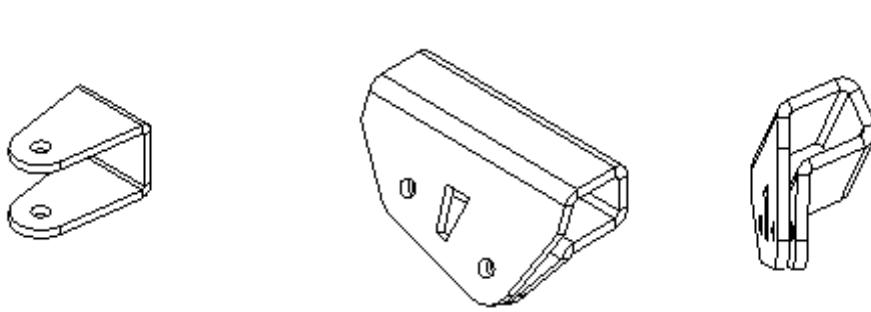


Figure 1.18 Aileron Pulley guides

## Stage 2: Building the Fuselage

The fuselage of the Dr.1 was made of welded steel tubing, braced with cables. The model simulates this construction with a combination of zinc castings, brass rods and thread bracing. Zinc is used as it is stiffer than Britannia. The best way to fasten zinc to itself or brass is with epoxy, not cyanoacrylate. To make the assembly easy, combinations of welded tubes in the original have been combined into cast sub-assemblies. The entire fuselage is constructed in a jig to ensure alignment.

### A. The Construction Jig

As shown in Figure 2.1 and on Sheet E, assemble the construction jig from the Side Panels (FW4) and Supports 5 – 10 (FW5-10). Use minimal glue to hold the pieces together as you may want to remove frames later for working on details. You may want to glue the bottoms of the jig sides (FW4) to a work board for stability. Do not glue in FW10 as it needs to be removable to get the fuselage out of the jig.

Part #	Name	Count	Material
FW4	Fuselage jig side	2	Laser cut ply
FW5	Fuselage jig 5	1	Laser cut ply
FW6	Fuselage jig 6	1	Laser cut ply
FW7	Fuselage jig 7	1	Laser cut ply
FW8	Fuselage jig 8	1	Laser cut ply
FW9	Fuselage jig 9	1	Laser cut ply
FW10	Fuselage jig 10	1	Laser cut ply
WP9915	Posts	12	1/8" dia x .75 brass tubing

Insert the precut posts in side panels and support members so they are centered. Do not glue these in place.

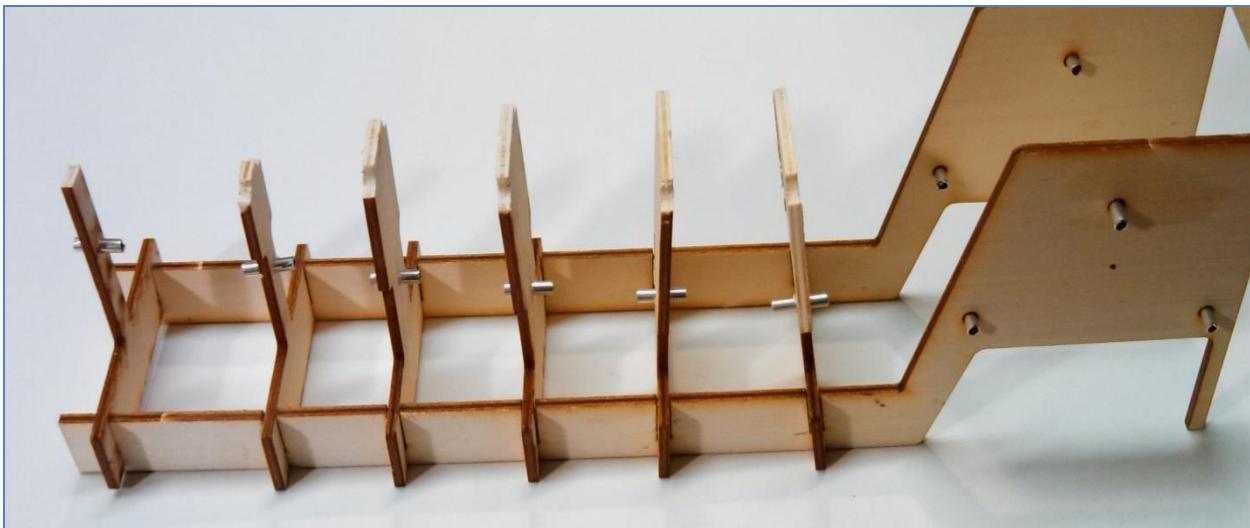


Figure 2.1 Fuselage Construction Jig

## B. The Basic Fuselage

### Basic Fuselage Parts List

Part #	Name	Count	Material
FC1	Fuselage side panel	2	Cast Zinc
FC2a	Motor Mount front	1	Cast Zinc
FC2b	Motor Mount rear	1	Cast Zinc
FC3a	Frame 3a	1	Cast Zinc
FC3b	Frame 3b	1	Cast Zinc
FC4a	Frame 4a	1	Cast Zinc
FC4b	Frame 4b	1	Cast Zinc
FC4d	Frame 4d	1	Cast Zinc
FC5	Frame 5	1	Cast Zinc
FC6	Frame 6	1	Cast Zinc
FC7	Frame 7	1	Cast Zinc
FC8	Frame 8	1	Cast Zinc
FC9	Frame 9	1	Cast Zinc
FC10	Frame 10	1	Cast Britannia
FC20	turnbuckles	10	Cast Britannia
WP1205	Rigging thread	stock	Gray Nylon Thread
FP2	Cockpit rear wall	1	.010' (.25mm) photo etched aluminum
WP162K	FM1-3, Stringers	stock	1/16 (1.6mm)brass rod

### 1. Preparing the cast parts

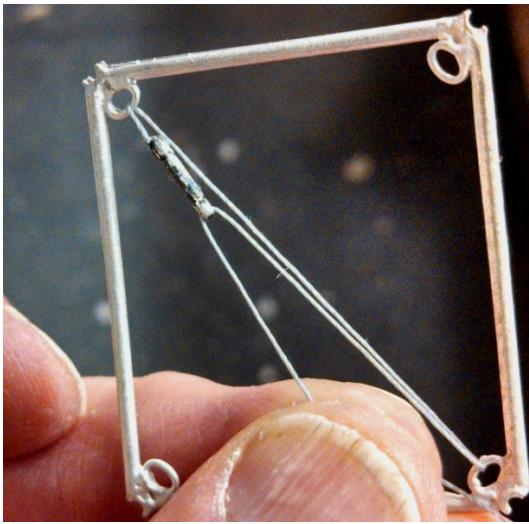
Remove and flash and straighten if necessary. On parts FC1, FC2a, FC3a, FC3b and FC 28, drill out the sockets 1/16" (1.6mm) for easy assembly. Bend the front bottom sides (FC1) where indicated on Sheet E inward slightly to clear the holes for the landing gear attachment. Use two pairs of pliers and if the casting breaks, just epoxy in place to clear the landing gear struts. File the posts on the front of FC1 as needed so they slip into the engine mount sockets (FC2a).

### 2. Preparing the Frames

For each of Frames 5-9 (FW5-9) add the cross bracing and turnbuckles (FC-20) as shown in Figures 2.2 and 2.3. The model is like the original with the bracing looped around fittings on the frames and a single turnbuckle tensioning the loop. Paint the turnbuckles black or leave gray. It is best to pre-stretch the rigging thread before using it. Soak it in water and hang a weight from it over night. To make the bracing loops, tie a 6 inch (150mm) length of rigging thread to the turnbuckle with a simple knot and put a dot of cyanoacrylate on the knot. Thread the loop through the fittings and pull taught as shown in Figure 2.3 and glue at each touch point. Finalize with a knot at the turnbuckle and trim excess thread. If a thread is loose, wet it, and when dry, put some clear finish or cyanoacrylate on it.



Figure 2.2 Frames with Turnbuckles



### 2.3 Stringing a Fuselage Frame

Frame 5, behind the cockpit also has a canvas panel that is simulated here with a piece of photo etched aluminum, the Cockpit Rear Wall (FP2). To make it look like canvas, relieve the surface at 45deg angle with 120 sand paper and then paint tan. Optionally, without sanding, take a fairly dry brush and streak the paint at 45 deg. After it dries repeat along the other diagonal.

Stitch the Rear Cockpit Wall to Frame 5 as shown in Figure 2.4 using the rigging thread. This is best done in two halves starting at the center bottom and meeting at the top. Then adjust the tension in the threads until the panel is centered. Glue the ends of the threads together.



Figure 2.4 Frame 5 with Cockpit Rear Wall

### 3. Assemble the engine mount

The engine mount is made from two parts FC2a and FC2b shown aligned in Figure 2.5. These are epoxied together. Two of the legs on FC2b are shorter than the other two. They go toward the bottom (the flat side) of FC2a. Be sure the center holes for the engine align and that the two surfaces are parallel. Best to epoxy the two bottom (shorter legs) first and then the two top legs.

Allow the epoxy to form a fillet as this joint needs to be strong. Paint the epoxy with aluminum paint and it will look like part of the casting.



Figure 2.5 Engine Mount

#### 4. Assemble the front of the fuselage

Epoxy the Right and Left Side Panels (FC1) in the Engine Mount as shown in Figure 2.6. Add Frame 3a (FC3a) to stabilize this structure (as seen in Figure 2.7). The sockets for the Top Wing Strut are forward. Do not install FC4a at this time. Make sure the sockets for the Top Wing Strut (FC32) are forward as shown in Figure 2.7. You can use the Strut to ensure the spacing of FC3a. Use minimal glue here as this frame may need adjusting in final assembly.

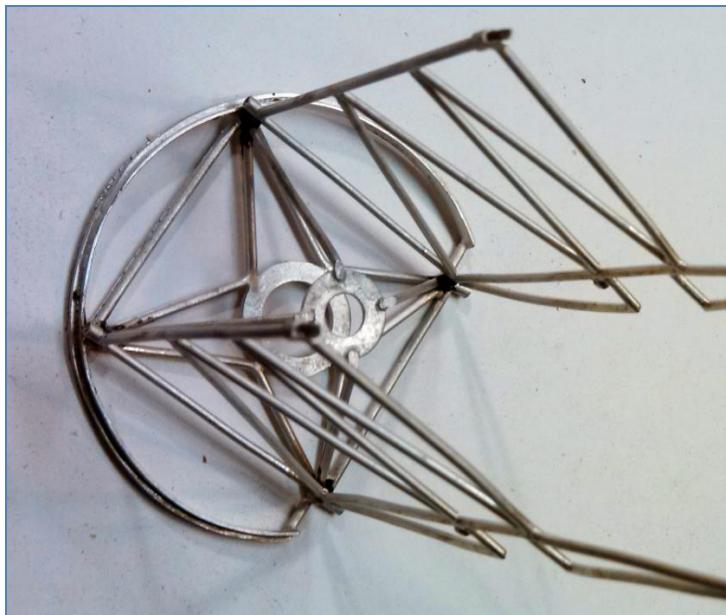


Figure 2.6 Forward Fuselage Assembly

## 5. Load the Jig

Load the jig with each frame aft of the support, sitting on the brass tube. Be sure that Frame 5 has the seat bracket facing forward. All the others have no preferred orientation. Frame 6 has guides on it for the control cables, be sure they are on the bottom. Frame 8 has a double cross bar. Be sure it is on top. Secure each frame with rubber bands as shown in Figure 2.7.

Put the fore fuselage in the jig as shown in Figure 2.7. It is easiest if the brass tubes are pushed out of the way (outboard) and then pushed back halfway as the fuselage is positioned as shown in Figure 2.8. Once in place, secure with rubber bands.

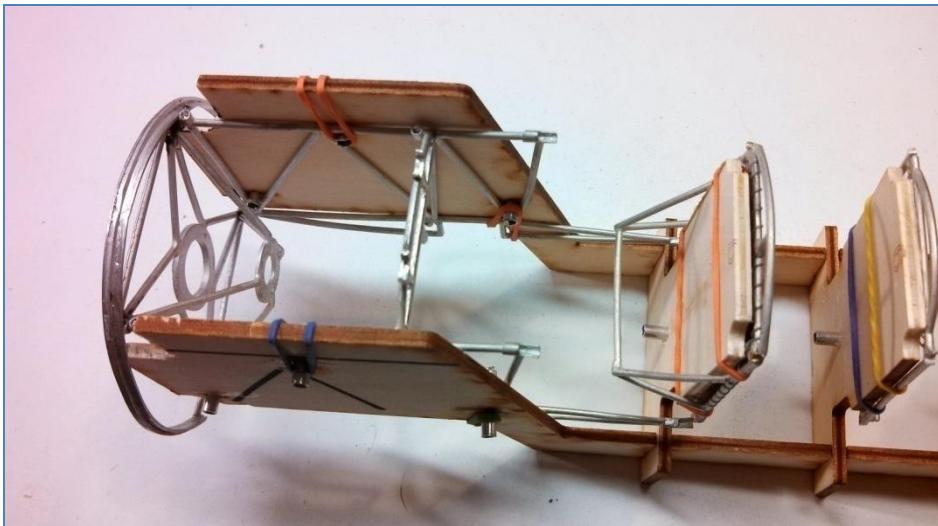


Figure 2.7 Fuselage in the jig

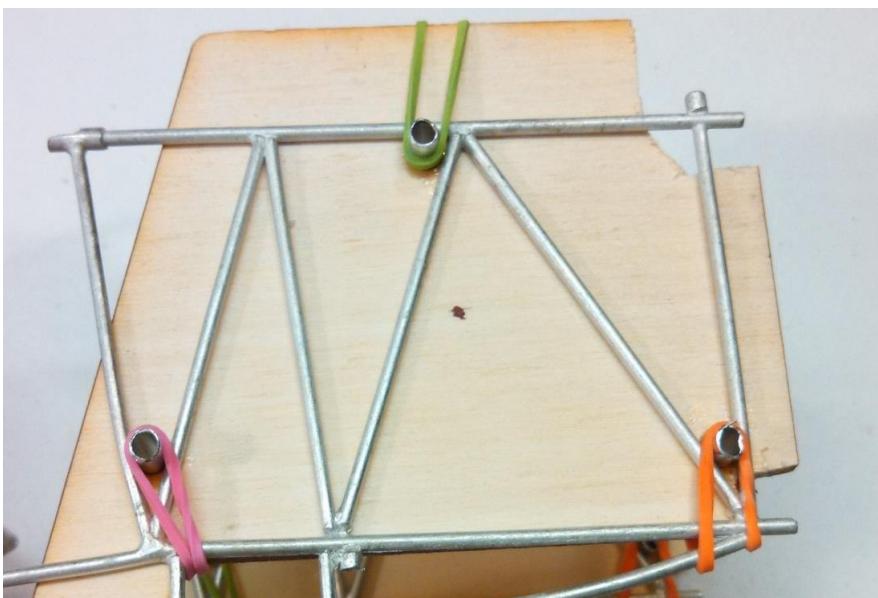


Figure 2.8 FC1 in the jig

Sight down the top and bottom of the stringer locations to be sure that all line up correctly.

## 6. Preparing the stringers

The stringers (FM1, FM2 and FM3) are made from 1/16" (1.6mm) brass rod. Cut 2 of each to length and carefully bend as shown on Sheet E. You should make these a little long and retrim them during test fitting described below. Note the front end of each stringer as labeled on Sheet B. Fit each stinger to the parts in the jig. You may need to tweak the bending and file them down to fit well in FC1. You may want to remove FC10 and its support during these steps and add it last after all stringers are in place and trimmed to length.

In the following steps, be sure to sand or file each interface and remember, rubber bands are your friends. It is not difficult to get a solid and straight fuselage, just take your time and don't be shy about only gluing one joint at a time.

Epoxy stringers FM1 in position one at a time using rubber bands or tape to hold them in the frames as shown in Figure 2.9. Start at the front and first glue to FC1, FC5 and FC6. Use a little too much epoxy as a small fillet is OK and excess is easy to trim. Aluminum paint will hide the epoxy color. When the epoxy has set, then epoxy to frames FC7 and FC8. Frame FC8, the forth one from the left in Figure 2.2 is different from the others. The holes in the frame are for FM3, NOT FM1. FM1 fits on the shoulder of FC8, just like the others.

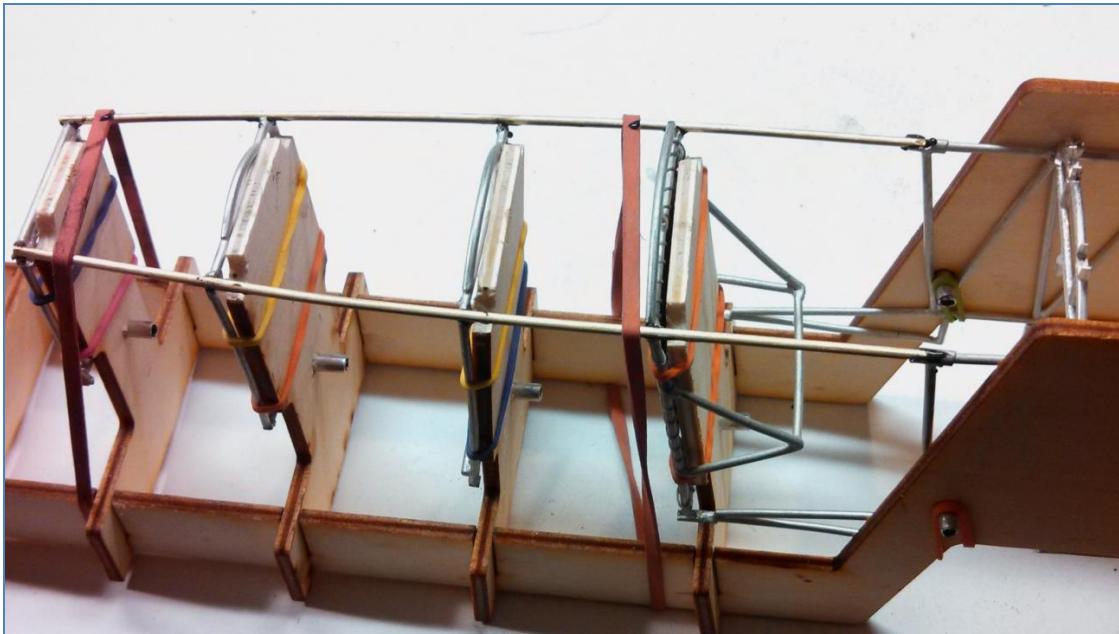


Figure 2.9 Top stringers in place

Next install the FM2 stringers along the bottom of the fuselage following the same procedure as the top stringers. Finally install FM3 stringers that support the horizontal tail. The front of these fit in sockets in Frame FC8. Make sure the top surface of FM3 stringers is flat for the horizontal tail.

Trim the stringers to length and add FC10, the final frame. Be sure it is square, aligned with the jig as the rudder mounts to this frame. Add the rear post (FC17). Be sure the eyelet on it is on the bottom and facing forward. The extension below the bottom of the fuselage is for attachment of the tail skid.

Add frame FC4d .63" (16mm) in front of frame 5. This forms the rear support for the floorboards. You can now remove the fuselage from the building jig.

You can either leave the stringers as brass or paint them with silver paint to have them match the castings and look more original.

## 7. Final Assembly jig

Part #	Name	Count	Material
FW11	final Assembly jig side	2	.112 laser cut plywood
FW12	final assembly jig end	1	.112 laser cut plywood
WP3643	Base	stock	1/4" (6.3 mm) square bass

Before continuing it is good to build the final assembly jig. This jig provides alignment for the wings, but is also handy as a cradle for the fuselage when working on it. Three parts are laser cut and the base is made from 1/4" (6mm) square stock. The assembly jig sides (FW11) and end (FW12) are glued to the stock as shown in Figure 2.10 and to scale on Sheet D. The jig is intended to hold all three wings in correct alignment with the fuselage which is supported by the lower wing. However, just use a piece of scrap in place of the lower wing and the fuselage can rest on it and the end, and then can be turned to any orientation to work on.

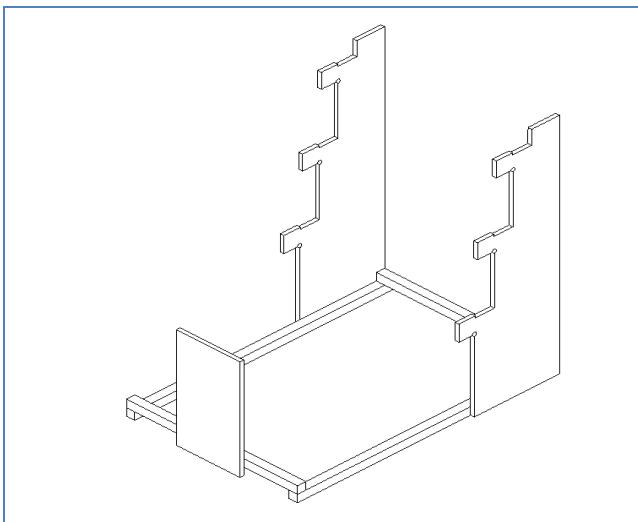


Figure 2.10 Final Assembly Jig

## 8. Installing the controls

Part #	Name	Count	Material
FC27a	Control column	1	Cast Britannia
FC27b	Control column	1	Cast Britannia
FC28	Rudder pedals	1	Cast Britannia
FC 29	Stick yoke	1	Cast Britannia
FC30	Aileron actuation shaft	1	Cast Britannia
FC31	Aileron bellcrank	1	Cast Britannia
FM4	Aileron bellcrank pivot	stock	.062 id x .092 OD brass tube
FM5	Fuselage control brace	stock	1/16" (1.6 mm) brass rod
FC20	Turnbuckles	10	Cast Britannia
WP1205	Rigging thread	stock	Gray Nylon Thread
FW1	Floor boards	2	1/32 laser cut plywood
FP21	Heel plates	2	.010' (.25mm) photo etched aluminum
FM2a	Fuselage frame member	stock	1/16" (1.6 mm) brass rod
FM3c	Fuselage frame member	stock	1/16" (1.6 mm) brass rod
FM4c	Fuselage frame member	stock	1/16" (1.6 mm) brass rod

The fuselage structure around the cockpit is integral with the controls. They will both be made and installed here, then finalized in Stage 5. The structure is shown in the exploded view, Figure 2.10. The controls can be made operational, but, the control surfaces are not balanced (in the original or the model) and will sag over time. It is suggested that once built, you freeze the controls in a neutral position by gluing the surfaces in place.

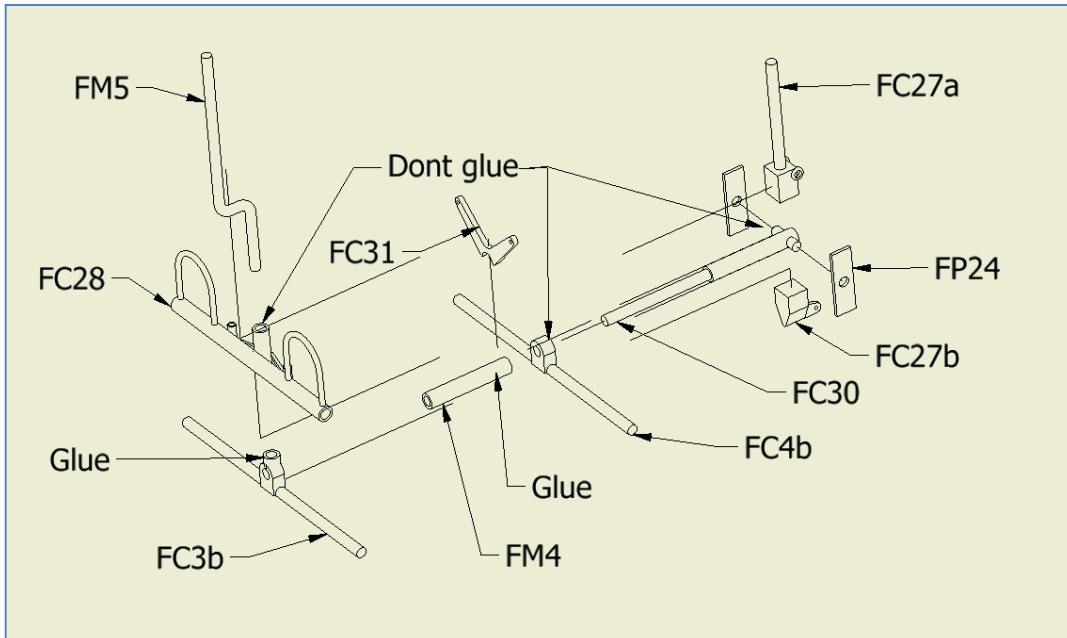


Figure 2.10 Exploded view of the controls

Make the Fuselage Control Brace, FM5 from 1/16" (1.6 mm) brass rod as shown on Sheet D. Assemble it with the rudder pedals FC28 (no glue) and glue into FC3b. Attach rudder control lines turnbuckles, FC20. Each turnbuckle has 1.5" (3.7cm) of cable to the rudder pedals and has a 12" (30cm) to later be attached to the rudder. For now wrap this 12" line around a notched scrap wood as shown in Figure 2.11.

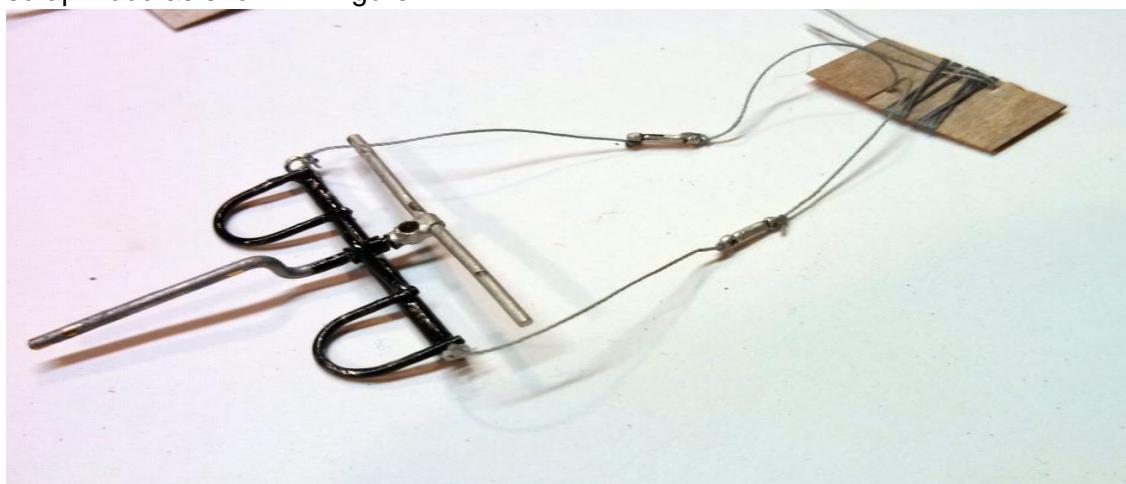


Figure 2.11 Rudder pedals on Control Brace

As a second sub-assembly, cut the aileron bellcrank pivot, FM4, to length (1/16" inside diameter tube (1.6mm) x .50" long (12.7mm)) and glue the aileron bellcrank FC31 to it centered between the ends. Attach aileron control lines and turnbuckles, FC20.

Each turnbuckle is as close to the bellcrank as possible and has a 16" (41cm) line that will later be attached to the ailerons. There are two lines on each side of FC31 as seen in Figure 2.12.

To make the control stick, glue the two FP24 plates to FC27a and FC27b, with FC30 captured to make the pitch pivot. Attach elevator control lines and turnbuckles, FC20. Each turnbuckle can be attached either  $\frac{3}{4}$ " (18 mm) (shown in Figure 2.12) or 1  $\frac{3}{4}$ " (43mm) from the stick to clear Frame 5. Either way add 12" (30cm) line beyond the turnbuckle that will later be attached to the elevators.

Insert FC30 in FC4b and glue on the FM4 assembly being sure that the aileron control is symmetrically aligned with the stick and that the assembly can rotate in FC4b.

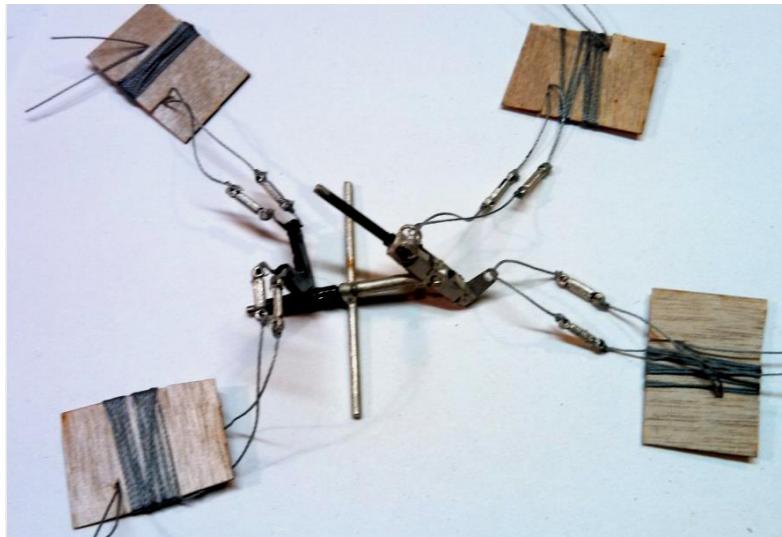


Figure 2.12 Aileron/Elevator Control Sub-Assembly

Glue the rudder control sub-assembly into the fuselage followed by the aileron/elevator control sub-assembly. Glue the floor boards (FW1) to FC3b, FC4b and FC4d. First clear finish and glue on the heel plates (FP21). They are metal plates attached to the floor to protect it and give the pilots a smooth surface for the heels of their boots as shown in Figure 2.13.

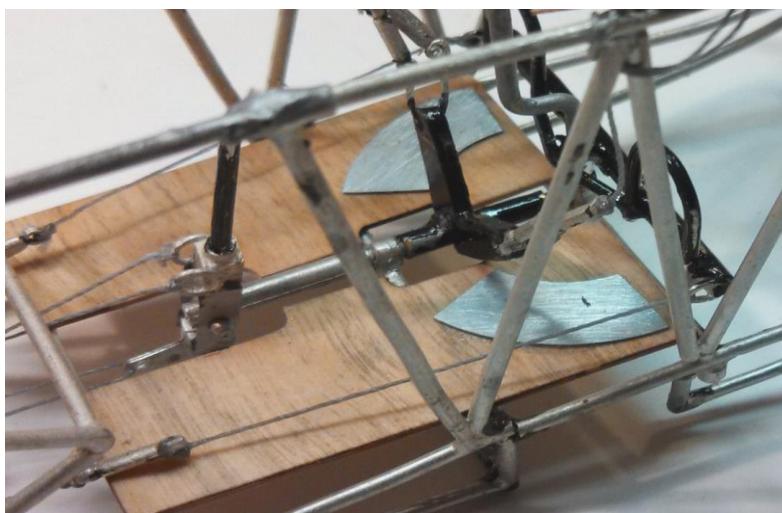


Figure 2.13 Heel Plates

Add fuselage members FM2a, FM3c and FM4c (see Sheet B). These are made from 1/16" (1.6mm) brass rod 1.66" (42.2mm) long.

## 9. Installing the Tail Skid

Part #	Name	Count	Material
WP3656	Tail Skid	stock	1/16 x 3/8 inch (1.6 x 9.5mm) bass
FP13	tail skid lower bracket	1	.010 photo etched aluminum
FP14	tail skid upper bracket	1	.010 photo etched aluminum
FC17	Rear post	1	Cast Britannia
WP0970	Bungee	stock	Elastic Cord

The tailskid is cut from 1/16 x 3/8 inch (1.6 x 9.5mm) bass and carved to shape shown on Sheet D. It can be clear or brown finished. The tail skid brackets (FP13 and FP14) are folded in a "U" shape, painted black and glued to the skid. The tail skid pivots on the rear post (FC17) which also supports the horizontal stabilizer. Epoxy the tail skid to it. The forward part of the skid is supported by a piece of bungee cord to give some suspension. Loop a short length of rubber beading (L02) through the upper tail skid bracket and tie with simple knot to frame FC9 as shown in Figure 2.14. Soak with thin cyanoacrylate and trim excess elastic cord.

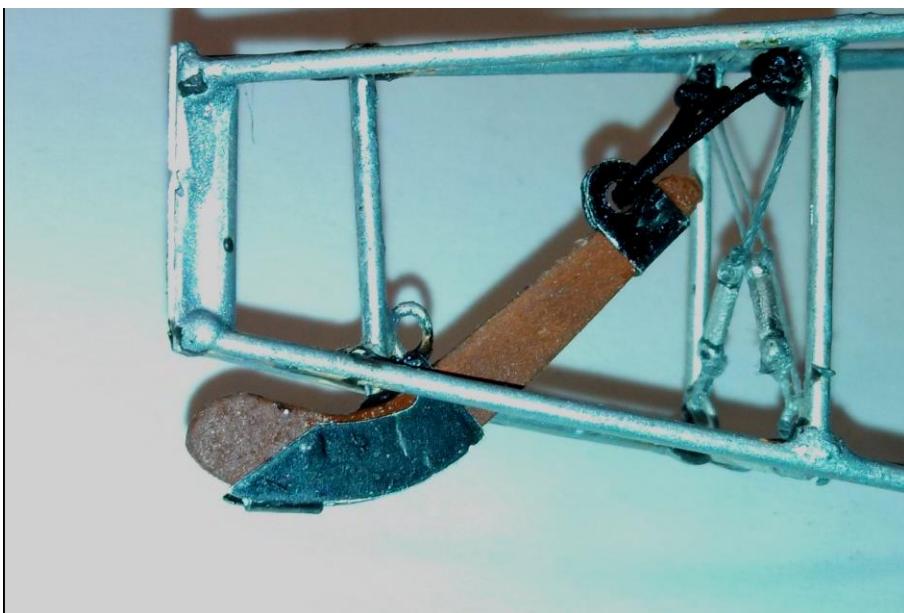


Figure 2.14 Tail Skid

## Stage 3: Building the Tail Surfaces

The tail surfaces on the original Dr.1. were made of welded tubing. To simulate this, the model is made of rod and photo-etched ribs that closely simulate the small diameter tubes used for the ribs. See Sheet D for layout of these surfaces.

### A. Stabilizer

Part #	Name	Count	Material
WP162K	TM1, Leading edge	stock	1/16 (1.6mm) brass rod
WP163K	TM2, Front spar	stock	3/32 (2.4mm) brass rod
WP163K	TM3, Rear spar	stock	3/32 (2.4mm) brass rod
TP1	Stabilizer rib 1	2	.020 photo etched brass

TP2	Stabilizer rib 2	2	.020 photo etched brass
TP3	Stabilizer rib 3	2	.020 photo etched brass
TP4	Stabilizer rib 4	2	.020 photo etched brass
TP5	Stabilizer rib 5	2	.020 photo etched brass
WP3625	TS1, Elevator Hinge Block	stock	3/32 (2.4mm) square brass

To build the stabilizer (Figure 3.1), first build the front spar (TM2). It is made of one piece of 3/32" (2.4mm) brass rod bent as shown on Stabilizer Layout Drawing on Sheet D. Make the bends as sharp as possible by cutting "V" notches in the rod and gluing. Cut the rear spar (TM3) to length from 3/32" (2.4mm) brass rod.

Slide ribs TP3 and TP4 onto the front spar before pinning to building board. Epoxy them and the front spar to the rear spar TM3. Be sure all surfaces are freshly sanded so glue will be as strong as possible. Complete the stabilizer by adding root ribs (TP1), root fore-ribs (TP2), tip ribs (TP5). Take care as TP2 and TP5 are nearly the same length. Cut leading edges (TM1) from 1/16 (1.6 mm) brass rod and glue in place. Figure 3.1 shows the elevator before cleaning up excess epoxy and finishing.

Make the elevator hinge block (TS1) by cutting grooves in the opposite sides of 3/32 (2.4mm) stock to fit the trailing edge of the stabilizer and the leading edge of the elevator (see Sheet D and Figure 3.2 for details).

To finish the stabilizer, either clear coat it to leave a brass finish or paint with silver before gluing on the elevator hinge block.

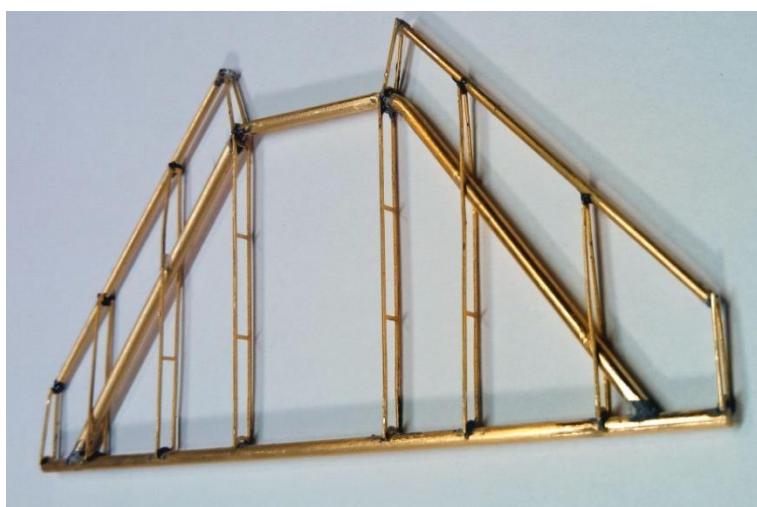


Figure 3.1 Stabilizer before finishing

## B. Elevator

Part #	Name	Count	Material
WP163K	TM4, Leading edge	stock	3/32 (2.4mm) brass rod
WP162K	TM5, Trailing edge	stock	1/16 (1.6mm) brass rod
TP6	Elevator rib 1	2	.020 photo etched brass
TP7	Elevator rib 2	4	.020 photo etched brass
TP8	Elevator rib 3	2	.020 photo etched brass
WP0976	Hinges	stock	Copper tape

The elevator's leading edge (TM4) is a 3/32" (2.4mm) brass rod tapered to match the trailing edge thickness at the tips as shown on Sheet D. This is done by hammering the tips to deform them. Before deforming, slide ribs TP8 onto it. Make two trailing edges (TM5) by bending 1/16 (1.6mm) rod to shape. Epoxy on the trailing edge and the ribs TP6, TP7 and TP8 as shown.

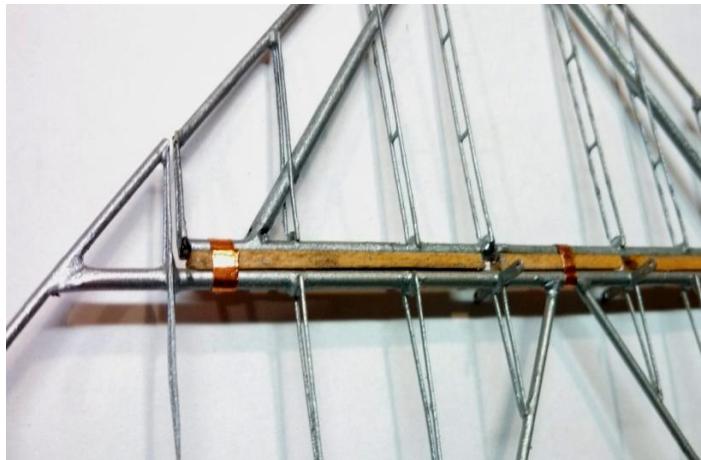


Figure 3.2 Elevator on Stabilizer

The elevator is connected to the stabilizer with three bands of copper tape 1/8" wide by 1 1/2' long (3.2 x 38 mm) wrapped around the elevator and stabilizer structure two times for strength. The copper tape comes 1/4" wide. Slice it down the middle.

The stabilizer is glued to the fuselage as shown on Sheet A at Frame 8 and the Rear Post. The original was bolted at these locations.

Add the stabilizer brace (TS2), shown in Figure 3.3, from lengths of 1/16 brass rod flattened at the ends match the bottom stringer and the elevator hinge block.



Figure 3.3 Stabilizer Brace

### C. Rudder

Part #	Name	Count	Material
WP162K	TM6, Trailing edge	stock	1/16 (1.6mm) brass rod

WP163K	TM7, Leading edge	stock	3/32 (2.4mm) brass rod
TP9	Rudder rib 1	1	.020 photo etched brass
TP10	Rudder rib 2	1	.020 photo etched brass
TP11	Control horn	1	.020 photo etched brass
WP0976	Hinges	stock	Copper tape

The comma-shaped rudder forms part of the iconic look of the Dr.1. Bend the edge (TM6) to shape from 1/16" (1.6 mm) brass rod using the drawing on Sheet D as a guide. Taper the 3/32" (2.4mm) post (TM7) as shown and slide control horn (TP11) and rib (TP9) onto it, but don't glue it yet. Epoxy TM7 and TM6 together on the Sheet. Epoxy ribs TP9 and TP10 and control horn TP11 in place. Either clear coat to leave the structure brass or paint with silver.

To assemble the rudder to the fuselage first cut a clearance slot in FC10 for the control horn (TP11). If you want the rudder to move cut the slot accordingly. Fasten rudder to fuselage using two lengths of copper tape as done with the elevator and shown in Figure 3.4.

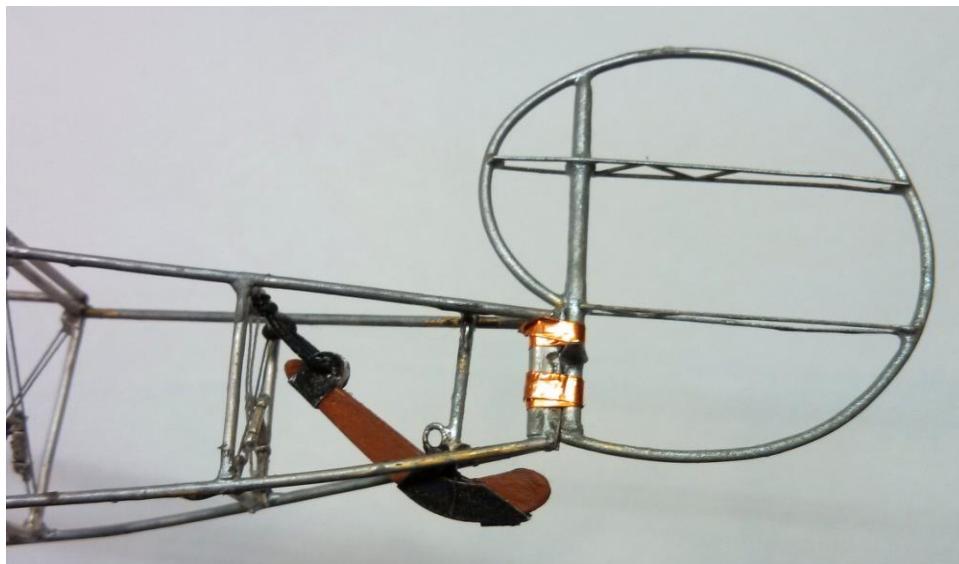


Figure 3.4 Rudder mounted to Fuselage.

#### D. Connecting the controls

Connect the control lines that were started in Step 7 of Stage 2 to the rudder and elevator by running them first through the eyelets on Frame 6 (FC6) in the order:

- Cable from left rudder pedal through left eyelet to left rudder control horn (TP11)
- One Cable each from top and bottom of control stick through second eyelet to top and bottom of the left elevator control (TP6). Be sure pulling back on the stick causes the elevator to rise.
- Same as above through the third eyelet to right elevator control (TP6).
- Cable from right rudder pedal through right (forth) eyelet to right rudder control horn.

Tie the lines as tight as possible and be sure the controls are centered when the rudder and elevator are neutral. Wet the lines to make them shrink and, when dry, coat with thin cyanoacrylate. Wetting only one line can help in aligning the controls and surfaces. The controls will work, but it is suggested that you glue the surfaces in a neutral or slightly deflected state as they will sag with time.

### E. Fuselage bracing

Add the fuselage bracing wires and turnbuckles as shown on Sheet E. Put in all except for those on either side of the cockpit at this time. See Figure 3.5 for a detail photograph of typical installation.

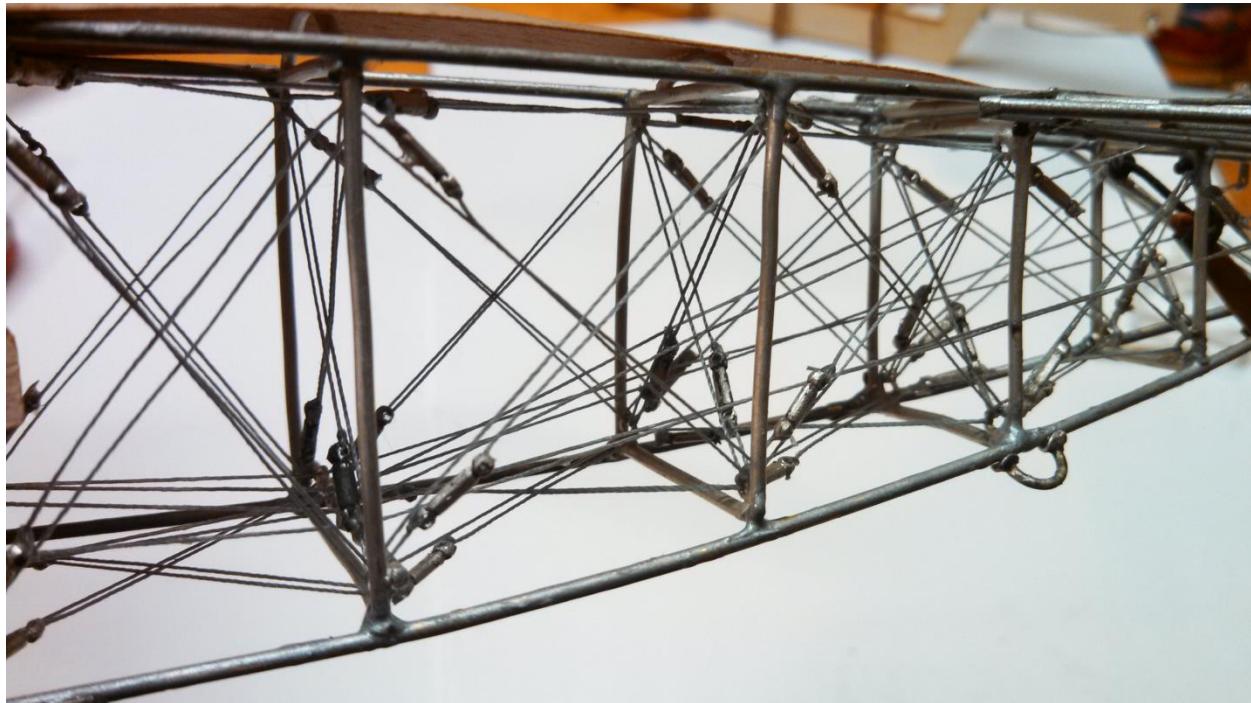


Figure 3.5 Fuselage Bracing Detail

### F. Step and Lift Handles

Part #	Name	Count	Material
FC15	Step	1	Cast Britannia
FC16	Lift handle	2	Cast Britannia

Add the step (FC15) on the left side of the fuselage as shown on Sheet A. It sticks straight down just behind Frame FC5. Install the two Lift Handles (FC16) that straddle Frame FC8 and stick out at 45deg as shown on Sheet A and in Figure 3.5.

## Stage 4: Building the Landing Gear

Part Number	Name	Count	Material
LC1	Wheel disk outer	2	Cast Britannia
LC2	Wheel disk inner	2	Cast Britannia
WPA013	LO1,Tire	2	Cast Rubber O-ring
LC3	Nut	2	Cast Britannia
LW1	Main ribs	4	1/32 laser cut plywood
LW2	Tip ribs	2	1/32 laser cut plywood
WP127K	LM1, Axel	stock	Brass tube 1/8 dia (3.2mm),4.73 in (120.1 mm) long
WPGR9-	LM2, Spacers	stock	1/8 ID (3.2mm) ID, 5/32 (4mm) OD, .74"

15			(18.8mm) long
WP266K	LM3, Landing gear spar	stock	5/32 x 5/16 rectangular tube (4mm x8mm), .014 wall, 3.25" (8.25cm) long
WP162K	LM4, Suspension posts	stock	1/16 brass rod, .36" long
WP162K	LM5, Front and rear spars	stock	1/16: (1.6mm) Brass rod, 3.7" (9.4cm) long
WP128	LM6, 2 <sup>nd</sup> spacer	stock	5/32 ID x 3/8 OD (4mm x 4.7 mm) x .25 in (6.3mm) long
LC4	Left landing gear strut	1	Cast Britannia
LC5	Right landing gear strut	1	Cast Britannia
WP0970	Bungee		Elastic Cord
WP498	LS1, Trailing edge		.015" dia wire (.4mm)

The main landing gear has a shock braced pair of wheels separated by sub wing that is distinctive to the Dr.1. The assembled and installed landing gear is shown in Figure 4.1

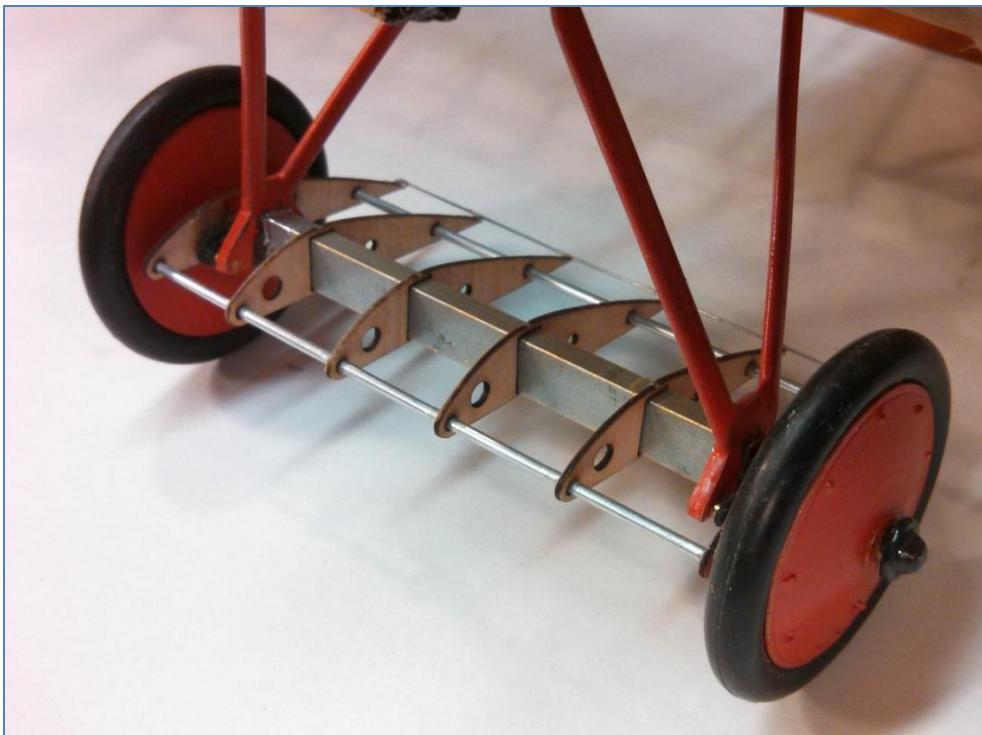


Figure 4.1 Landing Gear

Cut the stock material (LM1-6) to the lengths in the parts list. Paint the struts (LC4, LC5), the wheels, (LC1, LC2) and the nuts (LC3) red. Either leave the Landing Gear Spar (LM 3) brass or paint it silver to better match the front and rear spars (LM5). If you do paint it, mask off the ends where the struts will be glued.

Glue the four Center Ribs (LW1) to the Landing Gear Spar (LM3) using the drawing on Sheet D as a spacing guide. Glue the Front and Rear Spars LM5 in the ribs. DO NOT GLUE ON THE TIP RIBS (LW2) AT THIS TIME.

On each of the Left and Right Landing Gear Struts (LC4 and 5) epoxy the Suspension Posts (LM4). Then glue the struts to the spar, the shorter strut legs are front. Be sure that the posts on the tops of the struts are 1.74 in (4.4cm) apart, span wise, so they align with the fuselage.

Best to make a simple jig from scrap with 1/16" (1.6 mm) holes, 1.74" apart.  
Glue on Tip Ribs (LW2) and add trailing edge (LS1), cut from .016" (.4mm) wire.

Insert the axle in the spar and glue on the spacers (LM2), which keep the axle from sliding out of the spar. Add spacer LM6 and loop bungee over the suspension posts and axle as shown in Figure 4.2. Loop around twice and glue ends together.

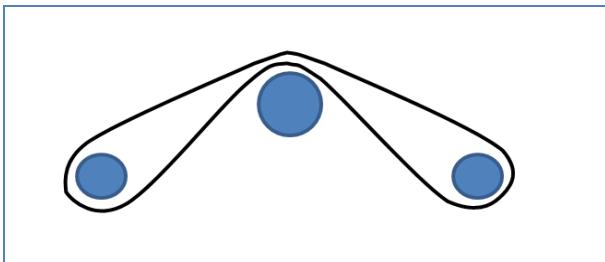


Figure 4.2 Bungee

Add the wheels and be sure they spin free, then epoxy on the nut (LC3). Fit the assembly to the fuselage, but DO NOT GLUE IT ON YET.

## Stage 5: Building the Oberursel Engine and Propeller

Dr.1s were powered by a number of engines, all derived from the French Le Rhône 9-cylinder, 110hp rotary. The majority of the Dr.1s were fitted with a virtual copy of the Le Rhône which was manufactured by Oberursel and called, the UR.II, the engine modeled in this kit.

Part #	Name	Count	Material
EC1	Crankcase front	1	Cast Britannia
EC2	Crankcase	1	Cast Britannia
EC3	Cylinders with spark plug	9	Cast Britannia
EC4	Intake manifold	9	Cast Britannia
EC5	Crankcase rear	1	Cast Britannia
EC9	Carburetor	1	Cast Britannia
EC10	Front mount-accessories	1	Cast Britannia
EC11	Rear mount	1	Cast Britannia
WPGR9-15	EM1, Main engine shaft	1	5/32 (.156), 4mm dia brass rod, 2.00' (51mm) long
WP105K	EM2, Main shaft spacer	stock	7/32 x .032 wall .156 ID Aluminum tube .46" (11.6mm) long
WP127K	EM3, Carb air intake tubes	stock	1/8 OD .097 ID al tubes, 1.5" (38mm) long
WP162K	EM4, Push rods	stock	1/16 (1.6 mm) brass rod
WP498	EM5, Spark plug wires	stock	.016 wire

### A. The Oberursel Engine

Drawings of the engine are on Sheet E. Before detailing the building instructions, a brief description of how it worked and was connected to the controls and instrumentation.

Rotary engines have a stationary crankshaft with the cylinders and propeller rotating around it. The kit is designed to move the same way. The completed engine is shown in Figure 5.1

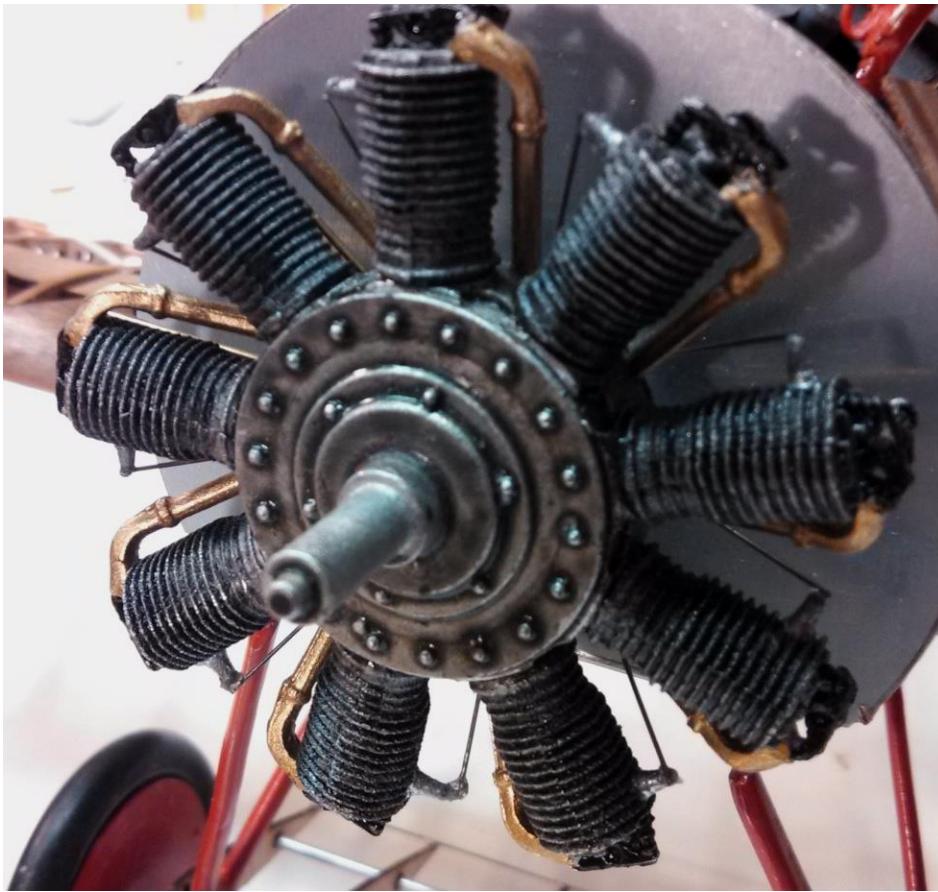


Figure 5.1 Completed Engine on Model

The nine cylinders each have a single intake manifold (EC4). In the kit, this is cast with valve train as one part. A single push rod (EM4) works a rocker that alternatively opens and closes the intake and exhaust valves.

Fuel and castor oil are fed to the engine through the shaft. The oil flows into the crankcase and centrifugal force delivers it to the pistons. The used oil passes through the exhaust valve and is blown or slung inside the cowl and everything aft. Pilots wore face scarves to keep from swallowing the castor oil as it is a purgative. Since the oil is not re-circulated, the left half of the "fuel tank" is actually an oil tank.

Fuel is gravity fed to the "carburetor" which really was very crude only controlling the amount of air the engine received.

The ignition is through a magneto which is part of the front mount (EC10). This mount includes the magneto, oil pump and gun synchronizers. They were all gear driven off the shaft, but are too small on the kit for detail.

You will need black, gray (dark and light), white (or silver) and copper paint to make the engine as real as possible.

To begin paint the cylinders (EC3) black and while the paint is still wet wipe it off the tops of the fins. This makes the grooves between fins look deeper. Paint the sparkplugs white or silver for contrast.

Paint the crankcase (EC2) dark grey but keep the paint off the surfaces that mate with other parts. Epoxy the cylinders into the crankcase. Paint the crankcase rear (EC5) light gray and epoxy to the crankcase. Take care that the pins for the spark plug wires are aligned as shown on Sheet E.

Make the crank shaft (EM1) (5/32 (4mm) dia, 2.00" (51mm) long) and spacer (EM2) (7/32" (5.5mm) dia, .46 in (11.6mm) long). Position the spacer on the shaft so that when inserted in the crank case front (EC1) and rear (EC5) the engine rotates freely on the shaft. Glue the spacer to the shaft and then the front on the crankcase aligning it so that when the engine is spun around the shaft it runs in a single plane. You can paint the front light gray, but do not paint the shaft where the propeller mounts. See Figure 5.2

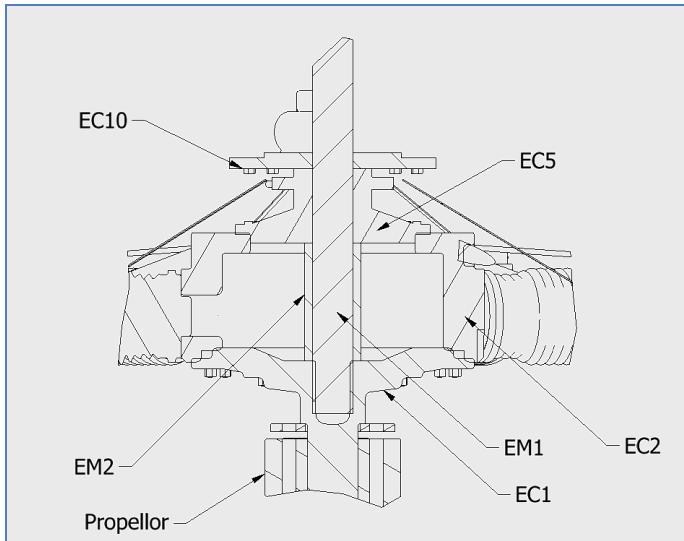


Figure 5.2 Engine Details

Paint the intake manifold portion of (EC4) bright copper and the valve train portion, black. Glue in place on each cylinder. Make the push rods (EM4) from 1/16" (1.6mm) brass rod and glue in place. They are about .75" (19mm) long, but need to be cut to length. And add the spark plug wires, EM5 (.016 (.4mm) wire). Both of these parts are shown in detail drawings on Sheet E.

The front and rear mounts (EC10 and 11) yet need be attached to the shaft. Do not do these yet, they will be added in the next stage.

Make the carburetor assembly as shown in the figure on Sheet E by cutting the intake tubes (EM3) to 1.25" (32mm) long. Glue the tubes to the carburetor body (EC9) which has been painted gray. Do not connect the carburetor to the shaft yet. This too will be done in the next stage.

## B. Propeller

Part #	Name	Count	Material
EP1	Propeller hub	2	.020 Photo etched brass
EO1	prop bolts	16	0-80 x .25 hex bolt
PW1	propeller laminate 1	1	1/16 bass
PW2	propeller laminate 2	1	1/16 walnut
PW3	propeller laminate 3	1	1/16 bass

PW4	propeller laminate 4	1	1/16 walnut
PW5	propeller laminate 5	1	1/16 bass
PW6	propeller laminate 6	1	1/16 walnut
PW7	propeller laminate 7	1	1/16 bass

The propeller on the DR1 is laminated from seven layers of alternating bass and walnut as was true of the original aircraft. Details for the lamination order are on Sheet D. Use the center hole and the bolt circle to align the layers and then sand to shape (see Figure 5.3).

The mounting hardware consists of two hub plates (EP1). To simulate the nuts and bolts on the original, use the supplied 8-80 bolts (EO1) inserted from both sides. They may need trimming to fit.

Do not glue on the propeller at this time. Later, the propeller may be glued to the engine or, if you want to get cowl off to show the engine detail, just mount it on the shaft with a snug fit.



Figure 5.3 Propeller

## Stage 6: Building the Cockpit and Connecting the Controls to the Engine

Part #	Name	Count	Material
EC10	Front mount-accessories	1	Cast Britannia
EC11	Rear mount	1	Cast Britannia
FP1	Firewall	1	.010 photo etched aluminum
WP123110	Heavy black wire	stock	19g (0.040") black wire
WP123119	Light black wire	stock	28g (0.016") black wire

All Dr.1s were hand built and no two were exactly the same. This is especially true in the cockpit where not only were the controls continuously evolving, but pilots customized their personal airplanes. The instruments and controls included in this kit are typical and as accurate as the 1/16 scale will allow.

## A. Engine connections and installation

The connection of the engine and controls are shown in Figure 6.1. Two different sizes of wire are used to represent all controls and hoses, 30G (thin) and 20G (thicker) as represented in the figure by thin and thick lines.

The circled numbers give a good sequence for assembling this stage of the model and reference is made to these in the following instructions with a "#".

To begin assembling the controls, first wire the engine front mount (EC10) (#1 on Figure 6.1). This mount includes the oil pump, machine gun synchronizers and magneto. At the scale of this model these are all small and hidden by the wires and tubes leading to them. To wire the engine mount use the shrink tubing to connect the wires as shown in Figure 6.1. Two wires (one thick and one thin) connect to the synchronizer (the two center posts on EC10). The thick one supplies a signal from the engine to only fire the machine gun when the propeller is not in the way. The thin wire goes to the stick yoke where thumb switches control when the pilot wants to fire the guns. These are both part of the interrupter system devised by Fokker so that the guns can fire without damaging the propeller.

Make all wires from EC10 at least 5 in (125mm) long for now and trim as needed during connection. Do not attach these wires to the yoke or guns yet.

Add single thin wires (#2) to the other four posts on the back of EC10.

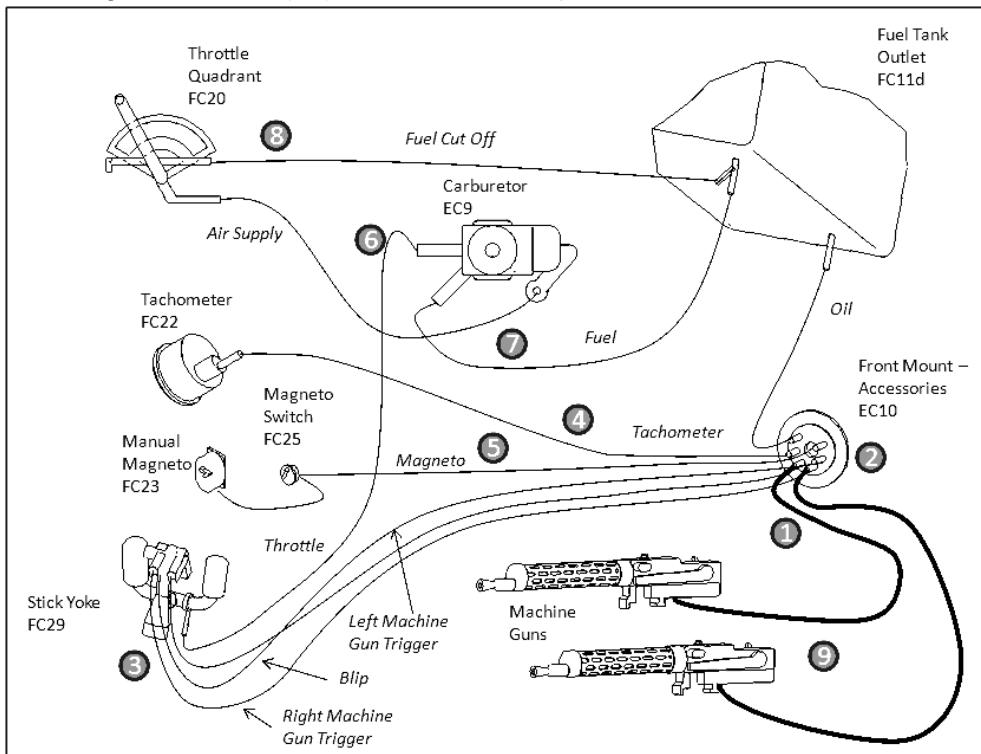


Figure 6.1 about here (shows connections)

After all the wires are connected to EC10, epoxy it to the crank shaft (see Sheet E) If you want the engine to rotate make sure not to epoxy it to the crankcase rear.

Epoxy the firewall (FP1) to the motor mount front on the fuselage. Be sure the center holes are aligned.

Epoxy the Rear Mount (EC11) to the Motor Mount Rear (FC2b). Feed the wires connected to the EC10 through the engine mount and firewall and below EC11. Then, epoxy the shaft to the rear mount and the motor mount front to FC2a. Be sure the wires exit the motor mount assembly on the bottom as shown in Figure 6.2.



Figure 6.2 Motor Mounting Detail

### B. Spent Ammo Can

Part #	Name	Count	Material
FC 12	Spent ammo can rim	1	Cast Britannia
FP11	Ammo can sides	2	.010 Photo etched aluminum

Build and install the spent ammo can from the Spent Ammo Can Rim (FC12) and the Spent Ammo Can Sides (FP11). Paint it brown or grey. It must fit snug against Frame FC3a or the middle wing spar will not rest on the top stringers of the fuselage. If needed move FC3a aft slightly to make sure of this fit. See section view on Sheet A for placement.

Run the four machine gun wires, the blip switch wire, the tachometer and magneto wires under the spent ammo can to the cockpit area. You can bundle the wires going to the control yoke together as shown in Figure 6.2. Note that the Ammo Can will sit just aft of Frame 3a, but don't install it yet.

### C. Control yoke.

Part #	Name	Count	Material
FC 29	Control yoke	1	Cast Britannia

The Control Yoke (FC29) has many functions. Besides providing hand grips so the stick can be moved to control pitch and yaw, the left hand also moves the throttle (rotating the grip about the horizontal axis); and the thumbs control the machine guns and the "blip switch". The "throttle" only really controls the amount of air passing through the carburetor. The "blip switch" shorts the magneto to shut the engine down for short periods which is actually the primary speed control for the airplane.

Paint the grips brown, the gun triggers silver and the blip switch red as shown in Figure 6.3

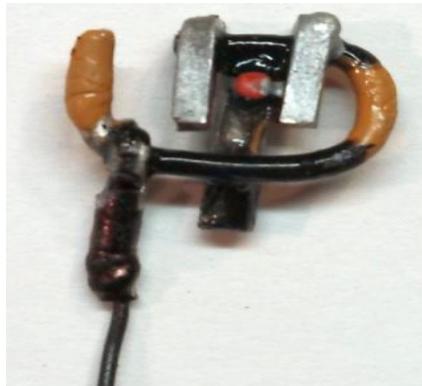


Figure 6.3 Control Yoke Detail

Connect a 5" (125mm) length of this wire to the throttle as shown in Figure 6.3. This will be connected to the carburetor in # 6.

Epoxy the Control Yoke on the Control Column FC27a. Attach the wires, #3, for the machine gun control in the detents behind the gun triggers and blip switch wire in the recess between them. Use thread to bundle these to the throttle wire to keep them neatly routed down the control column and forward.

#### D. Ammo can and Tachometer

Part #	Name	Count	Material
FC 13	Ammo can rim	1	Cast Britannia
FP12	Ammo can sides	2	.010 Photo etched aluminum
FC22	Tachometer	1	Cast Britannia
FO4	Tachometer dial	1	Paper card

Build the Ammo can from the Ammo Can Rim (FC13) and the two Ammo Can Sides (FP12). Paint it brown or gray.

Paint the Tachometer (FC22) black taking care not to paint the face. Cut out the Tachometer dial from the sheet supplied. Holding the Tachometer body face up, put the dial (FO4) in the recess and add a couple of drops of Cyanoacrylate. When hard, it will make a clear lens.

Mount the tachometer to the bottom of the ammo can assembly  $\frac{1}{2}$ " (12.6mm) from the left side of the can (exact placement is not critical). Install the ammo can aft of Frame 3a leaving a gap of  $\frac{1}{16}$ " (1.6mm) between the can and the frame. See section view on Sheet A for placement. Connect the wire to the Tachometer as shown on Figure 6.1, #4.

#### E. Magnetos

Part #	Name	Count	Material
FC23	manual magneto	1	Cast Britannia
FC25	Magneto switch	1	Cast Britannia
FP23	Magneto bracket	1	.010 Photo etched aluminum
FP22	Magneto switch bracket	1	.010 Photo etched aluminum

The magneto is on the Front Mount – Accessories assembly and provides spark to the engine when running. It is small and modeled here as the point to connect the wire to the Magneto Switch (FC25) and then to the Manual Magneto (FC23).

These are wired as shown in Figure 6.1, #5. Mount the Magneto Switch to its bracket (FP22) and attach to the upper fuselage stringer on the left side of the cockpit as shown on Sheet A. The Manual Magneto (Sheet A) is mounted on its bracket (FP23) and glued to the floorboard just below the Magneto Switch

## F. Fuel/air management

Part #	Name	Count	Material
FC11a	fuel tank rim	2	Cast Britannia
FC11b	fuel tank fillers and gage	1	Cast Britannia
FC11c	fuel rear support	1	Cast Britannia
FC11d	fuel tank outlet	1	Cast Britannia
FP8	Gas tank skin 1	1	.010 Photo etched aluminum
FP9	Gas tank skin 2	1	.010 Photo etched aluminum
FP10	Gas tank side	2	.010 Photo etched aluminum
FO5	Fuel level dial	1	Paper card

The fuel/air system has three controls similar to modern planes, a throttle, a fuel cut-off and a mixture control. The throttle line from the Stick Yoke can now be attached to the Carburetor (#6). This completes all the connections to the yoke.

Next, build the fuel tank frame from FC11a, b, c, and d as shown in the exploded view on Sheet E and in the section views on Sheet A. Be sure the indentation in the fuel gage is facing aft when gluing in FC11b. Before gluing, trim FC11b and FC11c so they fit in the notches in FP11 and so that the top of FP11 is level with the top of FC11a. When these are fit, FC11b, c, and d can be glued to the two FC11a rims. Be sure that FC11d has the valve on the left side. This is the fuel outlet and the value is the fuel shut off. The other post on FC11d, without the valve, is the oil outlet. Form tank skins (FP8 and FP9) to fit tank rim FC11a by bending them around a 3/32 dia. rod (2.5mm). Make sure that cutouts for the filler pipes and gage on top and outlet on bottom align. The skins FP8 and 9 will need additional cuts to clear the outlet pipes and may need to be trimmed in length to fit. Add the fuel level dial (FO5) in the indent in FC11b and make a cyanoacrylate lens as with the tachometer.

Fit the fuel tank and make sure it is as far forward as possible in the fuselage. Check its placement with FP5, the Upper Cowl Front. The middle wing should fit aft of the fuel tank with the spar sitting on the fuselage top stringers. Do not glue the wing on at this time. Add the fuel line to the bottom of the Fuel tank, #7.

Attach the fuel cutoff line and air supply line to the Throttle Quadrant (FC20). Paint the fuel cutoff handle red and the rest of the throttle quadrant dark grey. Epoxy the throttle quadrant to the left cockpit wall as shown Sheet A. Connect the cutoff to the fuel tank, #8. With the carburetor still not attached to the engine, connect the throttle, air supply and fuel lines and epoxy to assembly to the end of the Main Engine Shaft.

## G. Seat

Part #	Name	Count	Material
FP3	seat back	1	.010 Photo etched aluminum
FW14	seat bottom	1	1/32 laser cut plywood
FW15	seat cushion	1	1/32 laser cut plywood
WPC064	FO1, Seat trim	stock	Rubber tubing
WP0971	FO2, Seat belt	stock	Leather strip
FP25	Buckle	1	.020 Photo etched brass

The seat in this kit is made the same way as that in the original Dr.1. Form the aluminum back (FP3) as shown in Sheet D. Epoxy to bottom (FW14). Clear finish the bottom. Round the edges of the cushion (FW15) and paint to look like fabric (or fabric cover the top side) and glue to bottom.

Cut a slit in the piece of black tubing (FO1) supplied with the kit and glue it to the rim of the seat back as trim.

Make the belt (FO2) from 3/32" brown leather in Figure 6.4. The straps begin behind the seat back, come over the top of the back, cross over and are glued under the seat. Include buckle (FP25). Glue the seat in place.



Figure 6.4 Seat belt

## H. Final Cockpit Details

Part #	Name	Count	Material
FC 21	Compass	1	Cast Britannia
FC4a	Fuselage frame	1	Cast Britannia
FO6	Compass dial	1	Paper card

Paint the body of the compass (FC21) copper or brass. Do not paint the face. Add compass dial (FO6) and add cyanoacrylate lens. Epoxy compass to the floor board as shown in the layout on Sheet A.

Add Frame FC4a now that the cockpit details are complete. Now that the cockpit is finished, add the fuselage bracing and turnbuckles on both sides consistent with the rest of the fuselage as shown on Sheet E.

## Stage 7: Final Assembly of the Model

### A. Spandau Machine Guns

Part #	Name	Count	Material
FC40	LMG 80/15 "Spandau" breech	2	Cast Britannia
FC 41	LMG 80/15 "Spandau" shield	2	Cast Britannia
FC 42	LMG 80/15 "Spandau" sight	2	Cast Britannia
FC 43	LMG 80/15 "Spandau" barrel	2	Cast Britannia

The guns on the Dr.1 are LMG 08s manufactured at the Spandau Arsenal and, because of the Arsenal imprint on the cover, these are known as Spandaus. They are 7.92mm with a muzzle velocity: 2,821 feet per second (860 m/sec) and a range of 2,200 yards (2,000 m) at 400-500 rounds per minute. By the time of the development of the Dr.1, the machine gun "synchronizer" was well developed, primarily by Fokker. This was really an interrupter as, when the pilot pulled the trigger, the signal to the trigger was interrupted when the propeller was in the line of fire.

Each Spandau is made of 4 parts, the breech (FC40), the shield (FC41), the sight (FC42) and the barrel (FC43) as shown in Figure 7.1

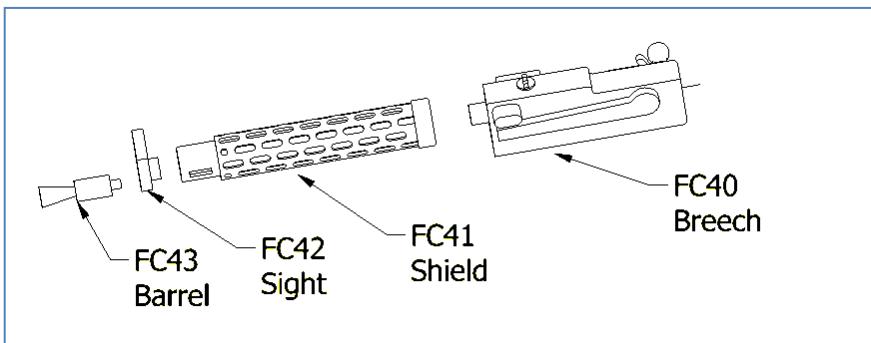


Figure 7.1 Spandau Assembly

Paint the guns dark grey and mount on Frames 3a and 4a as shown in the section on Sheet A. Glue the guns in place. You may need to bend the chutes on the top of the ammo can and spent ammo can to meet with the guns. DO NOT MOUNT THE GUNS PERMANENTLY YET, JUST FIT THEM.

The heavy lines on Figure 6.1, labeled #9, drive the machine guns from the engine. Bring these lines up the aft side of the ammo can under the machine guns and glue to the ammo can as it is nearly impossible to glue them to the bottom of the guns and this joint cannot be seen.

### B. Installing the lower and middle wings

With the lower wing in the assembly jig, glue the spar to the fuselage frame. The wing spar should fit nicely in the notches in the fuselage sides, FC1. The middle wing should sit on the top of the fuselage sides in the assembly jig just clearing the fuel tank and the spent ammo can. Glue it in place also.

### C. Wing Struts

Part #	Name	Count	Material
	Wing strut	stock	1/16 x 3/8 (1.6 x 9.5mm)
WP1	Wing strut End	8	.010 Photo etched aluminum

Cut four wing struts from 1/16 x 3/8 (1.6 x 9.5mm) stock, about 2 1/4" (5.7cm) long. Sand to airfoil shape and then trim per drawing on Sheet D and to fit your model. The struts between each pair of wings are the same length. Paint red to emphasize.

Fold wing strut ends (WP1) to receive the wing struts and fit over the wing spars. Paint them black for contrast. Install the struts between the lower and middle wings. Ensure that the span wise position is as shown on Sheet B so that they can be aligned with upper struts and clear top wing ribs. Fold the wing strut ends over the front and rear of the spars and glue in place. Mount the struts between the middle and bottom wings.

Take care with span wise spacing so that not only are these struts straight up and down, but that when you add the top wing, the struts between the middle and top wing are in the same plane as those mounted here.

## D. Adding the Landing Gear

The landing gear can now be added to the model. The struts should clear the lower wing and fit into the sockets in the bottom of FC1 and FC2a. Epoxy in place.

## E. Finishing the Fuselage

Part #	Name	Count	Material
FW3	Turtle deck	1	1/64 laser cut plywood
FP4	Upper cowl center	2	.010 Photo etched aluminum
FP5	Upper Cowl front	1	.010 Photo etched aluminum
FP6a	Upper cowl rear Left	1	.010 Photo etched aluminum
FP6b	Upper cowl rear Right	1	.010 Photo etched aluminum
FP26	Fuel gage windscreens	1	Paper stock
WPC064	Coaming	stock	Rubber tubing
WP3625	Machine gun padding	stock	3/32" square bass wood (2.4 mm)
FW2	Cheeks	2	1/64 laser cut plywood

### 1. Turtle deck

The turtle deck (FW3) can now be added as shown on Sheet A. Soak it in water and form it over a bottle to get the round shape. Trim it to fit the cockpit opening and fuselage and glue in place.

### 2. Fuselage metal skin

On the top of the fuselage there is a metal skin made up of one front piece (FP5), two center pieces (FP4), aft pieces (FP6a and b) and the fuel gage windscreens (FP26) as shown in Figure 7.2 (FP6b is hidden from view) and in the photo, Figure 7.3.

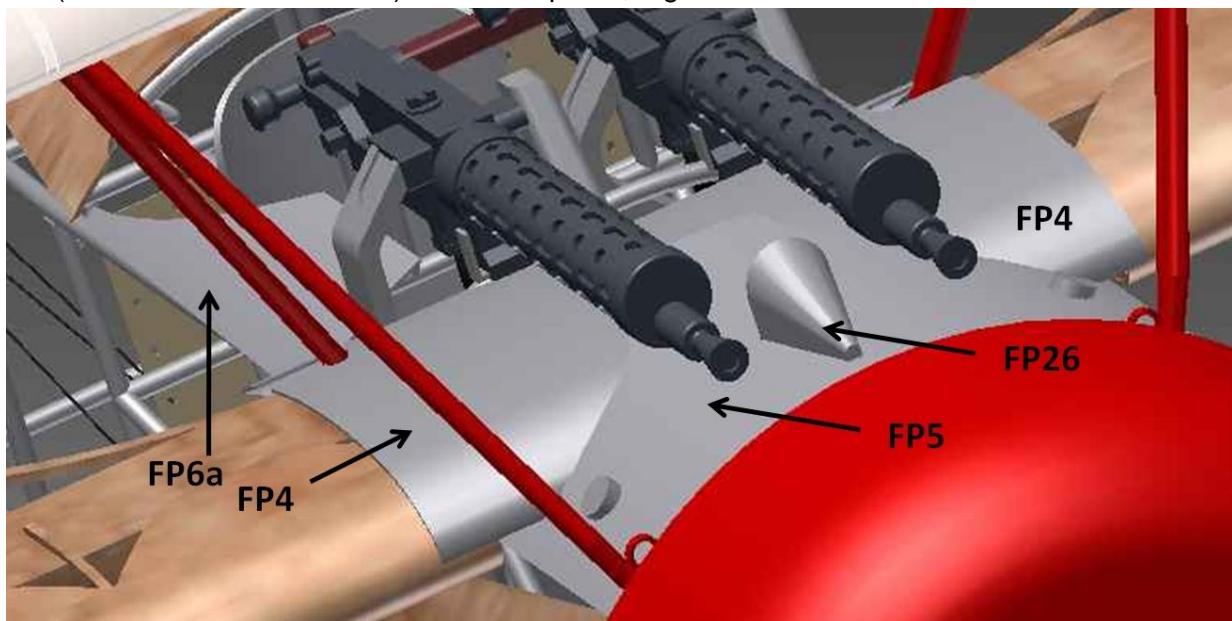


Figure 7.2 Fuselage Sheet Metal

Form FP5 to the same radius as the cowl and glue in place. Bend and trim the FP4 pieces making sure to leave clearance for the aileron control cables (See Section E).

They should lie along the top surface of the wing and mate against FP5. This is done by rolling the front edge to match the shape of the airfoil as can be seen in Figure 7.3. They may overlap each other at the center, either leave this or trim. Then add FP6a (right) and FP6b (left) to form the front edge of the cockpit. You may want to add the coaming to these first, see item 3 below.

Cut FP26 from its paper stock and paint red or aluminum to match the other parts. Form as shown in Figures 7.2 and 7.3 and bend tabs so it can be glued to FP5. Note: ignore the undersize part labeled FP26 on the etched aluminum sheet.

When fitting these skins be sure that the top wing strut fits. See Mounting the Top Wing, below. Also, installing these skins may take some trimming and bending.

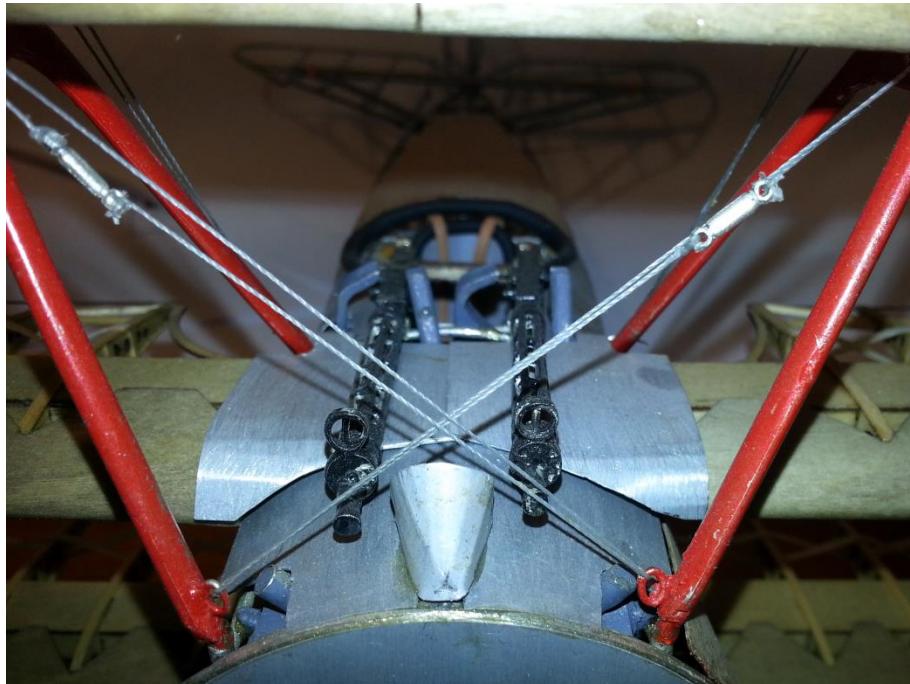


Figure 7.3 Front view of model with cowling removed

### 3. Coaming and padding

The cockpit edge is now fully defined by the turtle deck and sheet metal, so the coaming can be added. It is made from rubber tubing slit to fit over the turtle deck and sheet metal (Figure 6.4).

Padding on the back of the machine guns is made of three pieces of 3/32" square basswood 2.4mm glued together to make an "U" shape see detail on Sheet D and the photo in Figure 7.3.

### 4. Machine guns

The machine guns can now be mounted. Make sure they are parallel and aimed over the cowlings. See note in F, below.

### 5. Cheeks

On each side of the fuselage there are plywood cheeks (FW2) as shown on Sheet A. These need to be fit and a hole cut for the carburetor air tube. Once fit, trim the air tubes so they just barely stick out from the cheeks. Since the cheeks hide much detail, you can install only one if you wish leaving the other side open for better viewing.

## F. Mounting the Top Wing

Part #	Name	Count	Material
FC32	Top wing strut	2	Cast Britannia
FC20	Turnbuckle	2	Cast Britannia

With the model in the jig, the upper wing can now be mounted. Be sure the sockets in the fuselage for the Top Wing Strut FC32s are clean. Both struts are cast the same. To make a left and a right remove the bracing eyelets on the longer, rear legs of each strut since bracing is only between the front legs. Take care as the two legs are only slightly different in length. Deciding which eyelets to remove should be done with the model in the jig. The struts can be painted to match those outboard. Epoxy the struts in place in the fuselage sockets. Glue on the top wing. Add the outer struts aligned with those between the middle and bottom wings. Add bracing with turnbuckles between the front struts as shown in Figure 7.3. If all is well, the machine guns should be aimed to fire under the bracing wires.

## G. Stringing the Aileron Cables

The aileron cables can now be run from the bellcrank, between the ammo can and Frame 3a and up through the pulleys as shown in Figure 7.4. You can see them running just behind the wing strut in Figure 7.3.

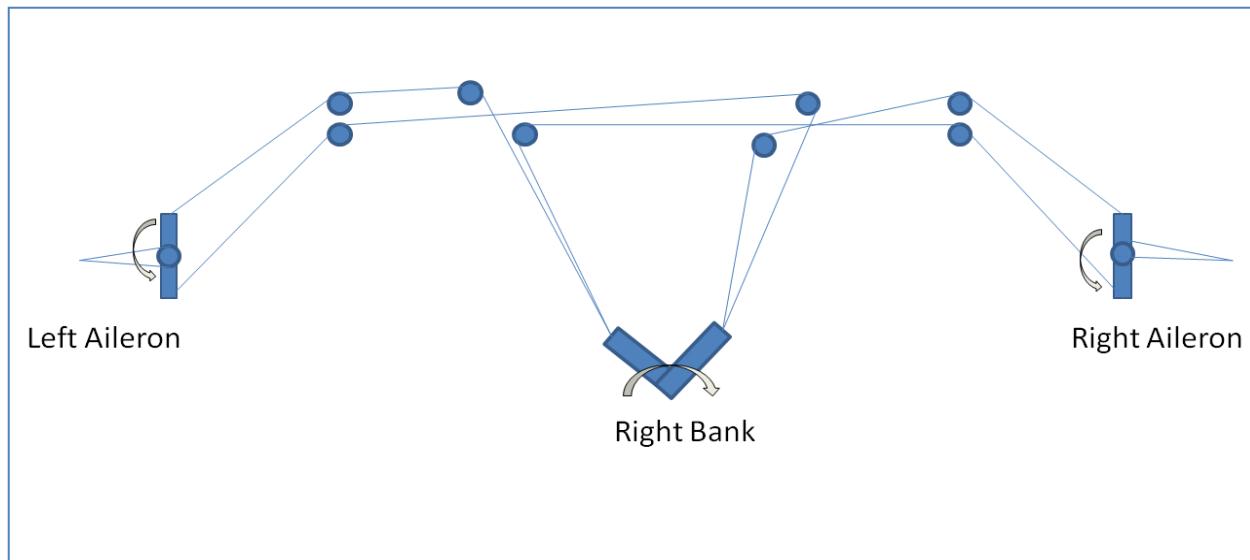


Figure 7.4 Aileron cable paths

## H. Cowl

Part #	Name	Count	Material
FO7	cowl	1	Drawn aluminum

The last part is the cowl (FO7). Paint it red. This can be glued on or just pressed into place so it can be removed to show off the engine. If you want to remove it, do not glue on the propeller, just press it on.

This completes the Dr.1. model. Congratulations on building an accurate model of this famous airplane.

## Bibliography

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Achim Engles started researching Fokker's planes when he was in his teens. He has now researched and built replicas of many of them, including two Dr.1s. He has developed detailed plans for these planes.

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