

CHILTON MONOPLANE

General Observations

The following is an attempt to give some help and guidance to prospective constructors from observations of my own machine and advice from other builders, it does not purport to be authoritative as there are many different constructional techniques that can be employed to build the structure, so the following notes should be read in that context.

The Mikron III engine

The re-emergence of interest in the Chilton Monoplane has coincided with the availability of the 65 H.P. Mikron III engine. This is a particularly suitable engine from all respects, not least that of maintaining the original nose profile. The original engine fitted to G-AFSV was the French built Train 4T of 40 H.P., this engine weighs 114 lbs. Due to the demise of the engine manufactures during the war and in the quest for higher speed for racing, when 'FSV' passed into private hands in 1956, the Train engine was removed and a Mikron II fitted. The original thrust line with the Train engine was 4.5 inches above the top longeron, however, the Mikron II was installed with a lower thrust line. This is because the magnetos on the Mikron II are fitted on top of the crankcase, thus installation of the engine on the original thrust line would have resulted in the requirement for two unacceptably large and unsightly protrusions on top of the cowling. Even with the engine in the lower thrust line position, cowling modifications are required to accommodate the top portion of the magnetos.

With the extra weight of the Mikron of about 25 lbs, over the original Train engine, one is aware of the importance of mounting the engine as rearward as possible. The Mikron III has its magnetos mounted vertically on the lower rear accessory casing, as did the Train engine. This firstly, enables the original thrust line to be maintained, secondly, because of the rearward slope of the firewall the higher engine position enables a further rearward movement of the engine.

A further option is possible, as used on both G-AFGI and G-AFGH, these two aircraft were originally fitted with Carden Ford engines. These were mounted on wooden engine bearers that formed the front of the fuselage. This configuration resulted in the top longeron terminating 5.25 inches aft of that on 'FSV'. As a result of modifications to these aircraft to enable the fitting of other engines in a more conventional manner, the wooden engine bearers have been removed and a new front bulkhead fitted, the new bulkhead terminating at the top longeron. This results in the front bulkhead being inclined rearward at a greater angle than that on 'FSV', this would enable a further useful rearward movement of the Mikron engine. 'FGI' is currently in this configuration and is fitted with the Mikron II engine from 'FSV' but because of the magneto position, the extra space created by this modification cannot be fully utilised. After a number of years with this modification, having been powered by a 55 HP Lycoming engine, 'FGH' has now been restored to its original configuration with wooden engine bearers, so as to permit the return of the Carden Ford engine.

A drawing layout with the Mikron III in its most advantageous position, gives a profile almost identical to that of the Train engined DW1A, the only external difference would be a slightly longer cowling. The higher fuel consumption associated with a more powerful engine may require extra fuel capacity. In the suggested configuration the size of the main fuel tank can be maintained, as the reduction in the available space behind the front bulkhead stops short of the tank position. In addition to the 10 gallons of fuel carried in the main tank the inclusion of the optional long range tank that is situated behind the pilot, (as fitted in 'FGI'), would give another 4.6 gallons of fuel. The Mikron II like the Train, does not have a scavenge pump, so the oil tank must be mounted below the engine, however the Mikron III has a scavenge pump so this gives more flexibility to the position of the oil tank.

Controls

The rudder pedals are steel tube fabrications, suspended from a fulcrum tube mounted in the forward upper area of the fuselage. Connected to each pedal is a balance cable with a turnbuckle for adjustment. This cable runs in a vee shape down via a pulley mounted on the front fuselage floor, thus any excess pressure applied to the pedals is not transferred to the rudder cables. As there is no natural tension in the rudder cable circuit, tension is applied by the simple expedient of a tension spring attached from each pedal up to a link plate secured to one of the upper engine mount attachment bolts, on each of their respective sides. The rudder pedals attach to the rudder cables via 10 c.w.t. turnbuckles, the two rudder cables are 10 c.w.t. and first pass through a fairlead directly in front of the front spar, then through an aperture cut in the front spar webs to a fairlead mounted on the rear spar joint. From this fairlead to one mounted adjacent frame No.1, then along the fuselage to a rubbing strip on frame No.7, through a fairlead screwed to the fuselage side, this fairlead is in two halves to enable the cable to pass through at an angle to the outside where it terminates at the rudder kingpost via shackles.

The dual circuit elevator cables are operated by levers fitted to each end of the elevator torque tube. The four cables are 5 c.w.t. and connect to the levers via 5 c.w.t. turnbuckles, these turnbuckles allow the tension of the control cables to be adjusted. The two sets of cables pass down their respective sides to the fairleads mounted on the rear spar joint, then to the fairleads adjacent frame No.1, along the fuselage to frame No.5. The top elevator cables pass over the top of this frame via rubbing strips, the bottom elevator cables pass underneath, then up through an aperture in the ply. Both sets of cables go through the slotted fairleads attached to the front face of decking former No.11. The top elevator cables pass upwards towards the top end of the elevator control arm, the cables attach via shackles to a "Y" shaped fitting, this

enables both cables to terminate at the control arm via a single linkage. The bottom elevator cables pass through the aperture in frame No.7 and terminate in the same type of fitting at the lower end of the elevator control arm. The elevator control circuit is the only one to have a trimmer, this takes the form of a lever on the starboard side of the fuselage. The lever has two tension springs attached at the top and bottom, these springs attach to the top and bottom of the adjacent elevator control lever. Thus radial movement of the trimming lever about its central fulcrum point pre-loads the control column as required, position locking is affected with a simple friction device tensioned by a wing nut.

The four aileron cables attach to the control column fittings via 10 c.w.t. turnbuckles, the aileron cables are 5 c.w.t. The cables exit their respective sides of the fuselage via apertures cut in the centre section ribs. The second rib inboard from each root end carries two fibre aileron cable guides. The cables move from the vertical plane to the horizontal plane as they pass through the wing ribs to rib No.3 where two more cable guides are mounted on the rib, from these guides the cables terminate at the aileron control lever via shackles.

Note, there are no control surface limiting stops in any of the three control circuits, thus any undue pressure applied to the control surfaces at full deflection will strain the respective control surfaces against their hinges.

Undercarriage, wheels and tailskid

The undercarriage is made up from four identical telescopic units. These units are set at an angle of 8 degrees to the centre section spar face, thus set at 10 degrees to the fuselage horizontal datum line. Each unit is retained by upper and lower fittings to the front centre section spar face. These fittings are secured by the same bolts that retain the upper and lower wing attachment plates. Further radial loads are carried by stay tubes to a triangular structure projecting from the front face of the rear centre section spar. The undercarriage has 4" maximum travel against the compression springs, the lower legs are retained in position under no load conditions i.e. whilst in flight, by slotted retaining rods screwed into the top of the lower legs.

When setting up each undercarriage assembly on to the front spar, it is very important that each unit is parallel when viewed from the front and in line when viewed from the side, as any errors in alignment will result in straining on the attachment fittings due to the vertical movement of the inner legs not coinciding with each other.

The original wheels used were Dunlop wheelbarrow wheels, running on plain phosphor bronze bearings, the wheels were fitted with 16" O.D. x 4" wide with low pressure tyres. An original Chilton drawing now numbered M.11, shows alternative wheel bearing and axle attachment fittings. The type of wheel used are still available and are used in many light industrial applications. The ball bearing version shown should be better than the plain bearings as fitted to Chilton G-AFSV, the lower rolling resistance of the ball bearing compared with that of the plain, should in theory give a more rapid acceleration and shorter take off distance.

In later years G-AFGI was fitted with a pair of front wheels from a Lambretta scooter, model LD that ceased production in 1958. These units are light with drum brakes and but take a narrower size tyre than the originals. As the Lambretta wheel had an integral threaded axle, the lower leg of the undercarriage was modified to give a fork end to locate the axle. A peg was required on each unit to take the torque reaction from the braking loads.

The tailskid loads are taken via a tension spring, the limit of the radial movement of the tailskid is controlled by a stranded cable. This cable should not limit the tailskid under normal conditions unless the spring becomes weak or a heavy landing is made, its main function is to stop damage to the underside of the fuselage and base of rudder spar should the tailskid spring break. The fulcrum bolt for the tailskid is mounted in two rubber bushes, these bushes are pressed into either side of the tailskid mounting block. There are washers either side, on the outside of the fuselage on the fulcrum bolt. These washers have to be tapered in section to coincide with the angle of the fuselage skin to the centre line of the bolt shank. This was achieved on the originals by building up across one side of a plain washer with weld then filing the angle to suit.

Fuselage

The fuselage is a box section with semi circular formers on top of the longerons for the rear decking. The entire fuselage is skinned with 1mm birch ply, with the exception of the front floor being 2.5mm. The top longerons are 5/8" square, locally reinforced in the cockpit area, aft of the cockpit the longerons taper to 1/2" square at the fin spar.

Originally the fuselage was constructed without the aid of jigs. Commencing with the skin, ply sheets sufficient to cover the fuselage length were scarfed together, then the fuselage structure was drawn on to the ply and trimmed to size. The first side was used as a pattern for the second side, and then the second side marked out in an identical manner. At this stage the longerons were glued to the fuselage skins with the exception of the front floor longerons, because of the inward and upward curvature required, they were glued to the front floor. The front floor is set up with the correct upward curvature set in using packing blocks at the front with the rear face clamped to a flat surface. The longerons are then glued into position along with the other front floor structure, thus the floor can be fitted to the fuselage as a complete assembly. The fuselage side has two main joints that locate on the centre section spars, these have members radiating from them with curved outer edges to coincide with curvature of the fuselage, this is mainly from the front joint. However because this is a very strong structure, it cannot be built flat on the skin with the intention of pulling it round to

the correct curvature on assembly. The side skin should be laid flat in the parallel cockpit area and the appropriate packing inserted under the skin in the areas adjacent to these radiating member so that when these members are glued into position with the joint assemblies, they will take up the correct position. With the above items glued to the skins, the two fuselage sides were positioned vertically, bulkhead 1, frame 1 and the fin assembly complete fitted, naturally at this stage no errors can be present in the alignment or squareness of the fuselage sides.

It should be noted that any offset of the fin to counteract torque (as built into the originals) should be obtained by setting the complete fin assembly in its required offset, thus the face of the fin spar will be slightly out of square with the centre line of the fuselage, thus when the fuselage side skins have been trimmed flush with the rear face of the fin spar, this will result in one side of the fuselage being fractionally longer than the other, so this should be born in mind when checking the subsequent alignment of the fuselage assembly. After the various formers have been glued into position and the geometry of the fuselage checked, the front floor can be fitted. Should this method of construction be employed, it cannot be stressed too highly that constant monitoring of the fuselage geometry and alignment is essential to avoid any errors being built in.

Bulkhead No.1 is a plywood and spruce structure with various apertures cut in the ply to pass such controls and pipework as may be required. Each corner of the bulkhead is cut away to clear the engine mount attachment fittings, the top & bottom cross members have corner brackets bolted through that attach to the engine mount fitting bolts to strengthen the corner. On completion, this bulkhead is covered with a stainless steel firewall flanged forward at the edges to prevent oil seepage behind.

Bulkhead No.2 is designed to clear the lower surface of the fuel tank, it is not intended to carry the weight of the fuel, this function is carried out by the straps attached to the fuel tank support blocks. However should stretching of these suspension straps go unnoticed, a strip of rubber should be attached to the top face of this bulkhead in case it contacts the lower face of the tank. The lower suspension straps are tensioned by a turnbuckle assembly, thus making any adjustment a simple operation.

Bulkhead No.3 is formed by a structure built on the vertical tapered member radiating from the main front joint. The upper rear part of this structure carries the angled fittings that retain the top of the instrument panel.

To be continued

Centre section

The centre section is built as a complete unit, the ply skinning adjacent to the fuselage sides being left till after assembly with the fuselage, to facilitate spotting through from the c/s attachment fittings. The centre section is retained by 12 fittings, the front spar is retained by fittings on its front and rear face, through the top spar flange. The rear spar is retained by fittings on the rear face only also through the top spar flange. Where the attachment bolts go through the spar flanges, there is local hardwood reinforcement pieces, these also act as packing pieces to securely locate the spars in the attachment areas. Hardwood pieces are also located on top of each spar, each side, underneath the fuselage main joints. These blocks are shaped to coincide with the angle on top of the spar.

The control assembly is bolted to the rear face of the front spar. On the lower rear face of the front spar is a rubbing block, so at full rearward deflection of the control column the lower control column fittings will not contact or damage the spar face.

The front floor has 3 blocks at the rear, through which 4 wood screws pass to secure the rear floor to the lower front face of the front spar. Packing pieces will normally be required to fill the gap between the rear face of the blocks and front face of the spar.

The hammock type seat is made from heavy duty canvas, with stitched webbing reinforcement, finally covered with leather or fire proof rexene, this same material is used for the padded head rest, back rest and the padded cushion for face protection attached to the top centre front face of the cockpit former. The seat is retained by screws through local ply reinforcement to the front face of the front spar and to the rear face of the rear spar. The seat back rest is hinged from the top of the rear spar, thus hinges forward to give access to the lower luggage stowage area. A fire extinguisher is fitted on the rear of the seat back. It should be noted that any items stored in the lower luggage area must be secured in such a way so as not to foul the movement of the flap actuating lever or control cables.

The safety harness attachment fittings are attached to the rear spar, no upper torso restraint is provided. Two spruce blocks are screwed on to the top face each side of the rear spar inside the cockpit area, these are steps to aid ones entry into the cockpit and are normally covered with serrated aluminium sheet to provide grip to ones feet. On the starboard side of the centre section just outside the cockpit area is a reinforced portion of ply skin for standing on the centre section prior to entry into the cockpit.

On G-AFSV a type V.1075/1 compass manufactured by H. Hughes of London, is mounted on a plywood base supported from a mounting block on front spar as per original fit. This located between the pilot's knees, because of this the control column was made from dural due to its close proximity to the compass.

Centre section wing attachment plates, as the width of the wing attachment plates, does not coincide with the width of the centre section spar, packing pieces are required to pack out the attachment fittings on the centre section spar, to give the correct dimensions to accept the wing fittings, originally these packing pieces were made from red fibre material, the same material used for the fairleads.

Accurate alignment of the centre section is necessary from both the aerodynamic & structural point of view. The exact position is achieved by aligning the lower surface of the centre section spar faces with the underside of the fuselage, the hardwood packing pieces between the top of the spar face and their joint aperture are sized to suit. It should be noted that the lower surface centre section trailing edge rib does not coincide exactly with the lower fuselage curvature, as the trailing edge it is higher than the adjacent fuselage underside. A slot should be cut in the lower longeron to pass the flap trailing edge member, this slot should not exceed 1/4" in depth due to weakening of the longeron, if the flap trailing edge does not lie flush with this depth of slot, material should be removed from the flap trailing edge member to suit.

Wings

The wings have two box spars and are covered with 1mm birch ply with the exception of the trailing edge ribs inboard of the aileron. These rear ribs are fabric covered, as is the aileron. The aileron differential mechanism is mounted on the rear face of the front spar and operates the aileron via a push rod through an aperture in the rear spar. The pushrod connects to the aileron kingpost via a small link fitting, this fitting allows the relative angular movement of the pushrod to take place. The pushrod length is adjustable by means of the threaded portion that terminates in a balljoint. The balljoint passes the radial movement of the differential arm to the reciprocating action of the pushrod. The aileron is attached to the wing by four lengths of brass piano hinge. These hinges are retained by countersunk head screws to the front upper face of the aileron spar. The other side of the hinge is retained by the same type of screws to the hardwood mounting blocks glued and screwed to the rear face of the wing spar. The mounting blocks are recessed to the thickness of the hinge material, so the top surface of the hinge is flush with the wing surface. The aileron differential mechanism mounting bracket is retained by 4 bolts through the front spar, 1" diameter washers should be used under the nuts on these retaining bolts on the front spar face.

The split flaps are mounted on the rear inboard ribs, the torque tube to which the flap ribs are attached rotates in two small bearing fittings bolted to the rib sides.

The wing attachment pins pass through the top & bottom spar flanges, the holes for these pins should be 1/16" diameter greater than the pin diameter to provide clearance. The pins should not be lubricated in case of contamination from grease etc. to the spar flanges. The pins are held in place by split pins at each end.

The aileron differential mechanism is operated by two cables that go from the mechanism via two fibre cable guides in rib No.3, the cables move from the horizontal plane through ninety degrees as they pass through the two forward apertures in the root end rib, then into the centre section through two more cable guides, these guides are set vertically one above the other in the second rib in from the centre section root rib. Thus the cables are correctly aligned for attachment via turnbuckles to the control column fittings. *To be continued*

Fin

The entire fin assembly is off set to the fuselage centre line to counteract the torque of the engine, the lower leading edge of the fin is secured to the rear fuselage decking former by a metal fitting. The offset of the fin centre line to that of the fuselage was 3/8" on G-AFSV measured at the leading edge of the fin adjacent the bottom fin rib.

Rudder

The rudder has a solid spruce spar, the top and bottom edges of the spar are slotted on the centre line to locate the trailing edge. The ribs are built up from square section spruce with ply cross pieces they locate along the outer edge of the spar. It is suggested that the ribs be left long at manufacture to facilitate trimming to length on assembly. The three hinge retaining bolt centres should be spotted through from the fin spar to ensure accurate alignment. The rudder operating lever is retained to the spar by four 4BA bolts, the penny washers under the bolt heads should be cut away to coincide with the spar edge. A spruce block is fitted at the spar top to strengthen the trailing edge, the block is covered by the ply gussets on each side.

Tailplane

The tailplane has a built up box spar, the ribs are built up with ply diaphragms and square section spruce members. The leading is laminated and shaped to section apart from the central portion that should be left in the in the basic angular section to facilitate attachment to the rear decking former. In the attachment area the leading edge is glued to the tailplane mounting platform attached to the rearmost decking former, the leading edge of the tailplane is also secured by three bolts.

Elevator

The elevator has a built up box spar, the ribs are built up with ply diaphragms and square section spruce members, the trailing edge is cut from 5mm ply. The elevator control arm is bolted to the rear face of the spar with 4BA bolts. The hinge centres must correspond with those from the tailplane spar so should be spotted through. The elevator control arm

is made from two pieces of steel riveted together. The lower surface of the tailplane has six semi-circular cut-outs adjacent to each hinge retaining bolt, these inspection apertures are covered by small fabric patches.

To be continued

Plywood face grain direction

The direction of the face grain on plywood has an important effect on a components strength and rigidity, ply should be applied as per the following guide. This information was obtained from observations of the ply on G-AFSV & components from the fifth uncompleted Chilton.

Fin spar - the face grain runs at 90 degrees to the spar centre line

Fin ribs - the grain on the ply diaphragms is at 90 degrees to the centre line of the ribs

Fin skin - the grain runs parallel to leading edge

Rudder spar - this is a solid piece of spruce, with the grain running vertically along its length

Rudder ribs - the grain on the gussets is at 90 degrees to the centre line of the ribs

Rudder trailing edge gussets - the grain is at 90 degrees to that particular part of the trailing edge to which it is affixed

Tailplane spar - the grain is at 90 degrees to the centre line of the spar

Tailplane skin top - grain runs at 90 degrees to angled root rib

Tailplane skin bottom - the grain runs parallel with spar

Tailplane ribs - the grain is at 90 degrees to the centre line of the ribs

Elevator spar - the grain is at 90 degrees to the centre line of the spar

Elevator ribs - the grain on the gussets is at 90 degrees to the centre line of the ribs

Elevator trailing edge gussets - the grain is parallel to that particular part of the trailing edge to which it is affixed

Elevator spar to rib gussets - at 90 degrees to the spar

Wing spars - all grain is at 90 degrees to spar centre line

Wing inter spar ribs - grain goes chordwise

Wing leading edge ribs - grain goes chordwise

Wing inter spar skin - grain goes chordwise

Wing leading edge skin - grain goes spanwise

Centre section spars - all grain is at 90 degrees to spar centre line

Centre section leading edge ribs - grain goes chordwise

Centre section inter spar ribs - grain goes chordwise

Centre section leading edge skin - grain goes spanwise

Centre section skin aft of front spar - grain goes chordwise

Fuselage sides - grain parallel with top longeron

Important - All spruce spar flanges should have the grain, when viewed from the spar ends, running at 90 degrees to the vertical spar faces i.e. the grain should be approximately parallel to the fuselage horizontal datum line.

The application and finishing of thin plywood

Apart from two areas, the front floor & centre section walkway, the entire skin on the Chilton is of 1mm birch ply. Due to the lightness of the construction, the outline of the fuselage structure and wing ribs will to some extent be visible through the ply. It is very easy for such thin ply to distort, so the following are some suggestions that should help alleviate some of the problems that can be encountered.

The best results are obtained with new ply, that is fresh manufacture, as unless the ply has been stored in ideal conditions distortions set in. Having acquired the ply sheets, they should be stored in an environment that is stable as possible in both temperature and humidity. The sheets should be stored flat on a flat floor, if floor space is at a premium, as it usually is, the ply can be stored vertically but on no account simply leaned against the wall. Ideally attach some wooden battens to the wall, stand the ply against it and secure the ply to the battens by some means. Care should be taken to position the storage rack out of direct sunlight to prevent drying out in hot weather. Naturally it follows that the remainder of the spruce etc. to be used for construction should be stored in the same conditions so as to let the moisture content in all the materials stabilise at a common level. Thus when the various parts are glued together, relative movements due to moisture content will be minimised. When applying the ply to the structure, Aerodux glue should be used where possible, as Aerolite glue with its liquid hardener tends to wet the ply too much, this induces distortion and the adhesive appears to shrink slightly during the hardening process. Aerodux does not have this wetting effect and is a gap filling glue so does not shrink, its easier to apply and see but in any case is a superior adhesive. Naturally where it is

possible to gain access to a freshly applied panel, any excess glue squeezed out from the joint should be removed. When preparing a piece of ply for application to the structure, it is normal to place the ply in the position required, pencil around the structure on to the ply, thus when the ply is removed, one has the outline of the structure marked on the ply ready for the application of the glue. However rather than glue the ply on, before applying the dope or varnish, it is advisable to apply any internal protective finish using the pencil marks as a guide, also a couple of coats of dope on the outer surface of the ply, letting the panel dry completely for at least twenty four hours before applying to the structure. This will allow any slight movement of the ply due to the application of the finish to take place, thus giving the best possible chance of a smooth distortion free panel when finally applied.

Then applying a surface finish to ply, either inside or out using dope, on no account should tautening dope be used. It is not possible to tauten ply, all tautening dope will do if applied is distort it. Thus for external finish, including the application of fabric to ply, only non-tautening dope should be used. For the required silver coat (to give u.v. protection) on ply it is suggested that aluminium surfacer or aluminium powder mixed with non-tautening dope be used. Silver dope should be avoided as this is usually of the tautening type. For internal protection of the structure Rhodius sailplane varnish seems to come highly recommended. For tautening of fabric, low tautening dope should be used to give maximum filling of the weave for minimum tautening. Care should be taken not to over tauten the fabric as the trailing edges will pull in between the ribs or distort.

Quantities of dope used in 'FSV's restoration was as follows:-

Nitrate non tautening	<i>6 x 5 litres</i>
Nitrate low tautening	<i>3 x 5 litres</i>
Nitrate alum surfacer	<i>2 x 5 litres</i>
Butyrate finish colour	<i>3 U.S. gals.</i>