CHAPTER 1

Making a start in the cockpit

‘Flatpack’ fuselage

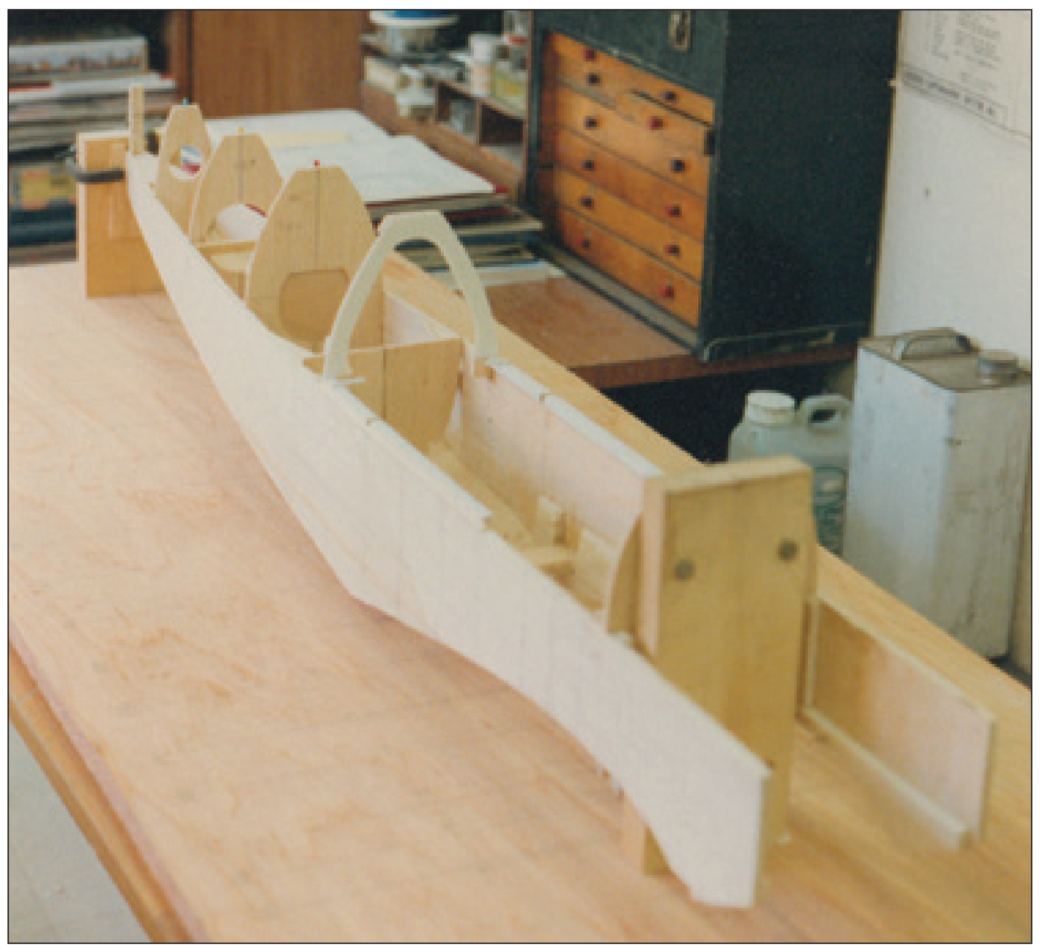
I had resolved from the beginning that my Spitfire would feature a fully detailed cockpit, and that is where the real work began. I had no illusions about the challenge ahead, and the time and effort that it would take. A Spitfire’s ‘office’ is a very busy place! It was also obvious that the simple practicalities of access meant that I would have to complete most of the visible interior, and then build the rest of the model around it. It would be like building a ship in a bottle, but where the bottle has to go around the ship.

With the aid of the notes provided with the kit, work on the basic fuselage structure took scarcely longer than a weekend. The photographs I took at the time show the result mounted parallel to the plane of a sturdy base-board, and they illustrate the very simple nature of the construction. In addition to drawing horizontal datum lines on the model, I scribed a fore-aft centre line on the board and a series of transverse sections marking the frame positions in the real aircraft – datum points that would be used throughout the build. The pictures show the simple box construction adopted by the kit’s designer, Rob Millinship. The lower fuselage sides start out as flat balsa sheet supported by transverse balsa and ply formers, none of which would be visible in the finished model. The foremost is located around the firewall position and strengthened, and I used it as a convenient mounting point; the others, aft of the cockpit, constrain the fuselage as it tapers to the rudderpost. It was the bit in between where the fun was to start, for I proposed to replicate everything that would be visible within and behind the cockpit from the firewall back to fuselage frame 12.

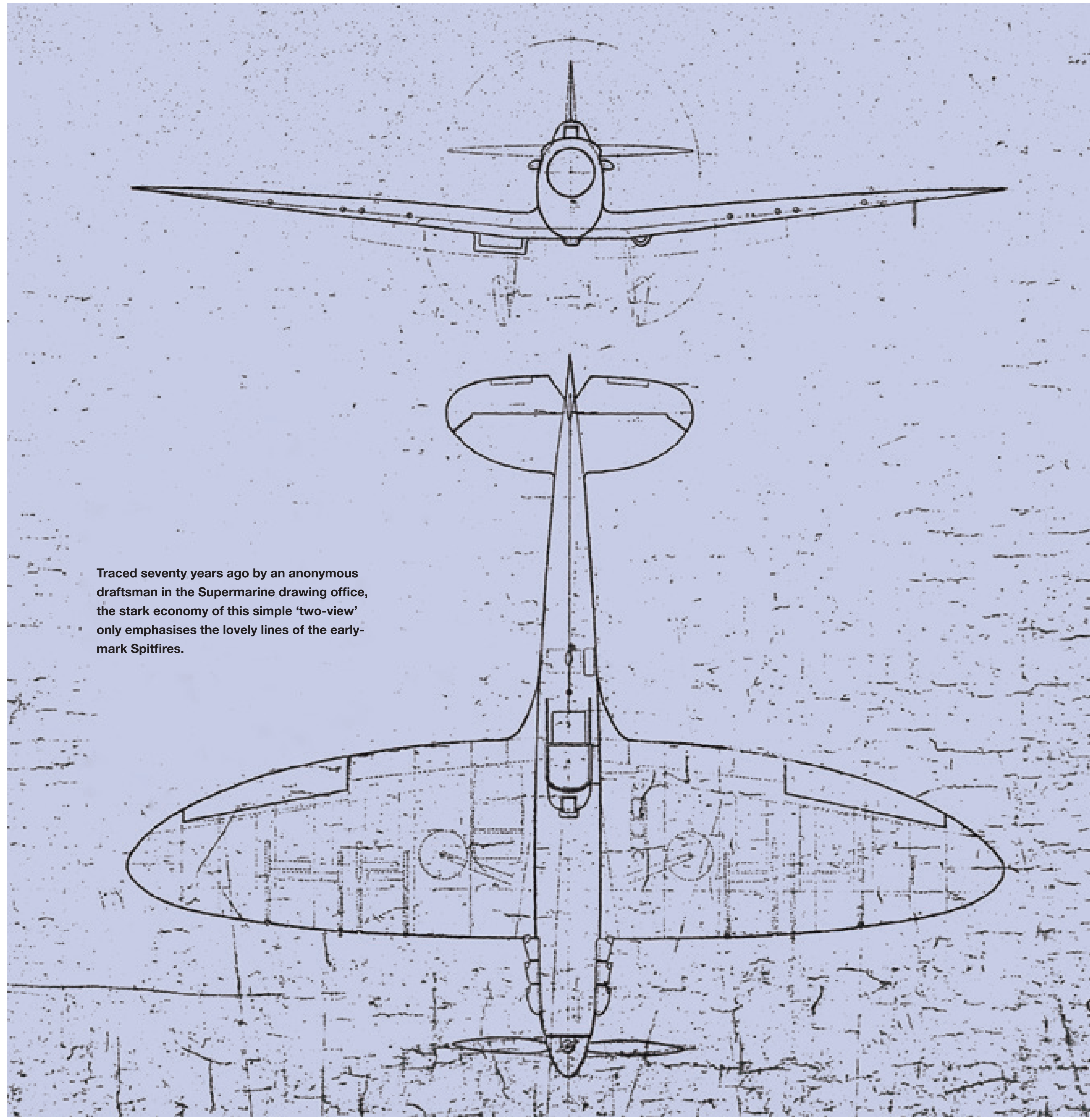
Before moving on, a word in praise of DB Models’ Sport and Scale Mk Ia Spitfire: While I created all visible elements of the model entirely from scratch, the kit provided the underlying structure and a sound basis on which to begin; and while I was to discard the vac-formed radiator fairing and canopy, this is not to denigrate them. They were all more than adequate for their intended purpose – a creditable flying model. The kit’s main plane comprises port, starboard and centre sections formed from expanded polystyrene skinned with high quality balsa. Separate balsa and ply parts make up the wing tips and leading edges. The foam would cause problems later, but I’m sure there is no better alternative where lightness and strength are paramount. The kit also featured an aluminium alloy spinner and a sturdy one-piece fibreglass nose section, and I made use of both – albeit after some major surgery.

I’ve touched on the issue of references, or the lack of them, but there was to be another problem that would occupy me during the opening stages. As I’ve described, the fuselage of the DB model below the horizontal datum starts life in the flat, and in the vicinity of the cockpit the balsa sides are reinforced by sturdy plywood ‘doublers’ and ‘trebblers’. This means that their combined thickness is 0·6in, roughly 10 per cent of the overall fuselage width. In the real aircraft, of course, skin thickness is negligible! A further issue arose from the one-piece wing construction, because the mid-section does not exist in the real aircraft whose cockpit is open all the way to the belly skin. I got around this in part by scooping most of the centre section out, but there was no avoiding a subtle down-scaling as well as a slight width-to-depth differential for everything below the waist. However, I was confident this would not be noticed, not least because the waist longerons jut prominently from the fuselage sidewalls immediately below the cockpit door, and I reasoned these would serve to buffer the effect of any minor distortion in scale visible below them; and in the event, I believe I was right.

Once I had reached this stage, I could begin the transmutation from kit builder to scratch builder, and I set about making patterns of the fuselage frames from drawings in the ‘Dutch Spitfires’ book. Half-frames in the cockpit were straightforward, but for reasons outlined above, I needed to enlarge the drawing of the full-frames in two parts: that above the waist to scale size, and below it marginally undersize. There was little chance of becoming bored during this stage of the build, since no two frames are alike.



This picture shows the very early stages of the fuselage structure using the kit’s pre-cut balsa and plywood components. None of the bulkheads seen here is visible in the finished model.



Traced seventy years ago by an anonymous draftsman in the Supermarine drawing office, the stark economy of this simple ‘two-view’ only emphasises the lovely lines of the early-mark Spitfires.

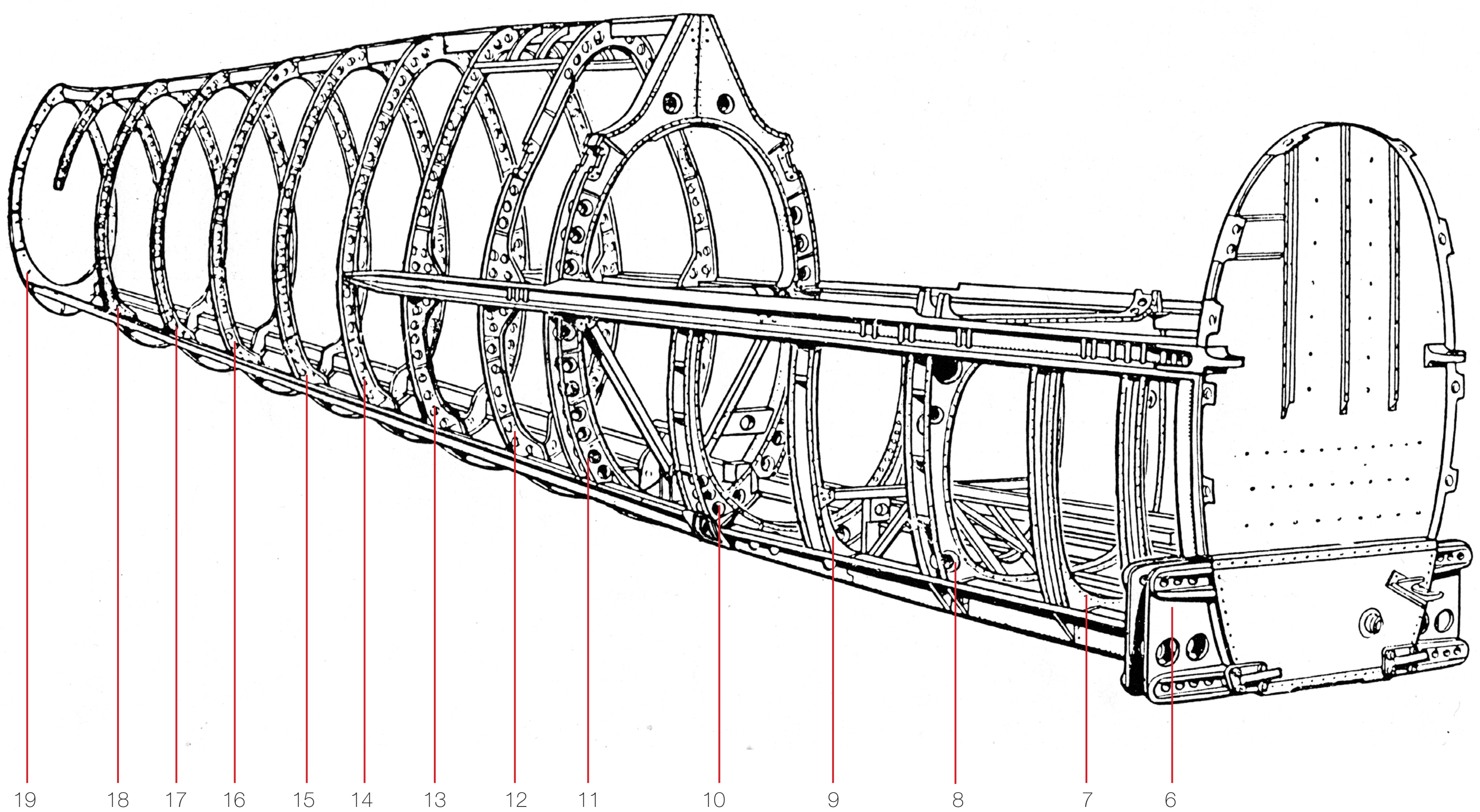
Drawing © BAE SYSTEMS

The fuselage frames

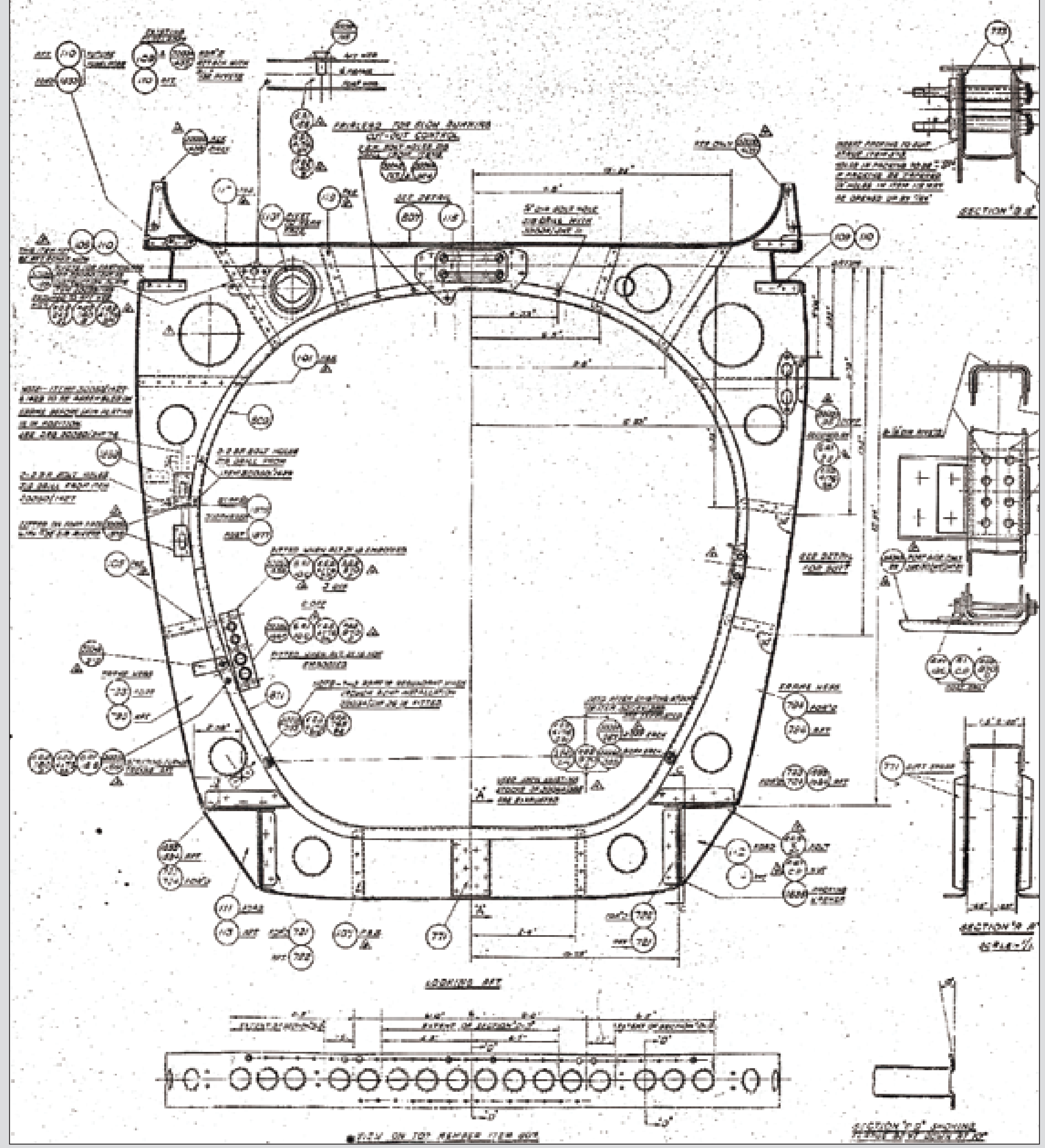
Faced with building the Spitfire's fuselage frames today, I would use litho-plate, but then I was still a plastic modeller 'working large'. To create the built-up frames of his award-winning Spitfire model, Rob Millinship had used almost paper-thin ply laminated onto expanded polystyrene, and I decided to do likewise, adding various items made from styrene or litho plate to build up the detail. First I tacked two sheets of 10-thou ply together temporarily with Spraymount (it rubs off easily with lighter fuel) and pasted on my photocopied paper pattern. This thin ply is beautiful to work with, and the two sheets were easily cut together using sharp scissors and a scalpel. I made the lightening holes by drilling undersize and then opening them out with a round file. By using the file like a reamer, the holes are made cleanly and without risk of tearing the ply. Once separated and cleaned up, I laminated both skins to the foam core with two-part epoxy, and I lined the thickness of the frame with 10-thou plastic sheet sanded back flush to both faces once the glue set. Where flanges were visible I cut them from more styrene sheet and carefully glued them in place. Finally, prior to adding the detail, I removed all foam core material visible through the lightening holes.

Rob Millinship simulated the numerous dome-head rivets with little blobs of white glue. The method works fine, although care is needed to ensure consistency, and since weight was not a consideration for my model, I abandoned the technique in favour of real rivets. Over the course of the project I was to use thousands of tiny alloy and copper rivets and many hundreds of steel and brass nuts, bolts and screws in the very small BA sizes, at considerable expense!

I used styrene square section for the cross bracing on frames 9 and 11, and the various plates, brackets and angled stiffeners were made from styrene or litho plate – the latter being specially good where bending is called for. Throughout the process, I was concerned that the wood grain would show on the finished frames. But the plywood's quality was superb, and after a coat of sanding sealer, followed by automotive primer and a final spray over with Humbrol cockpit green there was nothing to give the game away.

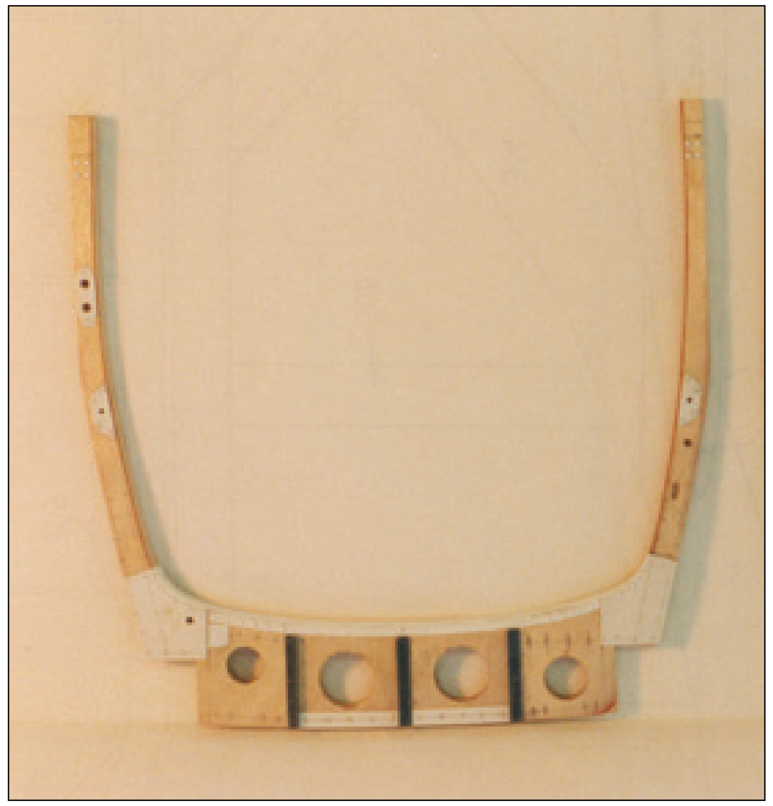


An isometric drawing of the frames, longerons and firewall of a Spitfire taken from the book *Dutch Spitfires* by Melchers and van der Meer. There are minor differences between the frames of the Mks I and IX, but I was able to correct most of them by reference to photographs.

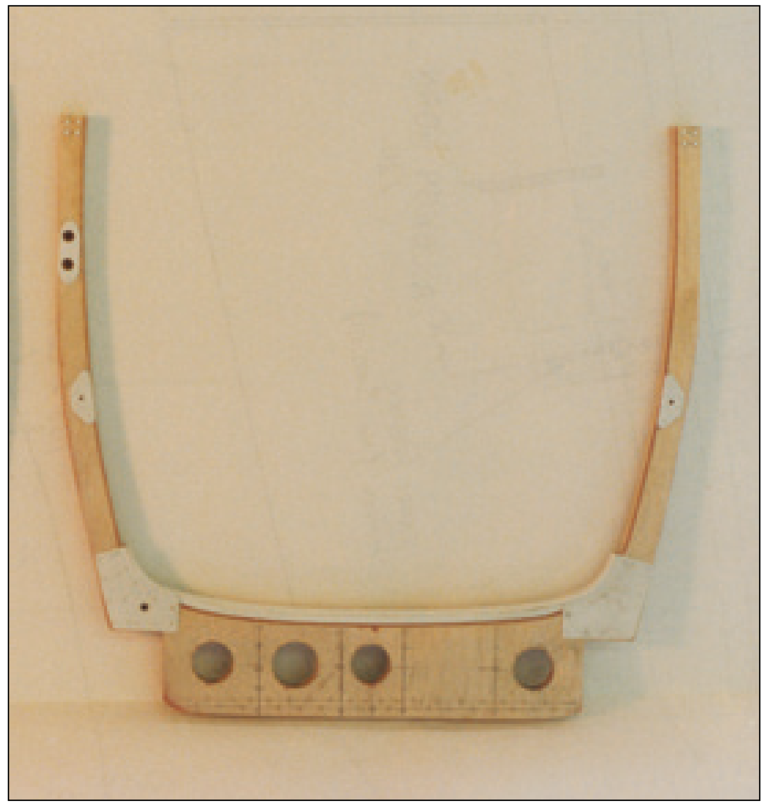


The Supermarine drawing of frame 8

The fuselage frames



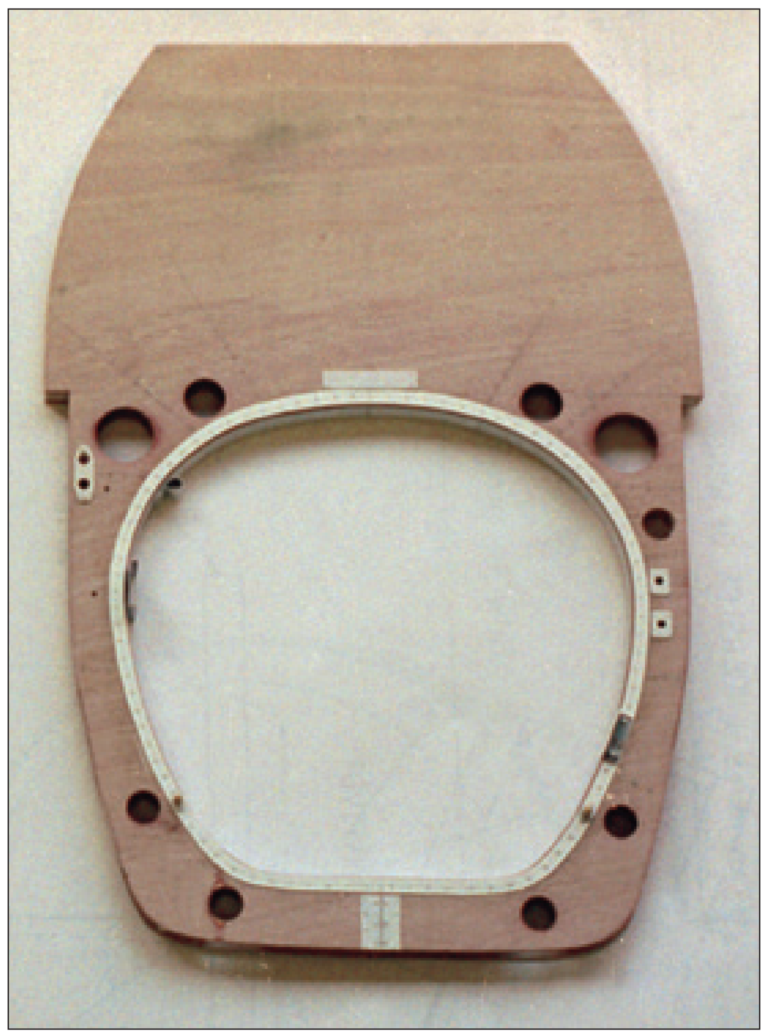
Frame 6



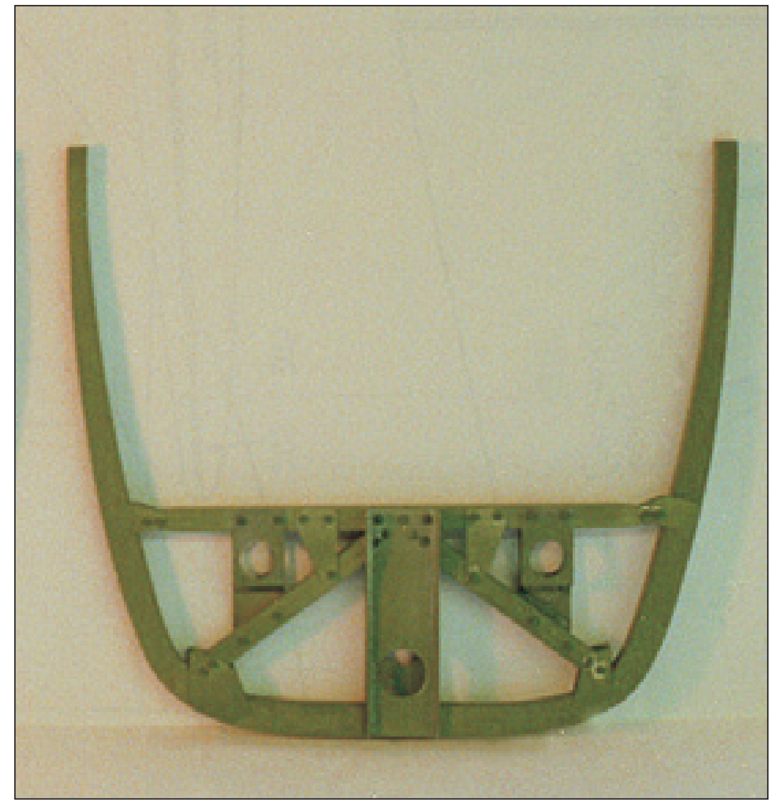
Frame 7

Seven fuselage frames can be seen from the open cockpit and I included them all, together with the firewall for completeness. Note that all but frame 12 are of composite construction, and I achieved the required thickness by laminating thin plywood onto a core of expanded polystyrene later removed by way of the lightening holes.

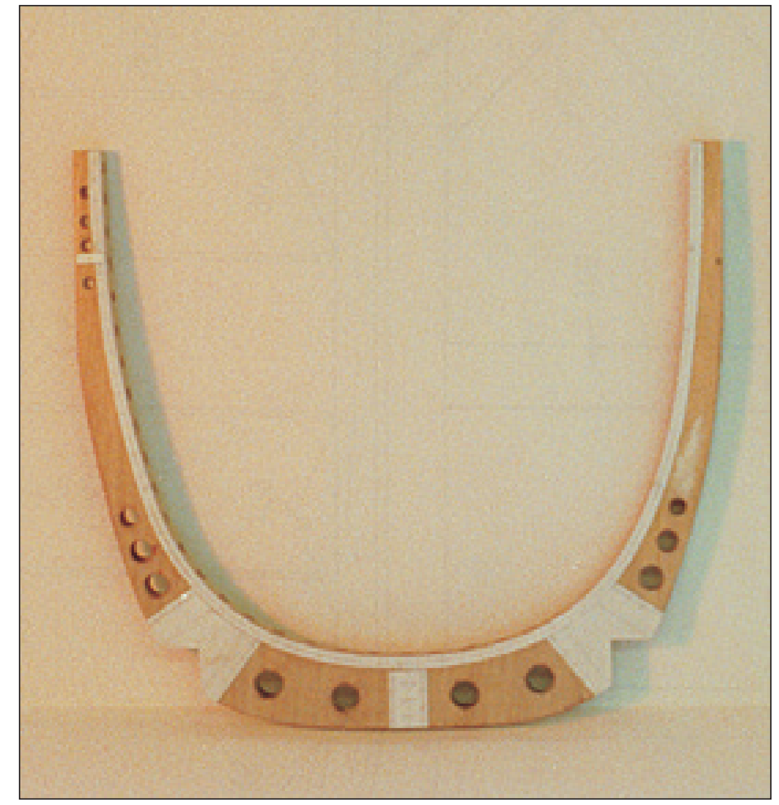
In reality, frame 8 (right) is a half-frame below the waist longeron, but in the model it is built as a full frame for added strength. The false upper half is completely hidden by the instrument panel.



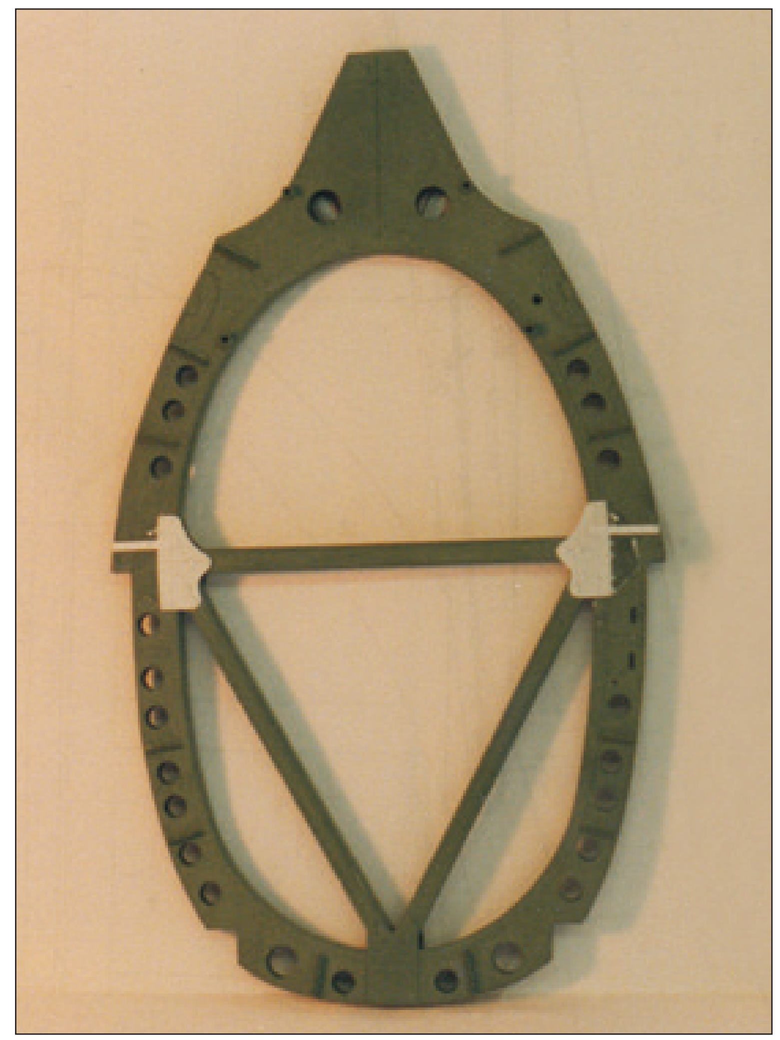
Frame 8



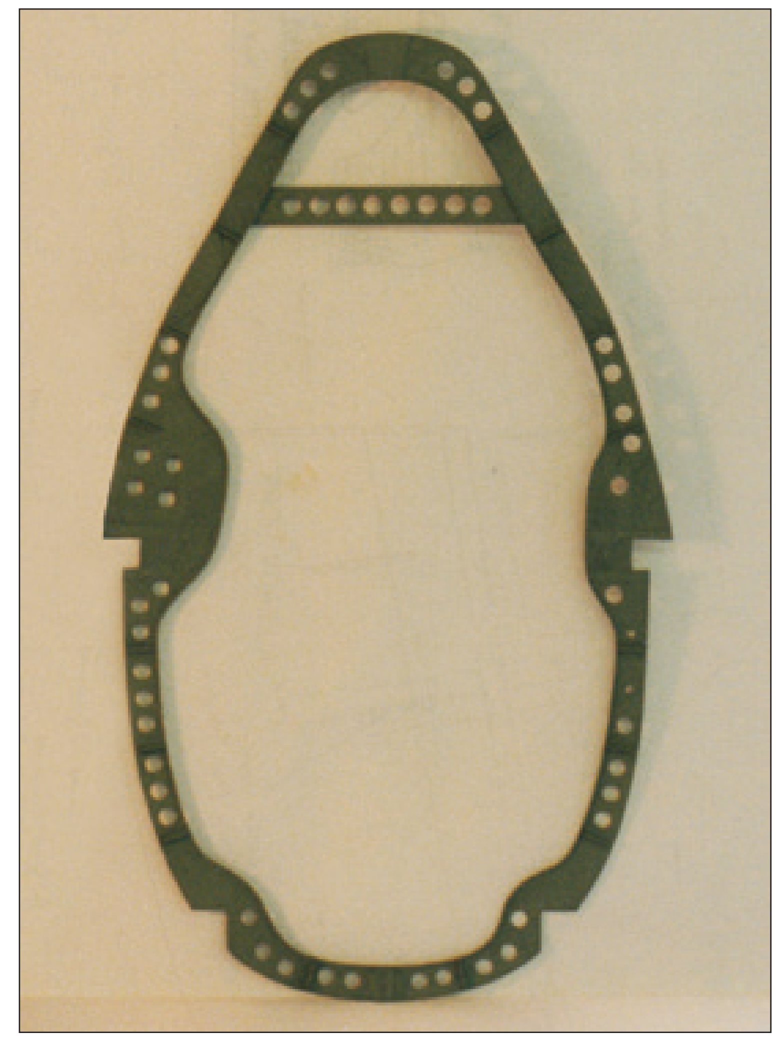
Frame 9



Frame 10



Frame 11



Frame 12

Building the fuselage sidewalls

With the frames completed, I turned to the two waist longerons which I made from balsa wood laminated with styrene sheet thick enough to hold a corner radius. With these installed, I was able to fit all the frame sub-assemblies and to build up and detail the barely visible firewall *in situ*. This opened the way for the interior skinning, starting with the section between the upper and lower main longerons. I cut manageable pieces of 30 thou styrene sheet to size and tacked them to the balsa sidewalls immediately beneath the waist longeron. Once joggled into position, the frames themselves served to pinch the skin in place and to hide the seams, and with their bases temporarily tethered in a simple jig to maintain relative alignment, I was able to curve the styrene sheet around them, pinning and gluing as I went.

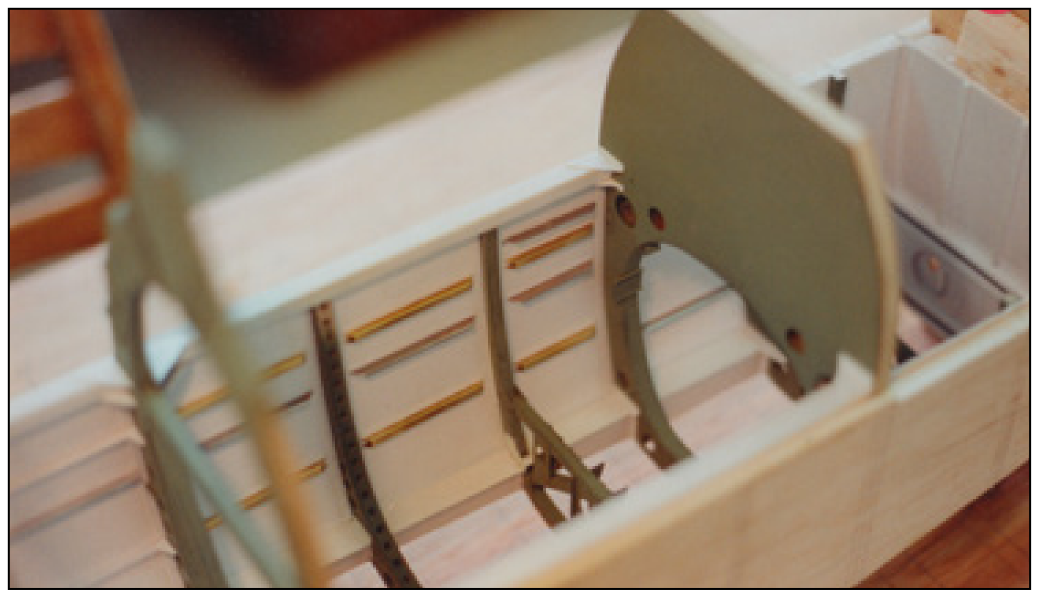
In the real aircraft the two sturdy V-section lower longerons tie the forward and main fuselage sections together. In my model these also added structural strength and provided a good landing for the sidewall and belly skin. Again I made them from hard balsa laminated over with styrene, and spent an enjoyable few hours adding big dome-headed rivets, each secured with a tiny dab of superglue. It gave a great scale feel.

Between the frames are numerous intercostals. Not yet adept at bending litho plate into a neat 'top hat' section, I used a combination of brass U-section flanked with styrene strip, the 'rivets' being back-pressed with a sharp point. Before fixing them in place I took the precaution of gluing short lengths of plastic rod to the fuselage sides, so there would be plenty for the brass to hang onto.

The belly-skinning came next, which involved pinning and gluing more thin plastic sheet around the basal curvature of the frames. My photograph (on page 87) of the inverted fuselage taken some time after the exterior woodwork had been finished shows this skin cemented in place and reinforced with seams of two-part epoxy. Later I encapsulated the whole underside with more epoxy resin, and it made for a very rigid job indeed.

With the skin done, work on the remaining intercostals and other basic structural furnishings that feature in the bottom of the cockpit could proceed. By this time I had started to source Supermarine factory drawings from the Royal Air Force Museum at Hendon, and I had also begun to use litho plate in preference to plastic. The thin alloy cuts and bends easily, and lends itself beautifully to the task at hand. As a result, and with the help of a small bench-top lathe and pillar drill (but not much else in the way of machine tools at that time) I set out to produce fabricated alloy, brass and steel parts that were pretty much exact copies of the original, even to the riveting.

To see the cockpit gradually emerge was extremely rewarding: first the empty fuselage shell crossed by its longerons, frames and intercostals, then the built-up support structure for the flying controls and heel boards, and then, one by one, the myriad fixtures and furnishings, all still in bare metal. If I had any doubts about being able to surmount the first major challenge of the model, they began to dissolve. It would have been nice at this stage to take a break from the minutiae of the cockpit interior. Long spells focused on the same or similar things can become drudgery, and when that happens standards tend to slip. Sometimes it is best to drop the thing altogether and paint another model, or paint the house! I worked on several lesser projects and kits while building the Spitfire, but I knew that until the entire inside lower cockpit had been completed work on the fuselage exterior would have to wait. Once the sidewalls had been built up above the waist, it would be tough getting one hand into the cockpit, let alone two, so over the next year or two I persevered with researching and making an endless collection of bits and pieces, some of which I describe shortly. Each one presented its own challenges and rewards, yet none more than a job that, for me, is a high spot of any aircraft model I make – the instrument panel.



The interior fuselage structure begins to take shape. The pre-painted frame sub-assemblies have been installed, followed by the upper and lower main longerons and then the intervening fuselage skin. Note the cocktail of materials: The longerons are made of hard balsa wood laminated with styrene sheet, while the various intercostals are cut from either brass or aluminium depending on their section.

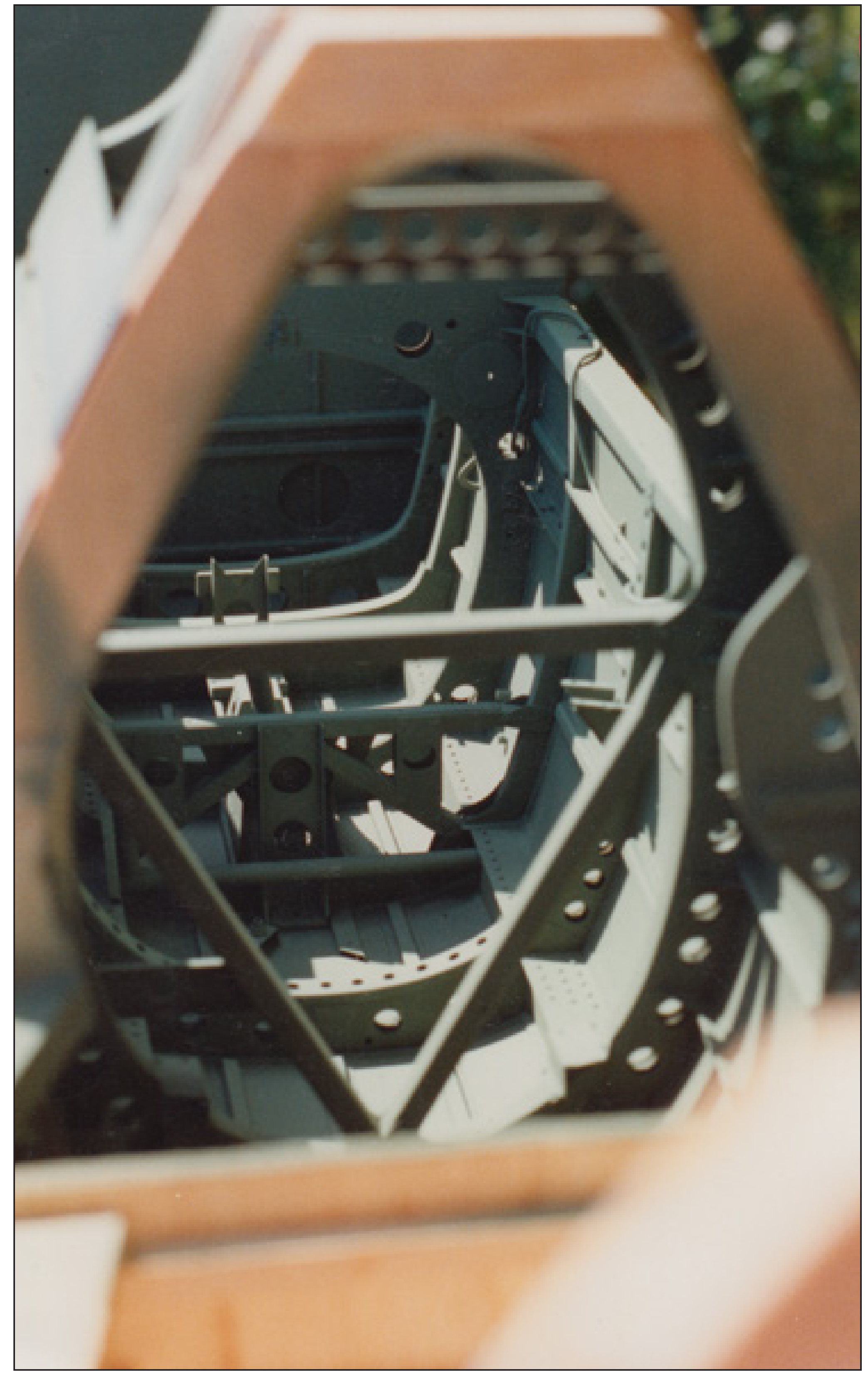
The firewall is hardly visible, if at all, in the completed model, but I added detail to it nonetheless. With the frames and mid-section skin in place, the trickier job of skinning round the underbelly could begin. I built this up piecemeal by cutting, pinning and gluing sections of styrene sheet between the frames. Later the whole lot was laminated over with two-part epoxy resin for additional strength and rigidity.

'Once the fuselage sides had been built up above the waist, it would be tough getting one hand into the cockpit, let alone two...'

Perhaps this is a good a time for a minor digression. There is no question that modern glues have revolutionised model making. How did we manage before two-part epoxy or superglues? Even dyed-in-the-wool traditionalists will concede to their phenomenal strength and versatility, and to the time they save. However, ever since reading an excellent little book called *Ships in Miniature* by Lloyd McCaffery (Conway Maritime Press), I have harboured a nagging concern. McCaffery devotes an entire chapter to materials and glues and their resilience and longevity. Following the example of the 17th and 18th century shipwrights, whose wonderful dockyard models are still with us in museums today, he works only with traditional materials that have stood the test of time. This is not conceit. As a professional model maker he is not unreasonably keen that his own fine work should outlast its creator. McCaffery made me think about plastics, which do degrade! He made me think about glues, and particularly the modern wonder adhesives. Their ease of use and prodigious strength are not in doubt. Yet what of their longevity? How will they resist changes in ambient temperature, humidity, light intensity and even the effect of micro-organisms? If such information exists in the literature, I have yet to find it.

While I have used mechanical fastenings where I can, my model is heavily reliant on cyanoacrylates, epoxy resins, contact adhesives and other formulae that can be taken only on trust. There are no 200-year-old masterpieces stuck with superglue; there are few resin-cast dockyard models recalling yesteryear's ships of the line; there are few plastic kits that much predate the middle of the 20th century!

You need only visit the model shows to see how the standard achieved by plastic modellers, even those content to build only from the box, touches new heights year-on-year as technology steps in to aid a hobby enjoyed by millions. Soaring higher still are those elite few, the 'Master Scratch Builders' like George Lee, John Alcorn, Ron Lowry and Bill Bosworth. Their breathtaking models deserve preservation in perpetuity for the admiration of generations to come. Yet they too have come to rely heavily on just the kinds of materials discussed here. Will these models be around 200 years from now? I very much hope so, but if I am worrying unduly, I do wish someone would tell me!

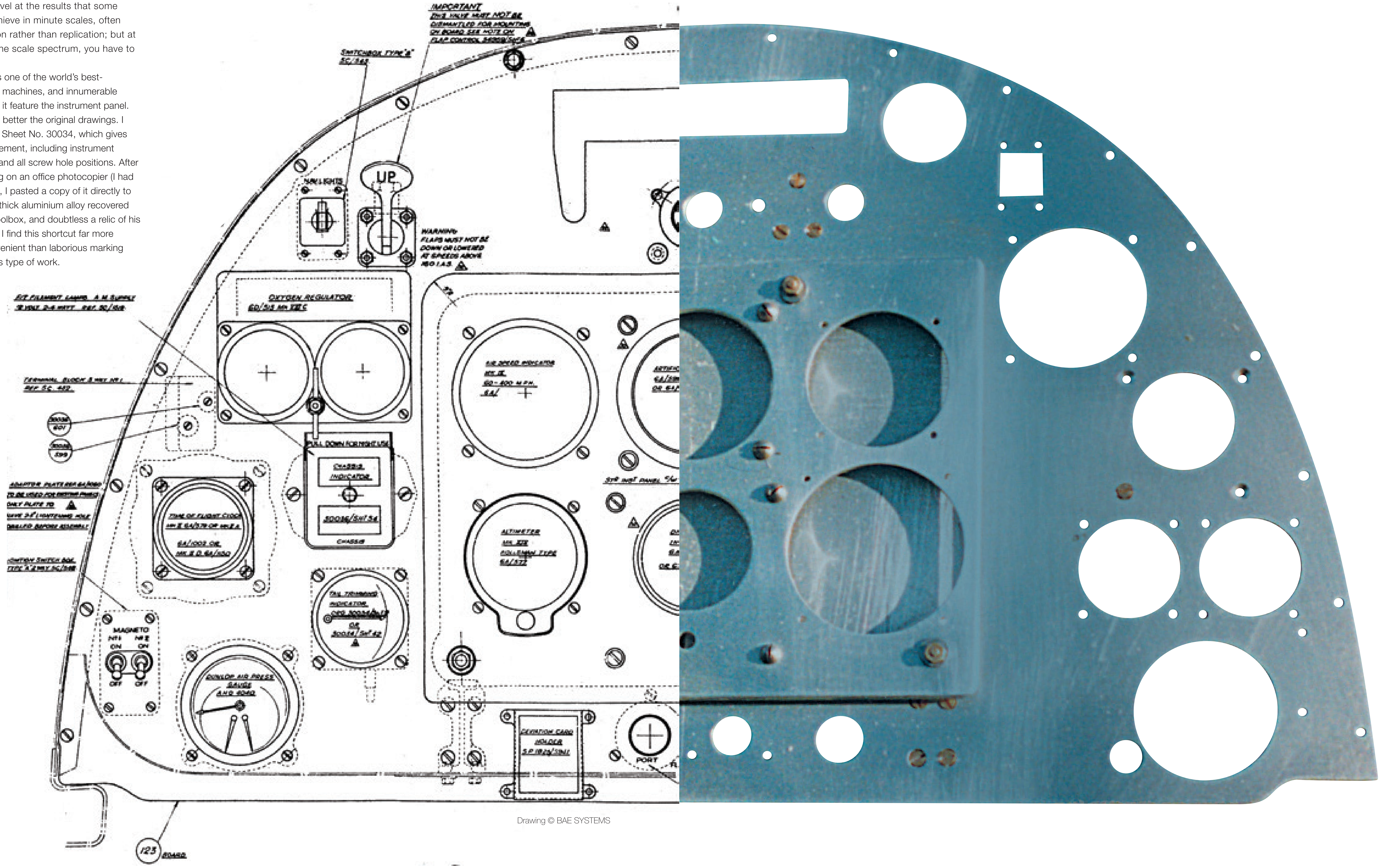


By the time this picture was taken, the fuselage interior had been spray painted RAF cockpit green.

Instrument panel

Ancient or modern, large or small, aircraft cockpits hold a special fascination for aviation enthusiasts. I marvel at the results that some model makers achieve in minute scales, often through suggestion rather than replication; but at the other end of the scale spectrum, you have to build it like it is!

The Spitfire is one of the world's best-documented flying machines, and innumerable publications about it feature the instrument panel. Even so, you can't better the original drawings. I used Supermarine Sheet No. 30034, which gives the general arrangement, including instrument bezels, stencilling and all screw hole positions. After scaling the drawing on an office photocopier (I had no computer then), I pasted a copy of it directly to a sheet of $^{1}/_{16}$-in. thick aluminium alloy recovered from my father's toolbox, and doubtless a relic of his de Havilland days. I find this shortcut far more accurate and convenient than laborious marking out, at least for this type of work.



Drawing © BAE SYSTEMS

‘Trickiest of all were the two rectangular and convex shaped fuel/oil pressure gauges.’

The completed panel is as satisfying outside of the aircraft as it is in, and would make a display model in its own right. Note the use of dark grey rather than black paint on the panel. Black would look totaly unrealistic, and even the black faces of the instruments have been toned with dark grey pastel.

I mentioned ‘panel’ in the singular, but there are two: the six primary flight instruments – airspeed indicator, altimeter, directional gyro, artificial horizon, rate of climb and turn and bank indicator – are arranged on what is termed the blind flying panel, which is fastened to the main panel by three brackets designed to dampen vibration. These are not visible, so I substituted simple tubular spacers.

Given a stock of brass or alloy tube in various sizes and gauges, round bezels are not hard to produce on a small lathe. Different instruments tend to have different bezels, so it’s a matter of careful study to get the shapes right, not forgetting to allow for a tiny internal rebate for the glass. Once in the swing, it is surprising how quickly a collection of nice freshly minted bezels can be machined.

Other detail is trickier: the oxygen regulator has a pair of gauges mounted on a single plate, for supply and delivery respectively. I made this from turned tube and shim, soft soldered together. The wings of the big butterfly control were sweated in one piece to slotted brass rod and filed to the correct profile. Similar treatment resulted in the spoon-shaped flap selector lever that on the Spit gives only two flap settings, all or nothing! Other cases for special treatment included the clock, the undercarriage up/down indicator and voltmeter. Trickiest of all were the two rectangular and convex shaped fuel/oil pressure gauges. Nothing for it but to laboriously solder together tiny bits of brass, being careful to allow enough space inside for the calibrated scale.

Various knobs, switches and buttons were simply turned or filed from brass or alloy. Hard black plastic from that old office filing tray made excellent Bakelite bits, and I sacrificed a black magnifying glass handle to turn the dimmer switches, a prominent feature near the top of the panel. I produced the delicate compass deviation card holder, with its four tiny securing lugs, by sweating together several layers of brass shim – not difficult but needing patience, careful filing and the delicacy of a watchmaker. For jobs like this requiring repeated soldering, it pays to have solders with differing melting points. And where only tiny amounts of solder are needed, some of the paint-on products can be useful. It also pays to have a clean workshop bench and floor. I’m invariably on my hands and knees groping for lost items that might prove quicker to remake than retrieve!

The instrument faces

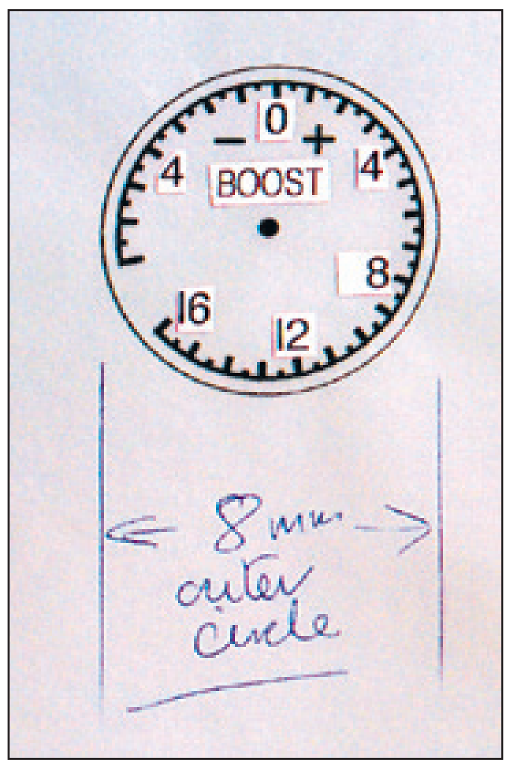
The next step, the instrument faces, came as welcome relief. My most useful single reference turned out to be a full-sized Spitfire panel that I photographed at an air show. The panel itself was clearly a mock up, but the instruments were genuine. Photographed square-on, these were my primary references. Taking each instrument in turn, I made a photocopy enlargement up to four to six inches in diameter. The results were blurred but good enough to trace over using architect's paper (which takes ink beautifully), ruler, protractor and Rotring pen set with compass attachment. It took patience but there are shortcuts: I found that the calibrations on the dial faces were best done with Letraset, particularly sheets containing lots of little dashes of differing weights and lengths. It is surprising how rapidly you can work around a calibrated scale, even the compass rose! I also used Letraset for the lettering and numerals, and with their huge range at that time, it was easy to find a reasonable if not exact typeface match. But there is no need to be ultra fussy, because when the artwork is scaled down, small inaccuracies all but disappear.

In those days, I ran a graphics studio equipped with a photo mechanical transfer (PMT) camera, a bulky piece of kit that could enlarge or reduce photographs or illustrations under the glow of a cosy red lamp. Today these dinosaurs are all but extinct, which is a shame for, unlike most digital processes, they produce razor sharp line art, either positive (black on white) or negative (white on black). With it I was able to reduce each tracing to scale and simultaneously reverse it from black-on-white to white-on-black. After developing with chemicals, again under the glow of a safety light, I was presented with an array of beautiful little instrument faces, and all as sharp as a pin. It really does make a man thank his creator for disposing him to model making and not stamp collecting! With hindsight I could have rescued the old camera when its time came for the scrap heap, but without space at home for a darkroom, it seemed impracticable. Even so, I have regretted it since.

Before I could assemble the dials, I needed to add colours. Reds or greens, of course, are commonly used on aircraft instruments, so where they appear on the real thing, I just coloured in the white areas using fine-tipped marker pens. The inks are transparent, so any you get over the black is all but invisible. As with cockpit placards (which I will describe later), a little muting down is beneficial. Using a flat sable brush, I gently dusted each instrument face with dark grey pastel. This tones down the blacks and makes the whites just a little less strident. Also, not all instrument finishes are the same, so a little more toning on some than others, or a change of pastel shade, adds subtle realism.

By this stage I had completed most of the priming and painting, using slightly different shades of dark grey (never pure black) for the two panels. Bezel shades were also varied, and some more than slightly. The oil pressure and temperature gauges have red and orange bezels, respectively, and the tyre pressure gauge is green. I left the Bakelite bits unpainted – very realistic fetched up with polish. Everything else was given a sealant coat of semi-gloss varnish.

Now for assembly: I placed each bezel into its respective hole in the panel and dropped in the 'glass' cut from thin acetate. This was followed by an identical acetate disk carrying the needles which I cut from white Letraset – improvising any arrow-heads and bosses. This had the effect of making them appear raised up from the dial faces. Finally, I cut the dial itself from its sheet, trimmed it around and dropped it into place as the third layer in the sandwich. Tiny blobs of masking fluid tacked everything together while I checked that the faces and needles were correct relative to each other and to the panel. Finally, I encapsulated the whole thing from the back with five-minute epoxy, bonding bezels to the panel and sealing their contents in perpetuity! As, one by one, the instruments go in, the panel comes to life. Switches, buttons, knobs and levers follow in quick succession, each secured at the rear by a little nut and/or blob of epoxy. The blind flying panel is attached to its spacers with scale screws. Then all that remains is to touch up any chipped paint, blacken off the screw heads and add the stencilled labels, complete with tiny fasteners in each corner, improvised from photo-etched bits. Looking back, I can't think of any other modelling task I've found more absorbing. A model within a model – every dial and placard clear, sharp and readable, and the little needles threatening to flicker into life at the touch of a switch!



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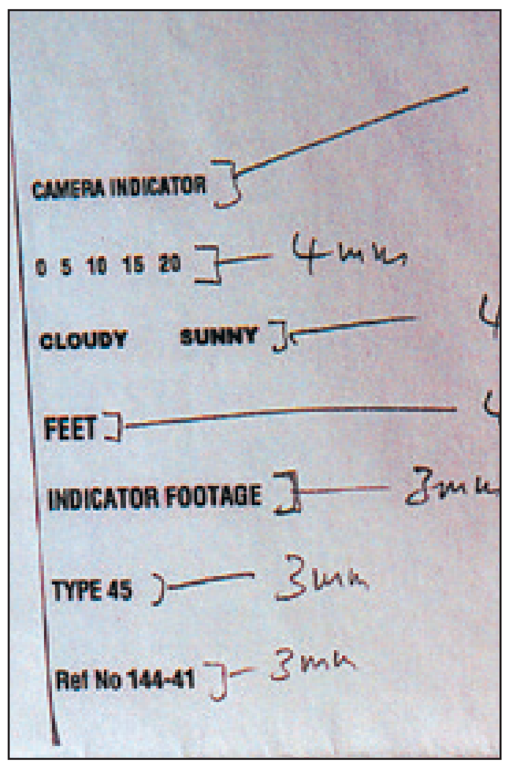

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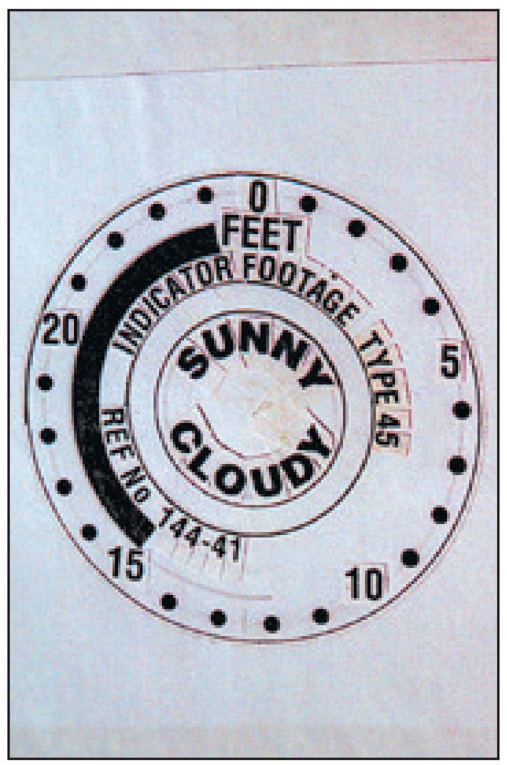

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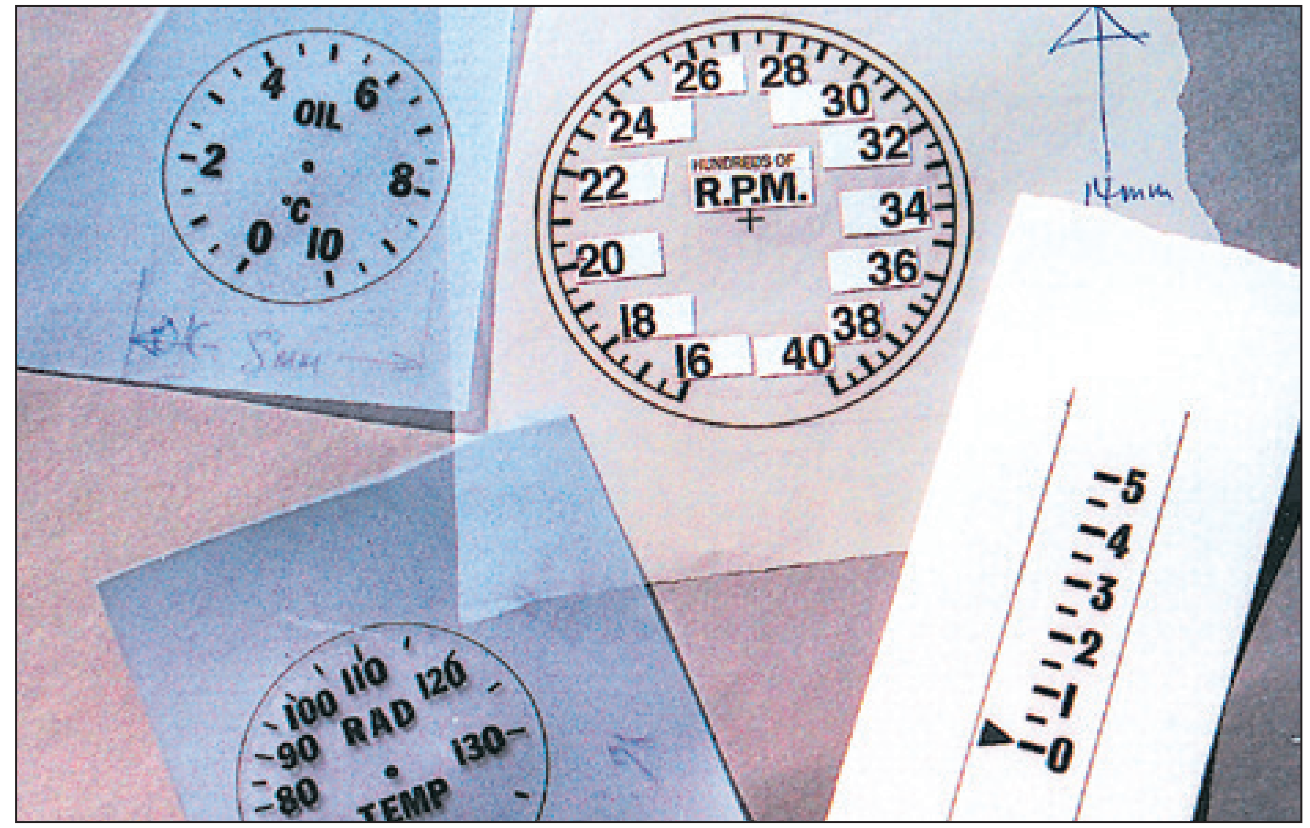
'My most useful single reference turned out to be a full-sized Spitfire panel that I photographed at an air show.'

Examples of the artwork I produced as the basis for my instrument faces. These were in the days before I had a computer and graphic design packages, so I used a combination of Letraset and commercial typesetting cut and pasted onto the tracings (I ran a small design studio back then, so I was able to cut a few corners!). Note the annotation in figures 1 and 2 (left) that gives the camera operator size instructions for the final print.



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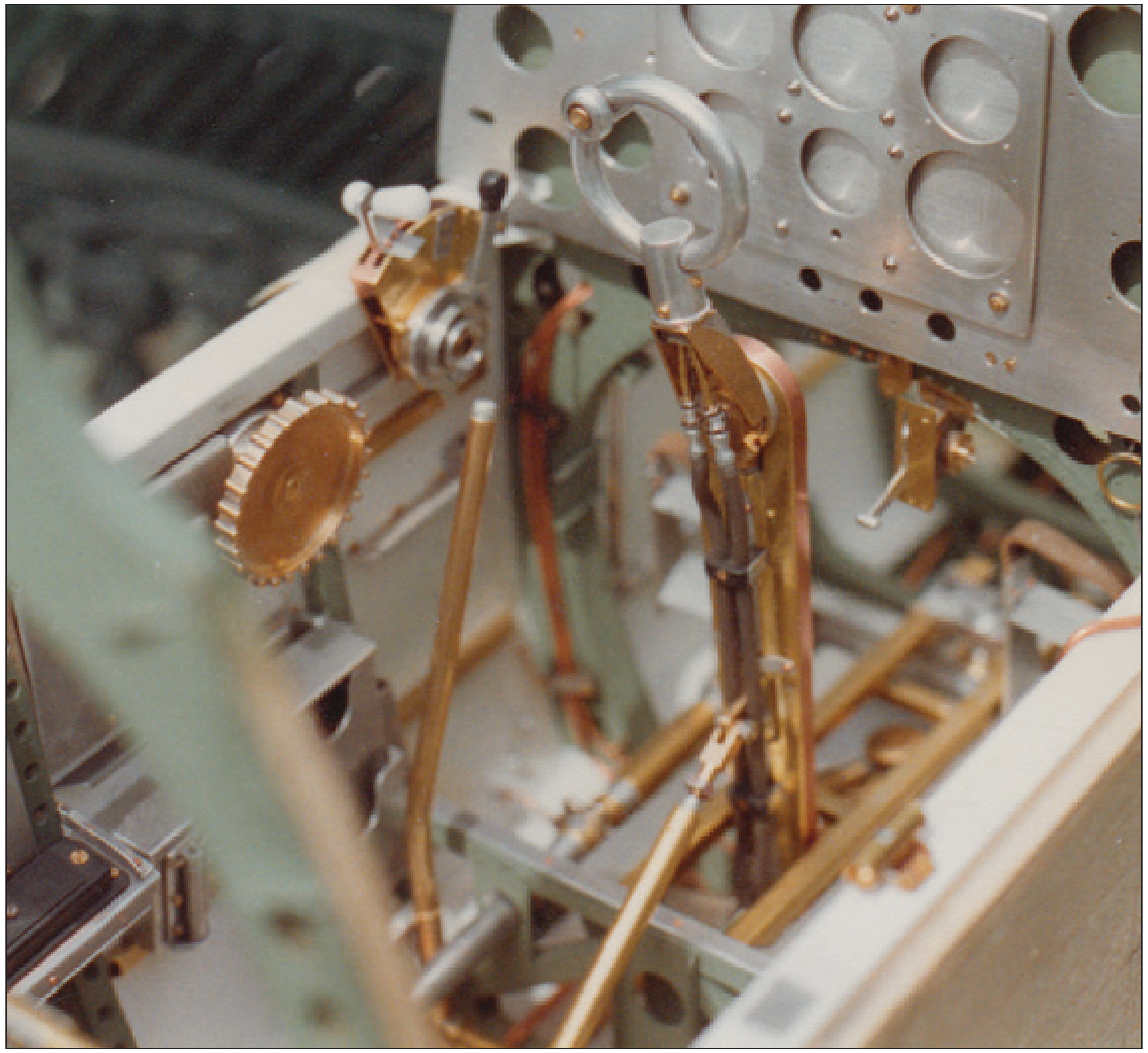
Most of the instrument faces were traced directly from my own photographs. It helped to make enlarged photocopies before starting work, because generally speaking the bigger the art work the easier it is to create, and any minor inaccuracies are lost in the subsequent photographic reduction. It seems a daunting task, but it is surprising how quickly the work progressed. Apart from the big circle drawn in ink, the compass rose (in figure 5, top left) is mostly Letraset, and it took about an hour and a half to do during a single sitting at the kitchen table!

5

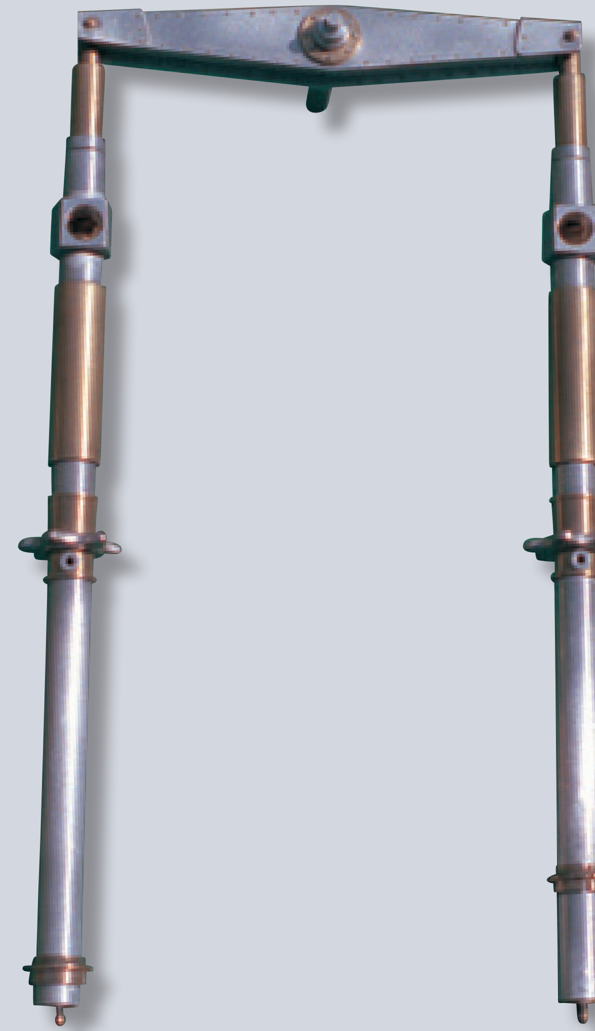
Devil in the detail – the fitting out

With the instrument panel done, I embarked on another trip to Hendon. I never did find everything I wanted because the Spitfire Mk I archive was then – and probably still is – sadly incomplete, but I was thankful for what I did obtain. Armed with another sheaf of photocopied drawings, I was able to begin furnishing the cockpit. I had sheets detailing undercarriage selector gear, throttle quadrant, map case, compass and compass tray, windscreen de-icing system, wheel-brake controls, instrument panel, fuse box pans, gun sight mounting and a whole lot more. Particularly helpful were a series of schematic layouts of the hydraulic, pneumatic, oil, fuel, and oxygen systems. These would enable me to pick my way through the jumble of 'plumbing' that clutters a Spitfire cockpit. Even so, there would be inevitable gaps in my knowledge, which would lead to much head scratching and wasted time.

On the basis of working from the bottom up, it seemed sensible to do the rudder pedal assembly, rudder bars and sleeves and the heel boards first. All of these are well illustrated in *The Spitfire V Manual*, and I was able to make most of them from sheet aluminium, brass and alloy tube and square section (of the kind available in hobby shops) over several weekends. Filing the star-shaped rudder pedal adjusters required care, as did the tiny butterfly cable shackles fixed to the aft end of the two tubes. The trickiest job was to mill the grooved treads on the pedal bars. I did not have a milling machine at that time, so I had to improvise by mounting the job on the cross slide of my lathe. The leather straps are just that – scraps of leather, much scuffed and abraded to soften them and impart a floppy, worn look. After spraying with cockpit green, the pedals and heel boards were given the wire wool treatment to remove paint and simulate wear.



The rudder bars and sleeves (1) entailed a minor amount of lathe work, but otherwise were relatively easy to make from aluminium and brass tube. The heel boards (2) were even easier.



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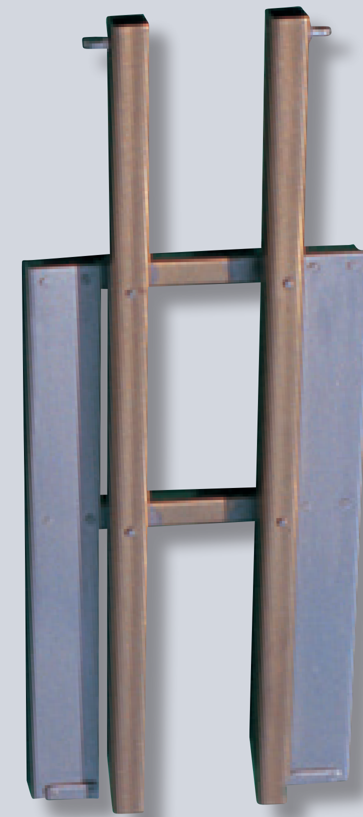
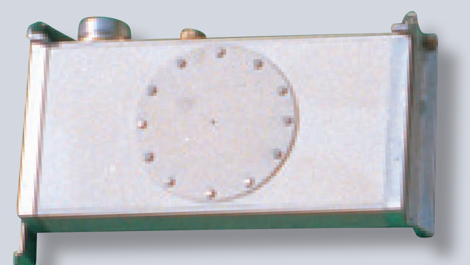


2

Some of the many minor cockpit components completed and awaiting painting: I made the de-icing fluid tank (3) from polystyrene, but the map case (4) and accumulator tray (5) are folded from litho plate.



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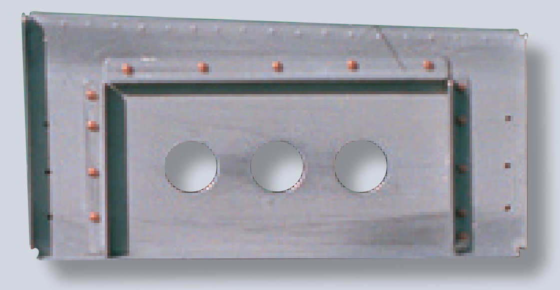
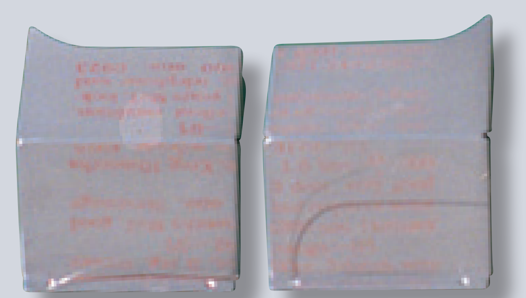


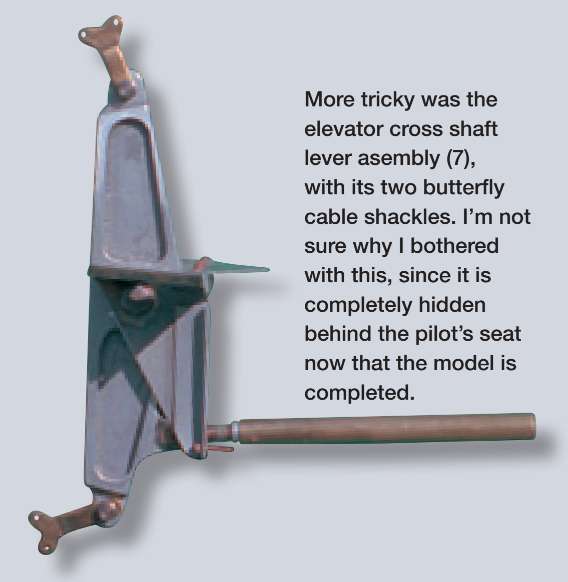
5

The two oddly shaped covers (6) are installed adjacent to the rudder pedals. These are there to protect pneumatic lines from heavy flying boots.



6

More tricky was the elevator cross shaft lever asembly (7), with its two butterfly cable shackles. I'm not sure why I bothered with this, since it is completely hidden behind the pilot's seat now that the model is completed.



7

The control column assembly

Excellent three-view drawings of the control column and its mounting are included in the *Spitfire V Manual*. I started by making the chain guard body from solid brass slotted to take the tubular brass column. About midway down I added a sleeve with the soldered-on lug for the elevator connecting rod. The pivoting section at the top was also made from brass soft-soldered together. To simulate the way the chain guard laps up on either side of the column, I used thin annealed brass shim formed to the desired curvature and sweated either side of the front face of the guard. With the edges cleaned up flush, the join was all but invisible. If it all sounds a bit hard to follow, the photographs should make things clearer.

The Dunlop type spade grip started life as an aluminium knitting needle, which I softened and shaped around a metal bar of just under correct diameter. The firing button housing was turned, drilled and filed to shape and threaded on before pinching the grip into its turned alloy neck. I made the brass firing button a push fit, but took the precaution of locking the whole lot up with some sparing runs of thin superglue. I cut and filed the brake operating lever and sprocket from alloy, creating the gentle curve in the lever by bending it over a former. I added a brake cable, and made and fitted the pivot for the brake lever so I could bolt the assemblies together. The two pneumatic hose retainers were made from thick black plastic from an old filing tray, each fashioned in two halves held together by screws just as in the full-sized job. The hoses themselves are lengths of synthetic rubber tubing. The hose unions were turned from alloy and brass hexagon attached to two short lengths of copper tube that disappear up into the neck of the spade grip. Various bolts and screw heads were added from the 'BA box' by way of fine detail, and that was that!

Looking back there was a lot of work in the column. It was a job I enjoyed and I was very pleased with the outcome. Apart from spraying, there remained only one small embellishment. Finding some rough, lumpy thread, I whipped this around the circular grip, securing it with low viscosity superglue before smearing the lot over with several sparing coats of Humbrol masking fluid, which hardens to a reasonably durable, rubbery shell. Painted black (dark grey), the overall effect was convincing.

In the real aircraft the control column is mounted on ball bearings, so it can pivot smoothly backwards and forwards when working the elevators. I didn't use ball bearings but I made the short torque shaft and drum cable for the aileron controls. The elevator connecting rod was turned to length from brass tube and its adjustable coupling was simple enough to machine. It runs under the seat to a short lever mounted in a cross shaft at the base of frame 11.

I scaled the cross shaft assembly from the drawings and made its housing mostly from litho plate. My photograph of the completed sub assembly prior to painting (see page 69) shows the two tiny brass shackles for the paired elevator cables, and a short stub shaft made to telescope inside the connecting rod at final assembly. The lever itself appears to have been milled, but in reality it is three pieces of alloy laminated together. The routing is faked by teardrop shapes cut in the two outer pieces – a simple wheeze, but convincing enough.

These details emphasise the extent to which I used brass and aluminium alloy, often combined with plastics, to make the cockpit fittings: they show the undercarriage selector lever assembly, the undercarriage warning klaxon, and the emergency undercarriage release control with its small CO_2 bottle.

Stencils and placards

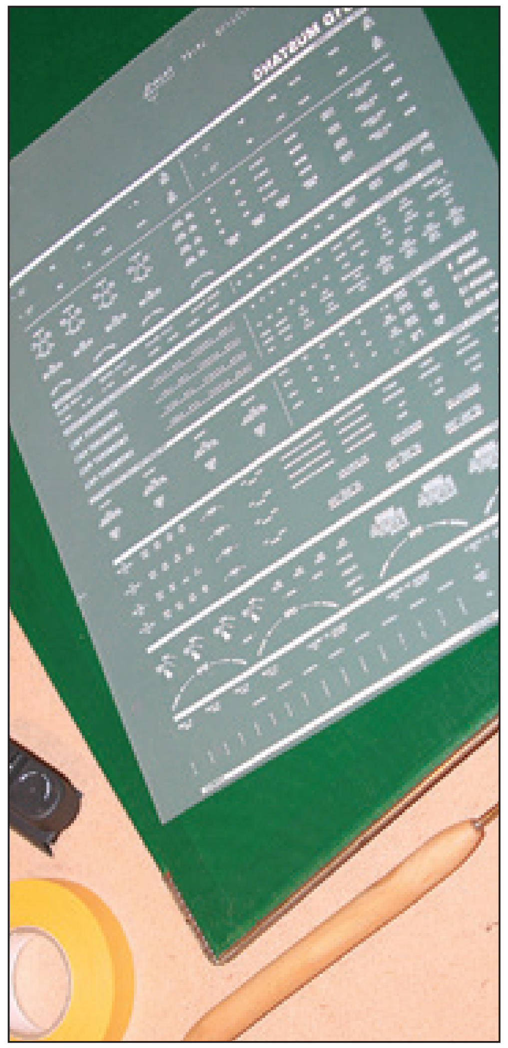
Stencils and placards are ubiquitous in aircraft cockpits. The US Air Force during World War II was particularly partial to them, as a look in the cockpit of a P-51D Mustang or P-47 Thunderbolt will reveal. Having said that, the Spitfire has its share. Essentially, they come in two flavours. First, as imprinted labels that are pinned or riveted onto their locations; secondly, as words or numerals printed directly onto a given component. Clearly these need to be tackled differently.

The first task in making labels is to create the art-work. Today, I use a computer, but then I used Letraset, and the method has much in common with making instrument faces described elsewhere. A good way to start is to take a square-on photograph of the subject, enlarge it on a photocopier and 'trace' over the characters. Where my stock of Letraset lacked fonts of the right size, I simply altered the original to fit, while working as large as practicable.

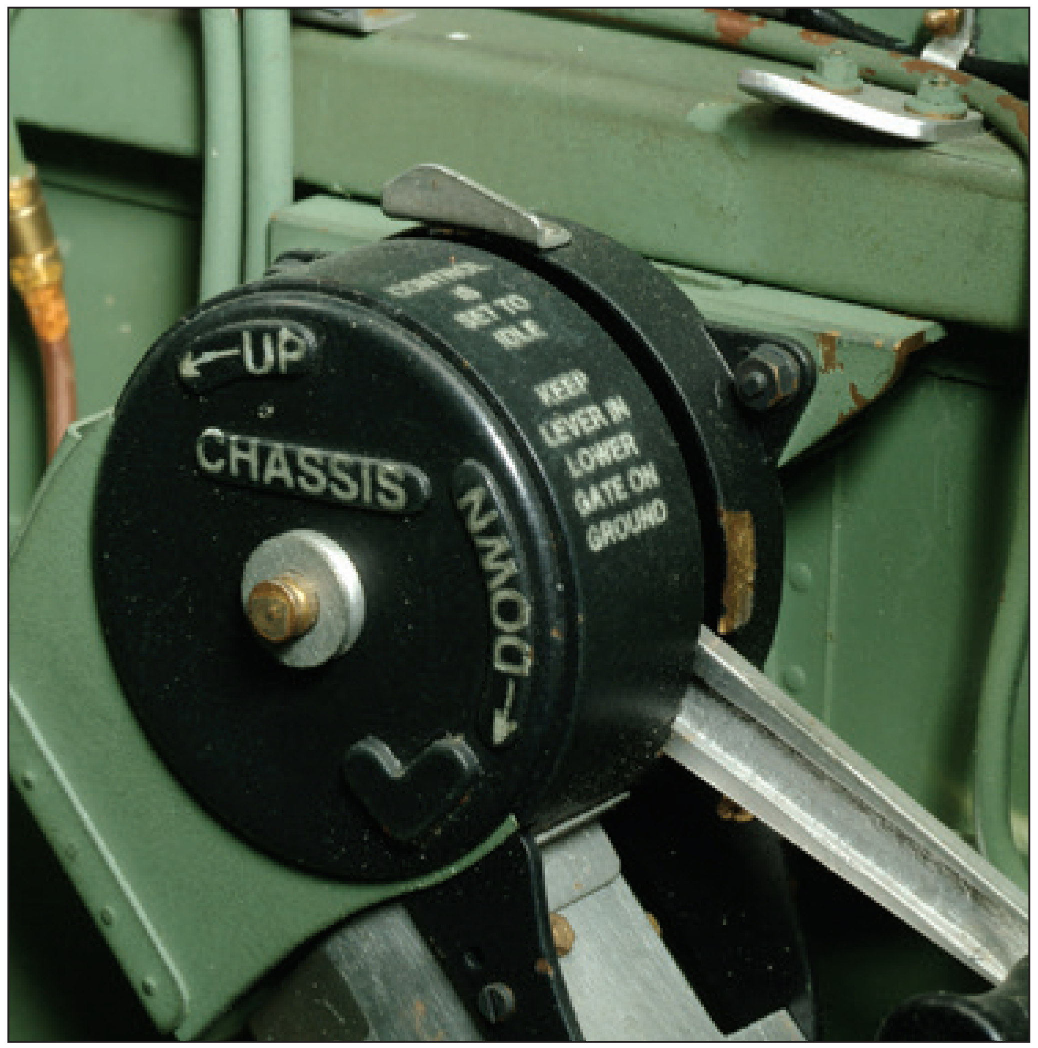
Placards and data plates are commonly white lettering on a black ground, and my PMT camera produced a ready-made product on photographic paper. All I had to do was cut it out, blacken the cut edges and fix it to the model. By varying the chemicals, it was even possible to get a rather nice bronzy background, reminiscent of weathered brass. If the lettering is, say, red on a black ground, no problem: it can be coloured in with a fine red marker.

For the second approach, things are not quite as simple. You can't cut out individual letters in about 3pt and then go sticking them on. What are needed are custom-made dry rubdowns, in other words, your own Letraset. There are studios that produce rubdowns to order when provided with art-work and a colour specification, usually a Pantone number. It's not cheap, but a lot can be crammed onto an A4 or A5 sheet. Anyone who has used Letraset will be familiar with the process, which involves rubbing through the carrier sheet with a ball pen or similar. This loosens the characters from their backing and transfers them to the subject surface. On three-dimensional objects, the process can be tricky even in the flat, and considerably more uncertain on curved or irregular surfaces – hence the need for plenty of duplicates on a sheet. Once the lettering has been emplaced satisfactorily, a coat or two of varnish will fix and protect it.

Finally, as I mentioned in my description of my instrument faces, I avoid specifying white, which will look too stark. Instead I specify the palest of greys. Alternatively, I damp down the white with a dusting of grey or grey-brown pastel, and this applies to placards as well as dry transfers. It really does make a difference to realism, and it has the effect of taking the edge off of blacks as well as whites.

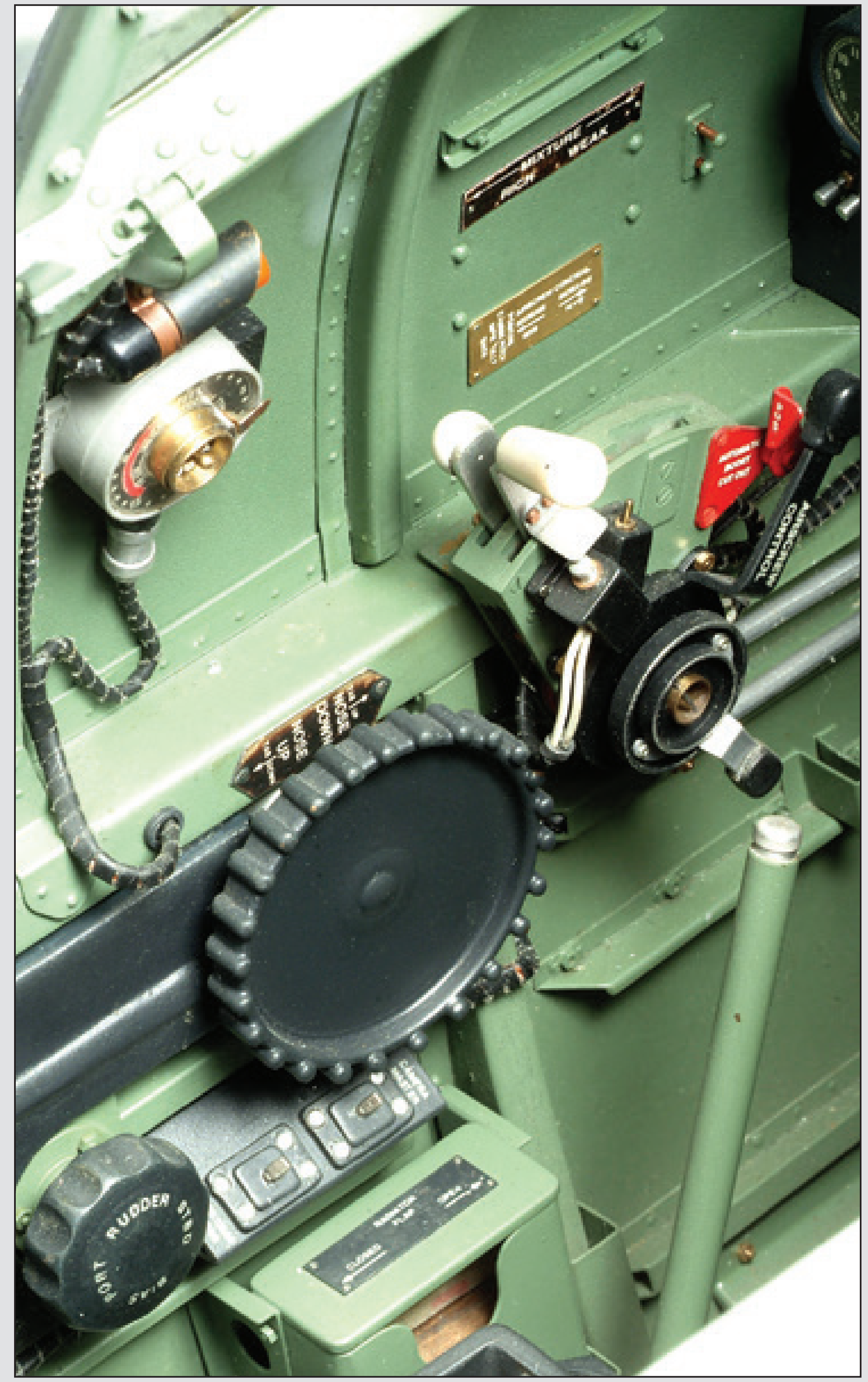


Custom rubdowns are expensive, but you can get a lot on an A5 sheet. This particular example is for my P-51D Mustang, but it illustrates the point. (Note the sheet is photographed from the reverse side).



The undercarriage selector gear provides an excellent example of the use of dry transfers. However, great care and patience are needed to apply the tiny rubdowns to awkward surfaces. Wastage must be anticipated, which is why it is better to make more than needed.

These pictures of the port and starboard cockpit walls nicely differentiate the use of dry transfers and photo-reverse reprographics to create labels as detailed in the text. Note how the placards have been weathered, and the addition of tiny fasteners attaching them to the airframe, just as in full size practice.



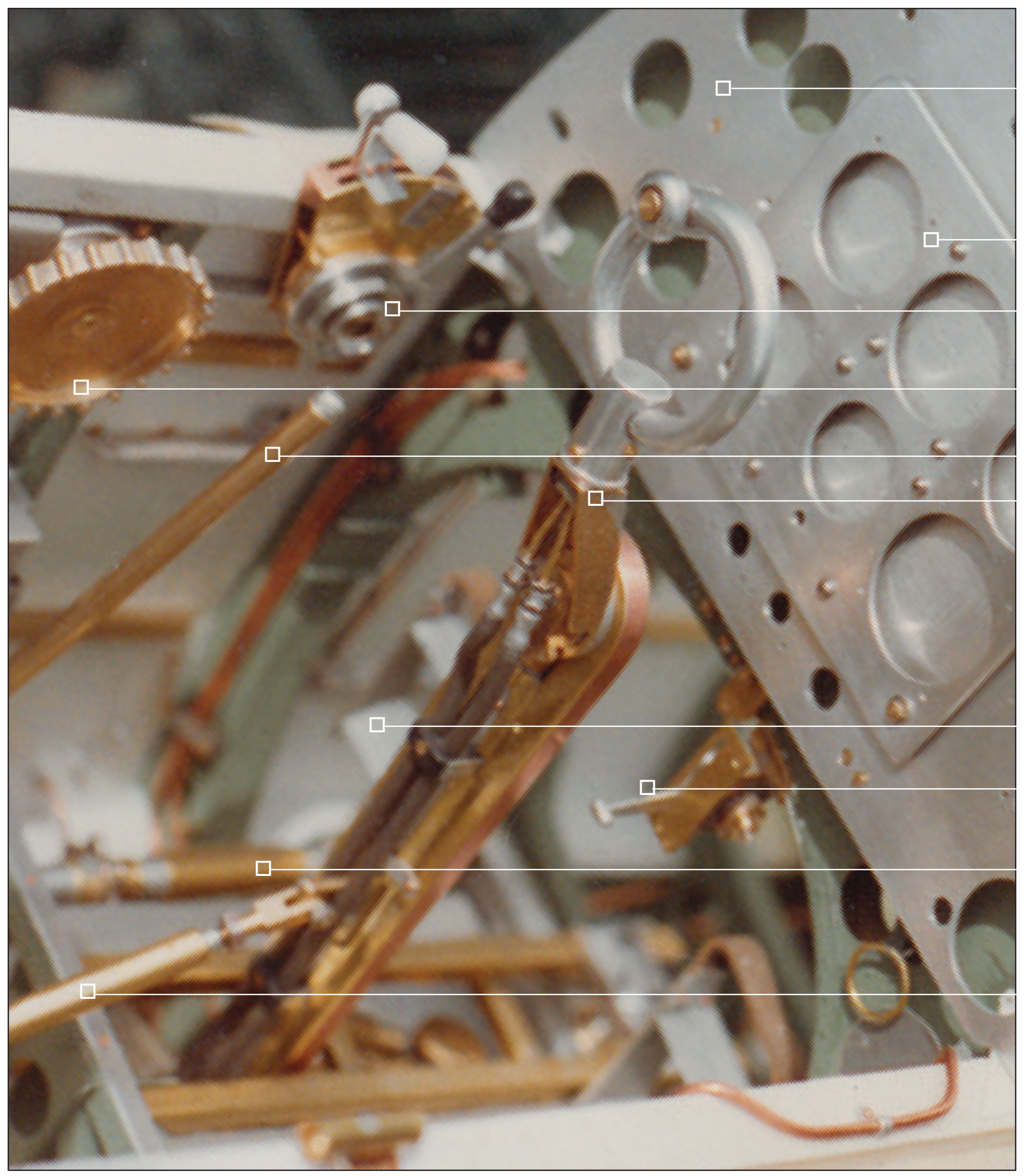
A detail from the port side of the cockpit showing the throttle quadrant and the aileron trim tab control wheel. The flat, mainly rectangular placards were created in a reprographics studio from artwork that was either typeset or made using Letraset. These days, I would do them on my computer.

More cockpit furnishings

As illustrated on page 77, two big 300psi compressed air cylinders are located on the port side of the fuselage just aft of the seat. They stand out in my mind because they were about the only cockpit fitting that I made of wood. They also created a lasting impression on my wife, Eva, who still mourns her broom handle cut down in its prime. Turned in the lathe, sanded and sealed with several coats of cellulose primer under an off-white topcoat and sporting the 'authentic' dry transfer stencilling, you'd never guess that those air bottles had such humble beginnings. The broom, by the way, is still usable by small people and those with a permanent stoop!

Mounted on the starboard fuselage wall is the oxygen bottle, which is secured by hinged metal straps with a screw device for tightening, and that's exactly how I made it (see the picture on page 107). The associated air filter is visible, so this too had to be made and plumbed. Pipe unions were turned from alloy or brass hexagon and the pipes themselves made of copper stripped from heavy-duty electrical cable. This is very useful stuff, and I employed quite a lot of it in various gauges, salvaged after the recent rewiring of our home. I was amazed at how some of the cable removed from the loft had been gnawed to the metal by rodents. Just how do they do that and live?

To describe the making of all of the many cockpit fittings would be tedious and, I have to confess, a decade or so on, my recollections are becoming sketchy. The throttle quadrant and the undercarriage selector gear stand out for being as enjoyable as they were challenging. Also prominent among the controls are the elevator trim wheel and the smaller rudder tab control. While the basic shapes were easily turned from brass, their outer circumferences called for the careful use of a round file in the case of the rudder trimmer and some tedious soldering-on of half-round brass in the case of the elevator trimmer. The Morse identifier on the starboard cockpit wall is memorable for one particular air show and the role in its creation of a stall-holder. I had spied the gadget in a heap of aeronautical bric-a-brac. Its owner was busy with customers and probably never heard me ask if I could 'borrow' his treasure for a minute or two. Without further ado, I snatched it up and took it outside to take pictures, while the man's expression spoke eloquently of my sanity and parentage! But the photographs proved a boon, and from them alone I was able to reproduce a quite complex component with reasonable accuracy. Good references of the remote contactor also proved elusive, with the result that there was a yawning space in the cockpit at almost the end of the project. When I finally came across one in a museum I had no camera with me and had to resort to sketches.

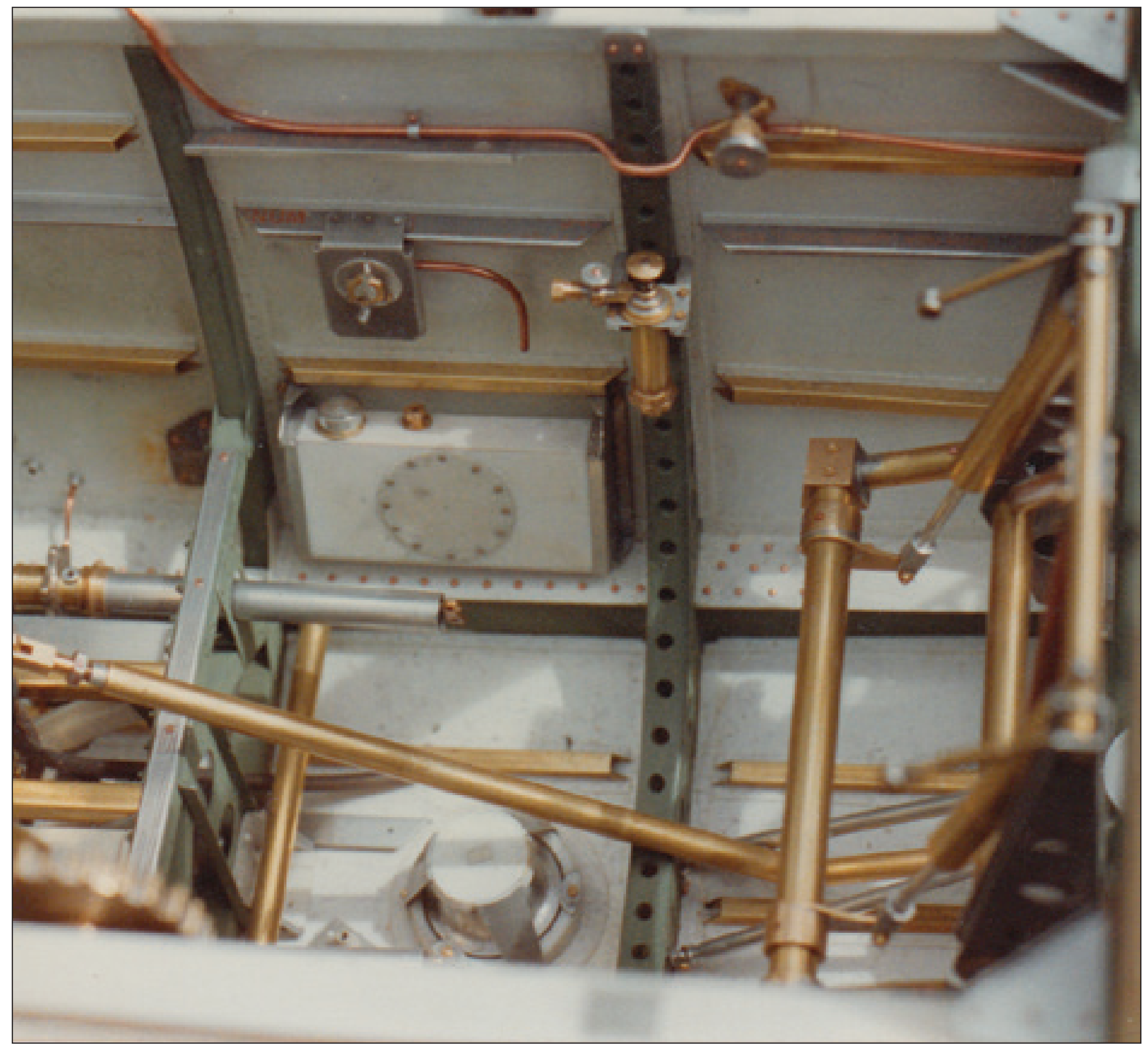


The dry-fitting stage

As well as lathe work, the cockpit furnishing involved considerable metal-working from the sheet. My photographs during the dry-fitting stage show two aluminium covers on the port side just below the longeron (pictured on page 77). They are there to guard the trim-tab cables running aft through apertures in frames 10 and 11. Both have stiffening flutes pressed into the aluminium, and I devised an easy method to form them. Taking measurements from my drawing, I made round-ended slots in an off-cut of $^1/_4$-in. ply to correspond to the exact dimension and position of the flutes. Next I copied the same outlines onto a scrap of litho-plate and – leaving it well oversize – lined up my marks over the slots in the former, clamping the metal securely to the ply. Then with a short length of hardwood dowel rounded to a diameter just slightly less than the slot's aperture, I was able to dish the thin alloy down into the slots by drawing the dowel back and forth along their length using firm but not excessive pressure. With care, nice even and accurate flute shapes emerge. Having annealed the litho-plate I took care to reinforce the cavities created with resin since the thinned, softened metal is very easily damaged. With the flutes impressed, I marked out the overall dimensions of the cover and, following full size practice, drilled a small hole in all four corners. Then I made two 90-degree cuts away from each hole and folded the sides over in turn using a former of square section brass bar. I will have more to say about working with litho plate later.

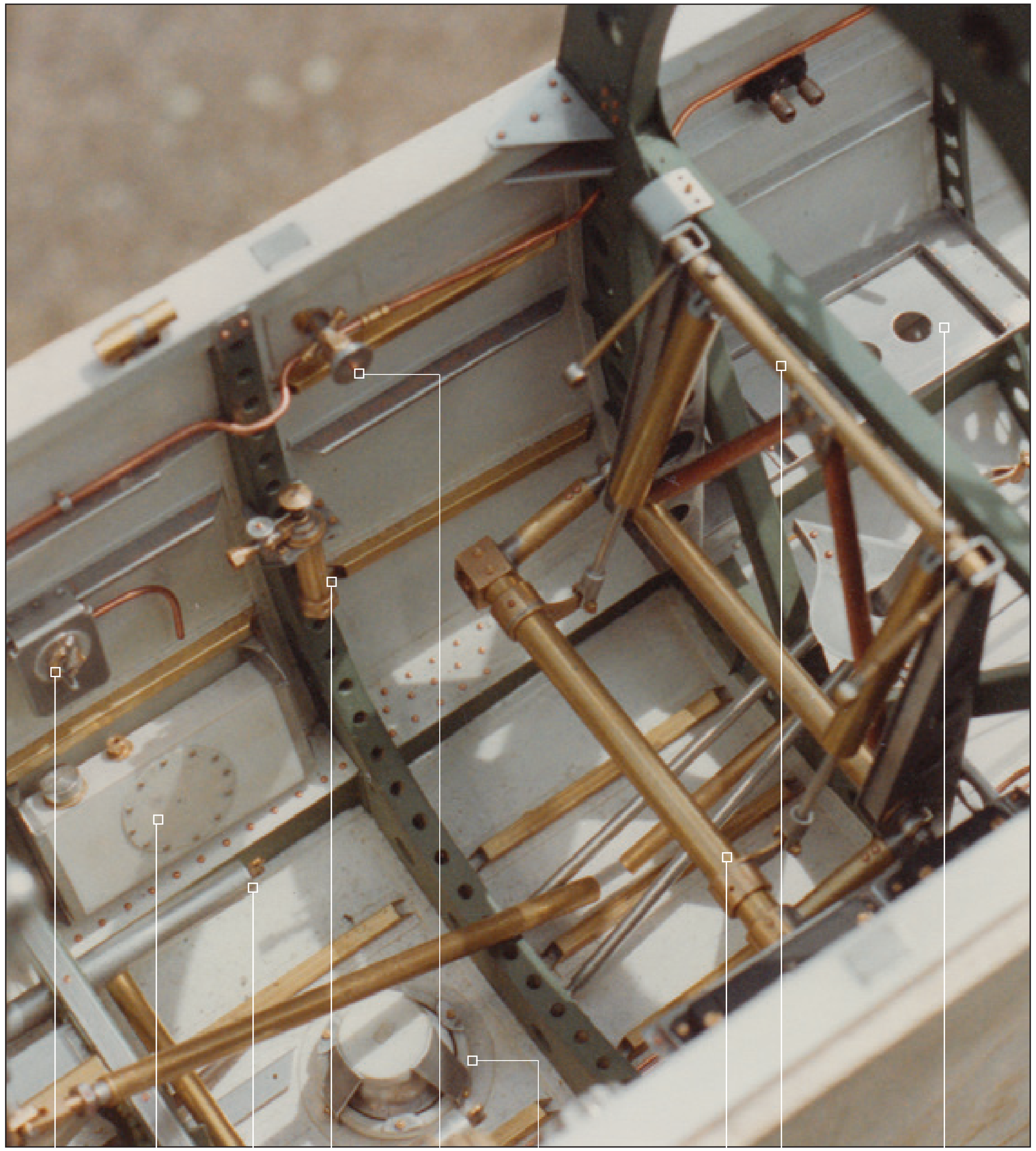
Furnishing the cockpit took many months. As I made a component I fitted it by means of screws, bolts or even simple pegs locating into push fit holes, but never permanently, and as I fitted various items, I plumbed them in, an enjoyable process, but often marred through lack of information. Often I would spend hours poring over drawings, photographs, books and magazines in a vain attempt to penetrate dark, obscure corners and crevices of the fuselage to fathom the source or destination of this or that piece of pipe-work. It would have been fascinating had it not been so wasteful of time. The schematic layouts were a great asset, but they were just that, schematic. They showed where a particular pipe-run started and ended, but not how it threaded its way on its journey. Yet slowly I built the picture up, and as each pipe went in, I scored it off by highlighting it in yellow on the master layout – that seemed to help.

Hydraulic, pneumatic, fuel and oxygen lines do not just sit there, they need clips, and where they vanish through bulkheads, the holes need grommets. I wish I had been paid for each clip I made – not difficult, but tedious and time-consuming. I cut strips of very thin alloy (the type that food trays are made of), or used lead or pewter shim which bends easily around a small drill shank. Thus supported, the two flat ends of the clip can be pinched tight with small, square nosed pliers and trimmed to length with scissors.



As cockpit components were made they were located *in situ* temporarily to ensure that everything fitted and connected together. I call this the 'dry-fit' stage.

‘It can be next to impossible, in an impossibly small space, to tighten the lot up with a tiny spanner in gigantic fingers.’

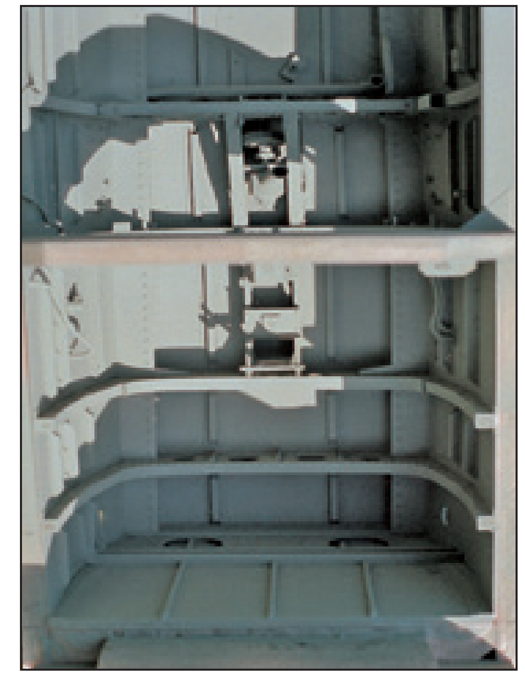


It is easy, with care, to drill them through and round off the corners neatly. It is easy to thread the clip onto the pipe, position it and check that the pipe run sits true. Mostly, it is less easy to drill the fixing hole (probably in an inaccessible place), insert a tiny 16BA bolt with tweezers and twist on a microscopic nut. It can be next to impossible, in an impossibly small space, to tighten the lot up with a tiny spanner in gigantic fingers. Try doing it 20 or 30 times with re-runs each time a tiny fastener becomes irretrievably lost!

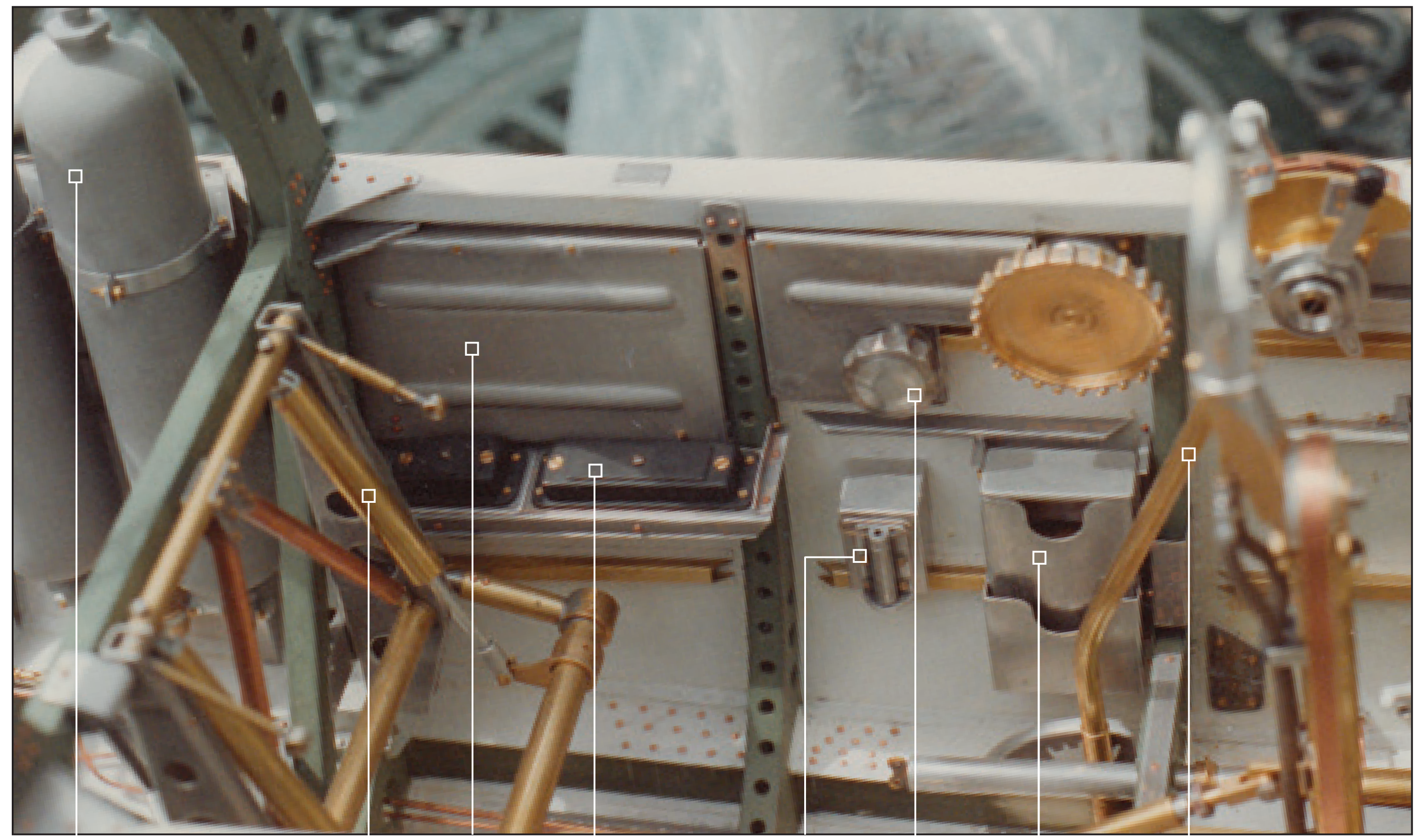
It is worth emphasising the importance of the dry-fitting stage. Even with reliable drawings and references, getting everything positioned correctly relative to everything else and within the confines of a severely restricted space is not easy. More difficult still is to ensure all hydraulic, pneumatic, fuel, oil, air, oxygen, antifreeze and coolant controls and accessories are correctly connected or plumbed together, to say nothing of the primary flying and engine controls.

As the succession of systems increases, so does the need for correction and fine-tuning. Yet ultimately comes the day when the final piece is in place – surely time for celebration. But no! Just when everything fits perfectly and has been connected up, it is time to strip it all out again for spray painting. Had I gone about things the other way around, there would not have been much of a paint job left!

One of the last tasks in the belly of the cockpit was to install the electrical wiring, or at least those runs that are clearly exposed in the original. This finishing touch can make or mar a model and depends much on the proxy material used. I hoard just about every piece of wire I come across, particularly the very fine stuff you find in radios, and the more insulator colours the better. Wiring runs in aircraft are often loomed together in close-tied bundles, and in the Spitfire these are also wrapped around with tape to protect against chafing. This took considerable time and Anglo-Saxon English.

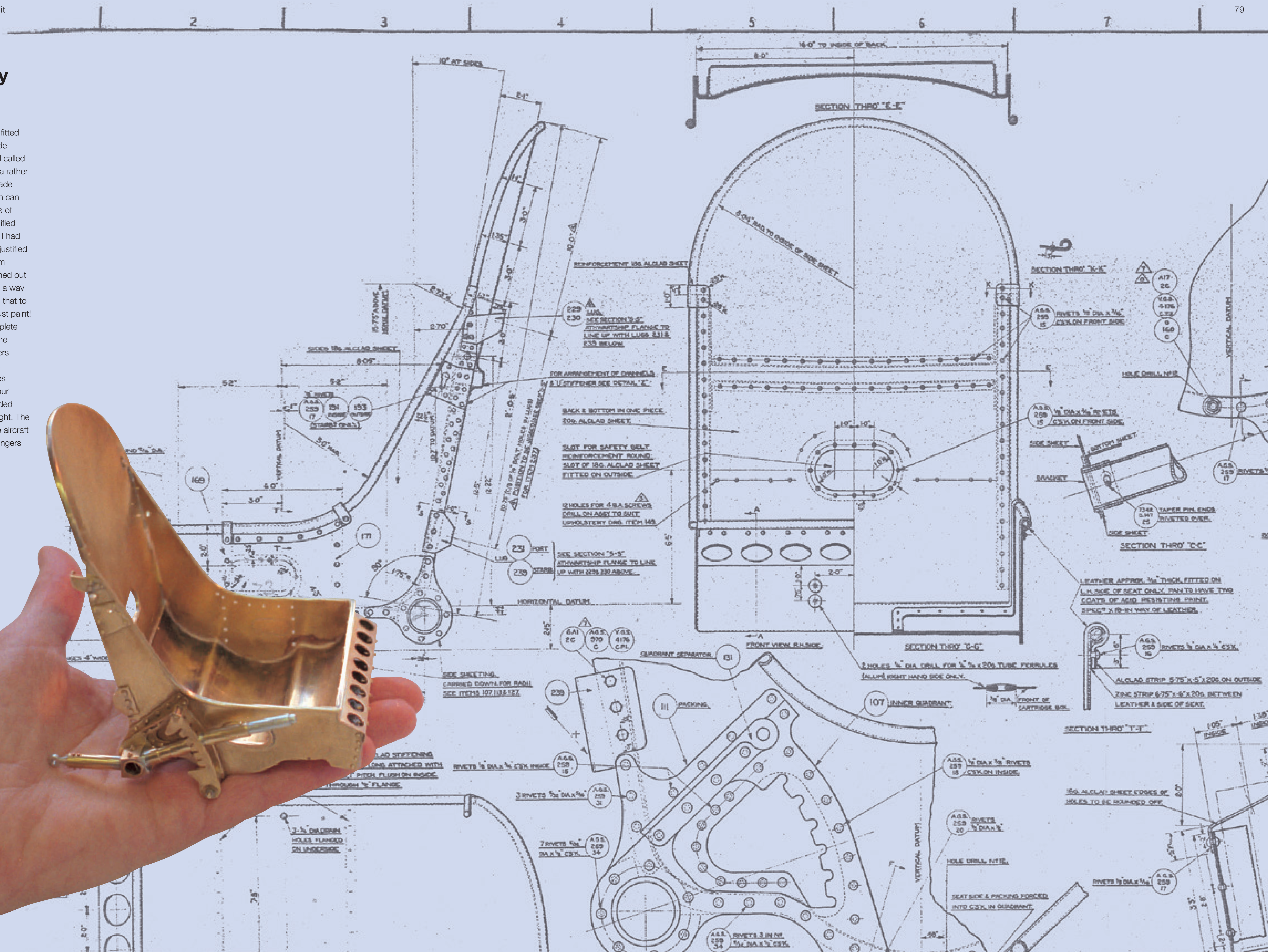


After the ‘dry-fit’ stage everything was stripped out again, and the entire fuselage interior was spray painted RAF cockpit green.



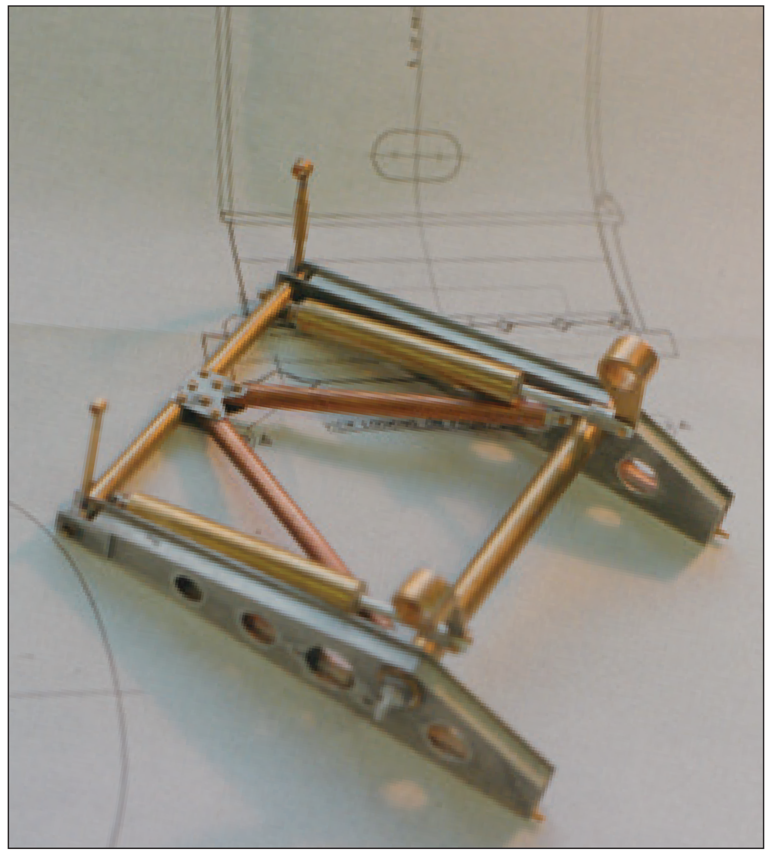
Seated comfortably

The pilot's seat was the last major item to be fitted into the cockpit. Early Spitfire seats were made from a composite of papier-mâché and wood called Synthetic Resin Bonded Paper, and they are a rather lovely mahogany red colour which is why I made mine of brass and painted it black! Confusion can be exacerbated by copies or extant examples of the original that have been substantively modified since their service years. Suffice it to say that I had seen black seats in Spitfires, and felt (guiltily) justified in corner-cutting. Painted, I could make it from whatever material seemed easiest, which turned out to be brass. Were I to do it again, I might find a way of mimicking a composite seat. But I suspect that to achieve the patina would require more than just paint! This was one of the jobs for which I had complete drawings, both of the seat and its support. The latter consists of two channel-section members with a simple arrangement of tubular bracing. A sturdy handle on the right hand side enables the pilot to adjust the seat position through four inches, a process assisted by two spring-loaded compensators that work against his own weight. The entire assembly is quickly removable from the aircraft by disengaging a couple of spring-loaded plungers located on the retaining fuselage frame.



Drawing © BAE SYSTEMS

Ratchets and brackets



I made the seat support from printer's plate folded over a balsa wood core. The prominent lightening holes were drilled and reamed afterwards, and I took pains to remove any underlying balsa visible to the eye. I used brass tube for the cross bracing and shaped the two fish plates at the top of the inverted V from litho-plate drilled through for 14BA bolts. This is the kind of job where superglue comes into its own. I often use it to tack metal items together while I drill them through for screws or bolts. If the mating surfaces are clean and abraded, cyanoacrylate provides a good metal-to-metal bond. By adding real nuts and bolts, the job becomes 'engineered'. I use this approach a lot, especially for holding small sheet metal parts while drilling rivet holes and I find it saves a lot of time. Any residual glue can be removed with steel wool or the tip of a scalpel blade, preferably before it has cured.

The bane of superglue is that the modeller's pinkies can end up 'case hardened', or worse. On one occasion, while using a particularly thin variety, I lost control in a most dramatic way. A wave of the stuff spilled over the back of my hand and onto my Omega wristwatch, a treasured gift. I managed finally to get the glue off my skin, but it was so runny that it penetrated the watch-case, and my faithful old timepiece stopped dead instantly and for ever! Back to the job at hand, I turned the compensator barrels from brass and fitted plastic liners so that the stainless steel plungers would be snug-tight and move smoothly in and out. I turned the upper and lower links and the sturdy cross-shaft onto which the seat hangs, but left the handle and its ratchet mechanism until the seat itself had been built. There were many hours of work in this assembly, much of them spent on linkages for the moving parts, but it paid off. While my model is 'static' in the sense that it is to be looked at rather than operated, there are one or two components that by virtue of having been made from the original drawings, work as did the original. The seat adjustment mechanism is one of them.

I had been dreading starting the seat itself because of the shapes involved. Just how would I translate the drawing into metal? In the event, like many model-making challenges, the contemplation proved worse than the execution. Actually, the seat wasn't particularly problematic. The worst part was shaping the three wave-like curves in the seat pan. But with annealing and some careful forming over solid round bar, something very close to the drawing was obtained. I cut out the two flat sides from sheet brass, clamped the three items together and soldered them. I cut the seat back from sheet brass of the same gauge, gently curved the top half of it and soldered that also, adding scale brass rivets where the drawing showed they should go. By using silver solder for the main body of the seat, I was able to apply the smaller detail with soft solder without the whole lot falling apart.

The detail included a rack for the Very pistol cartridges and the lip that runs around the entire edge of the seat and over its back, which I fashioned from brass wire filed from the round in a simple jig. Soft soldering can be a pleasure or pure hell, depending on the observance of a few cardinal rules: scrupulous cleanliness, tinning of components first, the correct flux (why can't I buy old-fashioned Baker's Fluid these days?), sufficient heat and an effective method of holding the job together while the heat is applied.

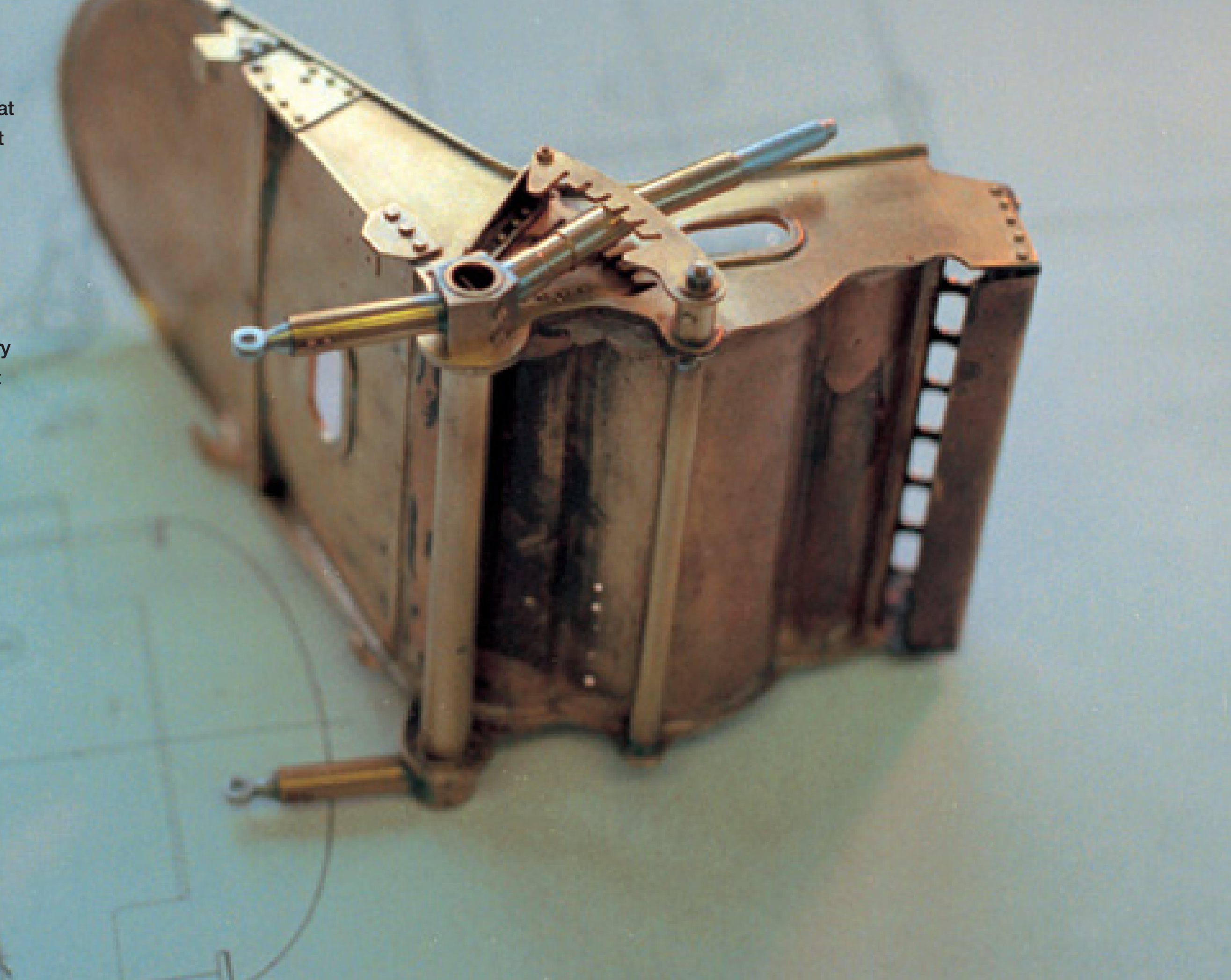
My photographs show some of the fine detail, including the ratchet and operating handle made from brass and aluminium tube, since the topmost grip part was not painted. Also visible are the brackets attached to the back of the seat for the armour plate. It is worth mentioning that, while I included the armour behind the pilot's head, I left the main part off since, although easy to make, it would obscure a great deal of detail incorporated in the fuselage, including the seat support.

There's not much more to say, except that the leather facing was added using real leather (from a doll's house supplier) edged with litho-plate strips riveted to pre-drilled holes in the brass. I'm still not entirely sure what this was for – perhaps to prevent abrasion of the oxygen hose?

The finished pilot's seat was well worth the several months of spare time spent on it – a prime example of my model-within-a-model concept. It was not fitted permanently until the very last weeks of the project. Even now, as in the real thing, it is easy to remove, since it does cover up a great many things in the cockpit and not all of them are sins.

The adjustable seat support and the completed and painted assembly (above) Note the leather patch (above right), the purpose of which still eludes me.

'The worst part was shaping the three wave-like curves in the seat pan.'



With detailed drawings from which to fabricate the many brass parts for the seat assembly, it was no great acomplishment to be able to make the thing work. With the seat mounted onto its frame, manipulation of the big brass lever on the right hand side raises and lowers its position, just as in the original. The finished seat looked so good in brass, it was almost a pity to paint it. Note the Very pistol cartridge rack attached to the front of the seat pan.

‘ ...the simple practicalities of access meant that I would have to complete most of the visible interior, and then build the rest of the model around it. It would be like building a ship in a bottle, but where the bottle has to go around the ship.’