ACCURATE SCALE DRAWINGS

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2007 Missel Thrush IV

ARMSTRONG WHITWORTH
2014 Siskin 111a
2651 Meteor N.F.14

AUSTER
2016 Autocar J.5B
2018 Ambulance B4

AVRO
2023 707A
2038 Vulcan
2675 504

BLACKBURN
2052 Monoplane 1912

BOULTON PAUL
2055 P.III

BRISTOL
2060 Brabazon I
2116 Britannia
2117 171 Mk. 4 Sycamore

CHILTON
2119 D.W.1a (Train.)

DART
2124 Kitten II
2125 Pup

DE HAVILLAND
2154 75a Hawk Moth
2149 88 Comet (Austr.)
2163 115 Vampire Trainer
2164 T.K.4
2167 106 Comet I
2168 110

ENGLISH ELECTRIC
2171 Canberra 2
2650 P.1

F.E.
2669 F.E.2B

FAIREY
2188 Swordfish III
2664 Gannet T1 and A.S.1
2656 Fairey FD2
2672 Fantome

FOLLAND
2196 Midge/Gnat

GLOSTER
2205 Gamecock I
2214 Grebe I
2217 Javelin G.A.5
2670 Javelin Mk. I
2220 Meteor VIII
2221 Sea Gladiator
2225 IVB Seaplane

HANDLEY PAGE
2234 Victor B.1
2677 Heyford

HAWKER
2241 P.1067 Hunter
2049 Woodcock
2250 N7/46 Sea Hawk
2251 Hart
2263 Hunter V

LUTON
2256 Minor
2247 Buzzard

MILES
2063 M.21 Hawk Speed 6
2279 M.20
2292 Sparrowjet

PERCIVAL
2300 P.56 Provost
2301 Mew Gull P.6
2661 Provost II

PRESTWICK
2302 Pioneer II

SHORT
2307 S.A.6 Sealand
2317 Seamew

SOPWITH
2320 Buffalo

SUPERMARINE
2331 S6B
2335 Sparrow
2347 Spitfire Vb and Vc
2048 Type 541 Swift
2355 Swift F4 and 5
2356 508
2357 510
2359 525

VICKERS
2358 Viscount 700 & 800
2360 Valiant
2659 Supermarine Walrus

WESTLAND
2398 Wyvern TF. Mk. IV

AMERICAN
AERONCA
2401 100

BOEING
2415 B.47
2673 F4.B4

CHANCE VOUGHT
2658 Cutlass F7U-3
2669 Crusader F8U-1

CONVAIR
2653 YF-102 (Prototype)
2226 F.102 (Production)

CURTISS
2671 Cleveland

DOUGLAS
2445 F4D-1 Skyray
2649 Skyhawk

ERCO
2446 Ercoupe 415G

LOCKHEED
2657 F.94 Starfire

NORTH AMERICAN
2489 F86E Sabre
2491 100A Super Sabre
2647 Harvard

DUTCH
FOKKER
2636 F.VIIA
2662 D.23

FRENCH
2648 Druine Turbi
2655 Druine Turbulent
2646 Jodel Bebe
2645 Sud-Ouest Vautour
2665 Leduc 021

CANADIAN
2633 Avro Canada CF.100
2652 D.H. Otter

DANISH
2637 KZIII Lark

ITALIAN
2674 Fiat CR.42

SWEDISH
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RUSSIAN
MIG.
2644 Mig. 15

GERMAN
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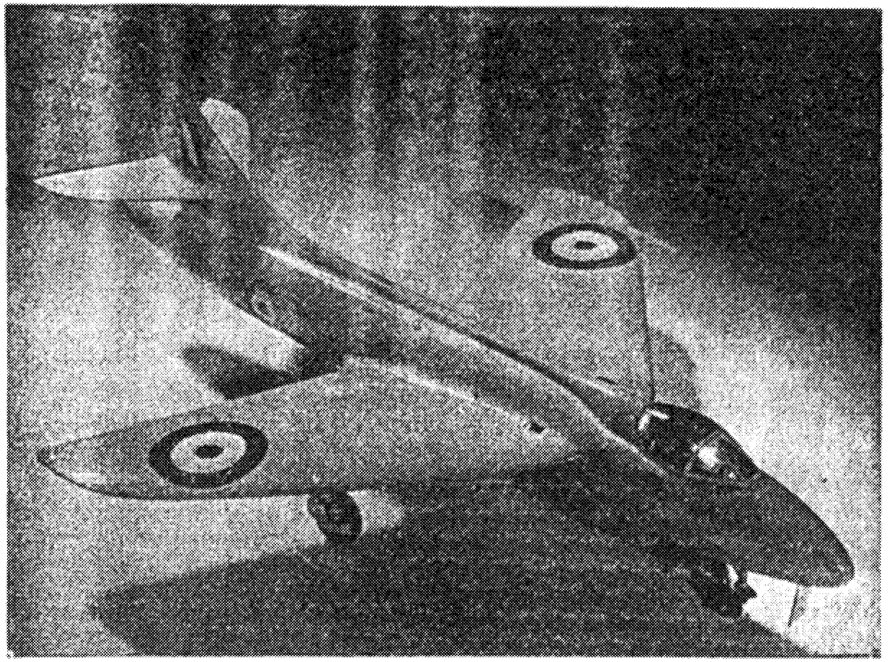

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THE MODEL AERONAUTICAL PRESS LTD

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Trade Distributors:
ARGUS PRESS LIMITED
42/44 HOPTON STREET, LONDON, S.E.1

*

Printed in Great Britain by The Broadwater Press Ltd
Welwyn Garden City, Herts.

CONTENTS

Chapter		*Page*
1	INTRODUCTION TO A HOBBY	7
2	MAKING A START	9
3	FUSELAGES	17
4	COCKPITS, CABINS, AND GUN TURRETS	29
5	MAINPLANES AND TAIL SURFACES	39
6	ASSEMBLING FUSELAGES, MAINPLANES, AND TAIL SURFACES	50
7	ENGINE NACELLES AND ENGINES	62
8	UNDERCARRIAGES	70
9	HULLS AND FLOATS	80
10	DETAILS AND ACCESSORIES	85
11	SPECIAL APPLICATIONS	98
12	PAINTING AND LETTERING	104

ILLUSTRATIONS OF THE AUTHOR'S MODELS

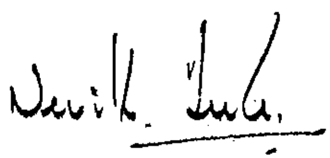
	Facing Page
Hawker Hunter	3
Supermarine Spitfire IX	16
Supermarine Spitfires	16
Gloster Whittle E.28/39	17
Gloster Javelin	17
Handley Page Hannibal	32
Handley Page Halifax	32
Avro Anson and Hawker Hind	33
Handley Page 0/400	40
Avro Lancaster	40
Bristol Fighter	41
Supermarine—Rolls Royce S.6.B.	41
Airspeed Ambassador	48
Gloster Meteors	49
Westland Wagtail and De Havilland Moth	49
Short Sunderland V	64
Avro 504K	64
Handley Page Harrow	65
De Havilland Comet I	65
Supermarine Southampton	65
Short 225	80
De Havilland D.H.50J	80
Westland Wyvern and Fairey Firefly	81
Vickers F.B.9	96
Westland S.51	96
Hawker Sea Hawk	97
Vickers Viscount	97

FOREWORD
BY
SQUADRON LEADER NEVILLE DUKE

Models of almost any description have an absorbing appeal and fascination for everyone. Those already fortunate enough to have discovered this hobby attain a vast pride in the making, and a satisfaction in the finished article, which cannot be understood by those as yet unenlightened or unawakened to the art.

As well as the joy and satisfaction of this hobby, the educational value is enormous, providing as it does an intimate study in detail of any particular subject—in this case aircraft.

If anyone doubts their ability to undertake this hobby let them read this book, when all will be clear. This volume is, in itself, a work of art, beautifully presented in text and illustration, covering every aspect of modelling aircraft in miniature.



CHAPTER ONE

Introduction to a Hobby

Scale models possess a fascination which is entirely their own. No matter what the subject may be the representation of it in all its detail in miniature form never fails to attract its hosts of admirers. The original may have the beauty of one of Wren's masterpieces of building or the functional utility of the more modern school of architecture; it may be a smoke-blackened tramp steamer or a trim ocean liner; a fussy little tank engine or a gleaming express locomotive; but whatever it is, the scale model will have its own intrinsic beauty, a beauty which in many cases is not even shared by its full-sized counterpart. For many years models of galleons and square-rigged sailing ships have held their place in the affections of seamen and land-lubbers alike, and now within the space of a mere half-century a new medium, the air, has produced new subjects to attract the skill of the model maker and delight the eye of the beholder. The modern jet aircraft with its clean, stream-lined shape provides a wealth of inspiration for the modeller, and just as models of the galleons and the four-masters of older days still hold their place in the affections of ship-lovers, so models of the older types of aircraft, with their forests of struts and miles of bracing wires, recall to the air-minded the spirit and the thrill of the earlier efforts of man in his conquest of the air. When set alongside models of later types they provide striking evidence of the rapid progress of aircraft design.

The art of producing scale models of aircraft is finding an increasingly large following, and this following is not only confined to the schoolboy. The man who spends his day in the office or the shop and who likes to do something with his hands in his spare time can find an outlet in this absorbing hobby, as well as an excuse for not digging the garden! The man who works in the factory, perhaps turning out some small component for a modern aircraft, finds satisfaction, when he has finished his day's work, in producing the complete article in miniature form.

The scope of the hobby, too, is boundless and, depending upon the ideas of the individual, it can range from one single model to a large collection. One may wish to build only a single model of some type which holds a particular personal interest. Another may perhaps require a small series of models of aircraft which he has used, either as pilot, air crew, or passenger, or with which he has been concerned in some other way. Again, some particular phase of aircraft development or some particular group of aircraft can be illustrated by the models as, for example, the development of the swept-wing or delta types, or perhaps single-seat fighters of the world air forces, or the evolution of the commercial air liner. One may wish to cover some particular period of aircraft history—for instance, either of the two World Wars, or even to confine himself to types produced since the end of the second World War. The modeller may perhaps, and especially the younger ones, decide to produce an all-jet fleet. On the other hand, one may wish to portray in model form a selection of aircraft produced by some particular manufacturer to form a history of the firm. At the other extreme there will be the person whose ambition is to build up a really comprehensive collection of models illustrating the development of the aeroplane right from its early beginnings up to the present day—a task which sounds somewhat formidable, but which nevertheless is one much more capable of realization than might be generally supposed. If anyone nurses an ambition to form a collection, even though it be only a modest one, he would find it extremely difficult, not to say expensive, unless he is prepared to construct the models himself, for the commercially produced models, and, it may be added, even those built as a hobby, can command exceedingly high prices.

For every one who has already embarked on this pastime there must be many hundreds of others who would like to begin, but who either lack the knowledge of how to go about the job or think that the subject is much too difficult and far beyond their capabilities. It is mainly for these persons that this book has been written. Whether the reader's requirements stop at one single model or whether his aim is a large collection, whether he has already made a start on scale-model work or whether he has yet to experience the satisfaction of putting the final touches to his first effort, it is the object of this book to help and encourage. The following chapters describe as fully and as clearly as possible the sequence of operations in the making of a model and an attempt is made to sort out the difficulties and pitfalls and to suggest how these may best be overcome or avoided.

It is well known that an ounce of practice is worth a pound of theory. This book is not a theoretical approach to the subject. All the methods described are those which have actually been used and found satisfactory during a period of nearly twenty-five years of active work in modelling aircraft to scale. Moreover, these methods have been evolved, not by a skilled craftsman with a completely equipped workshop and masses of expensive tools at his disposal but by an average person who could manage to distinguish the cutting edge of a chisel from its handle, who liked to produce things from lumps of wood, and who has been possessed of an incurable interest in aircraft. Anyone who can exhibit these few qualities can—without much blood (if he knows the handle end!), very few tears, and only a modicum of toil and sweat—turn himself into a producer of models which will command the envy and admiration of his less enterprising fellows.

To be a little more specific, what does the work of building a scale-model aeroplane involve? It involves, firstly, the ability to understand and work from simple scale plans. It involves the fashioning of a few pieces of wood into the shape of a fuselage, wings, tailplane, and rudder. This requires only an elementary knowledge of the use of one or two carpenter's tools. It involves the manipulation of some odd pieces of wire or scraps of metal into an undercarriage, with the aid of a pair of pliers and a file. Finally, it involves the fitting of these parts together, and the painting of the model.

In the succeeding chapters the reader will be taken from the beginning, step by step, through all the various constructional stages of a model up to the final operations of painting and finishing in such a way that the whole job is reduced to the simplest of tasks. He will find as he progresses with the hobby and as type follows type that he will rapidly develop his own skill until he is able to tackle the most involved model with complete confidence and success.

CHAPTER TWO

Making a start

Before we can make a start with the more interesting constructional work there are several important preliminaries which must be discussed. First and foremost are the materials which we shall need. For scale-model aircraft, wood is the only satisfactory medium, and will be used for all the major components, such as fuselage, mainplanes, tailplanes and rudders, engine nacelles, and also for many smaller fittings such as cockpit headrests, fairings for direction-finding aerials, "spats" or wheel fairings, struts, and in some cases undercarriage assemblies. It is important to start off with the right type of wood for the job in hand. The choice of the right type will not only ensure that the finished article will be worthy of the time and effort spent on it but will also save the modeller from a good deal of disappointment and exasperation which can arise when, after perhaps spending some hours on shaping a part, it is found that the particular wood being used is unsuitable because it is too soft, or the grain is too open, or that it is too brittle and inclined to break or splinter. For scale modelling, hard wood is the only suitable type, and here the term "hard wood" is used not in its generally accepted meaning, which defines hard wood as the timber from deciduous trees as distinct from the softwood timber from coniferous trees, but in the sense of the actual hardness of the wood itself. For this reason balsa wood (which by the silvicultural definition is a hard wood) is totally unsuitable for this type of work, although it has become very popular for solid-scale modelling, because of the ease with which it can be shaped. The outstanding property of balsa is, of course, its extreme lightness, and whilst this is of utmost importance in the construction of flying models, for which it is, of course, ideally suited, the problem of low weight does not enter into the construction of the non-flying scale model, and the successful modeller should be prepared to forgo a certain ease of working which can be obtained with balsa for the greater strength and the much finer finish which will result from using a harder wood. Almost any kind of fine-grained wood will be found to be suitable. Except for certain small parts the hard-cutting types can, and should, be avoided as these do make working extremely difficult. American whitewood is perhaps the ideal timber to use for solid models, but basswood, pine, beech, and even ordinary deal can be equally successful. Obechi can be used, but its use should be regulated by the particular component which is to be made. In hardness it lies somewhere between balsa and the hard types, it is very easy to work, but it is not recommended for use where any sharply defined lines are required, such as in the square box type of fuselage of the older biplane aircraft, or where cut-outs have to be made for such items as cockpits and cabin windows, as it is most difficult to get a clear-cut edge for these openings. When worked it is inclined to produce small flecks of grain which need a lot of treatment before a smooth paint finish can be obtained. The relative hardness of obechi also varies a great deal and one might find, even in a small piece, spots which are much softer than the wood on either side, and these soft spots are inclined to cut or file away much quicker than the hard parts. This has to be watched very carefully when the wood is being shaped. One stroke of a file in one place may remove as much wood as four or five strokes on a spot perhaps only an inch away. Perhaps the best use for this type of wood is for wings for fairly large monoplanes where the maximum depth of the wing is anything from ½″ upwards. If the modeller is unable to distinguish one type of wood from another by name, he need not be alarmed, there are few amateur modellers in fact who can, but after only a little experience most of them will know at a glance what types of wood can be turned into a successful model. The main qualities to look for are a fine close grain, and a freedom from knots. The wood should, of course, be dry and well seasoned, otherwise there is danger of its warping and it should also be free from resin which will only clog the tools and make working almost impossible. Odd scraps of wood which can be bought for a few shillings from a carpenter's shop or timber yard will often provide the modeller with sufficient material for a number of models, and even if he is tempted to purchase specially selected blocks for his modelling work, his outlay should not be in any way a large one.

In addition to this main material, many detailed parts of the model will need to be constructed from scraps of tin, wire, small metal tubes, pins, scraps of aluminium, and even paper. The modeller should, therefore, provide himself with a few lengths of brass or copper wire of various gauges, a few flattened cocoa-tins, a selection of pins from ½″ to 1″ in length, a few lengths of brass tube of between 1/16″ and ⅛″ outside diameter which are stocked by most model shops, and odd scraps of aluminium. In addition, some perspex will be required for cockpit covers, cabin windows, etc., and the modeller will find that a few square inches of perspex of three thicknesses 1/16″, ¼″, and ⅜″ will cover practically all his requirements. Plastic wood will be needed for fairing in joints between mainplanes and fuselages and for other fairing work. It is preferable to obtain plastic wood in tins rather than in tubes. A tube of glue will also be an essential part of the equipment.

Turning now to the tools and working space required, the modeller will find that whilst a well-equipped workshop is a great asset, the novice may have to make a start with limited accommodation and the minimum of tools and equipment, gradually building up his kit as he progresses and as his requirements dictate. For serious modelling work, and bearing in mind the fact that we shall be working in hard woods and not balsa, the penknife and razor-blade methods should be ruled out from the beginning, and the modeller should provide himself with sufficient woodworking tools to enable him to pursue his hobby in a workmanlike manner. Many readers will already possess a set of the usual carpentry tools, in which case they will find amongst them all that they will require. Assuming, however, that one is starting from scratch, the following are the tools that will be more or less essential. Firstly, a small hand-saw will be needed for cutting out the rough blocks from the planks and boards. For smaller and finer cutting a hack-saw will be required, and, in addition, a fret-saw, together with a supply of fine blades, will be found extremely useful for very small work and for cutting curves. For cutting curved work in fairly thick wood the fret-saw frame can be fitted with the rather more sturdy coping-saw blades. A small block plane will be used for the initial preparation and squaring up of the blocks and for one-seventy-second-scale work a metal plane with a blade width of about 1¼″ or 1½″ will be found capable of handling all requirements. The final shaping of the parts should be done with files rather than with cutting tools. In this way the block is brought gradually to the shape required and the modeller can check his work at frequent intervals, thus ensuring that the model is not spoilt by inadvertently cutting away too much wood, which can easily happen if cutting tools are used. Some uses will, however, be found for one or two chisels and gouges, particularly in the preliminary rough shaping of large models which can be accomplished more quickly and with less effort with cutting tools than with files. It is suggested that one ⅛″ and one ½″ chisel and one ¼″ and one ½″ gouge, the latter mainly for use in flying-boat and seaplane models, will cover most requirements. Since it has been recommended that the majority of the detail and final shaping of the parts should be carried out with files, the modeller should aim to build up a fairly comprehensive selection of these tools, but to begin with a 12″ rough file or rasp of the half-round variety and a similar-sized smooth file, together with a 6″ smooth-cut file and one or two of the much smaller variety, such as a half-round tapered file with a blade width of about ⅛″, a rat-tailed file and a small triangular file, will cover practically all the modeller's needs. A drill-brace and a selection of drills from 1/32″ to ¼″ will be a useful addition. The small drills will be used for making holes for strut fittings and the larger size mainly for the first stages of hollowing out cockpits and cabins and for drilling air-intakes and jet tail pipes. A pair of long-nosed pliers should find a place in the toolkit and a pair of fine-point tweezers will facilitate the handling and fitting of small parts and for other jobs where even the smallest fingers are far too big. Some metal parts will require to be soldered, and if a soldering iron does not already form part of the modeller's equipment it should be added. A 12″ metal rule, preferably one graduated in eighths, sixteenths, and thirty-seconds and also in sub-divisions of twelfths and tenths, will be needed and the list of equipment can be concluded with a few sheets of sand-paper of various grades. These tools will form the minimum requirements for the serious modeller, but if the hobby progresses and attention is turned to the production of a series of models both large and small, additions to this range can be made. The modeller will by then have formed a good idea of his own requirements and any shortcomings in his toolkit, and can build it up according to his needs.

Working accommodation will, of course, depend upon the facilities available to the individual modeller, but since he will require to carry out several of the normal carpentry operations, such as planing and sawing, some kind of bench or table on which he can work will be essential. If the modeller is fortunate enough to have the use of a separate workshop this is naturally the ideal, but a good substitute would be some corner of a garden shed or garage where a small bench can be accommodated. A bench 6′ long by 2′ wide by 3′ high would amply serve all the modeller's needs. This should be placed in front of a window where the maximum amount of light will fall on the work. It should be fitted with a planing stop and a woodworker's vice, although in place of the latter a smaller table-vice, which can be clamped to the bench when required and removed when space is needed for other operations, is more suitable for the person who has to work in a limited space.

The workshop of the amateur is a notoriously untidy place, but whatever his accommodation, whether it be a permanent workshop or the part-time use of the kitchen table, the modeller should aim to keep his tools and equipment in a tidy manner, for in this way not only will they come readily to hand when required but they will be unlikely to suffer damage when not in use. Such needs as pins, drills, small metal scraps, brads, screws, and many other items should be stored separately in boxes or tins—tobacco-tins are most useful for this purpose—and each tin should be clearly labelled as to its contents. It is also a good plan to keep a box in the workshop for small scraps of wood. The small waste pieces obtained when cutting out fuselages and wings from the main blocks can then be stored and when, as often, the need arises for a small piece of wood for some detailed part, the scrap-box will invariably produce just the right size and type of material, and the need to cut into fresh boards will be avoided. A little time spent in organizing the equipment in this way will, in the long run, save the modeller from wasting many hours in searching for something that he knows he's got somewhere, but can't for the life of him remember where he put it!

One important point which needs to be decided right at the beginning concerns the selection of the most suitable scale. This will, to some extent, depend upon the number of models or the size of any

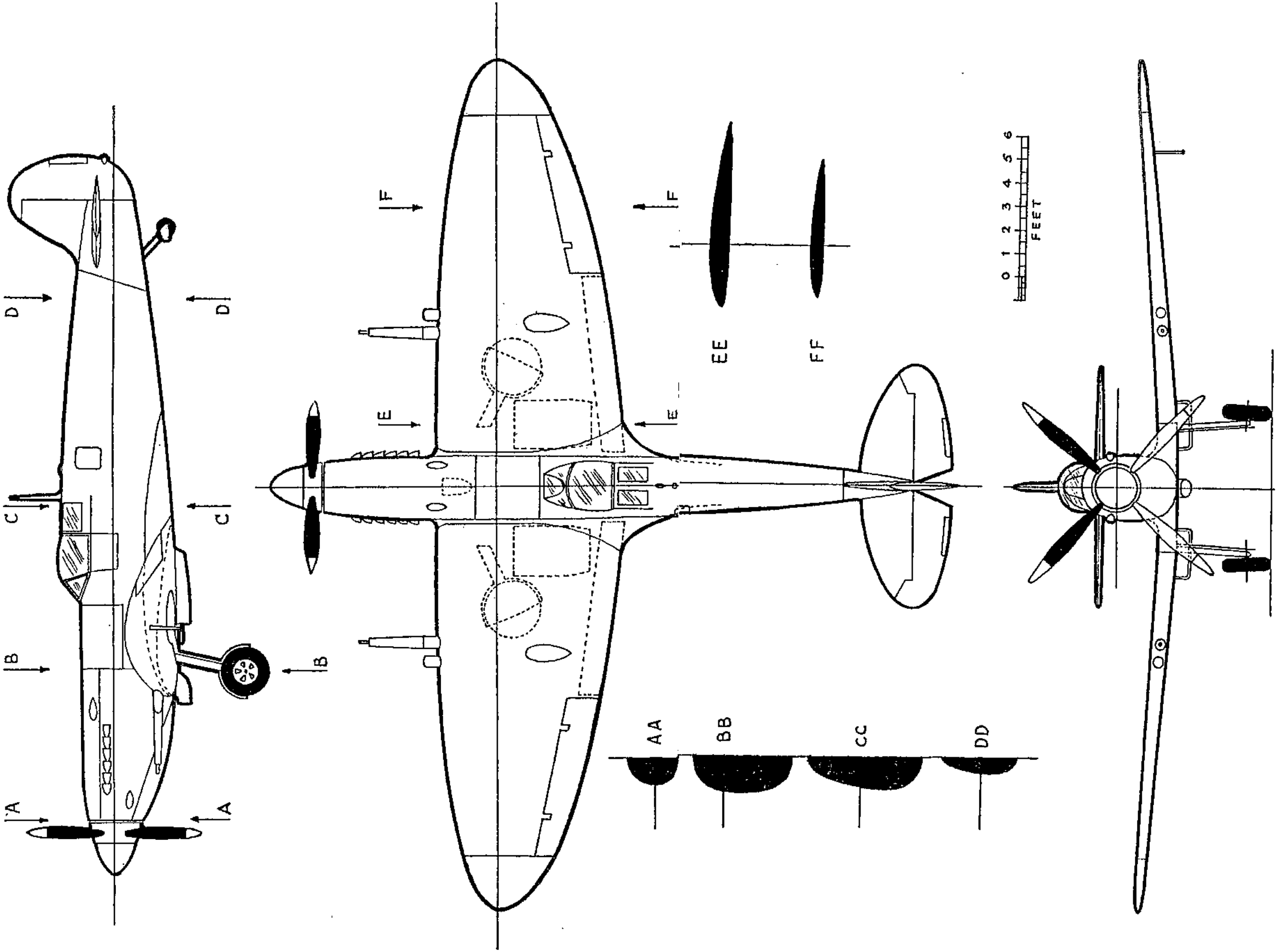


Fig. 1. Supermarine Spitfire Mk. IX, drawn to one-seventy-second scale.

collection which the modeller has in mind. If it is intended to build up a collection of a number of models it is more satisfactory to build each of them to a uniform scale, so that in size they will be directly related one to the other. The use of a uniform scale also enables a certain amount of standardization to be obtained in many detailed parts and in working methods. In addition, and this is important if a collection is to have some historic value, comparisons and contrasts between different types will be much more easily illustrated.

Popular scales for model-aircraft work are one-thirty-sixth full size or 1″ to 3′, one-forty-eighth full size or 1″ to 4′, and one-seventy-second full size or 1″ to 6′. The one-thirty-sixth and one-forty-eighth scales produce quite large models on which can be shown a considerable amount of detail, but if an extensive collection is aimed at the use of either of these scales may, in time, result in difficulties in storing or displaying the completed models. Therefore, the smaller scale of one-seventy-second is recommended as the most suitable, and it is on this scale that the notes contained in this book are based, although in their main essentials they may be equally well applied to the larger scales mentioned. The one-seventy-second scale is neither too small to render the inclusion of details difficult, nor is it too large to produce a problem in keeping the completed models. In addition, it is possible to obtain a very comprehensive range of aircraft drawings and small accessories, such as wheels, in this scale, facts which should weigh heavily in favour of its adoption.

We have now got a fair idea of the materials which we shall need, the tools to use, the accommodation which will be required for working, and we have discussed the choice of scale. It might be appropriate here to examine briefly a few other considerations which must precede the actual constructional work of a model.

We made mention in the previous chapter that the work involves, firstly, the ability to understand and use simple plans. These plans, or, more correctly, general arrangement drawings, show to scale the three main views of an aircraft and they will form the basis of all our constructional work. Nowadays, the model maker is fortunate in being able to obtain a very wide range of commercially produced scale drawings which have a high degree of accuracy and from which he can work with complete confidence. Modellers will be able to obtain these scale drawings for practically any type of aeroplane, either British or foreign, which they may wish to build. Moreover these drawings cover types from the early 1900s up to the present day. A typical set of drawings, those for the famous Supermarine Spitfire Mk. IX, is shown in Fig. 1, and for those who are as yet unfamiliar with them a few words on their use will be found helpful. These drawings are to one-seventy-second scale and show a side view, a head-on view, and a plan view of the aircraft. On some drawings the plan view is divided along the centre line and shows on one side details of the upper surface and on the other details of the underside. In other cases underside details are shown by means of broken lines, as they are in this case. From these drawings we are able to mark out on our wood-blocks the shapes of the fuselage, wings, tailplane, and rudder, and when these parts have been made we can again use the drawings as a guide to the assembling of the parts into the complete model. Notice first on the side view the datum line which is the horizontal line running from the centre of the airscrew spinner to the tail. This line will form the basis for all the measurements we shall have to take in setting out on our material the side view of the fuselage. In setting out we shall work from the nose of the aircraft and drop perpendiculars at intervals along the datum line, measuring off on these perpendiculars the distances from the datum line to the top and bottom lines of the fuselage. The points thus obtained are then joined up and give us the outline required, as shown in Fig. 2. On the plan view the fore and aft centre line is used as the datum for marking out the plan shape of the fuselage.

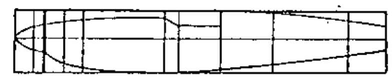


Fig. 2. Setting out side elevation of fuselage.

Again, lines at right-angles to the datum are marked on at intervals from the nose, and the width of the fuselage at these various points measured off, the points being joined up as before. For setting out the plan shape of the wing it is sometimes necessary to draw an extra datum line on the plan view at right-angles to the fore and aft centre line and at some convenient point on the wing. On the Spitfire drawing in Fig. 1 the line joining the wing tips is used for this purpose. Construction lines at right-angles to this wing datum and at intervals measured outwards from the fore and aft centre line are drawn in and the positions of the leading and trailing edges of the wing are measured from the wing datum, as shown in Fig. 3. For the tailplane the elevator

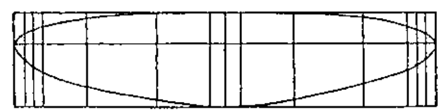


Fig. 3. Setting out plan shape of mainplanes.

hinge line can normally be used as a datum and the shape is set out in exactly the same manner as for the main wing. Similarly, with the rudder the vertical hinge line becomes a datum and the rudder and fin outline is obtained by taking measurements at right-angles to this line (Fig. 4). The head-on view, which is built up on a vertical centre line and a horizontal datum both running through the centre of the airscrew spinner, will serve to give us the thickness and taper of the mainplane, tailplane, and rudder, the

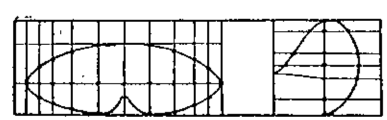


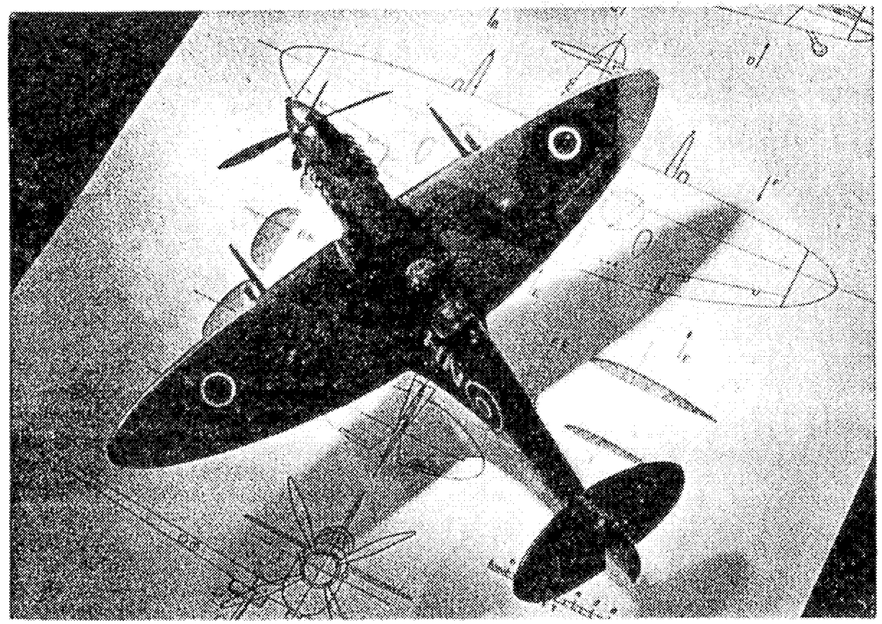
Fig. 4. Setting out tailplane and fin and rudder shapes.

dihedral angle of the mainplane, and the positions of undercarriage legs, gun ports, radiators, air-intakes, and other details. On drawings of biplane types the front view will also show the gap or distance between the upper and lower mainplane, the positions of interplane struts, and the arrangement of bracing wires.

In addition to the main outlines it will be noticed that the drawings contain cross-sections taken at points along the fuselage and on the mainplanes. These sections will be used as a guide in the final shaping of the parts as described in more detail in the following chapters. In assembling the model, the drawings will be needed to find the correct positions of the wings, tailplane, and rudder in relation to the fuselage, the shape and position of any wing-root fairings, the shapes and positions of ailerons, flaps, elevators, rudder, and trimming tabs, the position and setting of the undercarriage, the positions of radiators, air-intakes, exhaust-pipes, guns, and so on.

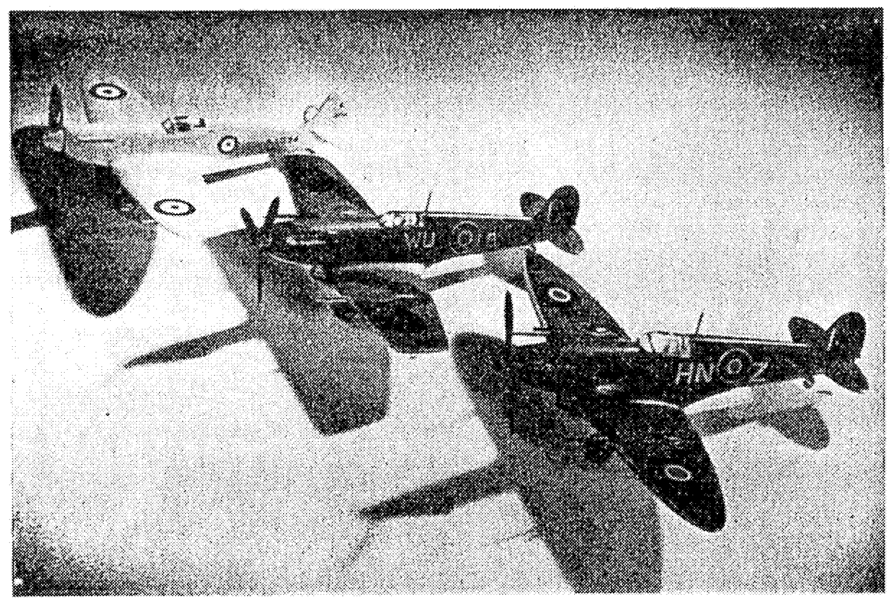
Whilst general arrangement drawings such as these give a mass of detailed information to the modeller, they are often not entirely sufficient in themselves and need to be supplemented by clear photographs, sketches of detailed parts, and often written descriptions, and the modeller should attempt to obtain as many of these additional aids as he can. Photographs are particularly useful as a guide to the detail painting and lettering of models, and as many different views of the type as possible should be obtained and kept ready at hand for reference during construction.

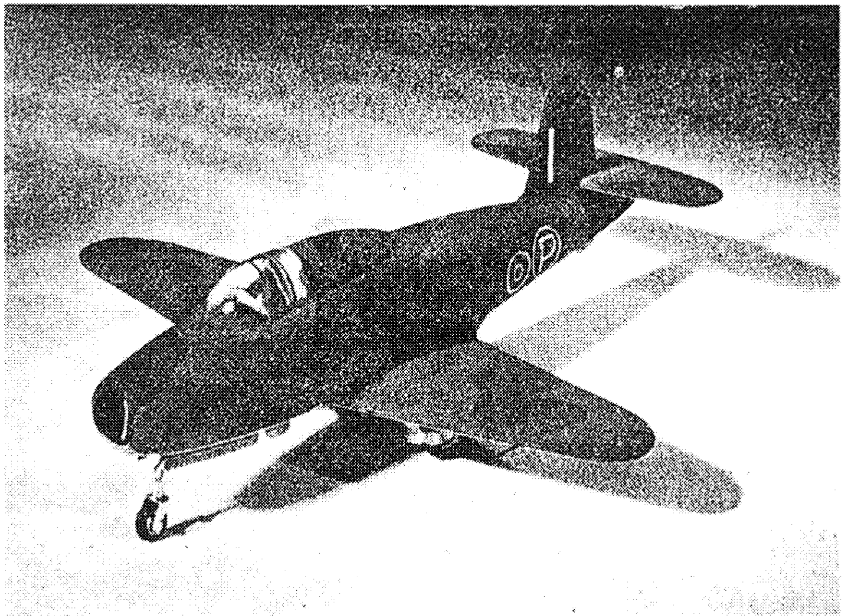
The reader will find many sources of information on aircraft types in the various aeronautical journals, such as *Flight*, *The Aeroplane*, *Aeromodeller*, *Aeronautics*, and *Air Pictorial*, as well as in books on aircraft recognition and the annual publication known as *Jane's All The World Aircraft*. For current types the special issues published by most of the aeronautical periodicals at the time of the annual display and exhibition of the Society of British Aircraft Constructors at Farnborough each year contain a wealth of information and illustrations of aircraft which are invaluable to the model maker. For information on the older types of aeroplane, bound copies of all the well-known periodicals, as well as copies of other published works can be obtained at or through local public libraries.



Supermarine Spitfire IX

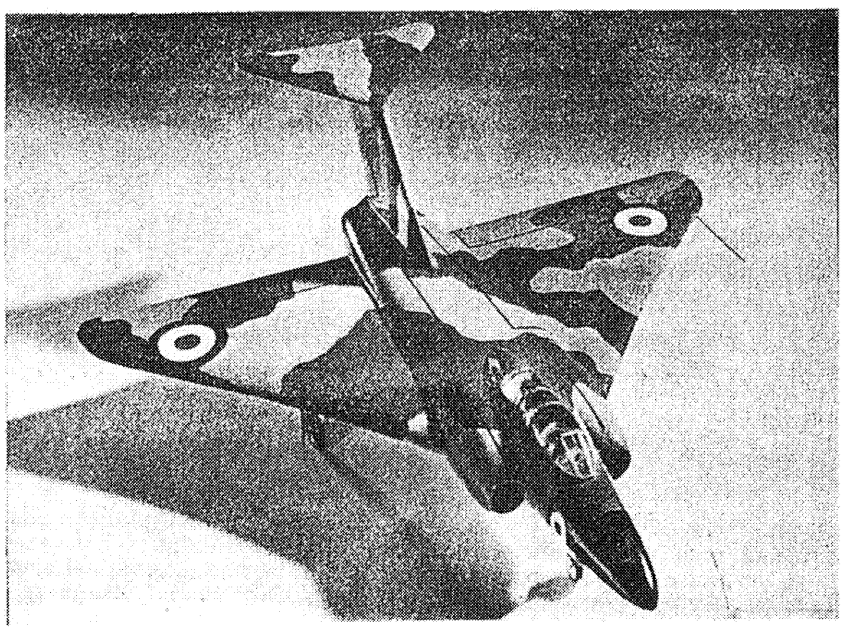
Supermarine Spitfires





Gloster Whittle E.28/39

Gloster Javelin



CHAPTER THREE — Fuselages

Although perhaps less important aerodynamically than the lifting surfaces, the fuselage can be considered to be the backbone of the aeroplane. From the modelling point of view the fuselage is of paramount importance, for whereas with mainplanes and tail surfaces the most noticeable characteristic is the plan form which is relatively simple to copy, the characteristics of the fuselage are "three-dimensional", and if our model is to bear a good likeness to the full-size aeroplane, accurate shaping of the fuselage in side view, plan, and front elevation, and also accurate representations of the correct cross-sections throughout its length will be most essential. The fuselage, therefore, is the one part which is likely to give the most trouble to the modeller.

In model making it is a good plan to tackle the more difficult parts of a job first, so we will commence by examining the why's and wherefore's—or rather the how's—of model fuselages.

During the rapid development of aircraft from about the late 1930s, fuselages have assumed a number of increasingly complicated and sometimes novel shapes. Before that time they were mainly simple box affairs with flat sides and bottom, and the only refinement found was a rounding-off of the top decking. From these we have progressed to fuselages of perfect stream-line form with hardly a square inch of flat surface anywhere. In addition, these fuselages have sprouted all manner of extra bulges and appendages as provision has been made for air-intakes, jet tail pipes, long-range tanks, radar apparatus, covered-in cockpits, and the like, all these adding to the headaches likely to be suffered by the poor model maker who strives to copy their shapes. But do not be discouraged. All these difficulties can be overcome by judicious planning of the work and by reducing each job to a sequence of simple operations which will enable the modeller to reproduce the most intricate fuselage lines with little more trouble than is involved in copying the simple forms of the old "slab-siders".

In this chapter we will first of all examine the method of construction of a simple type of fuselage, one lying somewhere between the old flat-sided type and the present-day super-stream-lined variety, and then proceed to apply the basic methods to the production of all the other types. For this purpose we cannot do better than use as an illustration the famous Spitfire, a type which, for all the modern high-performance jet aircraft, most modellers will want to build if they are anxious to form a collection of historic types. From the modelling point of view the basic shape of the Spitfire fuselage is repeated again and again in numerous other types of aircraft produced during the second World War period, and the same general methods of construction will apply.

All fuselages and, for that matter, all the different parts of a model aeroplane will start from a rectangular block of wood. From the general arrangement drawings first measure the maximum length, depth, and breadth of the fuselage. For the Spitfire IX, which we are using as illustration, these measurements for the fuselage proper for a one-seventy-second-scale model are $4\frac{1}{2}''$, $\frac{13}{16}''$, and $\frac{15}{32}''$ respectively. The length given here is measured from the rear face of the airscrew spinner to the vertical stern post and excludes the spinner itself and also the rudder; but in constructing the fuselage of the Spitfire, and all similar types where a large airscrew spinner is fitted to the nose, it is best to include the spinner as an integral part of the fuselage, at least for the early stages of shaping. This method involves cutting off the spinner at a later stage in the construction of the fuselage, and so as to ensure that the spinner when cut off will be the correct size, allowance must be made for the thickness of the saw blade when the spinner is separated. For this part of the work a small hack-saw or fine fret-saw should be used and a good allowance will be between $\frac{1}{32}$" and $\frac{1}{16}$". This may seem a small and relatively unimportant point, but with scale-model work many of the items will be small—yet none of them will be without their own degree of importance. The maximum length of the block in this instance should be taken, therefore, as $4\frac{23}{32}$". A block to these dimensions gives the maximum *finished* sizes for length, breadth, and depth, so to allow for truing-up and planing, the rough block should be cut slightly over-size all round. The modeller will find in time from his own experience and methods of working what tolerances he should allow, but for a start at least $\frac{1}{4}$" should be added to the length and $\frac{1}{8}$" to the breadth and depth to arrive at the size of the rough block. In passing, it should be mentioned that the grain of the wood must run fore and aft along the length of the block.

Having chosen or cut a block of suitable dimensions, first examine it closely for any knots or other flaws, particularly small splits along the grain which are not easy to detect at a quick glance, but which can be very annoying when they cause a part of the fuselage to fall apart during the later stages of shaping.

Planing a block to true rectangular form is an elementary woodworking exercise, but for completeness it is briefly described here. First, plane one of the sides smooth and level. Then plane the top of the block, checking with a try-square on the first face to ensure that both faces are exactly at right-angles throughout (see Fig. 1).

The maximum *finished* breadth of the fuselage is then marked on the top surface. This should be sufficient if the modeller is accurate in planing, but if there is any doubt, mark the breadth on the top and bottom surfaces, measuring, of course, from the planed side in both cases. The second side of the block is now planed down to the marked lines and checked for squareness with the top planed surface (Fig. 2).

Finally, the maximum *finished* depth of the fuselage is measured off from the top surface and marked on one or both sides of the block, and the remaining bottom surface is planed smooth and true.

The block is now ready for marking out preparatory to the first stages of shaping. The side view or profile of the fuselage is always marked and shaped first. As described in Chapter 2, the profile shape is marked out by reference to the datum line, running from nose to tail. This line is marked accurately on both sides of the block, its position being obtained by measuring from the point of maximum height of the top line of the fuselage on the general arrangement drawing and checking by a measurement from the maximum depth of the bottom

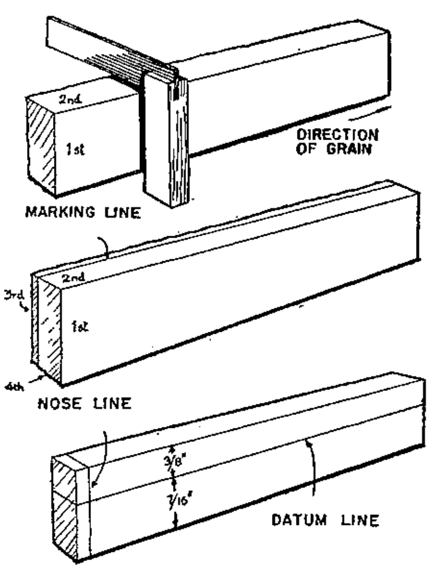


Fig. 1. First and second faces planed and checked with try-square.
Fig. 2. Block marked for planing third face.
Fig. 3. Datum line and nose line set out on block.

fuselage line on the drawing. For the Spitfire, these points occur at the rear edge of the window immediately behind the cockpit cover and at the mid-chord point of the mainplane immediately above the leading or front edge of the under-wing radiator. For a one-seventy-second-scale model the measurements are $\frac{3}{8}$" and $\frac{7}{16}$" respectively.

Next, a vertical line is marked near, but not exactly on, the front end of the block. The exact position of this nose line can vary within small limits, but if we have allowed an extra $\frac{1}{4}$" for the length of our block, it should not be more than $\frac{1}{8}$" from the front edge so as to ensure that a sufficient length of block remains on which to set out the whole fuselage and spinner (Fig. 3). This nose line, which should be continued around all four faces, marks the front of the spinner, and working from this line and from the datum line, the complete side shape of the fuselage can be set out.

Here the importance of accurate setting out must be stressed. A good model can only be built if close attention is paid to accuracy at all stages, and, naturally, however accurate one's working may be, it will be of no avail if the shapes have been set out badly. The following routine in setting out a job should be carried out until it becomes a habit: measure from the drawing, transfer the measurements to the wood, and then, before proceeding, check them on the drawing once more. The little extra time taken by the habitual use of this routine will be well worth while in the avoidance of mistakes.

Working from the nose line, we now mark off the various construction points along the datum line and through each of these points we draw vertical construction lines with the aid of a try-square. Points for the top and bottom outlines of the fuselage are now marked on each of the construction lines in the manner illustrated in Fig. 2 of Chapter 2, measurements being made in all cases from the datum line. The construction points are then joined up to give the complete outline of the fuselage (Fig. 4). Notice the two construction lines close together, marking the rear face of the spinner and the front of the fuselage proper. The space between these lines allows for the saw cut when the spinner portion is removed at a later stage.

It will be found that with a careful choice of the positions of the verticals an accurate outline can be easily reproduced, and is infinitely preferable to other methods such as tracing or pin-pricking through the general arrangement drawings. Where the outline is a straight line, a point marked at each end of the straight section will suffice. Where curved lines are involved, a number of points along the curve will be required and, after plotting, these are carefully joined up freehand.

Still using a try-square, the vertical construction lines are now continued across the top of the block and down the opposite side where the fuselage outline is again plotted. This will give us a guide on both sides of the block when we commence the shaping work. It will be noticed in the illustrations that the shape of the cockpit cover has been omitted. This is on the assumption that the cover and the small windows at the rear will be represented by a piece of perspex which will be shaped and fitted separately. The use of perspex or celluloid for transparencies gives the most realistic effect to a model and should be used in all cases. Some modellers may, however, prefer to shape these transparencies in wood and later paint them to represent perspex or glass. This method is definitely not recommended, for it completely spoils the finished effect, but if it is used the outline of the cover must be allowed for in the original block size and marked at this stage.

The profile shaping can now be carried out. This consists of removing all the surplus wood and working the block down to the outline we have marked. On small models this part of the job can be carried out with files, but where large portions of wood have to be removed they can be roughly sawn off, with the saw cuts kept just clear of the outline, and the block is finally worked down to the exact shape by filing. The cockpit section can be removed by making vertical saw

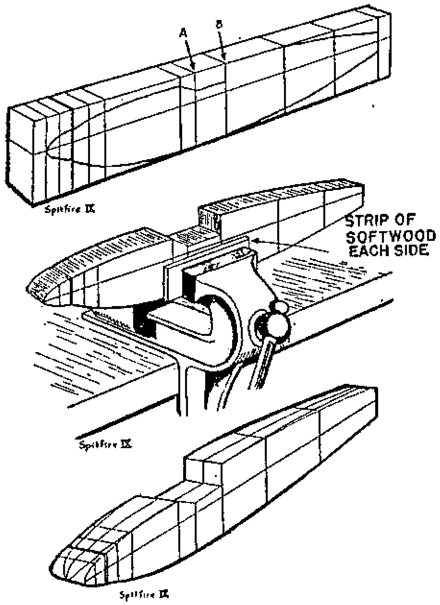


Fig. 4. Side elevation or profile set out on block.

Fig. 5. Profile shaping complete. Showing method of holding block in vice for working, and use of soft-wood vice-clamps to protect the work.

Fig. 6. Plan shape set out on block.

cuts at the points A and B shown in Fig. 4, the wood then being removed by chisel and mallet, working from the nose towards the tail. Again, when making the saw cut at point B, keep the blade just on the "waste" side of the line and finish the cut just short of the bottom edge of the cockpit. When removing the waste wood with the chisel, stop short of the bottom outline. This is a golden rule for all preliminary rough shaping with saws, chisels, and other cutting tools. The final shaping down to the exact outline should always be carried out with a file. This makes it easy to get a smooth and accurate finish and removes the danger of cutting into the outline and spoiling the work.

During these shaping processes, the block should be held firmly in a vice, and to avoid marking the block with the jaws of the vice, small vice-clamps consisting of strips of soft wood—balsa is ideal for this purpose—should be introduced between the jaws and the block (see Fig. 5). Shape the block down to the top fuselage line first. Then turn the block over in the vice and shape to the bottom fuselage line. The job is finished off with a few strokes of a sanding block—a block of smooth wood around which a piece of fine sandpaper has been wrapped.

The next stage consists of shaping the fuselage in plan. First, a fore and aft centre line is marked on the top and bottom surfaces and construction points are marked at intervals along these lines. To avoid measuring and marking new points, the vertical construction lines on each side of the block can be joined across the top and bottom surfaces and the plan outline marked on these (see Fig. 6).

The block is then turned sideways in the vice, not forgetting to make use of the soft-wood vice-clamps, and the surplus wood is removed. Invariably, the amount of waste wood to be removed will be smaller than when shaping the side elevation, so that for all except very large models the whole process can be carried out with files. The shaping of each side must be carried out in two stages, because it is important that we do not lose the datum line. This line and the centre line are of the utmost importance in our work and should be preserved right up to the final painting stages of the model. If the whole of the plan shaping on one side is carried out in one operation, the datum line will be filed off almost completely and it will be very difficult to reset it in the correct position. Therefore, shape the nose section only first of all and, when this has been done, redraw the datum line on this portion. If the datum line has been carried across the front and rear ends of the block re-marking will be simplified. Having fixed the datum again on the front portion, we can now shape the tail portion of the fuselage and re-mark the datum on this portion on completion. The operation is repeated on the opposite side and the block now appears as shown in Fig. 7.

At this stage the spinner portion is removed from the fuselage. A very accurate saw cut is required for this part of the work so that the spinner when finished off will sit well on the fuselage nose. As soon as the spinner has been cut off, the datum and centre lines are joined across the cut faces of the front end of the fuselage and the rear of the spinner block. This gives us a centre point from which, with a pair of compasses, we can first scribe the circle of the nose of the fuselage and then, without altering the compass setting, mark a similar circle on the rear face of the spinner block (see Fig. 11). The spinner block is then put aside in a safe place to be finished off later and we continue with the shaping of the fuselage proper.

If the cockpit is to be hollowed out, this work forms the next operation. The plan outline is marked on the block from measurements taken from the general arrangement drawings. The width of the cockpit should, however, be marked slightly less than as shown on the drawings, so that a "ledge" of about $\frac{1}{16}$" is left each side on which the perspex cover can later be cemented. After marking, the lines are carefully scored with a sharp chisel, particular attention being paid to the lines running across the grain of the wood, which should be scored first. This will help to prevent the wood splitting along the grain when the cockpit is hollowed out. Commence by drilling a hole with a suitable-size drill, taking care not to drill too deeply, and finish off the shaping with a small chisel.

Our next operation is to make provision for the fitting of the mainplane to the fuselage. Various methods for joining mainplanes and fuselages have to be used in modelling to suit the particular fuselage shape and wing setting for each type, and these methods are dealt with in detail in a later chapter. For types of low-wing monoplanes where the underside of the fuselage is curved in section, as on the Spitfire, the most satisfactory method is to set the wing up into the fuselage, and, for ease of marking out, the job is best done at this stage of the fuselage shaping whilst we still have the block in a rectangular section.

From the general arrangement drawings the position of the leading and trailing edges of the mainplane are marked on

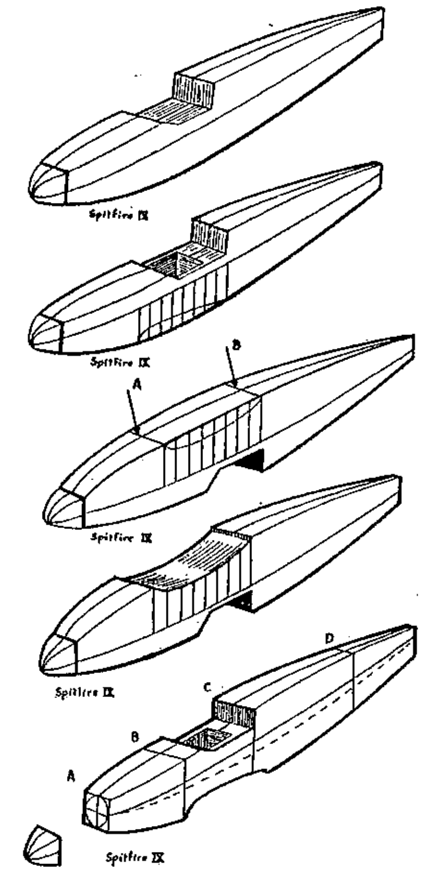


Fig. 7. Fuselage shaped in profile and plan. Datum line re-marked on sides.

Fig. 8. Setting out mainplane seating.

Fig. 9. Shaping of mainplane seating is started by making shallow saw cuts on lines A and B.

Fig. 10. Mainplane seating finished off with half-round file.

Fig. 11. Spinner cut off and cockpit hollowed out. Template check lines marked around block and maximum breadth line marked. (Shown by broken line.)

the underside of the fuselage block. The shape of the top surface of the mainplane is then marked on both sides of the block, measurements at, say, ½" intervals from the leading edge being taken from the datum line across the whole chord of the mainplane (Fig. 8). With the block held in the vice this seating is then filed out, using the curved side of a half-round

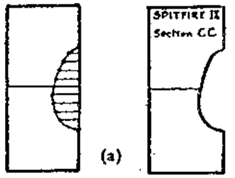


Fig. 12. Method of constructing templates.

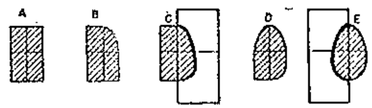
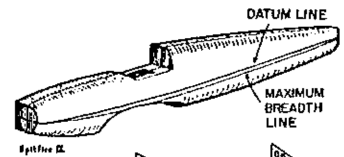


Fig. 13. Sequence of shaping fuselage to section, showing use of templates for checking.

file (Fig. 10). Shallow saw cuts can be made at points A and B shown in Fig. 9 to start the work off, and to ensure clean-cut edges.

We have now got a kind of rectangular caricature of the fuselage and the final task in the basic construction of this part of the model consists of shaping it to its correct cross-section. Here we make use of the fuselage cross-sections given on the general arrangement drawings, and so that these sections can be employed to check the work, we first of all cut out a series of templates. The reader will have noticed that the sections shown on the drawings in Chapter 2 are really only half-sections, that is they have been cut off on a vertical centre line. This is quite sufficient for our purposes. The templates are made from a fairly stiff sheet of cardboard, the right-hand edge of which will correspond to the vertical centre line. At right-angles to this edge draw the datum line and then mark off points at about $\frac{1}{16}$" or $\frac{1}{8}$" intervals above and below the datum. Mark similar points on the section given in the general arrangement drawings, and then plot the section by taking measurements from the centre line to the section outline at all these points. Finally, join up the construction points to reproduce the outline of the section (Fig. 12(a)). The outline is then cut out as shown in Fig. 12(b) and the section station marked on. Similar templates are made for each of the sections shown on the general arrangement drawings. Next, mark on the fuselage block the exact points at which each section is taken and draw lines round the block at each point. Now measure from the drawings the points at which each section reaches its maximum width—either above, on, or below the datum line—and mark these points on each side of the block. Join the points up freehand with a soft black pencil. We must not lose sight of this line during our subsequent shaping work. The maximum height and depth of the section will invariably be the top and bottom centre lines on the block, so make sure that these are easily visible also.

Except for very large models, where a small plane can be used in the early stages, shaping a fuselage to section should always be carried out by filing. Here a certain amount of artistry is introduced into the work, for we have only a few points at which we can make accurate checks against the templates. The modeller's own skill must come into play in merging these shapes one into the other along the length of the fuselage. Shape one complete side of the fuselage first, placing the block on its side in the vice. The use of soft-wood vice-clamps will be essential from now on. Commence the shaping at the nose where, in the Spitfire illustration we are using, we have already marked a circle on the front of the block, and carefully file the block down to conform to this mark and to merge along into the shape of the next section point. The job will be simplified if one segment of the section is shaped at a time, starting with the segment between the top centre line and the maximum breadth line which we have drawn on the side of the block (see Fig. 13(b)). Carry out the shaping of this segment right through from nose to tail, and at each section point make constant checks with the template as the filing proceeds. The lower portion of the template can be folded up for this stage so that the top segment can be checked. Carry on with the second operation of shaping the lower segment of the fuselage side, as indicated in Fig. 13(c), where a template is shown in use for checking the accuracy of the work. The block now appears as shown



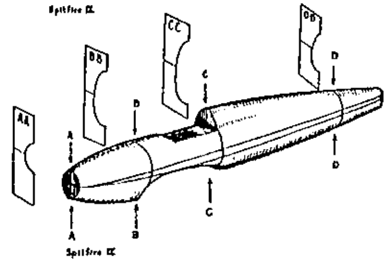


Fig. 14. Completion of first and second operations with port side of fuselage shaped to correct cross-section.

Fig. 15. Cross-section shaping completed.

in Fig. 14, and once again we must redraw the datum line if this has been filed away. This can easily be plotted by working back from the maximum breadth line which, obviously, should be intact. The two lines are shown in Fig. 14, the lower one being the maximum breadth line.

With the block turned over in the vice the whole operation is repeated on the opposite side, going through the stages as illustrated in Fig. 13(d) and (e), leaving the block as shown in Fig. 15. The basic shaping of the fuselage is now complete.

The lines representing the various detachable panels etc. are now marked out on the fuselage. Here the value of the datum and centre lines will become apparent for we are now working on curved surfaces and without these lines accurate setting out would be very difficult. Having marked the panels and checked our markings, the lines are then scored in, not too deeply, with a sharp chisel or penknife. The whole fuselage is then rubbed down to an absolutely smooth finish with a fine-grade sandpaper.

Although we have used a Spitfire as an illustration, the basic sequence of operations which have been described will always be used no matter what type or size of aeroplane the modeller wishes to construct. To get this sequence firmly fixed in our minds we can briefly summarize it as follows:

Stage 1. Rough block cut slightly oversize all round.
Stage 2. Block planed true to maximum breadth and depth.
Stage 3. Datum line marked and profile shape set out.
Stage 4. Profile shaped.
Stage 5. Centre lines marked and plan shape set out.
Stage 6. Plan shaped:
 (a) nose section first side;
 (b) tail section first side;
 (c) nose section second side;
 (d) tail section second side.
Stage 7. Spinner section cut off (if appropriate).
Stage 8. Cockpit hollowed out.
Stage 9. Mainplane seating cut (if appropriate).
Stage 10. Section shaped:
 (a) top half first side;
 (b) bottom half first side;
 (c) top half second side;
 (d) bottom half second side.
Stage 11. Panels set out and scored.
Stage 12. Fuselage cleaned down to smooth finish with fine sandpaper.

Note: After each sub-stage 6(a) to 6(d) the datum line is re-marked and after each sub-stage 10(a) to 10(d) both the datum and centre lines are re-marked where necessary.

Models of numerous aircraft of the same basic layout as the Spitfire will follow this pattern exactly. Such types as the Hurricane, Defiant, Fulmar, and Firefly come to mind, to name only a few. But fuselages come in a wide variety of shapes and sizes and, whilst their construction will always follow the same general lines, many will have detail variations, sometimes involving additional operations.

Turning to more recent aircraft, we shall often encounter the jet type having a single nose intake and tail pipe. The first British jet aircraft, the Gloster-Whittle E.28/39, is one example, and the American Sabre and Russian MIG. 15 are others. When it comes to air-intakes and other apertures found on aircraft, many modellers avoid trouble and resort to painting a few black blobs in the appropriate places. This is particularly so when models are constructed of balsa, for in this wood it is very difficult to get a clean-cut opening. This practice does not stamp either the model or the modeller as a good one and must not be adopted if any realism is to be obtained. The good model maker will always be striving after exactness in every detail and where there is a hole on the original aeroplane he will make one on his model. So on all jet types, drill or cut the air-intakes and drill the jet tail pipes.

These operations are best carried out in the early stages of construction, usually after the fuselage profile has been shaped and before the plan shaping is commenced, that is, between Stages 5 and 6. First, make sure that the nose and tail of the block are finished absolutely square, and then mark the shapes of the openings on the front and rear of the block, using continuations of the datum and centre lines carried round the ends of the block to get correct positions. For circular intakes the outline is scribed with

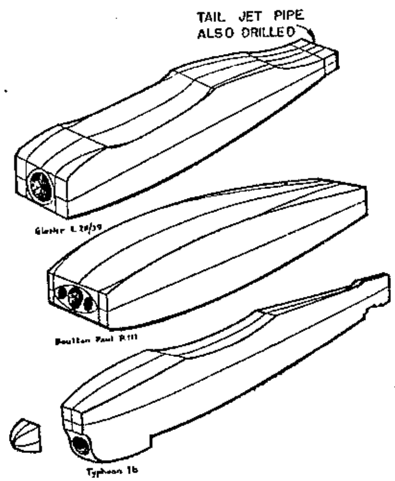


Fig. 16. Drilling nose intake and tail jet pipe.
Fig. 17. Method of using different size drills for first stage of cutting elliptical intake.
Fig. 18. Cutting chin or beard radiator opening after removal of spinner portion.

a pair of compasses. Notice that often two concentric circles will be required, the inner one being the exact size of the cut-out and the outer representing the outside diameter of the duct (see Fig. 16). Circular intakes are drilled out with an appropriate-sized drill or with a brace and bit. In some cases, however, intakes are slightly oval or pear shaped, the Boulton Paul P.111 and English Electric P.1 are examples. Here the drilling will have to be supplemented by cutting to final shape with a small gouge or filing with a circular or rat-tailed file. As much of the work as possible should, however, be accomplished with drills, and sometimes by using different-sized drills in turn, very little cutting will be left to do (see Fig. 17).

This method of cutting apertures is also used for aircraft, such as the Hawker Tempest and Sea Fury and the Westland Wyvern, where the engines are contained in circular cowlings.

The small hand-braces will take drills up to ¼" diameter so that where intakes of a larger size are required they must be cut out with a brace and bit. Drills can be obtained in sizes progressing by 1/32" and bits are usually in sizes progressing by 1/16". For one-seventy-second-scale models a hole ½" in diameter will hardly ever be exceeded.

Similar treatment is given to types with "chin" or "beard" radiators set close to the nose of the fuselage, as on the Typhoon 1b, but to avoid any possible damage to the spinner during drilling, this operation should be carried out after Stage 7 when the spinner section has been cut off (see Fig. 18).

Another variation found on jet aircraft is the bifurcated type of intake, one being set on each side of the fuselage, as in the Supermarine Attacker and Swift, and sometimes referred to as "elephant-ear" intakes. Here the profile shaping is carried out first in the normal way but an additional operation comes into the plan shaping just before Stage 6. This consists of cutting the nose portion ahead of the intakes down to the correct width. Saw cuts with a fret-saw or fine hack-saw are made along the lines A and B shown

in Fig. 19 and the surfaces cleaned up with a file. After re-marking the datum line on the nose portion, the shapes of the intakes are then set out on the projecting shoulders and the intakes are drilled out and cleaned up. The plan shape is then set out and the remainder of the shaping operations continued. Where the intakes are shallow, as on the Attacker, it is best to drill in at a slight angle towards the centre line. This will give room for the drill to be operated and will minimize the danger of drilling out through the side of the block.

When shaping this type of intake, allowances must be made for any small fairing of the rim of the intake where it meets the fuselage. This means that, after drilling, the face of the intake must be filed back on a curve similar to that shown at A in Fig. 20.

Dorsal intakes, such as those on the delta-winged Avro 707B and the Short Sherpa, are kindred types to the side intakes but need somewhat different treatment. On the 707B the top line of the fuselage drops considerably as it enters the intake, so most of the preliminary work here has to be done with a ⅛" chisel, and should be carried out as part of the section shaping at this point. The intakes themselves can be drilled and filed out in the normal manner after this stage.

Owing to the large forward fairing extensions on each side, the intake on the Sherpa also needs to be cut entirely with a chisel, the cockpit cutting procedure being more appropriate in this case, the inner sides of the fairings being scored with a chisel or penknife after marking, and the surplus wood between these marks then being carefully carved out with a small chisel.

The Gloster Javelin is another aircraft with intakes similar to the elephant-ear type; but here a further complication occurs because a fully circular intake has to be merged into a circular fuselage section, and the faces of the intakes are slightly smaller in side elevation than the depth of the fuselage at that point. After carrying out the normal profile shaping, therefore, and cutting the nose down to correct width, the forward portion of the

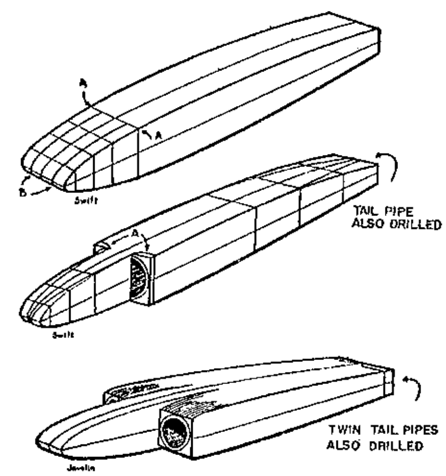


Fig. 19. First stage in cutting side intakes.
Fig. 20. Second stage in cutting side intakes.
Fig. 21. Drilling and shaping circular side intakes.

intakes must be filed down to the correct size, as shown in Fig. 21. The intakes and tail pipes are then drilled and the plan shaping is carried out in the usual way, after which the whole of the nose portion is shaped to its correct section (see Fig. 22). Attention is then turned to the section shaping of the *inner* sides of the intakes to merge them into the fuselage

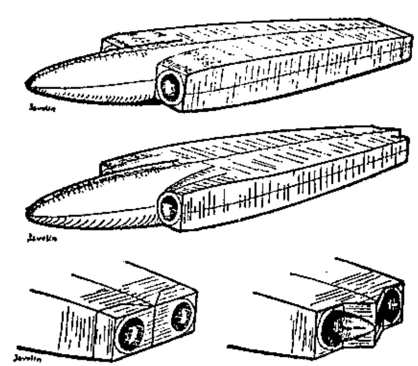


Fig. 22. Nose portion shaped to cross-section first.
Fig. 23. Inner sides of air-intakes shaped to cross-section.
Fig. 24. Drilling tail pipes before cutting tail to correct plan shape.

shape. For this work a $\frac{1}{8}''$ chisel or a very small gouge will be handy, and cuts should be made towards the nose from the point where the nacelle lines merge into the top and bottom lines of the fuselage (see Fig. 23). The work is cleaned up to a smooth finish with a small, tapered half-round file and finally with a piece of fine sandpaper.

The twin tail-pipes of the Javelin also need a little thought. They are situated close together and separated by a small fairing triangular in shape in plan view. The fuselage should be set out so as to include these fairings, as shown in Figs. 21 and 22, but the rear end should be left square until the tail pipes have been drilled because these pipes slightly overlap the fairing portion, and drilling in the correct position would be impossible once the fairing has been cut back. When this drilling has been done, the tail pipes can be cut back to their correct shape and the small "channel" extensions of the inner sides of each pipe are filed out with a half-round file (see Fig. 24). The shaping of the outer edges of the fuselage to correct section then follows.

A rather similar problem is encountered on the Avro Canada CF–100 twin-jet fighter. With this type the process of cutting the nose down to correct width as a preliminary to the plan shaping proper is repeated for the tail section also so as to make provision for the two tail-pipes which, in this aircraft, are situated alongside the fuselage.

These types of aircraft present one of the most difficult shaping problems that the model maker is likely to come across, and the Javelin, CF–100, or any other aircraft of similar layout should not be tackled until the modeller has gained some experience and skill on more straightforward types.

Apertures in the sides of a fuselage are sometimes required, as, for instance, in turbo-prop aircraft, such as the Westland Wyvern and Fairey Gannet, where the jet pipes project through the fuselage side. These apertures are best cut after the section shaping has been completed. They can be started off with a drill, but as the pipes usually emerge at an acute

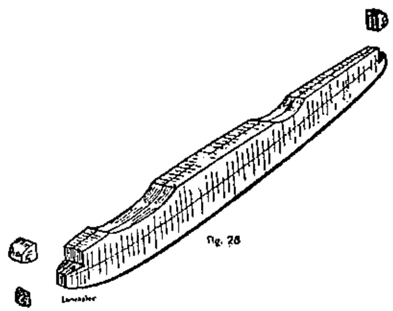


Fig. 25. Fuselage for bomber with nose and tail turret and bomb-aimer's window sections cut off and seatings filed for cabin and dorsal turret.

angle the holes will be elongated and they must be shaped to this form with a round file. Mark the shape of the aperture and drill in first at right-angles to the fuselage surface at the widest point of the opening. When a depth of about $\frac{3}{16}''$ has been reached, fit a slightly smaller-size drill and then drill in at the required angle. The hole is then finished off to outline with the file.

Larger aircraft do not necessarily mean bigger problems, but they sometimes involve additional stages to the basic sequence. On bombers, such as the Wellington, Whitley, Stirling, Halifax, and Lancaster, for instance, provision will have to be made for bomb-aimers' windows and nose, dorsal, and tail gun-turrets. As with cockpit covers, these turrets should be made separately of perspex and appropriate seatings cut in the fuselage to receive them.

As far as turrets and bomb-aimers' windows are concerned the fuselage shaping should proceed through its stages up to Stage 6 as though these parts were going to be made integral with the fuselage. Dorsal-turret seatings can be treated in the same way as cockpits and the seatings filed out after Stage 6. Seatings for nose and tail turrets and bomb-aimers' windows, where appropriate, can be cut out with a fret-saw or fine hack-saw, the seatings being finally cleaned up with files and sandpaper in the normal way (see Fig. 25).

One other type of fuselage which must

receive mention is the type where the section is circular throughout its length. Many modern aircraft, both military and civil, make use of this form—the Comet, Canberra, Brabazon, Viscount, and Valiant are only a few examples. One naturally thinks in terms of lathes when contemplating shaping anything to circular form, but such an expensive piece of machinery is usually outside the scope of the amateur's pocket. Moreover, the use of a lathe is by no means necessary or even desirable, for the amateur's model should be entirely hand made. The following simple sequence of operations, if carefully undertaken, will enable anyone to carry out this work quite satisfactorily using only those tools which have already been suggested as forming the model-maker's kit.

When we reach the stage of section shaping we shall have a block which is square in section throughout its length. The centre portion will be a uniform square for a matter of several inches where the fuselage "tube" will be at its maximum. From this section towards the nose and tail, the fuselage will taper in profile and plan, but still the sections at any point will be square, except perhaps for a short length at the extreme nose. The maximum breadth line must be marked on the sides of the block since the nose and tail portions of the fuselage will nearly always taper to points above or below the datum line, and the latter will not, therefore, mark the true centre of the fuselage "tube". Two sets of templates will be needed, one giving the final sections, as shown in Fig. 26(a), and the

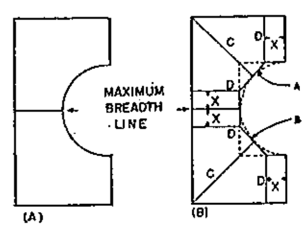


Fig. 26. Templates for checking two stages of shaping fuselages to circular section.

other giving the sections at an intermediate stage in shaping, as shown in

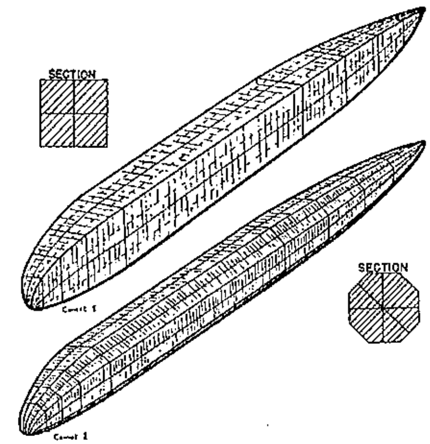


Fig. 27. Marking out for preliminary stage of shaping fuselage to circular cross-section.

Fig. 28. Preliminary stage of shaping completed. Fuselage in octagonal section.

Fig. 26(b). This latter set is constructed by first drawing the circle of the finished section, as shown by the broken lines in the illustration. The lines A and B are then drawn in at an angle of 45 degrees to the squared lines so that they just touch the circle at their centres, the template then forms one-half of an octagonal section. The centre lines of the two angled faces are then marked (C) and lines are drawn parallel to the maximum breadth and centre lines from each of the corners made by the faces (D). We can now take measurements from the centre and maximum breadth lines to the corners—shown as x in Fig. 26(b), these measurements, incidentally, should all be the same—and plot them on our fuselage block for every template station. The points are then joined up on the block, as shown by the broken lines in Fig. 27. The block is now worked down to these lines to form an octagonal section throughout, as illustrated in Fig. 28. On large models most, if not all, of this work can be carried out accurately using a small plane or a spokeshave. When these tools or any other cutting tools are employed, always make the cut from the widest portion towards the narrowest so as to avoid cutting into the ends of the grain and ripping the wood. Check all section stations with the intermediate templates.

The centre lines of each of the eight faces are then plotted on the block with a soft black pencil. The top and bottom centre lines and the maximum breadth lines should also be boldly marked, since all these lines now indicate the *finished* size of the fuselage all along their lengths and they must not be filed off. The second and final stage of shaping, the rounding off of the block on each of the eight segments between the marked lines, is now carried out, checks being made with the circular section templates.

This method, if carried out carefully, will result in a finished job of almost perfect circular section. It will not, perhaps, be as precise as if the work is done on a lathe, but visually there will be very little difference, certainly not sufficient error to affect the finished appearance of the model.

Mention has already been made of the rectangular type of fuselage found on most of the older aircraft and no enlargement on this form will be necessary. Most of the shaping work will be completed at Stage 6, apart from a slight rounding of the top deck in some cases, and a rounding of the engine cowlings. These fuselages can be shaped almost without the aid of templates.

The method for cutting cockpits has already been described and a similar method is employed for cutting housings for nose or tail wheels on models having retractable undercarriages.

CHAPTER FOUR

Cockpits, Cabins, and Gun Turrets

Before we leave the subject of fuselages we must examine the various methods to employ in representing or making provision for cockpits, cabins, gun turrets, and the like.

COCKPITS

The open type of cockpit is rarely encountered on present-day aircraft, but if models of some of the older aeroplanes are contemplated, the cockpits will form an important part of the characteristics of the fuselage, and their shapes will have to be copied carefully. Before anyone thought of putting a lid over the cockpit and protecting the occupants from the elements, these openings ostensibly provided a means whereby the pilot and passengers could put their heads through and see what was going on outside. More often than not they also provided a means of attracting draughts, rain, snow, and other unwelcome intrusions to whip round the hapless occupants!

On at least one early cabin aeroplane even the cabin windows were left as open spaces, and in a description of this particular aeroplane in a reference book at the time this feature was described as being effective in removing all traces of stuffiness and feeling of helplessness so often found in the totally enclosed type! Today, with our sealed pressure cabins, it seems that the air traveller has overcome his former claustrophobic aversion, and the model maker is faced with one more operation—the fitting of glass in the cabin windows!

OPEN COCKPITS

Open cockpits have either curved or square-cut edges or sometimes a combination of both. Most first World War aircraft had curved-edge cockpits, and examples of the square-cut variety are found on the Tiger Moth, Gauntlet, and many of the ultra-light aircraft that were produced just before the second World War. In making either type, the profile outlines are marked out and shaped with the fuselage profile, and the cockpits are drilled out after the plan shaping stage. Cockpits having squared lines must be finished off by cutting with a small chisel. Windscreens for this type of cockpit can be made of thin transparent celluloid. Cut the celluloid about twice the depth of the windscreen and form two "prongs" for fitting into small holes drilled in the fuselage as shown in Fig. 1.

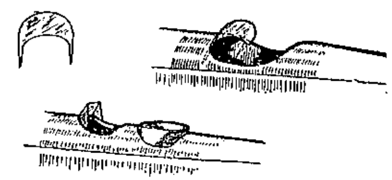


Fig. 1. Celluloid windscreen for open cockpits.
Fig. 2. Gunner's cockpit with built-up fairing.

GUNNERS' COCKPITS

Gunners' cockpits on the older types were invariably circular with a Scarff or high-speed gun-mounting on the top. These cockpits are simply drilled out, preferably before the final shaping of the top deck is carried out. For one-seventy-second-scale models either a $\frac{1}{4}''$ or $\frac{3}{16}''$ drill will usually give the right size. Where the fuselage was flat-topped, as on the famous Bristol Fighter or the Armstrong Whitworth Atlas, nothing need be done beyond drilling, but on types where the fuselage had a rounded fairing on top, as with the Hawker Hart and Audax, a circular fairing, looking something like a squat chimney, was used to provide a level surface for the gun-mounting. This fairing can be represented by a piece of thin cardboard or tin rolled to shape around a pencil and inserted in the drilled hole so that it stands up from the fuselage top decking. Cut the card or tin so that the edges just meet when rolled and do not overlap (see Fig. 2).

TRANSPARENT COCKPIT COVERS

Since the late 1930s the majority of aircraft have cockpits completely covered in with a transparent canopy or hood, the Spitfire, of course, being a typical example. On models, this type of hood should also be represented by some transparent material and not merely in painted wood. Transparent cockpit covers moulded in acetate sheet are marketed for a range of different aircraft types, and the beginner in the scale-model field may decide to make use of these covers rather than go to the trouble of making them himself. But sooner or later he will no doubt find himself wanting to build a model for which no commercially produced cockpit cover is available and he will be thrown back upon his own resources.

MOULDED COVERS

Covers can be moulded from very thin acetate sheet, and although the writer has never made use of this process, preferring the solid type of cover described later, a description of the method used in moulding cockpit covers is given here for the benefit of any who may wish to make use of this type.

The shape of the cockpit cover is first carved out in a separate block of wood as though the wood cover were being used on the model, but with the difference that the overall dimensions should be reduced by the thickness of the transparent sheet to be used. This forms the mould. Then in a sheet of thin wood a cut-out is made to the exact size of the base of the cover to form a frame. A sheet of the transparent material is then pinned securely over the cut-out and heated over an electric fire. When it is heated sufficiently the material will become pliable, and when in this state the shaped mould is pressed into the cut-out

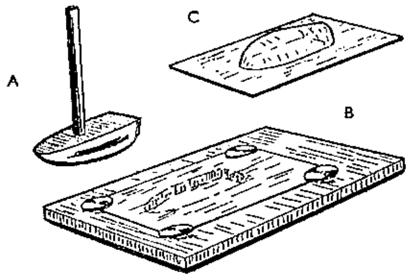


Fig. 3. Method of moulding cockpit covers in thin acetate sheet: (a) Mould; (b) Frame; (c) Moulded transparent cover ready for trimming.

until the material has assumed the shape required (see Fig. 3). It will be necessary to fit a small handle to the shaped mould for this process and this can be made from a length of wire or wood dowel-rod. When the material has cooled it can be trimmed off round the base and then cemented on to the model.

This system is, however, not recommended as it is difficult to get a crystal-clear representation of the cockpit cover, the most common fault being white blemishes which appear if the material is not heated sufficiently and is strained in the moulding process.

"SOLID" TRANSPARENT COVERS

A much more satisfactory method is to make the cockpit cover out of a solid block of perspex. This material is easy to shape with files and, when polished, produces a miniature cover which looks exactly like the real thing. The one disadvantage is that no interior detail can be shown in the cockpit, but in fact this drawback loses much of its importance, for on a small-scale model accurate cockpit detail is very difficult to reproduce without a specialized skill far beyond that of the average modeller for whom these notes are intended. In addition, no matter how clear a moulded cover may be, a good deal of the interior detail will be lost to sight when the cover is in place unless the added complication of some form of interior lighting is incorporated.

The sequence of shaping a cockpit

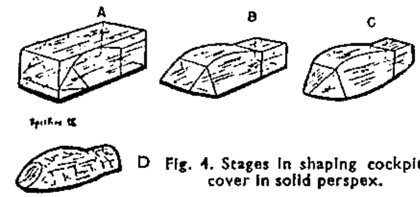


Fig. 4. Stages in shaping cockpit cover in solid perspex.

cover in solid perspex closely follows the method for a fuselage. First, a rectangular block of the exact length and of a breadth and depth equal to the maximum breadth and depth of the cover is cut out. This material can be cut with a fine hack-saw and trued up by filing with the block held in a vice. The two sides of the block are then lightly rubbed with fine sandpaper to provide a suitable surface upon which the side elevation can be set out in pencil (Fig. 4(a)). The block is then filed down to this outline, as shown in Fig. 4(b), following which the plan shape is marked out and the surplus material again filed away (Fig. 4(c)). A coarse file can be used for the preliminary shaping, but the finishing of each stage should be carried out either with a very fine file or with fine-grade sandpaper. The fourth and final stage consists of rounding off the cover to its correct cross-section (Fig. 4(d)). Here some difficulty may be experienced in holding the perspex in a vice owing to the smooth surface of the material and the shape of the cover; the modern one-piece "bubble"-type covers are most troublesome in this respect. This difficulty can be overcome if the front and rear halves of the cover are shaped in separate operations with the cover held by its tail or nose in the vice, as the case may be. Vice-clamps must be used for this operation to prevent marking the work (Fig. 5).

The illustration shows a cockpit cover

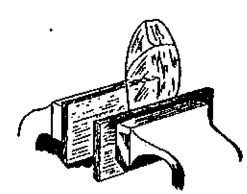


Fig. 5. Holding cover in vice for shaping.

for the Spitfire, but the method for all similar covers, including the fully streamlined type set on top of the fuselage, as on the Swift, is exactly the same.

The shaping process will leave the cover with a "frosted glass" surface and it must then be polished until a crystal-clear finish is obtained. A polish especially for use on perspex can be obtained, but the ordinary household metal polish is just as effective. After the first rubbing over, the surfaces will probably show small scratches and these must be removed with a very fine file or crocus paper — a fine sandpaper — and the polishing continued until a perfect surface is obtained.

In the illustration given here the windscreen, the sliding portion of the hood, and the small fixed transparent panel at the rear are all shown as shaped from one piece. Where longer covers are needed, such as on the Fairey Battle, they can be made either in one piece or in sections, depending upon the preference of the modeller or the size of material available. Care must be taken to secure a fairly good "seating" of the cover on the fuselage, but any slight imperfections will not matter since the framing, which is put on later, will mask any small gaps.

This type of cover should be fitted to the fuselage with special perspex cement, a liquid adhesive which can be obtained in small bottles from any model or handicraft shop. It is an extremely quick-drying substance and swift working is needed. It is best applied with a thin metal rod—a length of wire inserted in the end of a piece of dowelling makes an excellent tool for this purpose. Apply the cement to the edges of the cockpit and press the perspex cover firmly into place. In a few minutes a very strong joint will have formed. The inside of the cockpit should first be painted with a dull-black paint or black drawing ink.

FRAMING COCKPIT COVERS

The representation of the framing is obtained with very narrow strips of thin paper cemented on to the cover. The width of the strips can be measured from the general arrangement drawings, but will usually be in the region of only $\frac{1}{32}$″ or less, so delicate handling will be needed. The strips are cut from the edge of a sheet of paper using a razor-blade and metal rule or straight-edge. The single-edge backed variety of razor-blades are most suitable for this job, being both easier to handle and safer than the double-edged type. A cutting-board of fairly hard smooth wood should be used and the metal rule must be held firmly pressed down, otherwise the strip will "cockle" as it is cut. A sharp blade is, of course, essential.

Perspex cement is again used for fixing the frames, and owing to its quick-drying properties, deft working is required. A pair of fine-point tweezers will also be needed. Fix the vertical or athwart-ships frames first, in the following manner. Mark the points on the fuselage where each section of the frame meets the cockpit edge. Then, holding a length of paper strip in one hand, apply the cement to a very small section of the end of the strip just sufficient to give an "anchorage". Then place the end of the strip against one of the marks and set it in place with the tweezers (see Fig. 6). When the end is

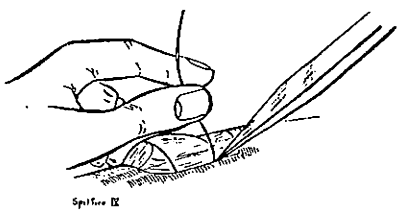


Fig. 6. Method of fitting paper strips for frames.

firmly fixed, apply cement to another short section of the paper strip and hold this section on to the cover with the tweezers until the cement sets. Continue the operations until the base of the hood on the opposite side is reached and then trim off with the razor-blade. Fix all the vertical members in the same manner, including the frames edging the front windscreen. Note that where the cover butts on to the fuselage, as at the rear of the Spitfire hood, the paper should be fixed so that it masks the joint between the perspex and the wood.

Then fix any horizontal or fore and aft strips, using the same method of working, and finally fix the strips to frame the base of the hood all round. This can often be done with one complete length of paper, starting at the rear corner of the hood on one side and working round to the opposite corner on the other side; but where a sliding hood is to be represented a more effective appearance is given if the sliding portion is framed with a separate strip.

Do not apply too much cement to the strip, because if this is done the adhesive will squeeze out at the sides as the strips are laid on the perspex and the polished finish will be marred. If this does happen, allow the cement to set hard and then carefully shave it off with a thin razor-blade and rub over with a little more polish.

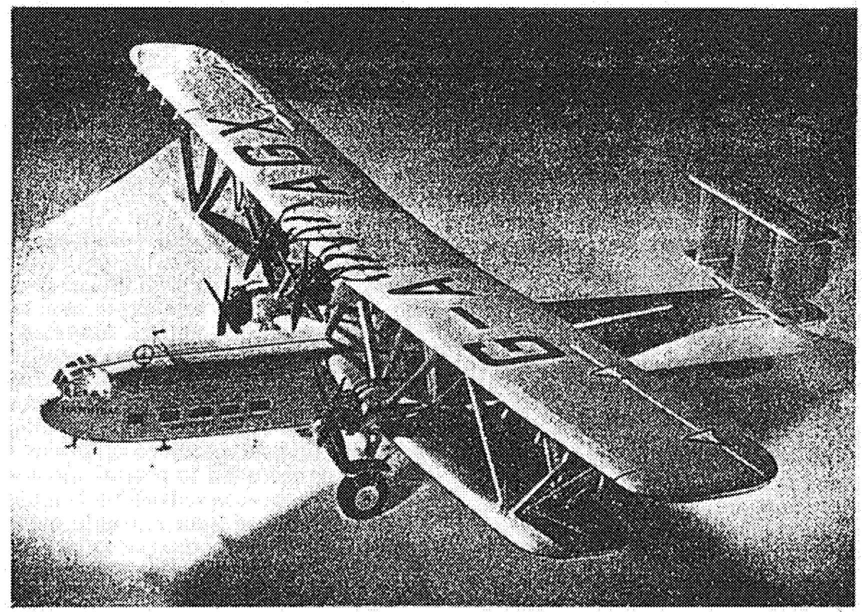
CABINS

Cabins of almost endless variety will be found on the different types of aircraft which the model maker will come up against, and the representation of cabins can range from the completely solid model, with windows painted on, to the hollowed-out fuselage in which seats, controls, and all manner of interior details are fitted.

The painstaking model maker will never be satisfied with the painted-window type and will want to use a transparent material for windows no matter whether any interior detail is fitted or not. As regards interior detail, however, one should be guided by the amount of it which will be visible when the cabin is closed in and the windows and framing are fitted. Very often, depending on the particular aircraft type, little or none of the detail can be seen in the finished model, and many hours of patient work is brought to naught when this is the case. So study each type carefully, and if you want to include interior detail decide in advance how much of it will be seen in your finished model and plan the detail accordingly.

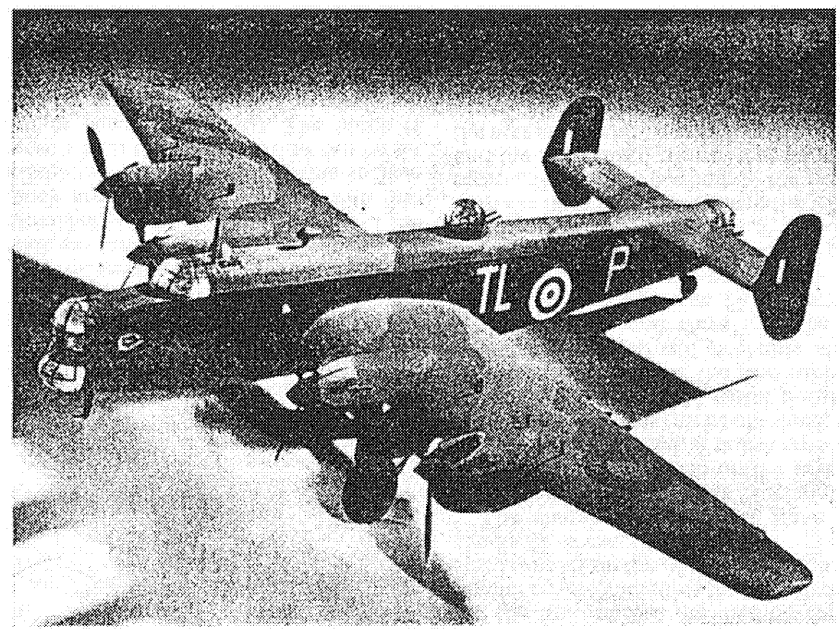
SOLID CABINS

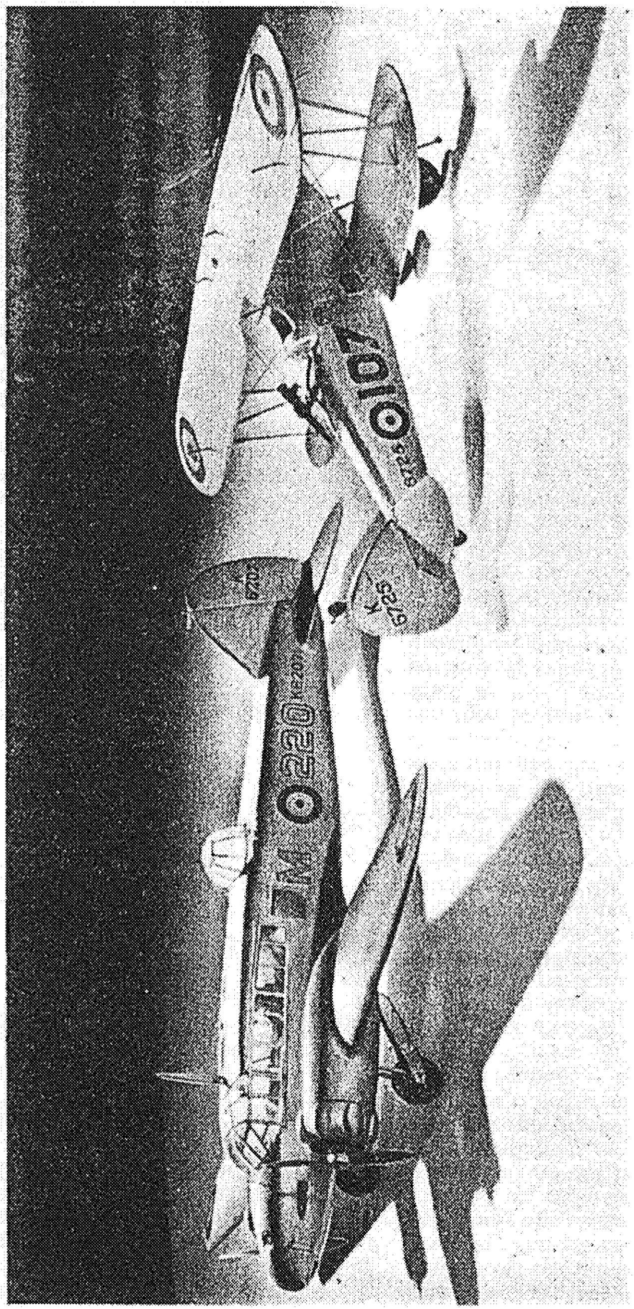
Taking the simplest form first, the completely solid cabin presents very little



Handley Page Hannibal

Handley Page Halifax





Avro Anson and Hawker Hind

difficulty, its shape being set out and carved as part of the fuselage. The beginner will find that this method is very convenient on models of high-wing monoplanes or on biplanes where the top wing is mounted directly on top of the fuselage, examples being the Puss Moth, Auster, and Dragonfly. On such types it is a simple matter to fit the wing on to the top of the solid cabin.

A number of different methods can be used for fitting glazed windows to cabins, and the choice of method will depend upon, firstly, the particular aircraft type, and, secondly, on whether or not interior detail is to be included.

RECESSED WINDOWS

Again taking the simplest form first, we have the method which can be used where the fuselage is left solid, but shallow recesses are cut for the window shapes, the recesses being painted dull-black inside and having thin celluloid or perspex fitted in to represent the glazing (Fig. 7). This method is particularly advised on modern air-liner types, such as the Hermes, Ambassador, Viscount, Comet, and Britannia, where the fuselage section is circular, which makes the hollowing out of the cabin particularly difficult, and where, in any case, the size of the windows is so small that no cabin detail would be visible. Externally, it provides a very realistic effect.

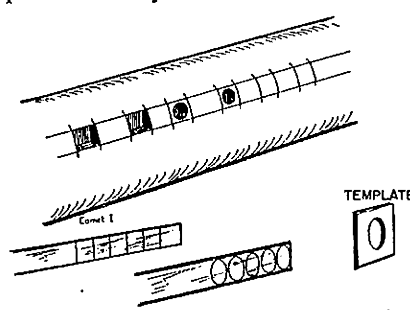


Fig. 7. Marking out and cutting recessed windows.

Fig. 8. Cutting windows from celluloid strip. Template shown for marking out oval windows.

The recesses should be cut to a depth of about $\frac{1}{4}$". The marking out for such windows consists of first drawing two parallel lines along the fuselage side representing the top and bottom of the windows. Where the windows are rectangular, as on the Comet I, they are then marked out between the parallel lines by short vertical lines. Where they are circular or eliptical, as on the York or Viscount, the centre of each window should be marked by a single vertical line. For circular types the window can then be scribed with a pair of compasses, but on eliptical types two further lines should be marked at points representing the maximum breadth of each window, and the shape should then be carefully copied from the general arrangement drawings. The edges of the windows should then be scored with a sharp chisel or gouge, of appropriate curvature to prevent splits running along the fuselage, in exactly the same manner as for cutting out cockpits. When this has been done the space within the lines can be drilled out to a depth of approximately $\frac{1}{4}$", using the largest size drill possible. The recess is then finished to its correct shape, if necessary with a chisel or gouge.

The actual glazing is carried out late in the final painting stages of the model, but for completeness the method is described here. Transparent celluloid of about $\frac{1}{32}$" in thickness is the best material to use for this type of window, since it can be cut quite easily with scissors and can be bent to follow the curved surface of the fuselage. Thin perspex can be used, but this may need filing so that the window follows the curve of the fuselage and will need to be polished after fitting, and as this work is done when the model has already been painted, the paint may be damaged by the polish. The material should be cut into strips exactly equal to the depth of the window and the window shapes then marked out along the strip (Fig. 8). The sharp point of a pair of dividers should be used for marking out, and where the windows have curved outlines it is a good plan to use a template made from a piece of thin cardboard, with a hole cut in it to the shape of the window. This hole should be cut very slightly oversize. The recesses will already have been painted dull-black inside, and the windows are then fitted by smearing a thin layer of glue or cement round the edges of the cut-out and pressing the transparent material into place. Each window should, however, be tried for a close fit before the adhesive is applied.

WINDOWS CUT THROUGH FUSELAGE

A variation of this method, illustrated in Fig. 9, consists of cutting the window

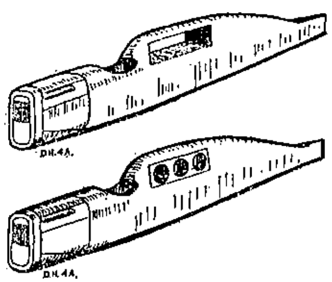


Fig. 9. Window aperture cut right through narrow fuselage.

Fig. 10. First stage in cutting aperture. Holes drilled through fuselage.

aperture right through the fuselage, the inside of the aperture then being painted dull-black and celluloid or perspex glazing being fitted as before. This method gives a rather better effect, but is recommended only where a fuselage is relatively narrow and particularly where a single long cut-out can be made for all the cabin windows, the separate panes then being represented by framing with narrow paper strips. Examples of types on which this method can be used are the early commercial aircraft, such as the D.H. 4A, 9C, 18, 34 and Armstrong Whitworth Argosy and on the more recent De Havilland Dove. Where this method is used the window shapes should be scored on both sides of the fuselage after marking out, and the wood within the markings is then drilled at close intervals (Fig. 10). Drill completely along one side of the fuselage first to a depth approximately equal to half the fuselage width, repeat the process from the opposite side of the fuselage, and then clean out with chisels and files. Rather more care is needed with this method to ensure that the cut-out is true right through the fuselage. The glazing is simplified because only one single strip of material is required on each side of the fuselage. Again, this should be fitted during the final painting stages of the model, and narrow paper strips are then cemented on to the transparent material to represent the framing.

HOLLOWED CABINS

Where a hollowed cabin is required the shape of the particular fuselage will, to a large extent, dictate the method to be used. The whole of the cabin space is hollowed out, either from the top of the fuselage or from the bottom, a separate strip of wood being fitted afterwards for the roof or floor. Wherever possible the hollowing out should be done from the bottom of the fuselage so that cabin seats and other details can be built up on the separate floor strip, and these details can then be painted before the floor is fitted to the fuselage. This method is particularly suited to all the earlier commercial types where the fuselage section is mainly rectangular. Examples are the D.H. 34 and Argosy already mentioned as well as the Armstrong Whitworth Atalanta, Handley Page Hannibal, and many other similar aircraft types. In all cases the window openings should be cut

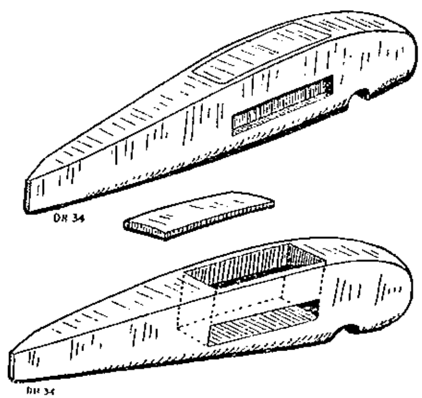


Fig. 11. Hollow cabin. First stage with window recesses cut and floor cut-out marked.

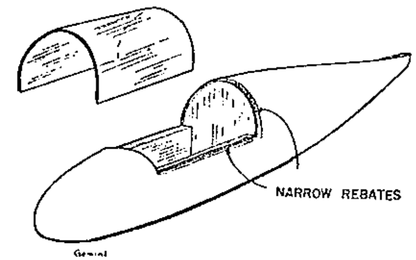
Fig. 12. Cabin hollowed out from underside of fuselage.

in the sides of the fuselage first, with shallow recesses of 1/8" to 1/4" depth as described above. The plan of the cabin is then marked on the bottom of the fuselage, the sides of the fuselage being left between 1/16" and 1/8" thick (see Fig. 11). The outline is then scored with a chisel and the cabin is hollowed out by drilling with large-size drills or with a brace and bit. After drilling, the walls are cleaned up smooth with chisels and files (see Fig. 12), particular attention being paid to the inside edges of the windows which have already been cut. A separate strip of thin wood is then cut out to fit exactly the opening in the bottom of the fuselage to form the floor, and if cabin detail is to be included this can then be built up on the floor strip. The cabin details and, of course, the inside walls of the cabin must be painted before the floor is finally glued in place. After the floor has been fitted, any small gaps are filled with plastic wood, and the bottom of the fuselage should then be rubbed over with fine sandpaper.

If the hollowing out is done from the top of the fuselage, cabin detail can be built up on a thin strip of wood which can be fitted into the cabin to form a false floor before the cabin roof is fixed.

HOLLOW CABINS—LOW-WING MONOPLANES

Where interior detail is required on cabin monoplanes of the low-wing type, the hollowing out is best done from the top of the fuselage. From the modelling point of view this class of aircraft falls roughly into two categories: firstly, the type on which the whole of the cabin sides and roof are formed of transparent material, examples being the Miles Gemini, Percival Gull, Proctor, and Prentice; and, secondly, aircraft where the cabin is surmounted by a "solid" roof, such as on the Anson and Dove. In the former category, which consists mainly of the smaller aeroplanes, the whole of the cabin outline should be omitted when shaping the fuselage, in a similar manner to the omission of the cockpit cover, as described in relation to the Spitfire fuselage in Chapter 3. The



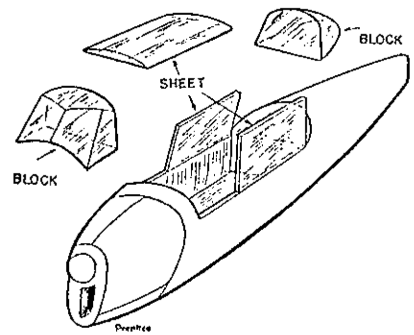


Fig. 13. Cabin cover made of thin celluloid bent to shape.

Fig. 14. Composite cabin glazing with shaped solid perspex block and thin sheet.

hollowing of the fuselage is also dealt with in a similar manner to the hollowing of the cockpit. Then, after the internal details have been fitted, the transparent cover can be built up on top. For the transparent cover the modeller can use either a moulding of acetate sheet as described earlier in this chapter or the transparencies can be built up with sheet celluloid or thin perspex. If the built-up method is chosen the type of material to use will depend to some extent on the shape of the transparencies. Where no double curvatures are found, that is where the cabin section is curved in front view but not in plan, as, for instance, on the Miles Gemini, Percival Gull, or Proctor, thin celluloid is the best material to use. This material can be moulded very easily if it is immersed in warm water and bent to the shape required. Where this material is used a narrow rebate should be filed in the fuselage around the edges of the cabin to which the celluloid can be cemented (see Fig. 13). Even on this simple type of cover the front windscreen will almost invariably have a double curvature, and the windscreen should, therefore, be shaped from a solid block of perspex and fitted separately. A narrow rebate will also be needed on the rear edges of the windscreen to allow the celluloid to fit neatly on to it.

Where double curvatures are found in the cabin cover a combination of thin sheet perspex and solid perspex may have to be used. An example of this is found on the Percival Prentice where the rear of the cabin canopy curves down to the fuselage deck as well as being curved in cross-section. On this and similar types thin sheet perspex or celluloid can be used for the centre portion of the canopy, that is between the front windscreen and the rear curved fairing, thus enabling the cabin detail to be included, and the windscreen and rear fairing can be formed from two solid blocks of perspex. If sheet perspex is used for the centre portion, separate strips will be needed for each of the two side panels and for the roof, the latter being filed to the correct curvature on top. The front windscreen should be fitted first and then the two side panels are cemented in place, after which the shaped roof is cemented on top and, finally, the shaped rear portion is fitted (see Fig. 14). When the paper strips are cemented on to form the cabin framing, this type of built-up cabin will be quite strong.

With the larger cabin types, such as the Anson and Dove, the fuselage should be completely shaped as though the cabin were to be left solid, then the whole of that part of the fuselage forming the cabin should be cut down to the level of the bottom of the cabin windows and the interior hollowed out and fitted with the cabin details. Thin sheet perspex is then fitted to form the side windows and a separate piece of wood is shaped for the cabin roof. It may be found necessary on these types to provide some additional support for the roof portion, and this support can take the form of short lengths of wire plugged into holes drilled in the cabin floor, the upper ends of the wires being fitted into holes drilled in the underside of the roof portion (see Fig. 15). Where these additional supports are

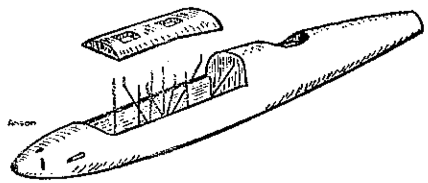
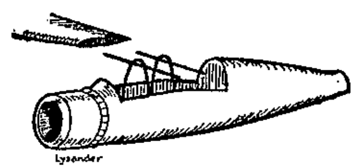


Fig. 15. Wire supports for solid cabin roof.

used they should be arranged so that they follow the framework of the actual aircraft, or so that they will be masked by the paper-strip window-framing which is put on afterwards. The Anson is a particularly good example of this type of cabin construction, since with its large windows one is able to see clearly into the cabin even on a small-scale model, and the extra work of fitting interior details is well worth while.

HOLLOW CABINS—HIGH-WING MONOPLANES

The use of internal formers will also be necessary on high-wing cabin types, such as the Lysander and Auster, to provide a means of fitting the wings to the fuselage. On such types the formers will have to follow exactly the pattern of those on the



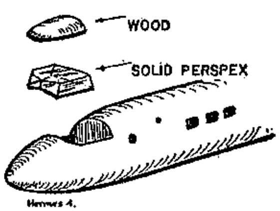


Fig. 16. Use of formers on high-wing cabin type showing wire dowels soldered on to provide for fitting of wings.

Fig. 17. Pilot's cabin windows and cabin roof.

actual aeroplane, and to the tops of these formers short lengths of wire will have to be soldered so as to project from the sides of the cabin to fit into holes drilled in the wing roots (see Fig. 16). The transparent panels are then built up in sheet perspex or celluloid around the formers. The modeller will no doubt find that a certain amount of trial and error will have to be used in fitting the transparent panelling on these types of model.

PILOTS' CABINS ON LARGE AIRCRAFT

Pilot's cabin windows on modern airliners, such as the Comet, Viscount, Ambassador, and Britannia, are best shaped from a single block of perspex, since practically no cockpit detail can be seen on small-scale models of such aircraft. In any case, on nose-wheel types the nose of the fuselage must be weighted so that the model will "sit" properly on its undercarriage and not fall back into its natural tail-down attitude, and the pilot's cabin, if hollowed out, provides an excellent place for inserting the required amount of ballast. The method used for pilots' cabins is, firstly, to completely shape the fuselage as though the cabin were to remain solid, then the upper part of the cabin, down to the bottom line of the windows, is cut off and the cabin is drilled out. The cabin windows are then filed to shape from a solid block of perspex, and a separate piece of wood is shaped to fit on top of the perspex block to form the cabin roof (see Fig. 17). These two parts are then put on one side for fitting later when the model has been assembled and the correct amount of ballast has been inserted in the hollowed-out cabin. The method for ballasting nose-wheel models is described in Chapter 11.

GUN TURRETS

Gun turrets can be represented by moulding in acetate sheet where full internal details are required to be shown; by shaping the turret in solid perspex where no details are required; or, as a compromise between these two, by being built up in several sections of perspex so that a limited amount of detail can be included, particularly the protruding gun barrels. This latter method is recommended for use by the amateur for although it is more difficult than shaping the turret from a single block of perspex it does enable a reasonable amount of detail to be fitted whilst avoiding the difficulties of making mouldings.

The exact manner in which a turret is built up on these principles will, of course, depend upon the type of turret which is being copied, but the illustration in Fig. 18 shows, as a typical example, a complete set of nose, dorsal, and tail turrets for the Lancaster bomber built up by these alternative methods. The guns are

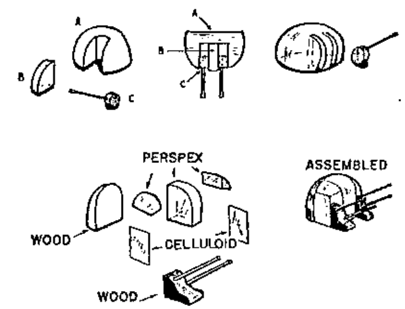


Fig. 18. Turrets for Lancaster III made of combinations of solid perspex and celluloid sheet, with gun-mountings in wood and guns made from pins or wire.

Fig. 19. Gun-mounting in wood. Broken lines show finished size after holes drilled and guns fitted.

formed from short lengths of wire or pins which are inserted into small wooden fittings shaped to represent the elevating mechanism. To overcome any difficulty in fitting the wire representing the gun barrels into these wooden parts, which on a one-seventy-second-scale model will be no thicker than $\frac{1}{16}''$, the wood parts should be first made considerably wider than required and the holes for the gun barrels drilled with a fine drill (see Fig. 19). When this has been done the wire or pins should be inserted in the wood which is then filed down to its correct thickness.

BOMB-AIMERS' WINDOWS

Bomb-aimers' windows can also be shaped from solid perspex. Their form will vary, of course, with different types of aircraft. The war-time Halifax and Stirling, for instance, have bomb-aimers' windows set into the fuselage under the nose turret, and similar seatings to those used for gun turrets are made into which the shaped perspex can be fitted. The Lancaster, on the other hand, had a small domed transparency for the bomb-aimer projecting from the front of the fuselage just under the front turret, and somewhat similar provision is made on the Mosquito bomber and the more recent Canberra. When shaping domed transparencies such as this from solid perspex, start by cutting a square block about ⅛″ to ¼″ longer than the depth of the dome so that this portion can be held firmly in a vice whilst the shaping is carried out. The block is first filed to the shape of the side elevation and then to plan shape before filing it to its circular form. When complete the domed portion is polished and then cut off ready for fitting (see Fig. 20).

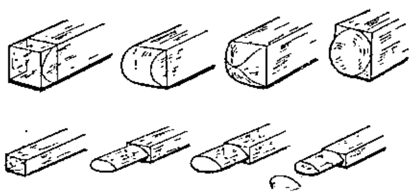


Fig. 20. Shaping domed transparencies on end of square bar.
Fig. 21. Shaping small transparencies on end of rod.

ASTRODOMES

The smaller astrodomes can be shaped in a similar manner, but an easier method with these small parts is to use a piece of perspex rod of the correct diameter, one end of the rod can then be filed to the dome shape and polished and then the part can be cut off allowing about ⅛″ for setting into a hole drilled in the fuselage.

"BLISTER" TRANSPARENCIES

The small "blister" transparencies sometimes found on the sides of the pilots' cockpit on second World War aircraft—both the Lancaster and the Mosquito are examples—are best made separate from the cabin transparencies and cemented on afterwards. To make these fairings, cut a rectangular strip of perspex in the form of a short rod, the end dimensions of which are equal to the breadth and length of the fairing in side elevation. Then, with the rod held in a vice, file about ½″ of one end into its stream-line shape and then file the extreme end to its correct cross-section and polish, after which the shaped end is cut off to the exact depth of the fairing and cemented to the cabin window (see Fig. 21). Where more than one "blister" fairing is required, the process of shaping the end of the rod, polishing, and cutting off is repeated.

Occasionally, the modeller may find that he requires a cockpit transparency deeper than the thicknesses of perspex which he has available. In such cases it is often possible to build up the transparency in two or three layers. This can be done where the cockpit framework can be used to mask the joins between the layers. The illustration in Fig. 22 shows a solid perspex cover for a Sunderland made up of two slabs of material, one ⅜″ thick and the other ¼″ thick, the join being masked by one of the cabin frames.

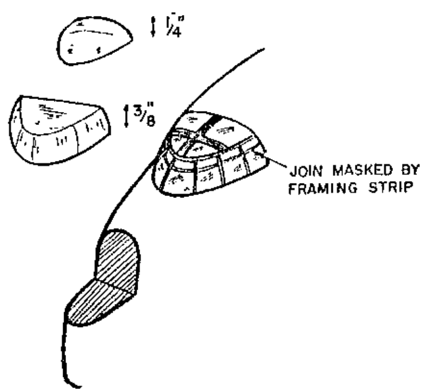


Fig. 22. Method of making deep cockpit covers in two layers of solid perspex.

CHAPTER FIVE

Mainplanes and Tail Surfaces

The mainplanes and tail surfaces of a model are, as a rule, much more easy to construct than the fuselage, but even so, they form a most important part of the structure and as much care should be taken over them as over any other part.

For all except large models of swept-wing types, the mainplanes are best made in one piece, irrespective of the method which will be used to fit them to the fuselage. The one-piece wing is easy to set out on the block and symmetrical shaping of port and starboard sides is facilitated. If the wing has eventually to be fitted to the fuselage in two separate halves, it is a simple matter to cut out the centre section for this purpose.

MONOPLANE WINGS

The methods for monoplane and biplane wings will vary slightly, so let us examine first the construction of a simple monoplane wing, taking again the Spitfire IX as an example.

First, a block is cut out slightly greater in thickness than the thickness of the wing root and a little larger than the span from wing tip to wing tip, and chord—the width from leading to trailing edge at its maximum point.

The block is then planed smooth on one face and marked on the two long edges to the correct depth of the wing root. The second side is then planed down to this size. One edge of the block is now planed straight and true.

The plan shape of the wing is then set out on the block (see Fig. 1). A fore and aft centre line and a wing datum line at right-angles to the centre line is used for setting out as described in Chapter 2. The fore and aft centre line is marked first, exactly in the centre of the block and square with the planed edge. A try-square should be used for marking this line. A spanwise wing datum line is then marked exactly at right-angles to the centre line and at any convenient point on the wing surface. This wing datum line for the Spitfire is shown in the illustrations in Figs. 1 and 3 of Chapter 2. When no wing datum is shown on the general arrangement drawings one can be drawn in a suitable position.

The wing is then cut out to the plan shape (Fig. 2). For wings with curved outlines, as on the Spitfire, the cutting can be done with a fret-saw, but where the leading and trailing edges are straight the rather more sturdy tenon-saw or hack-saw can be used. In either case it is a good plan to cut slightly on the outside of the outlines and afterwards true up the outline by filing with the block held in a vice, or, if the wing has straight edges, the block can be planed down to the outline.

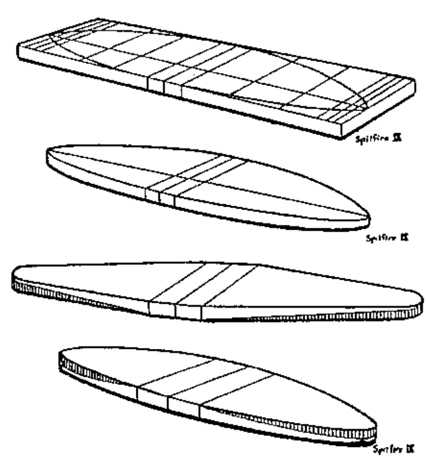


Fig. 1. Plan shape of wing, marked on block.
Fig. 2. Wing cut out to plan shape.
Fig. 3. Wing tapered in thickness from root to tip.
Fig. 4. Spitfire mainplane marked for taper on upper surface.

The next operation is to taper the wing in thickness from root to tip. In nearly all cases this tapering occurs on the lower surface of the wing, as illustrated in Fig. 3. The Spitfire wing is, however, a little unusual in this respect, and a glance at the head-on view in the general arrangement drawings in Chapter 2 will show that there is practically no taper from the wing root to a point just outboard of the gun-mountings, but from that point the wing taper occurs on the upper surface.

Using the head-on view for measurements, this taper is marked on both the leading and trailing edges of the block (Fig. 4). Remember to set out your measurements from the centre line on the plan surface of the block and not on the curved edges, otherwise you will taper off too finely at the tips. For wings of comparatively small depth, the operation of tapering is best carried out by filing with a coarse file, and a G-clamp should be used to hold the block flat on the bench (see Fig. 5). Clamp the block at the centre, making use of a packing block of soft wood to prevent damage, and file off each side in turn.

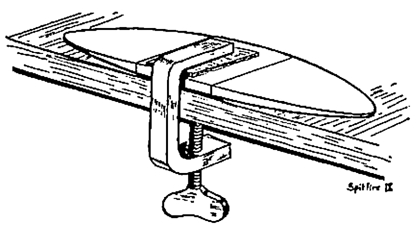


Fig. 5. Use of G-clamp to hold mainplane on bench during filing of taper.

On wings of deeper section much, if not all, of this tapering can be carried out with a chisel or plane. When this method is used always work from the centre section outwards to the tips so that the cuts are made over and not into the grain of the wood. When very deep wings are being made, such as for the Brabazon, where on a one-seventy-second-scale model the maximum depth is $1\frac{1}{12}''$ tapering to less than $\frac{1}{8}''$ near the tips, cutting tools must be used if the job is not to take an inordinately long time, and for

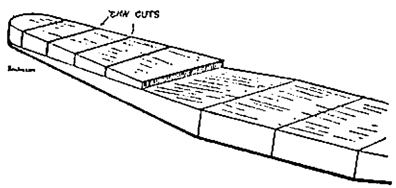


Fig. 6. When tapering mainplanes of thick section make saw cuts at intervals and remove wood a section at a time with chisel and mallet and clean up with files afterwards.

wings of this nature chordwise saw cuts should be made at intervals along the wing, the surplus wood being removed a section at a time, using a chisel and mallet (see Fig. 6). The roughly tapered wing is then finished off with a plane or by filing.

During these operations, make sure that the original fore and aft centre line remains intact and now, before the operation of shaping the wing to its correct section is commenced, the centre line should be carried round the leading and trailing edges of the wing and marked also on the other face of the block.

The marking lines required for shaping a wing to its correct section or camber are, firstly, a line on the leading edge of the block, marking the "nose" of the leading edge; a similar line on the trailing edge of the block, marking the point of the trailing edge of the wing; and a line on the upper and lower surfaces of the block, marking the maximum depth points of the wing. To set out these markings, rectangles are drawn around the wing sections given in the general arrangement drawings, as shown in Fig. 7, and the points of the nose, trailing edge, and maximum depth can then be measured off. Where sections are given at two or more places along the wing, measurements are taken for each position and the points are plotted on the block and joined up. Where, however, as is fre-

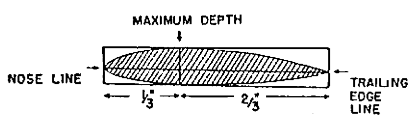
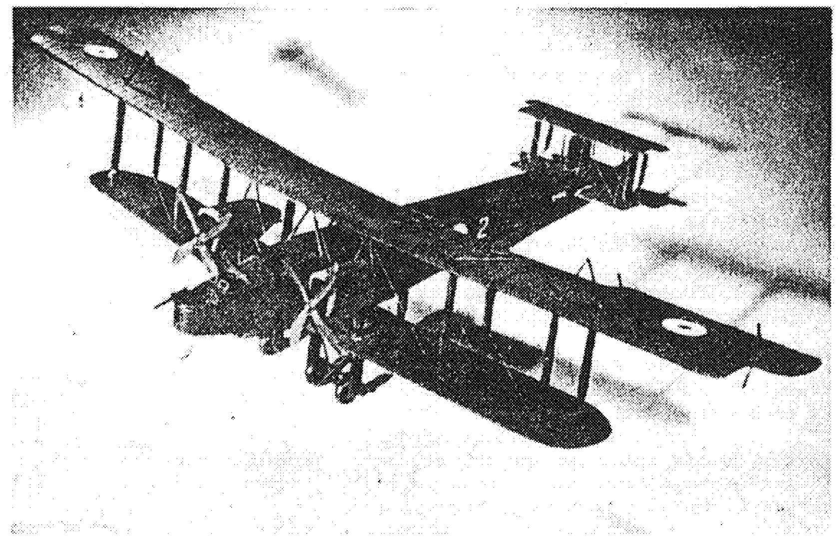
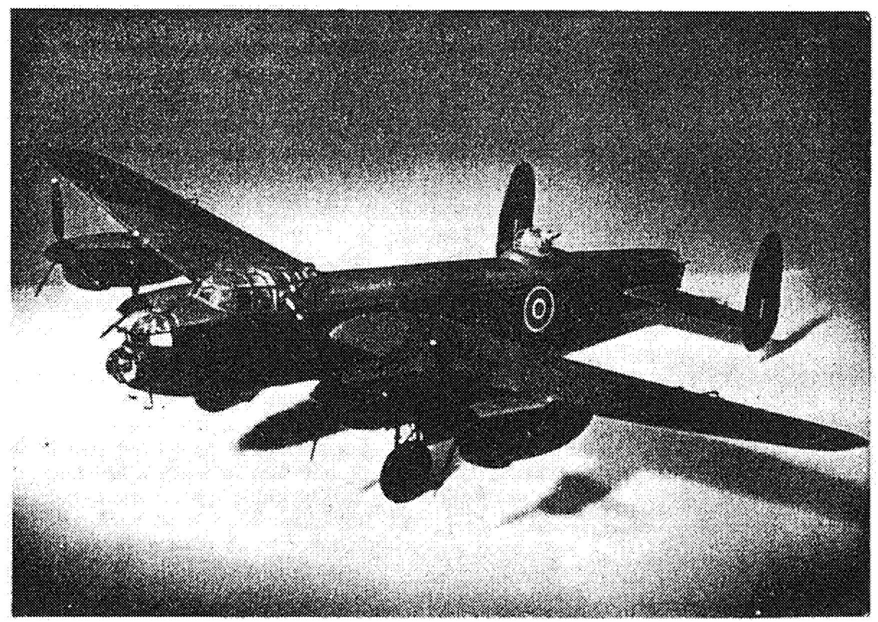


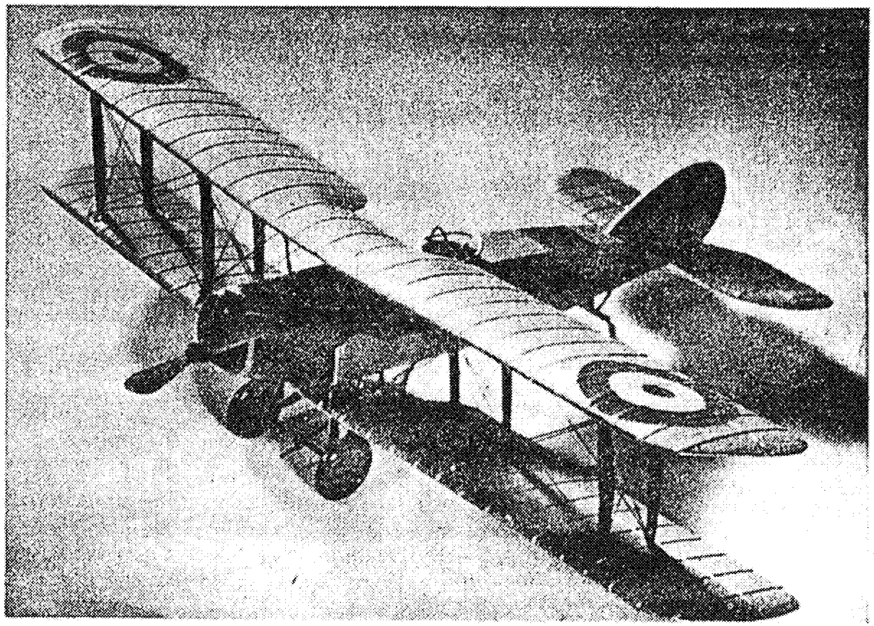
Fig. 7. Rectangle drawn round wing section to ascertain location of maximum depth and leading and trailing edges.



Handley Page 0/400

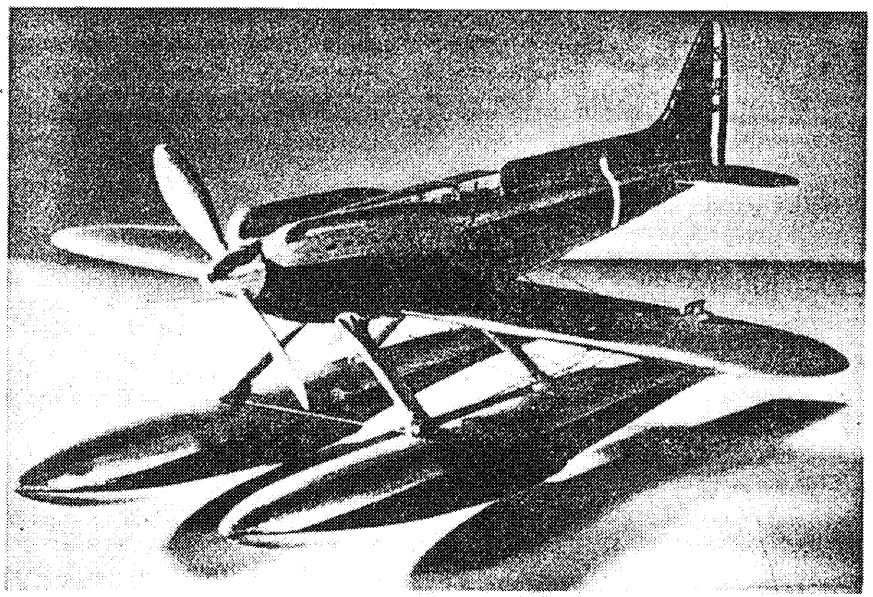
Avro Lancaster





Bristol Fighter

Supermarine—Rolls Royce S.6.B.



quently the case, only one typical section is given on the drawing, usually near the root of the wing, it is necessary to scale down from the section given in order to get measurements at a point near the wing tip. Wherever possible choose your section point where the wing has tapered in plan to half the chord of the section given. The measurements then taken from the first section can be halved for the second position.

As a general rule, the modeller will find that the nose line runs along the centre of the leading edge of the block and the trailing-edge line also runs along the centre of that edge or very slightly below the centre. The maximum depth of a wing usually occurs at a point one-third of the chord back from the leading edge, as shown in Fig. 7.

Templates should be constructed for checking the wing shaping in much the same way as we used templates to check the fuselage section shaping. For each section the template should be constructed in two parts, one for the upper and one for the lower surface of the wing, as shown in Fig. 8.

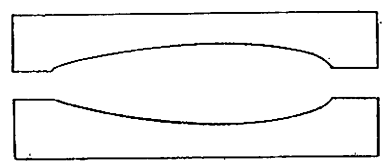


Fig. 8. Typical upper and lower camber templates.

For all except very large wings, the camber can be shaped with files. The block should be clamped flat on the bench by means of a G-clamp with an extra block of waste wood about ½" thick

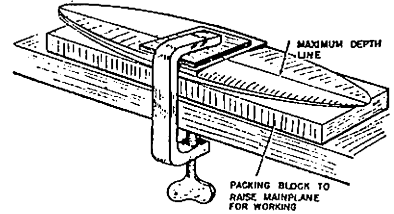


Fig. 9. Mainplane clamped to bench for filing camber.

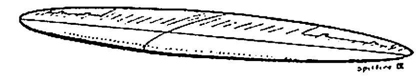


Fig. 10. Mainplane cambered and control surfaces scored.

inserted between the wing block and the bench to facilitate the filing work. The leading edge of the block should be towards the worker, and the clamp should be placed over the fore and aft centre line of the wing block (see Fig. 9). The surplus wood between the maximum depth line and the trailing edge is filed off first on each side of the clamp until the wing surface is a gentle curve between these two points. The leading-edge portion is then filed in a similar manner.

The filing work should be checked at frequent intervals against the templates which have been made for the purpose. The clamp is then moved to a position to one side of the centre line and the centre portion of the wing, which up to now has been covered by the clamp and packing block, is filed down flush with the surfaces on either side. This filing of the centre portion should be carried out in the same sequence, that is, the trailing portion of the wing first, and then, before the leading portion of the camber is shaped, the centre line should be re-marked from the maximum depth line to the trailing edge. After the nose portion of the centre of the wing has been cambered the fore and aft centre line on this portion should be re-marked.

The wing block is then turned over and the filing process is repeated on the other surface, leaving our block as shown in Fig. 10.

The whole wing should now be finished off with a rubbing of fine sandpaper, care being taken not to obliterate the centre-line marking on upper and lower surfaces.

The lateral wing datum line should now be marked again on both upper and lower surfaces of the wing, and the ailerons, flaps, and trimming tabs marked out by reference to this datum and the fore and aft centre line. These control surfaces are then scored with a penknife or chisel, using a steel rule as a guide.

Considerable care is needed for this operation. The rule must be held firmly down on the surface and the chisel or knife drawn slowly along the line. When scoring the hinge lines of ailerons or flaps, work from the wing tips towards the centre and when scoring the lines from the trailing edge to the hinge lines, work in all cases from the trailing edge. When scoring along the grain of the wood, keep the tool pressed tightly against the steel rule, otherwise there may be a tendency for the tool to "run off" to follow the grain.

Fig. 11. Shaped ailerons.

On many monoplanes the ailerons themselves are of aerofoil section, as shown in Fig. 11, and where this is so the leading edge of the aileron just behind the hinge line will curve slightly downwards. To obtain this effect on a model a small blunt-nosed three-cornered or knife-edged file should be carefully worked along the scored hinge line until the aileron surface has the appropriate shape.

DIHEDRAL

Most aircraft, both monoplanes and biplanes, have a certain degree of dihedral built into the mainplanes, that is the mainplane is bent upwards from the centre or near the centre to the tips. This dihedral angle of the wings of an aeroplane is always a prominent characteristic and must be copied accurately in the model. In most cases we find that the wing has a short horizontal centre section projecting on each side of the fuselage and that the outer portions only of the wing are set at a dihedral angle. To reproduce this in the solid wooden wing of a model we must, therefore, bend the outer sections of each wing upwards. This task is much more simple than it at first seems, for on mainplanes up to ½″ or ¾″ in thickness the work can be done by steam bending. First of all a line is marked across the wing on both upper and lower surfaces parallel to the fore and aft centre line and at the point where the dihedral angle occurs. On the Spitfire, which we have been using as an illustration, this point lies just under ½″ outboard of the centre line on each side and is shown in the head-on view in the general arrangement drawings in Chapter 2. Having checked our markings, we then score along these lines on both upper and lower surfaces so as to cut the surface fibres of the wood. The wing is then held so that a jet of steam from the spout of a kettle plays on this line on both upper and lower surfaces (see Fig. 12). This will soften the wood at this point and, when it is sufficiently softened, the wing can be bent quite easily. Whilst the steam jet is being played on the wood the wing should be held between thumb and forefinger lightly flexed in the direction in which it is required to be bent. Do not force the wing to bend, but keep a gentle pressure and allow it to bend in its own time.

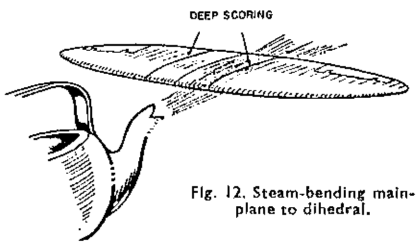


Fig. 12. Steam-bending mainplane to dihedral.

To check the correct setting of the dihedral, measure off from the head-on view of the general arrangement drawings the height of the wing tip above the bottom surface of the wing centre section. During the steam bending process, the wing is placed on a level surface and the height of the tips above this surface is checked with the drawings (see Fig. 13). Make sure that the wing is bent at a clean angle at the correct points on both leading and trailing edges. When the wing has

Fig. 13. Measuring dihedral at wing tips.

been correctly bent it should be left for a while to dry, and then the portions of the wing which have been steamed must be rubbed over with fine sandpaper to remove the roughness which the steaming will have caused. When the wing is completely dry and smoothed down a further check should be made to ensure that the angle has not altered.

The ease with which a mainplane can be bent to dihedral will, of course, depend upon the thickness of the wing. The thin wings of a biplane can be bent after a few seconds in a steam jet, but thick monoplane wings of, say, from ½″ to ¾″ will take longer. In the case of thick wings it is often better to make shallow saw cuts along the dihedral line instead of scoring. The saw cuts can be made either with a fret-saw or a fine hack-saw, and the cut on the upper surface, or the inside of the bend, can be made a little deeper and can also be cut with a thicker saw blade than the lower surface (see Fig. 14(a)). When

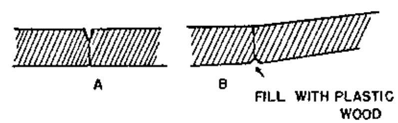


Fig. 14. Steam-bending mainplanes.

the wing is bent the edges of the cut on the upper surface will close together whilst those on the under surface will open out, and these must be filled with plastic wood and rubbed down so that no crack or join can be seen (Fig. 14(b)). In extreme cases, with very thick wings, steam bending will be found to be impracticable, but if the modeller is working to one-seventy-second scale there will be very few aircraft types with wings so thick that they cannot be bent by the method described. However, when steam bending cannot be used it will be necessary to cut right through the wing at the point of the dihedral angle and to file the root of the outer sections of the wing at such an angle that they can be jointed on to the centre section again with the correct amount of dihedral (see Fig. 15). Wire dowels should be used for refixing the outer sections, and for a strong joint these dowels should be arranged in pairs,

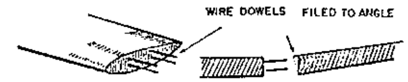


Fig. 15. Alternative method of forming dihedral in mainplanes of thick section.

as shown in the illustration. The faces of the joint should, of course, be glued and, when the joint has set, any small cracks should be filled with plastic wood.

The basic sequence of wing shaping has now been covered and we can briefly summarize this sequence as we did in the case of fuselage shaping.

- Stage 1. Rough block cut slightly oversize all round.
- Stage 2. Block planed down to maximum thickness of the wing root.
- Stage 3. Fore and aft centre line and wing datum line marked and wing plan set out.
- Stage 4. Wing cut to plan shape.
- Stage 5. Wing tapered in thickness from root to tips.
- Stage 6. Wing cambered:
  - (a) trailing edge of upper surface;
  - (b) leading edge of upper surface;
  - (c) trailing edge of lower surface;
  - (d) leading edge of lower surface.
- Stage 7. Score control surfaces etc.
- Stage 8. Steam bend dihedral.

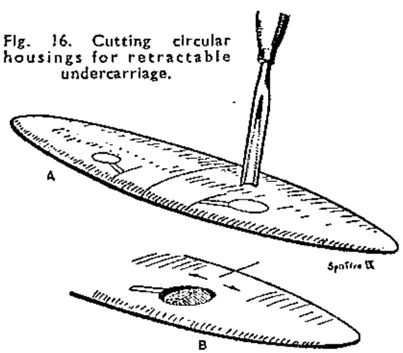
This sequence can be followed for all monoplane wings, and for most types of fixed-undercarriage monoplanes nothing more need be done, but on aircraft types where the undercarriage retracts into the wing, as on the Spitfire, or on jet types where air-intakes are situated in the wing roots, as on the Hunter, Vulcan, and many others, or where radiators are positioned in the leading edges, as on the Whirlwind, Mosquito, Hornet, and Firefly V, one or two additional operations will be called for on the model.

RETRACTABLE UNDERCARRIAGE HOUSINGS

Dealing first with retractable undercarriages, we shall find that in most cases where the undercarriage is retracted into a wing, the wheel lies flat, as it does in the case of the Spitfire, and we shall, therefore, have to cut an opening in the underside of the wing for the wheel housing, and, as a rule, the cutting of a narrow channel will be needed in addition to house the undercarriage leg. The layout of the retracted undercarriage and its fairings is normally shown on the general arrangement drawings. In these drawings of the Spitfire in Chapter 2, the retracted position of the undercarriage is shown by broken lines on the plan view. These shapes are carefully set out on the under surface of the wing, all measurements, as usual, being taken from the centre and wing datum lines. Some difficulty may be experienced by the novice in setting out these shapes, and an alternative is to trace the shapes on to a separate piece of paper or thin card, the shapes can then be cut out and used as a template for tracing on to the wing surface.

Circular wheel housings are the most difficult to deal with because, as the depth of the wing will be small, we cannot use drills or a brace and bit and the housings must be cut out with a gouge. Wherever possible a gouge, having the same curvature as the wheel circle, should be used, and the complete circle is scored on the wing block, the scoring being as deep as possible (see Fig. 16(a)).

Fig. 16. Cutting circular housings for retractable undercarriage.



The surplus wood is then removed with a small, preferably a ⅛″, chisel, the cuts being made along the grain of the wood from the centre of the circle towards the edges (Fig. 16(b)). A considerable amount of care is necessary for this operation, particularly in the first stages, to prevent the chisel from cutting beyond the outer edges of the housing. Do not attempt to remove the wood to the full depth of the housing on the first operation, the first cuts should leave a shallow depression only, and the gouge is then run around the circle to score a little deeper, and more wood is removed with the chisel. These operations are continued until the housing has been cut to the required depth. Again, take care that the cutting is not pushed right through to the upper-wing surface. The inside of the housing can finally be cleaned up with a strip of sandpaper held over the end of a round pencil or circular piece of wood. Where a gouge of exactly similar curvature to the wheel circle is not available, the modeller will have to resort to using a gouge of smaller curvature and the circle must be trued up afterwards with the tip of a small file. The channels for the undercarriage legs are rather more simple, since, having straight edges, they can be cut with a chisel. On most types it will be found that this channel is not so deep as the wheel housing. Fortunately, circular wheel housings are not very common, and more often one finds that the wheel retracts into a rectangular housing, the shape of which depends upon the internal wing construction of the actual aircraft, and in these cases the housing can be scored and hollowed out with a small chisel. This also applies to the few types where the wheel retracts rearwards and is housed vertically in the wing. The Fairey Battle is one example and, as on most aircraft with this type of wheel housing, the lower portion of the wheel remains clear of the under-wing surface when retracted so that only a shallow cut-out need be made in the wing.

WING-ROOT AIR-INTAKES

To represent air-intakes situated in the wing root of jet aircraft, such as the Hunter and Vulcan, cut-outs should be made to a depth of between ¼″ and ½″.

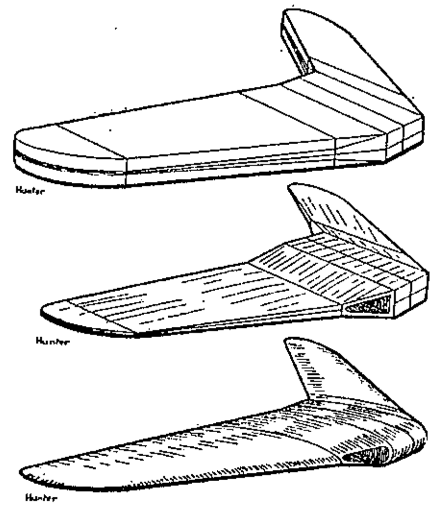


Fig. 17. Wing with root air-intakes. Marking block for shaping to correct taper.
Fig. 18. Taper filed and root intakes cut out.
Fig. 19. Wing cambered.

These cut-outs are made before the final shaping of the wing to its correct section or camber is carried out, that is immediately after Stage 5 of the basic operations. On small aircraft, like the Hunter, the wing roots are deepened in thickness so as to accommodate the air-intakes, and form a compound taper of the wing. After the wing has been cut out to plan shape from a block which is deep enough to provide for the thickened wing root, the shape of the wing in front view must be set out on the leading and trailing edges of the block (see Fig. 17), and on such types we shall find invariably that taper occurs on both upper and lower surfaces. The block is then filed flat to these markings, as shown in Fig. 18, and the shape of the air-intake is then marked out on the leading edge of the wing root and the intakes cut out. Drills should be used for this operation as far as possible, the wood remaining after drilling being cleaned out with a small chisel. Once this has been done, the wing is cambered to its correct section as shown in Fig. 19.

An added complication occurs in wings for models of such types as the Sea Hawk, where not only has the air-intake to be cut in the leading edge of the wing root but also the jet efflux pipes have to be accommodated in the trailing edge of the root. On such types the wing plan is marked and cut out in the normal way, and the taper is marked on the leading and trailing edges, as shown in Fig. 20. Whilst the drilling of the air-intake can be left until after the wing has been tapered, it is best on these types to drill the efflux pipes before tapering is carried out, because the taper of the portion of the wing from the root to a point just outboard of the air-intakes, whilst forming a straight downward slope at the leading edge, will gradually merge into a curve downwards at the trailing edge where the wing surface follows the curve of the jet tail pipe. Once the tail pipes have been drilled, the circular holes in the trailing edge will

Fig. 20. Wing with root intakes and jet tail pipes marked for tapering. Jet tail pipes drilled first.
Fig. 21. Wing tapered and air-intakes drilled out.

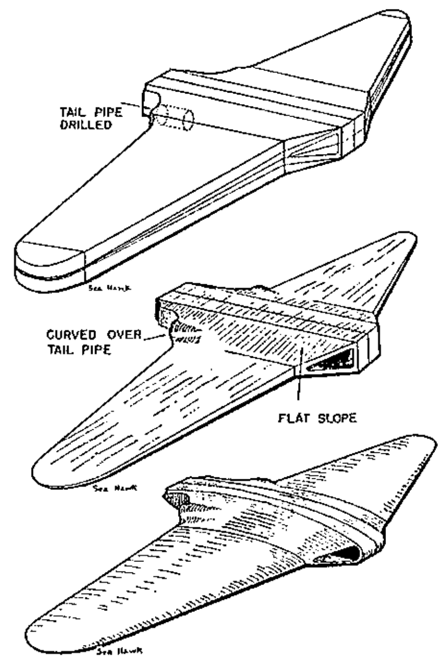


Fig. 22. Wing cambered.

provide guides for the shaping of the wing surface during the tapering operation. After filing the taper, the leading-edge air-intake is then drilled out and shaped (see Fig. 21), and, finally, the wing is cambered, as shown in Fig. 22. This type of wing, which is also encountered on one or two other Hawker types, is somewhat complicated not only to describe but also to construct, and models of these types should not be attempted by the beginner until some experience has been gained in making models of more straightforward aircraft.

LEADING-EDGE RADIATORS

Leading-edge radiators, such as those found on the Whirlwind, Mosquito, Hornet, and Firefly V, should also be hollowed out after the wing has been tapered in thickness and before it is cambered to its correct section. In most cases only narrow slits will be required for these radiators, and they are best formed by drilling a series of small holes

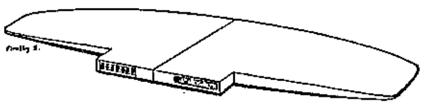


Fig. 23. Cutting out leading-edge radiators showing first and final stages.

along the leading edge and then cleaning out the remaining wood to the exact shape required with the tip of a small fine file (see Fig. 23).

LANDING LIGHTS

Sometimes provision must be made in the leading edge of the mainplane for the accommodation of landing lights, and for these a simple cut-out is made with a fret-saw and cleaned up with a fine file. At a later stage in the construction of the model the cut-out is covered with thin celluloid or filled with a solid block of perspex filed to the shape of the leading edge (see Fig. 24).

As has already been mentioned, wherever possible, mainplanes should be made in one piece, but for some types, such as the large, sharply swept wings which are found on the modern V-bombers and for aircraft with a delta-

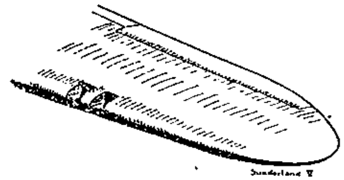


Fig. 24. Cut-out in leading edge for landing lights.

wing plan form, cutting the complete mainplane from one block may result in a large wastage of wood, and in these cases it is often better to construct the port and starboard wings separately.

BIPLANE WINGS

Wings for biplane types generally require less work than those for monoplanes, but the basic sequence of their construction is broadly the same. First, a block is cut slightly bigger than the span and chord of the wing and is then planed down to the maximum wing thickness. In most cases this will be considerably thinner than for a monoplane type and, invariably, the leading and trailing edges will be parallel and with little or no sweep back. The thickness of biplane wings is usually uniform throughout the span except at the wing tips. The wing plan is marked on the block, which, in cases where the wing has no sweep back and is of uniform chord, can first be planed down to the exact width required. Marking will then merely consist of plotting on the shapes of the wing tips and perhaps the shape of a cut-out in the trailing edge of the wing at the centre section, which is often a feature on wings of biplane aircraft (see Fig. 25). As no thick-

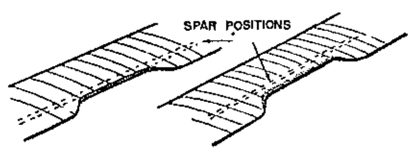


Fig. 25. Alternative forms of finishing trailing-edge cut-outs.

ness taper will be needed, the wing can be cambered to the correct section as soon as the plan shape has been cut out. The shape of the camber differs from

that of a monoplane wing to the extent that the under surface usually has a concave shape over at least part of the wing section (see Fig. 26). This concave cambering should be carried out first, and is best done by using the curved side of a fairly coarse half-round file, the strokes being made along the span of the wing, as shown in Fig. 26. The wing block

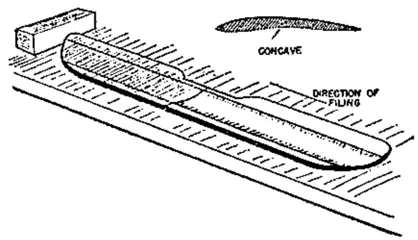


Fig. 26. Section of wing, showing under camber.

Fig. 27. Filing concave camber in under-surface of biplane wings.

should be placed flat on the bench for this operation and held in place by a bench stop. The shaping should be worked from one wing tip towards the centre and when this is completed the wing is turned round and the operation repeated from the opposite wing tip. When the rough shaping has been completed with the coarse file, the surface should be cleaned up with fine sandpaper. The leading- and trailing-edge lines are then marked on the edges of the block and the under surface finished off to these marks. The upper surface is then cambered by filing, after first having marked a line across the wing span representing the point of maximum thickness, as in the case of monoplane wings. Cambering of the upper surface can be carried out with the wing held on the bench by means of a G-clamp, as for a monoplane wing. The wing tips are then shaped down to a clean knife-edge. Where trailing-edge cut-outs are made in the centre section of biplane wings, the edge of the cut-out is sometimes brought down to a sharp knife-edge, but in other cases, where the edge of the cut-out coincides with the rear wing spar on the actual aircraft, the cut-out must be left at a thickness corresponding to the depth of the spar (see

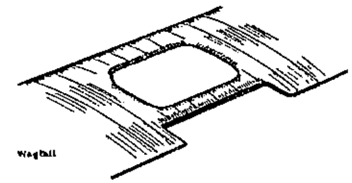


Fig. 28. Pilot's view hole cut in top-wing centre section on some first World War aircraft.

Fig. 25). This will not often be shown clearly on general arrangement drawings, and the modeller will have to study photographs of the particular type to find out exactly how the edges of these cut-outs should be finished.

In a number of biplanes used during the first World War a hole was cut in the top-wing centre section to improve the pilot's view upwards. The Sopwith Camel and Westland Wagtail are two examples. (Fig. 28). This cut-out was made between the front and rear spars of the wing, and on models of these types the shape of the cut-out is marked on the wing, small holes are drilled at each of the four corners, and the section is removed with a fine fret-saw. As this operation will leave only a narrow strip of wood on the leading and trailing edges, careful working will be necessary. Where the wing also has a dihedral, the steam bending should be carried out before the cut-out is made.

Ailerons are marked and scored as they are for a monoplane wing, but, as the biplane wing will be very much thinner, the scoring, especially along the hinge line of the aileron, must not be too deep or the control surface will be cut off.

WING RIBS

Models of biplane types are always improved if the wing ribs are represented. On the actual aircraft the wing ribs, shaped to the wing section and lying across the chord of the wing, were fitted at short intervals throughout the wing span. When the wing was covered with fabric and doped, the fabric stretched taut so that ridges occurred along each of the ribs.

A very effective method of representing wing ribs is to fix narrow strips of paper to the upper surface of the wing at each rib position. Strips should be cut with a razor-blade from the edge of a sheet of paper in the manner already described for cabin framing. The rib positions should then be marked in pencil on the wing and a strip of paper fixed over each of these markings. Clear dope, which can be obtained from any model-aircraft shop, is the best adhesive to use for this purpose. A film of dope should be brushed across the wing at a rib station, and one end of a strip of paper is placed with tweezers exactly on the trailing edge and pressed down towards the leading edge where it is trimmed off with a sharp razor-blade. Another brush of dope over the paper strip will fix it firmly in place (see Fig. 29). This operation is repeated for each rib

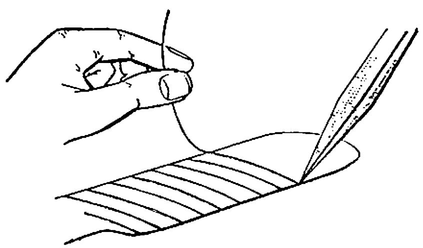


Fig. 29. Fixing narrow paper strips to represent wing ribs.

position and, whilst it is a somewhat tedious job, it produces a very realistic effect in the finished model.

On many early biplanes the trailing edge of the wing was formed from a length of piano wire stretched along the trailing edge of the ribs. When the fabric

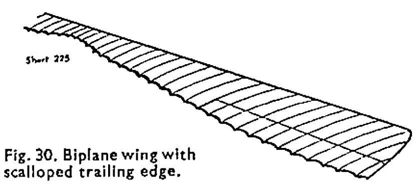


Fig. 30. Biplane wing with scalloped trailing edge.

was put on and doped, the wires were pulled taut and formed curves between each rib position, giving a scalloped effect to the trailing edge. To obtain this effect on a model the trailing edge of the wing is filed with a small half-round or round file between each rib position after the camber has been shaped, each filed portion then being brought again to a knife-edge (see Fig. 30). This trailing-edge shaping should be carried out after the rib positions have been marked but before the paper strips are doped on.

TAIL SURFACES

Little need be added to these notes concerning the construction of tail surfaces, since these will follow the basic methods already described for mainplanes. On monoplanes both the tailplane and the rudder will taper in thickness from root to tip, whereas on most biplane types there will be little or no taper in thickness, but in the case of tailplanes for both types, the section will be symmetrical, that is the camber of the under surface will be the same as that of the upper surface and not concave as in the case of the mainplane. The rudder sections for both monoplanes and biplanes will also be symmetrical.

The rudder and fin are made from a single block of wood and the shape can be cut out with a fret-saw. A centre line is then marked around the edges of the block and the rudder is shaped to a symmetrical section by filing, finishing off with a rub of fine sandpaper. The rudder hinge line and any trimming tabs are then scored in with a penknife or chisel. On many recent aircraft the fin is extend-

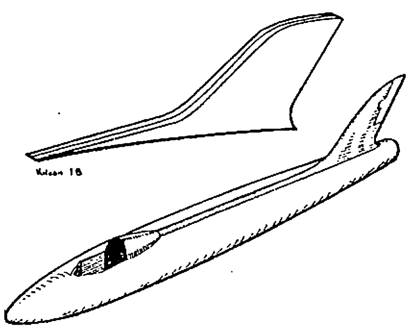
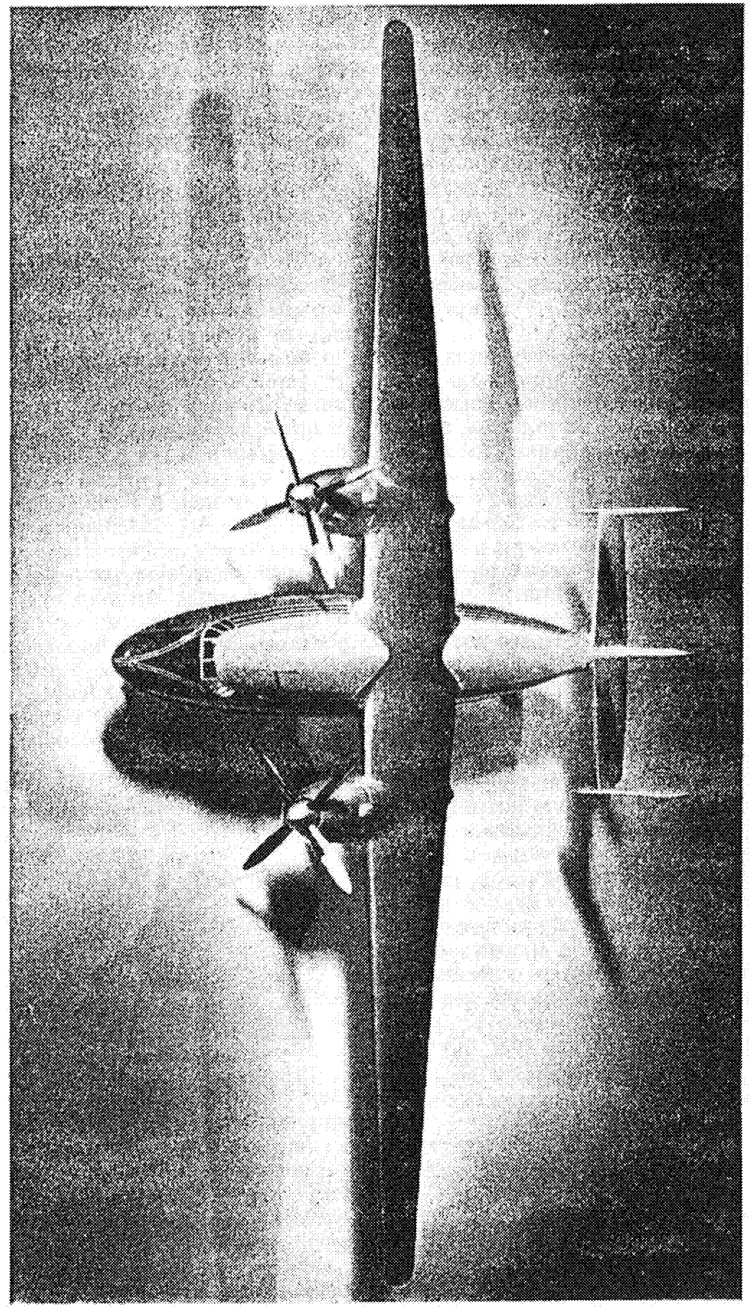
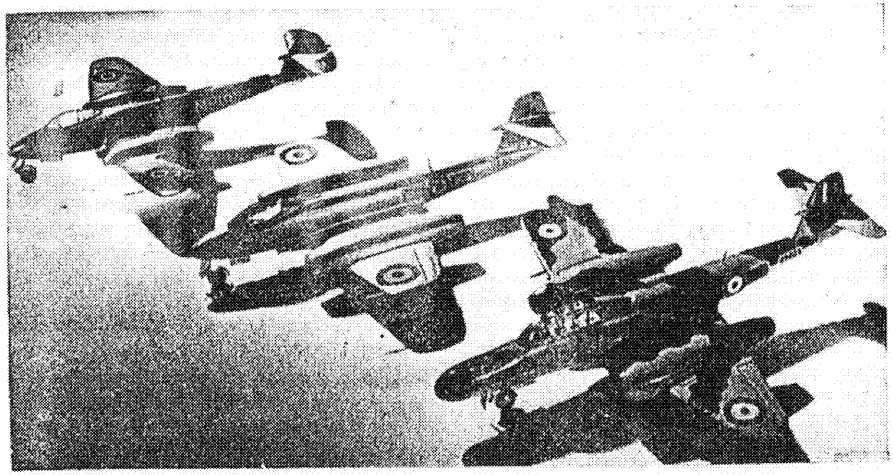


Fig. 31. Rudder and dorsal-fin extension cut in one piece.
Fig. 32. Extended dorsal fin or spine fairing. Rear cockpit fairing separate piece.

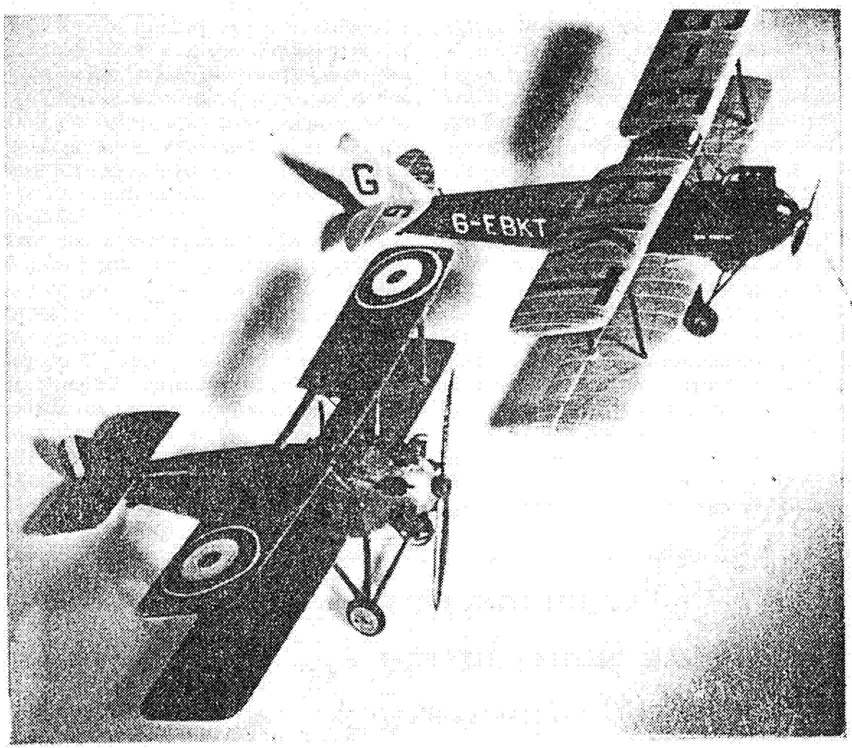


Airspeed Ambassador



Gloster Meteors

Westland Wagtail and De Havilland Moth



ed forward to merge gradually into the fuselage line or, in some cases, extends as a kind of "spine" right up to the cockpit; examples of the latter are the Hunter and Gnat and this spine is also found on the Supermarine Seaplanes which were used in the Schneider Trophy Races between 1927 and 1931. These dorsal-fin extensions are best constructed in one piece with the rudder, as shown in Fig. 31. In the case of the Hunter and Gnat this fairing expands at its front end to form the rear fairing of the perspex hood and, in these cases, the forward extension can be made as part of the fin up to the point where it begins to widen into the rear hood fairing, and this latter part should be made with a separate piece of wood, as shown in Fig. 32.

On some aircraft, where the tailplane is fitted on the fin, the intersection between the horizontal and vertical surfaces is composed of a bullet-shaped fairing or "acorn". This type of fairing is best shaped as part of the fin and rudder, and a block of wood should be chosen thick enough to provide for the extra width of this fairing. The shape of the rudder and "acorn" fairing is marked on the block and cut out, and then the portions above and below the fairing are filed down to the correct rudder section (see Fig. 33), after which the "acorn" fairing is filed to shape.

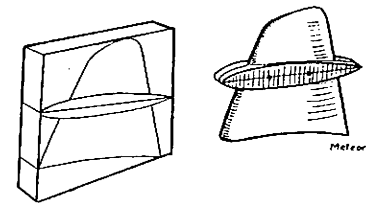


Fig. 33. Shaping fin and rudder with bullet fairing.

CHAPTER SIX

Assembling Fuselages, Mainplanes, and Tail Surfaces

The method to be used for fitting mainplanes to a fuselage will vary according to the particular type of aircraft being modelled. In the actual aeroplane the position of the mainplane in relation to the fuselage varies between low-wing, mid-wing, shoulder-wing, high-wing, and parasol-wing positions for monoplanes, whilst biplanes will be a combination of two of these types. For model purposes the method will also depend upon the cross-sectional shape of the fuselage.

In this chapter we will discuss various methods suitable for aircraft of different characteristics, covering most of the known contingencies that might arise in this stage of assembling a model. Some of the methods described are in the nature of alternatives, and the modeller is left to decide for himself which he considers to be the best. Where alternative methods are possible, the over-riding factor in deciding which to use should be the degree of strength likely to be obtained in the finished job. Whilst models of aircraft should give the effect of a somewhat delicate piece of work, and thus reflect the lightness in character of the original, they should also be made sufficiently strong to withstand, without damage, any mishandling which they are likely to receive from the "ham-fisted", though well-meaning, admirer. The combination of strength with delicacy is nearly always apparent in the full-sized aeroplane and a well-made model will also exhibit the same characteristics.

LOW-WING FITTINGS

In our discussions on the construction of the fuselage for a Spitfire in Chapter 3, we have already covered one method of making provision for the fitting of a mainplane by shaping the underside of the fuselage so that the one-piece mainplane will fit completely into it. This method must be used on all types of low-wing monoplane where the underside of the fuselage is curved in section. In fitting, the fuselage seating is smeared with glue and the mainplane pressed into position so that the centre line on the underside coincides exactly with the centre line on the underside of the fuselage, two or three panel pins are then driven in to fix the mainplane securely in place. This method is applicable to practically all modern low-wing types, ranging from the Spitfire up to the Viscount and Comet, and in all cases the seating in the fuselage to accommodate the mainplane is filed in the early stages of fuselage construction, as described in Chapter 3.

In older types of low-wing monoplanes where the fuselage section is rectangular, examples being the B.A. Swallow produced in 1935 and the De Havilland Moth Minor which appeared just before the beginning of the second World War, as well as some of the Miles monoplanes, such as the Hawk and its variations, two methods of fitting the mainplane to the fuselage are available. One method is by making a simple woodworking joint which results in a very strong and robust job. First, small sections of the leading and trailing edges of the mainplane are cut out, the width of the cut-out being the exact width of the fuselage at the position of the joint. Care must be taken to ensure that these cut-outs are made exactly in the centre of the wing span, and this is one reason for preserving the fore and aft centre line on the wing throughout all stages of its construction. The depth of the cut-outs can be any convenient measurement to suit the particular model, and normally a depth of one-quarter to one-third of the wing chord

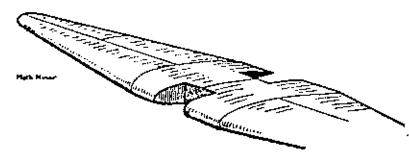


Fig. 1. Cut-out in mainplane for fuselage joint.

will be found to be appropriate (see Fig. 1). The cut-outs can be made with a fret-saw, the cut surfaces being cleaned up with a small file, but during the filing the modeller must be careful not to widen the cut-outs or a loose joint will result. The positions of the leading and trailing edges of the mainplane are now marked on the underside of the fuselage in the manner described in Chapter 3. Between these marks two further lines are drawn at points equal to the depth of the cut-out made in the leading and trailing edges of the mainplane. These lines must be absolutely square with the fuselage centre line. Lines are now marked on each side of the fuselage equal to the depth of the inner ends of each wing cut-out (see Fig. 2) and the tops of these

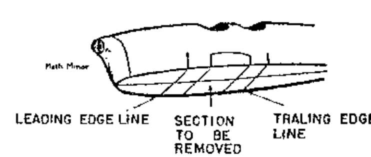


Fig. 2. Marking fuselage for mainplane joint.

lines are then joined up. These markings will give the shape of the section of the fuselage which is to be removed and into which the uncut portion of the mainplane will fit. The vertical cuts should be made with a tenon-saw or fine hack-saw and the surplus wood removed by chipping out with a chisel and finishing off with a small file. Fig. 3 shows the fuselage and mainplane ready for fitting, the joint is glued, the mainplane pressed into position and secured with panel pins. Any slight rounding-off of the corners of the underside of the fuselage ahead of and behind the mainplanes is then carried out to complete the fuselage section shaping. If the joint has been made a little loose and there are gaps between the mainplane and fuselage these can be filled in with plastic wood, which should be allowed to set for a few hours and then cleaned off smooth with a file and sandpaper.

An alternative method for this type of fitting consists of cutting out the whole centre section of the mainplane and fitting the two halves to the fuselage by means of a dowelled joint. This method eliminates the need for cutting the fuselage. The centre section of the mainplane is cut out after all shaping operations, including any bending to dihedral angle and the scoring of ailerons, flaps, etc., have been carried out. The limits of the leading and trailing edges are marked on the sides of the fuselage by vertical lines and each half of the mainplane is then held in position on the fuselage whilst the outline of the wing root is traced round with a pencil. A line is drawn on each of the wing roots from the point of the trailing edge to the leading-edge nose line. If the latter has been obliterated during the shaping of the mainplane, a fresh marking can be made on the leading edge for this purpose. With the wing held in position on the fuselage, matching points are marked at the trailing and leading edges and, with the wing removed, these points are then joined up. Wire dowels are then fitted into the fuselage exactly on this line, and

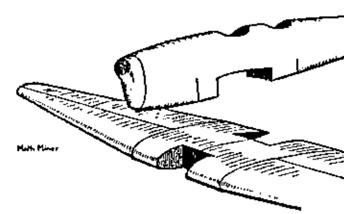


Fig. 3. Fuselage and mainplane ready for assembling.

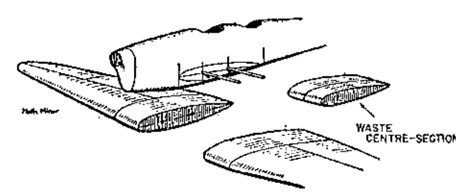


Fig. 4. Low-wing assembly with wire dowels.

matching holes are drilled exactly on the line on the wing root. For small models two dowels will be sufficient and they should project about 1" from the fuselage side. The wing root is then glued and pressed into position on the wire dowels. This method is illustrated in Fig. 4, and when it is used a careful check must be made to make sure that the mainplane is set in the correct position on each side of the fuselage. Care must also be taken to ensure that the mainplane has the correct amount of dihedral on each side. As before, any shaping of the lower corners of the fuselage in front of and behind the mainplane is carried out after the wing has been fitted.

Either of these two methods is equally applicable to the fitting of the lower mainplane for biplane models, but considerable care will be necessary if the dowelling method is used because of the much thinner wing section into which holes for the dowels will have to be drilled. This method does, however, follow more closely that used in fitting lower mainplanes on full-sized aircraft.

In some cases it may be found that the mainplane is set a little way above the bottom line of the fuselage. Here the dowelling method of fitting will be most appropriate, but in some cases, particularly on biplane types where the lower wing is of narrow chord and thin section, the use of dowels may not result in a sufficiently strong joint. One example is the Armstrong Whitworth Siskin single-seat fighter in service with the Royal Air Force in 1926, and on this and any similar types it is best to leave the mainplane uncut and to deepen the cut-out in the fuselage which is made wide enough to take the full width of the mainplane. The wing is then fitted and a separate piece of wood is used to fill the space remaining under the wing. This small block is made a tight fit in the gap and is best fitted in its rectangular form, as shown in Fig. 5, and when firmly in position it can be shaped to the lines of the underside of the fuselage, first with a small chisel, finishing off with a file and sandpaper. As an alternative to using a separate block for this fairing, the gap can be filled with plastic wood which, when set, can be shaped with a file and sandpaper. In passing, it might be mentioned here that when plastic wood is being used for fairings such as these it should be built up somewhat larger than the finished size of the fairing because in setting a certain amount of shrinkage takes place.

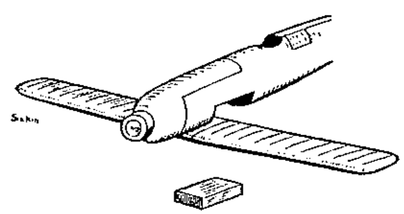


Fig. 5. Mainplane set up into fuselage and faired underneath with separate block of wood.

MID-WING FITTINGS

Several methods can be used for fitting mainplanes in the mid-wing position. Firstly, the centre section of the mainplane can be cut out and each half fitted to the fuselage with wire dowels in a similar manner to the method described above for low-wing types, the marking and fitting being carried out in exactly the same way, and for all smaller models this is the most simple arrangement to adopt. It can even be used for large one-seventy-second-scale models of such types as the Lancaster, Halifax, Stirling, Wellington, and Whitley, but with these larger types it is wise to use dowels in pairs, fitting them one above the other to increase the strength of the joint. The size or gauge of the wire dowels should also be increased (see Fig. 6). A rather stronger joint for these large models can be obtained by setting the wing root a little way into the fuselage on each side. If this method is employed, allowances must be made when cutting out the centre section of the mainplane for setting a portion of the wing root into the fuselage. Usually this inset can be between ⅜" and ½". The position of the wing root on the sides of the fuselage is set out by first marking the leading- and trailing-edge lines on the side of the fuselage and then holding the wing in position and tracing its outline with a pencil. This outline is then scored and first drilled out and then cleaned up to shape with chisels and gouges. The wing roots should be marked to show exactly how much is to be set into the fuselage and the wing is then glued and set in. Wire dowels can also be used to strengthen the joint (Fig. 7). When using this method, very careful setting out of the wing positions is necessary to make sure that the mainplanes line up correctly on each side of the fuselage.

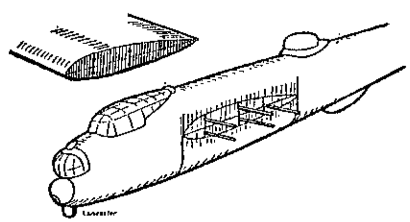
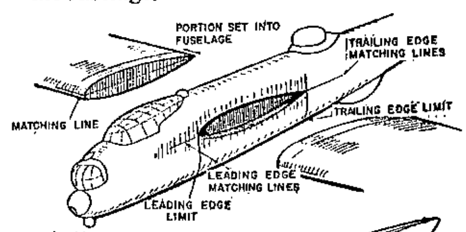


Fig. 6. Method of fitting mid-wing mainplanes on paired dowels.



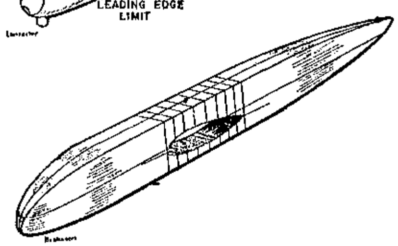


Fig. 7. Method of marking and fitting wing roots into fuselage.

Fig. 8. Wing seating cut through fuselage, showing construction lines used for setting out wing position and section shape.

A third method, which will only be necessary for very large types like the Brabazon, is to cut the shape of the wing-root section right through the fuselage so that the one-piece mainplane can be slid through into position. Here again careful setting out on the fuselage is necessary and must be done when the fuselage profile and plan shaping has been completed and before any shaping to section takes place. By this means the straight edges of the rectangular section fuselage will be available from which to make accurate measurements. Fig. 8 illustrates this type of wing fitting.

SHOULDER-WING FITTINGS

Shoulder-wing aircraft are those where the mainplane is set a little below the top line of the fuselage or hull, and when the fuselage or hull is of rectangular section the dowelling method can be used. In some cases, however, such as on the Short Sunderland and Empire flying boats, the top of the hull is curved in section, and in these cases the method of fitting a section of the wing root into the hull will have to be used and the sequence of setting out and fitting will be the same as for setting-in the mid-wing types already described. Again, it will be preferable to cut the wing seating in the hull or fuselage before the final section shaping is carried out, and wire dowels can be used to strengthen the joint.

These shoulder-wing types are always troublesome, and modern aircraft using this layout tend to become even more difficult where the upper surface of the mainplane rises almost to the top line of a fuselage of circular section. Britain's first V-bomber, the Valiant, is an excellent example, and in this type the difficulty of joining the mainplane to the fuselage is further aggravated by the fact that the mainplane is set at a relatively

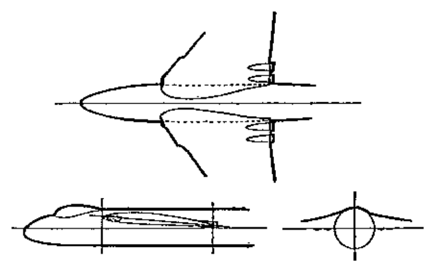


Fig. 9. Shoulder-wing setting of Vickers Valiant B.I.

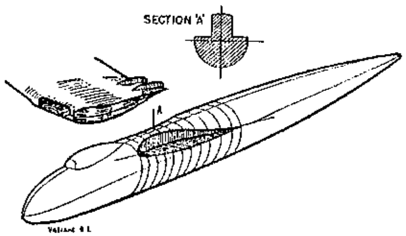
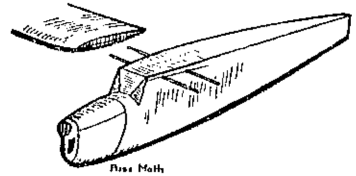


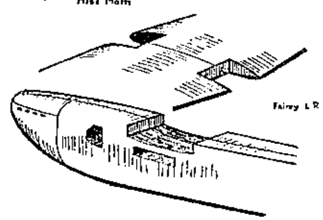
Fig. 10. Shelf seating for shoulder-wing fitting, showing method of marking out.

large angle of incidence so that near the leading edge the mainplane surfaces almost meet at the centre, whereas at the trailing edge the roots are separated by almost the whole width of the fuselage, as shown in Fig. 9. The simplest method of fitting the mainplane to the fuselage on a model such as this is to cut a seating in the fuselage after it has been completely shaped to section. The shape of the wing joint is marked on the fuselage by reference to the datum and top centre lines and the seating is cut out in the form of a "shelf", as shown in Fig. 10. The mainplanes are then cut so that the root end follows the plan of the seating and the mainplanes are fitted by means of dowels which in a thick wing section should be paired as previously described. This "shelf" type of seating is also applicable to another modern type of somewhat smaller size, namely the Folland Midge or Gnat, where the top surface of the wing merges into the top of the bulged air-intakes on the sides of the fuselage.

HIGH-WING FITTINGS

High-wing monoplanes comprise those aircraft in which the top surface of the wing is level with or rises a little above the top line of the fuselage, and the choice of one of several different methods of jointing the fuselage and mainplanes of such models will depend upon the characteristics of the particular aircraft. With fuselages of rectangular section the mainplane is sometimes bolted directly on top of the fuselage, this being the simplest type from the modelling point of view, the mainplane merely being glued to the top of the fuselage and held by one or two panel pins, the heads of which should be punched just below the wing surface and the holes filled with plastic wood. Examples are the Desoutter monoplane of 1929 and the upper mainplane fitting of the Handley Page Heyford biplane heavy bomber of 1932. More commonly we shall find, however, that the mainplane is set partly above and partly below the top line of the fuselage, one such type being the De Havilland Puss Moth, a three-seat light cabin aircraft, and another being the more recent Auster. If the cabin has been made solid the two halves of the mainplane can be fitted on fine wire dowels fixed into the fuselage, as shown in Fig. 11. Where, however, the cabin has been hollowed out, a framework will have to be provided to which the wire dowels can be soldered, as described and illustrated in Fig. 16 of Chapter 4. For some other types of aircraft with rectangular fuselages, such as the Fairey Long-range





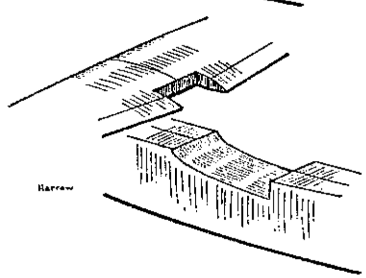


Fig. 11. High-wing fitted on dowels on solid cabin model.
Fig. 12. High-wing joint fitting.
Fig. 13. Alternative high-wing joint fitting.

Monoplane of 1933 and Handley Page Harrow, a form of joint, similar to that described for low-wing types, can be employed by cutting a seating in the top of the fuselage and cutting out sections of the leading and trailing edges of the mainplane to fit (see Fig. 12). The joint should be faired in to a smooth finish with plastic wood where necessary. In other cases it will be necessary only to cut a section from the trailing edge of the mainplane, as in the case of the Harrow, the front end of the fuselage seating being shaped to conform to the contour of the under surface of the wing at its leading edge (see Fig. 13).

The most difficult type of high-wing joint for the modeller occurs in modern aircraft having fuselages of circular section, the Airspeed Ambassador, British European Airways "Elizabethan" Class

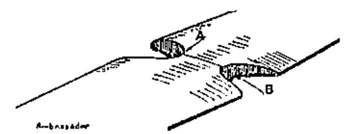


Fig. 14. U-shaped mainplane cut-outs for high-wing fitting on fuselage of circular section.

air liner, is a typical example. For such types U-shape cut-outs must be made in the leading and trailing edges of the mainplane centre section (see Fig. 14), and a suitably shaped seating must be cut in the top of the fuselage to receive the mainplane. The sequence of making the fuselage seating is as follows. First, a transverse cut-out is made with a back-saw, chisel, and file equal to the width of the uncut portion of the mainplane (see Fig. 15), the depth of the front and rear

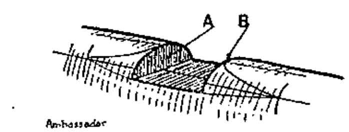


Fig. 15. First stage of cutting fuselage to fit U-shaped cut-outs in mainplane. Markings shown for second stage.

faces of this cut-out being equal to the depth of the wing at the apex of the U-shaped cut-outs in the leading and trailing edges (A and B) respectively. The plan outlines of the mainplane cut-outs are then marked on the fuselage forward and rearward of the transverse cut-out which is then extended forwards to the leading edge and rearwards to the trailing edge to conform to the shape of the wing cut-outs. This work is best done by cutting downwards along the marked lines with a sharp chisel. At the same time the bottom of the fuselage cut-out must be curved to follow the camber of the lower surface of the mainplane (see Fig. 16). During this operation the main-

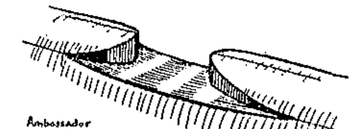


Fig. 16. Finished cut-out in fuselage.

plane should be tried for fit at frequent intervals so that the seating is brought gradually to shape by a method of trial and error. When the cut-out is completed, the mainplane is fixed to the fuselage with glue and panel pins, the pin heads being countersunk and the holes filled with plastic wood. Finally, the joint should be finished off by fairing the wing and fuselage surfaces into one another with plastic wood.

PARASOL-WING FITTINGS

Parasol-wing types of monoplane are much more straightforward, for here the mainplane is supported above the fuselage on struts fitted to the wing centre section and, in most cases, supplemented by struts running from the outer sections of the wing down to the bottom of the fuselage. The Westland Widgeon light aeroplane of 1927 is an excellent example of this type of aeroplane.

STRUTS

Struts of one form or another will be frequently encountered if one desires to build models of the older type of aeroplane, particularly biplanes. For modelling purposes, these struts can be made either from wire, strips of sheet metal, or wood, the choice of these alternatives being left to the particular preference of the modeller, except that wooden struts will be found to be practicable only where the struts are of comparatively large section. The average modeller will find that wire is the most suitable material. Most struts, even those on the older types of aeroplane, were shaped to a stream-lined section to reduce air resistance in flight and if wire is used it should be flattened and filed to a similar section. For this reason copper wire is the best material as it is soft and easy to file. A length of wire of suitable gauge (or diameter) to suit the particular job is chosen and the wire is flattened by hammering along its length. This will result in the wire curving slightly, but if it is turned over and hammered on the opposite side it will straighten out. One edge is then filed down to a knife-edge for the trailing edge of the strut and the hammer marks are removed with a fine file and by rubbing with emery cloth. Suitable lengths can then be cut off for the struts required. They are fitted by plugging the ends into holes drilled in the fuselage and mainplane, so that when cutting the wire, allowances must be made for a short section at each end which will be plugged into the drilled holes. These holes should be as small as possible and the ends of the struts should be filed down to a shank which will form a tight fit in the holes without forcing or splitting the wood. In most cases, too, the ends of the struts are shaped down to a narrow section at the points where they are attached. When making and fitting struts, the modeller will have to work to fairly fine limits and the measuring and marking must be done accurately. The marking of the metal is best done by scratching with some sharp point or by

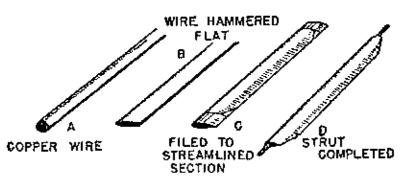


Fig. 17. Method of making stream-lined strut from soft wire.

filing a mark with a knife-edge file. Fig. 17 illustrates the making of stream-line shaped struts from wire. If struts are cut from sheet metal they must also be filed to stream-line section and shanks provided at each end for fitting into the wooden parts of the model.

Another method of making struts is to use unflattened wire of suitable gauge and, after fitting, using thin paper fairings to obtain a stream-lined section. The fitting of these paper fairings is, however, a tedious operation, but if the modeller prefers this method a paper strip of the exact length of the strut and of a width a little more than double the width of the strut is cut out, lightly folded along its centre, the inside edges are glued, and the paper is then placed on the wire strut from the forward end and the glued edges pressed together with a pair of tweezers (see Fig. 18).

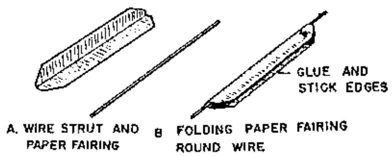


Fig. 18. Method of making stream-lined strut with wire and paper.

Wooden struts are cut from a thin sheet and then filed to a stream-line section. To fit wooden struts, small pins are used, the heads being cut off and the pins being inserted in the ends of the struts. For this operation the pins should be firmly held by a pair of thin-nosed pliers and care must be taken that the wood is not split when they are pressed into the strut. For this reason wooden struts should only be used where they are of comparatively large cross-section.

The shapes of struts must be carefully copied from the general arrangement drawings of the particular aircraft being modelled, and it will be found that, whilst most struts will be of uniform width throughout, in some of the early aeroplanes the leading and trailing edges curve throughout their length. These curved struts are often found on aircraft of the first World War period, the

famous B.E.2.C being one example. Fig. 19 illustrates several shapes of struts likely to be encountered.

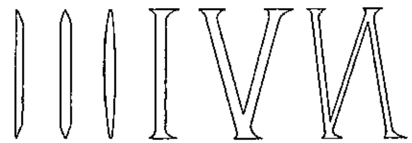


Fig. 19. Some typical strut shapes.

BIPLANE WING ASSEMBLIES

The fitting of biplane wings to fuselages will, as a rule, entail the use of a combination of the low-wing method of jointing or dowelling for the lower mainplane and the parasol-wing method for the upper mainplane. Two only of the many examples of this type are the well-known Avro 504 and the De Havilland Moth. In a few cases, however, the upper mainplane is fitted directly on top of the fuselage, this applies mainly to the early types of commercial aircraft, such as the D.H.34.

For the low-wing and parasol combination the lower mainplane is fitted first, by either the joint or dowelling method. The positions of the interplane struts are marked on the upper surface of the lower wing and on the under surface of the upper wing, and, in addition, the

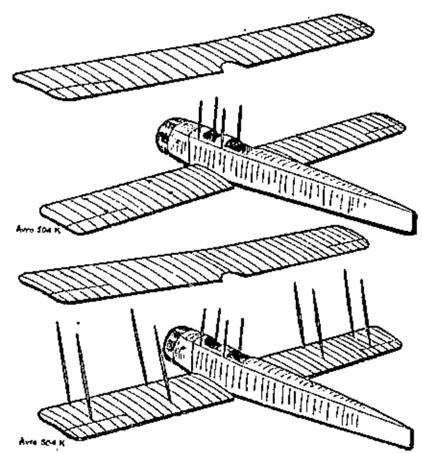
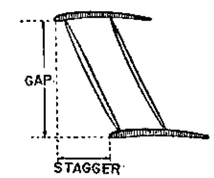


Fig. 20. First stage in fitting biplane wings.
Fig. 21. Second stage in fitting biplane wings.

positions of the centre-section struts are also marked underneath the top wing. The positions of the centre-section struts on the fuselage are next marked and all holes for strut fittings are drilled. On the mainplanes these holes may be made by piercing with the point of a pair of dividers, but, whichever method is used, the hole must not be made right through the wing. The centre-section struts are then fitted into the fuselage and the top wing is trial-fitted on to these struts and checked and adjusted until the wing is the correct height above the fuselage (see Fig. 20). The top wing is then removed and the interplane struts are fitted to the lower wing (Fig. 21), the top wing then being refitted on the centre-section struts and the upper ends of the interplane struts. The whole assembly is then checked for correctness of gap—that is the distance of the top wing above the lower wing—and for stagger—the setting of the top wing forward (or in some cases rearward) of the lower wing (see Fig. 22).

Fig. 22. Checking gap and stagger.



If any dihedral is incorporated, as it usually will be, this must also be checked. When the seating is satisfactory the top wing is again removed, and spots of glue are put on the ends of each of the struts and the top mainplane is then finally assembled. Again checks on gap, stagger, and dihedral should be made and the model is then left for the glue to set.

WIRE BRACING

Models of biplane types bring with them the added complication of wire bracing. Some modellers overcome this difficulty by ignoring the fact that bracing wires exist and leave their models without it, but wire bracing is such a feature of the old biplane types that no model looks properly finished unless the bracing is included. Even the finest wire is unsuitable for use in amateur model building as

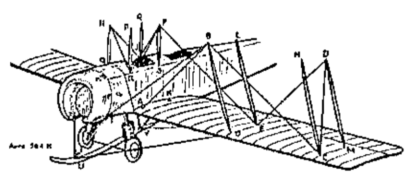


Fig. 23. Rigging biplane wings.

it is practically impossible to fix these wires taut, so for small-scale models fine black or grey cotton or, better still, nylon thread should be used. For the smaller models the thread can be tied to the ends of the struts, but on larger models separate fittings should be used as anchorages for the bracing, and for this purpose the heads of very small pins can be fitted into the mainplanes close to the ends of the struts, the exact positions being determined from the general arrangement drawings. Where the thread is tied to the strut ends, the bracing should be carried out by using the minimum number of separate lengths of thread. For a two-bay biplane, that is a biplane with two sets of interplane struts on each side, the thread should be fitted as illustrated in Fig. 23. First, two small holes are drilled in the root end of the lower mainplane, these holes are marked A and K in the illustration. A length of thread is then knotted at one end and threaded through hole A from the underside. With a little practice the knot can be pulled up into the wing surface so that it does not show from underneath. The thread is then carried up to the top of the inner leading interplane strut—point B in the illustration—and tied, the knot being secured with a spot of glue. From there the thread is taken to points C, D, E, F, G, H, J, and F on the illustration, being knotted at each point and each knot being secured with glue. The final knot at F should be tightly secured and the surplus thread cut off short with a razor-blade. The process is then repeated by threading another length through the hole K, again from the underside, and continuing round the structure to points L, M, N, O, P, Q, R, S, and P, where the thread is secured and the surplus cut off again. This completes the wing bracing on one side except for the incidence bracing between points L and O and B and E, and these two are now completed with separate lengths of thread for each. This sequence is repeated on the opposite wing with the difference that the thread is finally secured at the tops of the centre-section struts R and H. For clarity of illustration the diagram is drawn with the top wing removed, but in practice, of course, the wire bracing will be carried out after the mainplanes have been finally fitted.

Occasionally, additional bracing wires are employed and the general arrangement drawings will have to be carefully studied so that every wire is reproduced. On the Avro 504K, for instance, additional wires ran from point B to T in the illustration, and also from under the lower mainplane at O and E to points U and V respectively on the undercarriage. In this type these latter wires can be made extensions of the bracing between LO and BE, small holes being drilled at O and E to carry the wires through the mainplane.

Where separate fittings are used as anchorages, each piece of thread must be put on separately and trimmed at each knot. In these cases always fit the interplane incidence bracing wires first, that is those running from L to O, B to E, D to C, and N to M in the illustration.

WING-ROOT FAIRINGS

Before leaving the subject of fitting mainplanes to fuselages we must discuss the method of reproducing wing-root fairings. The wing roots of most monoplanes, and in some cases of biplanes, are carefully faired into the fuselage in order to give as good an aerodynamic form as possible and to prevent undue interference to the airflow by the two adjoining surfaces. As well as running the horizontal surface of the wing in a gentle curve up to the fuselage side, the trailing edges of the wing roots are often curved back to merge gradually into the fuselage lines some distance aft of the wing. The best method of reproducing these fairings is to use plastic wood which can be applied and moulded into shape after the

mainplane has been fitted. General arrangement drawings normally show the position and extent of these wing-root fairings. A glance at the general arrangement drawings of the Spitfire in Chapter 2 will show that these fairings are indicated in both the side and plan views and that a typical section of the curve from the mainplane into the fuselage is also indicated on the head-on view. The mainplane and fuselage should first be marked to show the position of the fairings, and the plastic wood is then applied by spreading on with a small penknife blade and being pressed into the rough shape of the fairing with the fingers. Aft of the trailing edge the plastic wood is pressed firmly against the fuselage side and roughly shaped in a curve to the trailing edge. As mentioned earlier, plastic wood shrinks as it dries and sets, so the fairing should be built up oversize throughout. The modeller need not be worried if on completion of this operation very rough and uneven surfaces have been made, as these can be smoothed out later. The fairings should then be left for several hours to set thoroughly hard and preferably no further attention should be given to them for twenty-four hours. In any case the modeller will find that he will have to spend some considerable time, after carrying out this operation, in removing bits of plastic wood from his fingers! When the wood has set properly it can be filed down to a smooth finish and to the correct shape, as shown in the general arrangement drawings, a small half-round or rat-tailed file being used. When the shaping is correct and the fairings merge accurately into the wing and fuselage surfaces they can be finally cleaned down with fine sandpaper. A strip of sandpaper rolled around a short length of wood dowel makes a useful sanding block for this stage of the work. If it is found then that not enough allowance has been made for shrinkage and the fairing is undersize or is pitted in places, a further application of plastic wood should be made, which is again allowed to set before being shaped up with files and sandpaper. In most cases at least two applications will be necessary before the fairing is satisfactory, and, where large fairings are concerned, it is better to build them up gradually, allowing one application to set before applying another over it, until sufficient plastic wood has been put on for the final shaping to be carried out. In this way the fairing is less liable to crack after it has been finally shaped. Attention should also be directed to obtaining a smooth surface on the underside of that part of the fairing which extends behind the trailing edge of the wing. Fig. 24 illustrates this type of wing-root fairing as applied to the Spitfire.

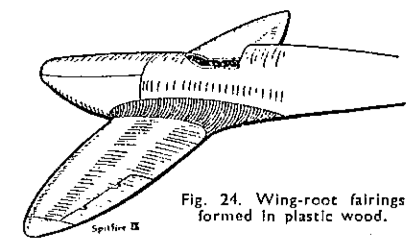


Fig. 24. Wing-root fairings formed in plastic wood.

TAILPLANE FITTINGS

The fitting of tailplanes to a model follows, in general, the methods used for the fitting of mainplanes. The majority of tailplanes will be mounted either directly on top of the tail end of the fuselage or approximately midway between the top and bottom lines of the tail. Most of the early types of aircraft will have the former method of fitting, including many of the first World War types and such aircraft as the Hawker biplanes and the Moth light aeroplane, types so much in evidence just before the second World War. For such aircraft the rounded top decking of the fuselage is filed down to provide a seating on to which the tailplane can be fitted. Two small pins with the heads cut off are inserted into this seating with the points upwards, and matching holes are drilled on the centre line of the tailplane into which these pins will fit. Where a central fin and rudder are employed these pins should be made long enough to provide a fitting for the vertical tail surfaces also (see Fig. 25).

For tailplanes fitted on the side of the

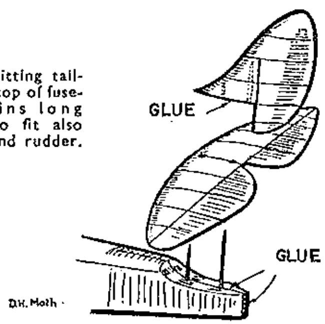


Fig. 25. Fitting tailplane on top of fuselage. Pins long enough to fit also into fin and rudder.

fuselage, as on the Spitfire, small pins can be used as dowels. The centre portion of the one-piece tailplane is first cut out with a fret-saw, the position of the tailplane is marked on each side of the fuselage, and two holes are drilled horizontally through the fuselage into which small pins can be fitted to project on each side. Matching holes are drilled in the root ends of the tailplane which can then be fitted on to the ends of the pins (see Fig. 26). A thin layer of glue should be used for both types of seating.

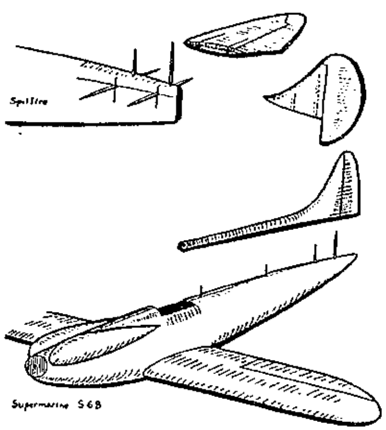


Fig. 26. Fitting tailplane on side of fuselage. Fin and rudder fitted on separate pins.
Fig. 27. Fitting vertical tail surfaces with dorsal-fin extension.

Many modern aircraft have tailplanes fitted on the fin, the Hunter being an example. Here again, two holes are drilled horizontally through the fin after the position of the tailplane has been marked, pin dowels are set in these holes projecting on each side and each half of the tailplane is glued and fitted on to the ends of the pins. Occasionally, the tailplane will be fitted at the top of the fin as on the Javelin. On such types pins are inserted in the top of the fin with their points projecting just sufficiently to engage with the tailplane, but not long enough to push right through, and the tailplane is glued on to the top of the fin where it is held firmly by the pins.

Some tailplanes are fitted with a fair degree of dihedral, the Vickers Viscount being an example. On these types the root ends of the tailplane are filed at an angle to give the dihedral, and the pin dowels, after being inserted in the fuselage sides, are bent upwards to the correct amount. When the tailplane is glued and fitted, the model should be placed on a level surface so that the height of the tips of the tailplane can be measured and the fitting adjusted until each side is at the correct height. Alternatively, if the fin and rudder have already been fitted, the dihedral of the tailplane can be checked by taking measurements from the tips of the tailplane to the top of the rudder and checking these measurements against the general arrangement drawings.

FIN AND RUDDER FITTINGS

Fins and rudders are also normally fitted on pin dowels, and where the tailplane is fitted on top of the fuselage the pins used to position the tailplane can be made sufficiently long to insert into the fin, as shown in Fig. 25. Otherwise separate pins must be used, as for instance with the Spitfire illustrated in Fig. 26.

Where the fin and rudder are fitted on top of the fuselage, as on the Hunter, Wyvern, Comet, Brabazon, and many other types, pins or wire dowels are used, depending upon the size of the model. In cases where the fin extends forwards along the fuselage, either in the form of a dorsal fin, as on the Comet or Brabazon, or as a "spine", as on the Hunter and the Supermarine Schneider Trophy seaplanes, pins should be inserted at intervals along the fuselage to hold these extensions firmly (see Fig. 27).

Many aircraft carry two or more fins and rudders either in conjunction with a single tailplane or in some cases with a biplane tail. The positions in which these control surfaces are fitted vary. In some cases the fins and rudders are fitted as end-plates to the tailplane, as on the Lancaster and Halifax, and in these cases short pins can be pushed through the fin and into the end of the tailplane, as shown in Fig. 28. The heads of the pins

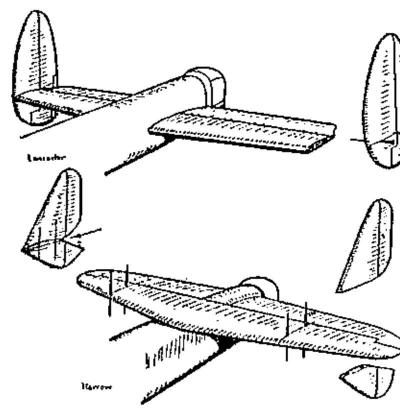


Fig. 28. Fitting end-plate fins and rudders.
Fig. 29. Fitting vertical tail surfaces inset from tips of tailplane and with sections above and below tailplane.

should be filed flush with the surface of the fin and the joint should, of course, be glued. In other cases the fins and rudders may be set wholly on top of the tailplane, as on the De Havilland Albatross and many flying-boat types, such as the Southampton, Scapa, and Singapore III. In these cases the base of the fin is filed to fit the top camber of the tailplane. Pins should be inserted in the base of the fin point downwards with just sufficient projection to press into, but not through, the tailplane, and the joints are made by gluing. In yet another type of fitting we may find that whilst the main fin and rudder are fitted on top of the tailplane, smaller fin surfaces are also fitted underneath, the Handley Page Harrow being an example. Here the whole fin and rudder, including that portion below the tailplane, should be cut out and shaped as one piece. The parts are then separated by cutting out a portion corresponding to the cambered section shape of the tailplane, holes are drilled in the tailplane through which small pins can be inserted projecting both above and below, and the upper and lower portions of the fin and rudder are then glued and fitted on to the pins (see Fig. 29).

Where a biplane tail surface is used in conjunction with twin or triple fins and rudders, as in the case of the Handley Page Hannibal, both the top and bottom of the fin is filed to the camber of the top and bottom tailplanes, and pins are inserted in each end of the fin so that their points can be pushed into the tailplane surfaces. In all cases two or more pins or lengths of wire should be used on these fittings so as to prevent any movement taking place from the correct alignment.

One or two modern aircraft have small auxiliary fins fitted on the leading edge of the tailplane near the tip, the Wyvern and Gannet are two examples. In these cases the auxiliary fins can be cut from a sheet of thin metal, such as aluminium, and set into fine saw cuts made with a fret-saw in the leading edge of the tailplane (see Fig. 30).

As with mainplanes, plastic wood is used for fairing tail surfaces neatly into the fuselage, but in these cases the fairings will be very much smaller.

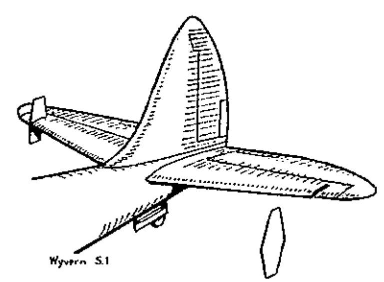


Fig. 30. Auxiliary fins shaped in thin metal and set in saw-cuts in tailplane.

CHAPTER SEVEN

Engine Nacelles and Engines

In models of multi-engine types, provision will have to be made for fitting the wing engines. Nowadays, most multi-engine aircraft have either two or four engines, in all cases mounted in or on the wings, but between the Wars a number of three-engined aircraft were produced, mainly commercial types where a third engine gave greater payload and added safety. On such types one engine was usually mounted on the nose of the fuselage, the other two being mounted on wing nacelles. On models of such types the nose engine, except where an uncowled radial engine was used, will be shaped as part of the fuselage, and in the first part of this chapter we shall be concerned only with those engines mounted outboard on the wings.

ENGINE NACELLES

For modelling purposes wing engines fall into four main classes, based on the method adopted for their mounting. These classes are, first, engines slung between biplane wings or mounted on struts above or below monoplane wings; secondly, those mounted under the wing surface; thirdly, those mounted on top of the wing surface; and, lastly, those mounted in the leading edge of the wing.

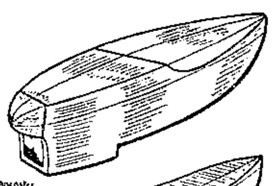


Fig. 1. Marking block for under-wing fitting of engine nacelle.

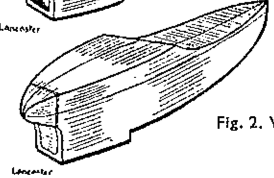


Fig. 2. Wing seating filed to shape.

In the first class we have such types as the Handley Page 0/400 and the Short Singapore III flying boat, and in models of such types the construction of the engine nacelles follows exactly the sequence used for fuselages and they are assembled on to the model by a system of struts.

The second class of aircraft, with engines fitted under the wing surface, comprises such types as the Supermarine Scapa flying boat, Avro Lancaster, Airspeed Ambassador, Vickers Viscount, and more recently the Handley Page Herald. Here again, the sequence of shaping the nacelles is mainly the same as for fuselages, but provision has to be made at some stage for fitting the nacelles to the mainplane. This should be done when the block has been shaped to profile and plan and before it is shaped to its correct cross-section. First, the position of the leading edge of the wing is marked across the top of the nacelle block, and it should be noted here that where the leading edge of the wing is tapered in plan form this line will not be square with the nacelle centre line but at a slight angle to it, the correct alignment being obtained from the plan view on the general arrangement drawings. Next, the shape of the under camber of the wing from this line towards the tail of the nacelle is marked on both sides of the block (Fig. 1). Again it should be noted that where the mainplane tapers in section or where dihedral is employed on the wing the junction of the mainplane with the nacelle will be slightly higher on the outboard side of the block than on the inboard side. This must be watched carefully in marking and shaping, otherwise the nacelle will not fit truly vertical. The top rear section of the nacelle is now filed down to the wing

camber lines to provide the seating, as shown in Fig. 2, the nacelle being tried in position under the wing to check the seating. When a good fit has been obtained the shaping of the nacelle to its correct section can be carried out.

It is advisable when making two or more identical parts, such as engine nacelles, to carry out each single stage in the shaping on each part in turn before proceeding to the next stage. This saves time in marking out, as each single measurement on the drawing can be applied to all the parts in turn, and the modeller will find that in this way it is much easier to make the parts absolutely identical. When fitting this type of nacelle, it will usually be necessary to use plastic wood to fair the top of the nacelle neatly into the upper surface of the mainplane, as shown in Fig. 3. Where

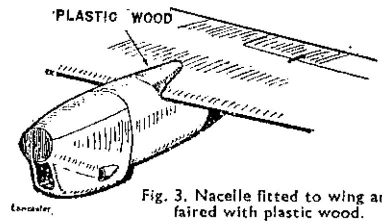


Fig. 3. Nacelle fitted to wing and faired with plastic wood.

airscrew spinners are constructed in the first place as part of the nacelle block, this part should be cut off and finished separately at the same stage as has previously been described in respect of spinners on the nose of a fuselage. Similarly, where the engine is enclosed in a circular cowling, as on the Ambassador, this cowling should also be shaped as part of the nacelle block and the front of the cowling drilled out for the fitting of the engine.

The third class, where the nacelle is mounted on the upper surface of the wing, is not often encountered, one example, however, is the Boulton Paul Overstrand. Here the method of marking and shaping the seating is exactly the same as for under-wing nacelles except that the seating is formed on the underside of the nacelle block.

The most common type of mounting for wing engines is to set them in the leading edge of the wing. Numerous examples come to mind, ranging from the famous Blenheim to the Handley Page Hermes and the Bristol Britannia. Various methods can be used for fitting these nacelles to the mainplane and in all cases provision is made when the nacelle is in rectangular section after completion of the preliminary profile and plan shaping. In some cases the method will be dictated by the fact that the portion of the nacelle beneath the wing extends further towards the trailing edge than the portion above the wing or vice versa. This is so in the case of the Blenheim and Hermes nacelles, for instance, and in making these the block should be cut long enough to accommodate the longest portion of the nacelle and the plan shaping should, in the first place, be carried out throughout the whole depth of the block on the outline of the plan of the longest portion. This type of nacelle is best fitted by partly jointing it into the leading edge of the wing. When the profile and plan shaping of the block have been carried out, the line of the leading edge of the wing is marked across the top and down both sides of the block. Again, if any wing-plan taper is present this line will not be square with the top centre line of the block. A further line is marked square across the top of the block a short distance aft of the leading-edge line, the

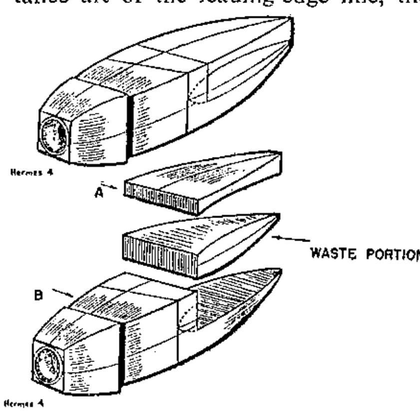


Fig. 4. Marking nacelle block for jointing into mainplane.
Fig. 5. Nacelle block cut for jointing.

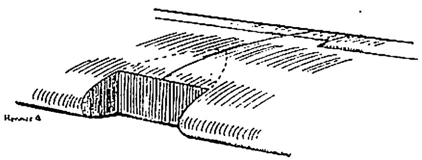
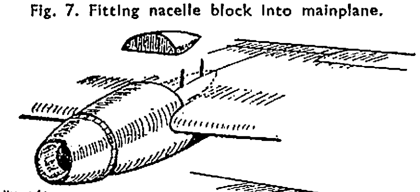


Fig. 6. Mainplane cut-out for nacelle joint.

exact distance depending upon the size of the nacelle and mainplane, but normally it can be any convenient measurement of between ¼″ and ½″. The shape of the wing section is then marked on both sides of the block (see Fig. 4). The block is then cut into the three portions shown in Fig. 5, the centre portion of which is waste wood and can be discarded. The centre line of the nacelle is then set out on the wing surface and the leading edge is marked for a cut-out into which the main portion of the nacelle block (part B in Fig. 5) will fit, so that the leading edge of the wing coincides with the leading-edge lines on the block (see Fig. 6). The main portion of the block is then trial-fitted to the wing and the shape of the leading edge of the wing is marked on the nacelle block by running a pencil around the wing surface on each side. The block is then removed and the section shaping is completed, leaving untouched the portions which will abut against the wing section. This part of the

Fig. 7. Fitting nacelle block into mainplane.



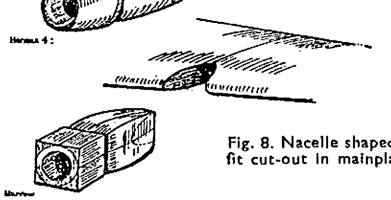


Fig. 8. Nacelle shaped to fit cut-out in mainplane.

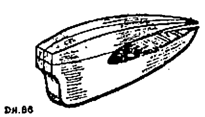


Fig. 9. Nacelle cut to fit wing section.

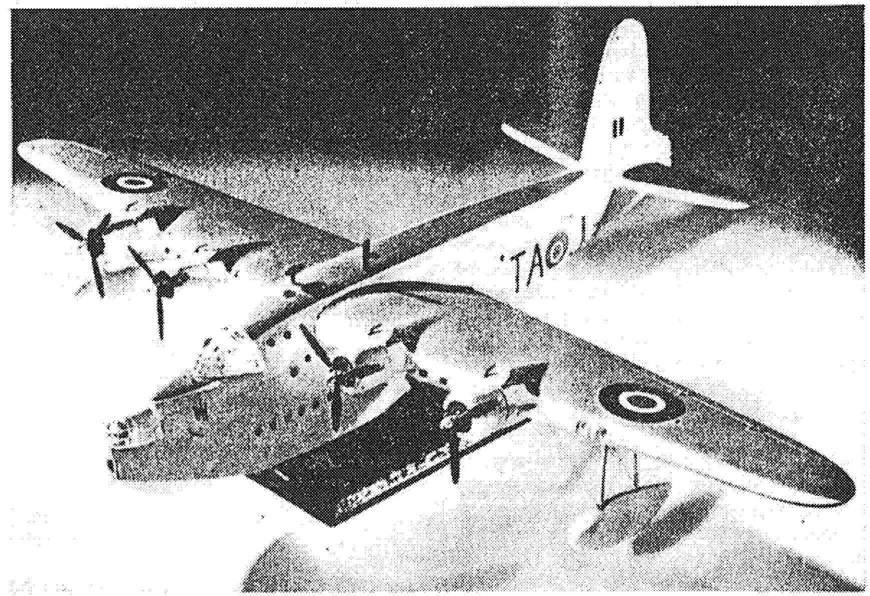
nacelle is then glued in position on the mainplane, pin dowels being used to strengthen the joint. The upper portion originally cut from the main block (part A in Fig. 5) is next cut down to the length of the top-wing fairing and shaped to the correct plan form for this portion. Finally, it is shaped to section and glued to the top surface of the wing, pin dowels again being used to strengthen the joint (see Fig. 7). The section shaping of this portion need only be carried out roughly before it is fitted to the wing, and the final shaping and matching up with the forward portion of the nacelle can be carried out after fitting. Any small gaps or cracks should be filled in with plastic wood.

If a sufficient length of the nacelle projects in front of the leading edge of the wing, the nacelle can be cut on the leading-edge line and the wing seating carried forward on the nacelle to this point. This will eliminate the necessity for cutting the mainplane. The top rear fairing will, of course, have to be made as a separate piece.

A third method of fitting this type of nacelle is to leave the nacelle uncut, but to cut a section from the leading edge of the wing shaped so that the nacelle will fit into it. Here again, the marking of the cut-out on the wing should be carried out when the nacelle is in its rectangular form and the cut-out should be made and the nacelle trial-fitted before the final shaping of the nacelle proceeds. Again, the shape of the leading edge of the wing should be marked on the nacelle block when it is trial-fitted and the final shaping of the block should leave this portion untouched (see Fig. 8).

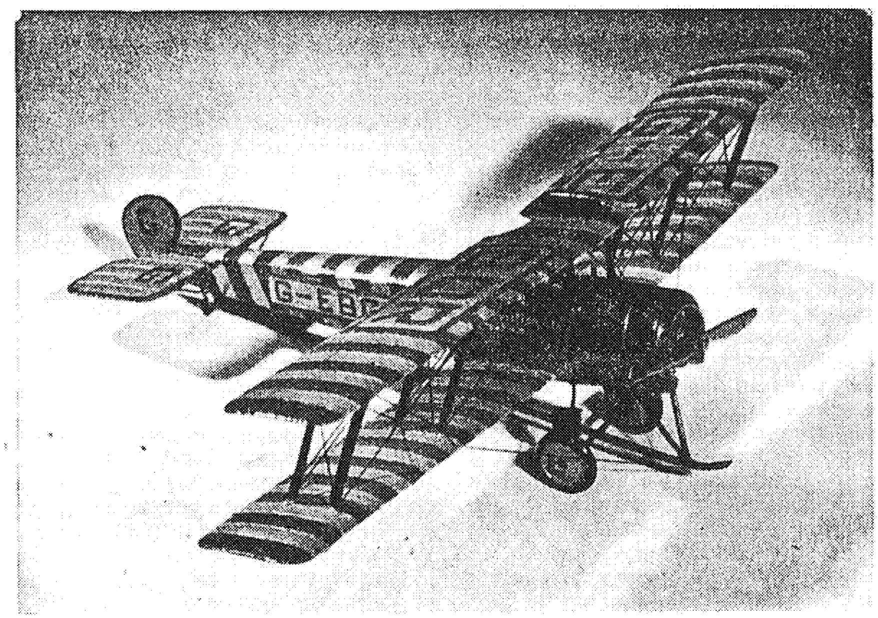
A fourth method of fitting nacelles is the opposite to that just described, that is instead of a cut-out being made in the wing leading edge the cut-out is made in the nacelle to fit the wing section. As before, the marking and cutting out of the wing section in the nacelle should be carried out whilst the block is in its rectangular form (see Fig. 9).

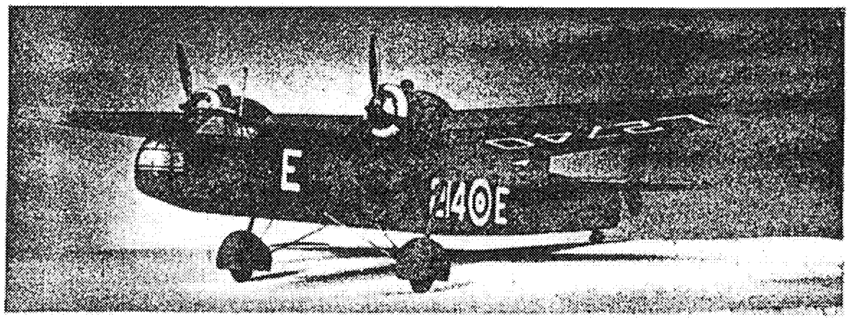
Reference has already been made to the importance of ensuring that the nacelle is seated on a correct vertical



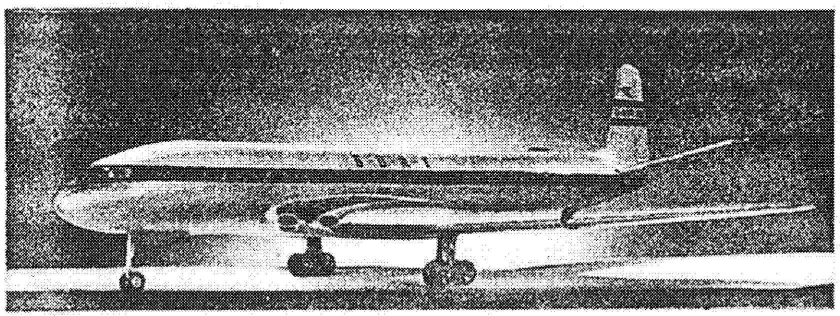
Short Sunderland V

Avro 504K



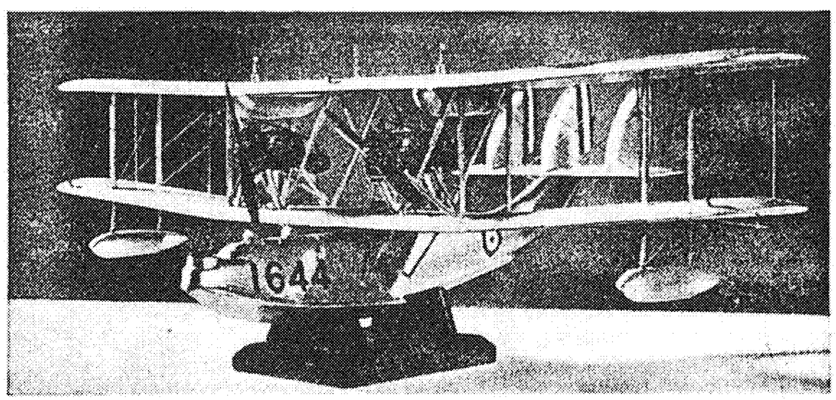


Handley Page Harrow



De Havilland Comet I

Supermarine Southampton



alignment. It is equally important to ensure that the fore and aft alignment of the nacelle is correct. This can be done by marking lines fore and aft on the top of the mainplane which must match up with the fore and aft centre line on the nacelle. Normally, the alignment will be parallel to the centre line of the aircraft, but in a few cases wing engines may be set at a slight angle, or "toed-out" or "toed-in" from the fore and aft line of the aircraft. The exact setting will be shown on the plan view of the general arrangement drawings.

Often housings are formed in wing nacelles to accommodate a retractable undercarriage, which means that the undersides of the nacelles have to be hollowed out to provide the undercarriage housing. This part of the work is best carried out after the nacelles have been finally shaped to section. The outline of the housing is then marked, scored with a chisel or sharp knife, and the housing then hollowed out first by drilling, finishing to shape with chisels in exactly the same way as for nose or tail wheel housings in a fuselage (Fig. 10).

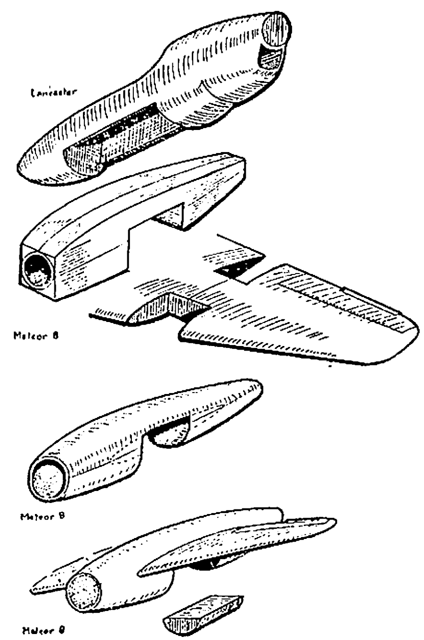


Fig. 10. Undercarriage housing cut in nacelle.
Fig. 11. Joint fitting for jet-engine nacelle.
Fig. 12. Jet-engine nacelle ready for fitting.
Fig. 13. Nacelle fitted and fairing block shaped to fit under.

Wing nacelles for jet aircraft fall into a separate class from those already described and require distinctive treatment. Meteors, Canberras, and the Comet are examples of this type. Each nacelle is made separately in the usual way, first the profile, then plan shaping, followed by the drilling of the front air-intake and the rear jet pipe. At this stage provision is made for fitting the nacelle to the wing. With these types the nacelle will project not only forward of the leading edge but also rearward of the trailing edge of the wing and a joint somewhat similar to the wing fuselage joint, described in the last chapter, gives the best results. A cut-out is made in the underside of the nacelle, as shown in Fig. 11, and a matching cut-out is made in the wing. Normally, the wing will be set on the centre line of the sides of the nacelle, that is an equal amount of the nacelle will project above and below the wing, and the top of the nacelle cut-out will correspond to the shape of the upper surface of the wing. It should be noted here that the wing should already have been shaped to its correct camber and when the cut-outs have been made the nacelle is trial-fitted to the wing and checked for correct alignment and seating. Each side of the nacelle is then marked to show the positions and shape of the leading- and trailing-edge wing sections. The nacelle block is then removed and finished off to its correct section, leaving untouched those portions against which the wing abuts (see Fig. 12). A separate piece of wood will be required to fill the nacelle cut-out on the underside of the wing. This block is inserted after the nacelle has been finally fitted to the wing, as shown in Fig. 13.

On large aircraft, such as the modern V-bombers, the engines are completely buried in the wing and their only external indication, apart from the large air-intakes in the leading edge, are bulges in

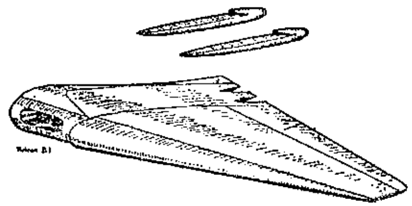


Fig. 14. Jet tail pipe fairings on large aircraft.

the wing surface as the tail pipes emerge from the trailing edge. For modelling purposes, therefore, only these tail pipes need to be constructed as separate items, and Fig. 14 shows the method of shaping and fitting these pipes to the mainplane of the Avro Vulcan. On this type the bulge of the tail pipe underneath the wing is considerably longer than that on the top of the wing surface. The cut-outs in the trailing edge of the wing are made equal to the depth of the tail-pipe fairing which is visible on top of the wing and the separate tail pipes are shaped to circular section only for the length of this top fairing, as shown in the illustration, the portion forward of that being filed down to fit the contour of the under-wing surface. When fitted, the parts are faired in with plastic wood where necessary.

As a rule, no wheel housings are formed in jet nacelles, for the simple reason that the housing of an undercarriage would interfere with the air flow through the jet engine. On most jet types the wheels will be retracted into housings in the wing itself.

Most American types carry their jet engines in "pods" slung on a pylon fairing below the wing. These are much more simple to model. The nacelle will be shaped in exactly the same sequence as has already been described, namely, profile, plan, and section, and a separate piece of wood will be shaped for the pylon fairing. Pin dowels should be used for fitting the nacelle to the pylon and the pylon to the wing.

AIR-COOLED ENGINES

The modeller who builds any early types of aircraft will sooner or later come up against the problem of representing the engines in a fair amount of detail. Nowadays, all engines, whether they be air-cooled, liquid-cooled, or gas turbines, are neatly enclosed in streamlined fairings which can easily be reproduced in wood. With the earlier types, however, all the air-cooled engines and some liquid-cooled types were mounted with their cylinders exposed to the airflow to obtain maximum cooling effect, and these types call for some intricate work on the part of the modeller. General arrangement drawings may be a little difficult to follow in building up these older types of engine and the modeller is advised to supplement the information given in the drawings with photographs of the engines themselves which will often show more clearly the various bits and pieces which go to make up the complete installation. Bound volumes of old Aeronautical periodicals which can be obtained through local libraries are an invaluable source of reference for this type of work.

Dealing first with air-cooled engines having exposed cylinders, each cylinder will have to be shown separately, together with its valve gear, induction and exhaust pipes. These engines are in two main classes: in-line, in which the cylinders are placed in a row one behind the other, and

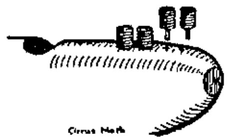


Fig. 15. Cylinders represented by small bolts.

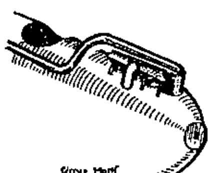


Fig. 16. Wire and pins used to represent exhaust and induction pipes and valve rods.

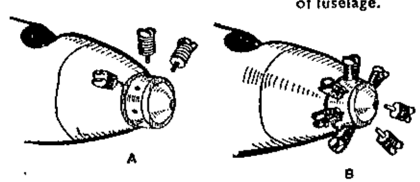


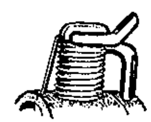
Fig. 17. Building up radial engine on nose of fuselage.

radial, where the cylinders are placed round a central crank case in the form of a star. In-line engines, such as the Cirrus fitted to the early De Havilland Moth aircraft, can be built up on the nose of the fuselage. Short lengths of heavy-gauge wire can be used to represent the cylinders, or, better still, small bolts of about 8BA size, the threads of which give a lifelike impression of the cylinder fins. With either material small shanks should be filed on the bottom of the cylinders to fit into small holes drilled in the fuselage and where bolts are used the heads must be cut off (see Fig. 15). Valve-rod casings are represented by lengths of thin wire or small pins running up the side of each cylinder, and the induction pipe can be represented by a length of wire soldered to the sides of the cylinders near the top, with a further length of wire to represent the carburettor which can usually be fitted into a hole drilled in the fuselage so as to form a T with the induction pipe (see Fig. 16). The exhaust gases were usually collected in a single pipe running along the top of the cylinders, and this can be represented by another piece of wire of suitable gauge soldered to the cylinder tops and then curved down to run along the side of the fuselage, as shown. In some cases baffle plates were fitted along the sides of the cylinders to direct the airflow, these can be made from thin strips of tin fitted into slots cut to receive them—when they will unfortunately cover up most of the intricate work one has put into the engine!

Radial engines were either of the single- or two-row type, the former including such engines as the Armstrong Siddeley Lynx, Bristol Jupiter, Mercury, and Pegasus, and the latter the Armstrong Siddeley Jaguar and Tiger. The single-row radial class was always built with an odd number of cylinders either five, seven, or nine, the two-row radials being formed by adding another ring of cylinders to form a complete engine of ten, fourteen, or eighteen cylinders. The second ring of cylinders was arranged to come opposite the gaps in the first ring. On single-row types one cylinder was vertical at the top, and on two-row types one cylinder of the rear row was vertical at the top.

In modelling, these engines should wherever possible be built up on the nose of the fuselage or nacelle which will have to be shaped to form the circular crank-case. Again, lengths of wire or small bolts with shanks filed on the lower ends can be used for the cylinders, holes being drilled round the wooden crankcase into which the shanks will fit (Fig. 17(a)).

Small fairings enclosing the valve-operating gear or rocker arms were fitted to the tops of the cylinders and these can be represented by filing the top of the bolt or wire to represent the shape of the fairings. Valve-rod casings are again represented by thin wire or small pins inserted in the crankcase in front of each cylinder and running up to the rocker boxes. On most Bristol types a single casing was used, whereas on the Armstrong Siddeley engines two casings forming a V ran one to each of two separate rocker boxes (Fig. 17(b)). On some air-cooled engines separate short exhaust pipes were fitted to each cylinder. These can be formed from short lengths of wire bent to an L shape and soldered to the top of each cylinder (see Fig. 18). In other cases an exhaust ring either on the front or at the rear of the engine was used to collect the gases from all the cylinders, the exhaust then being discharged through a single or twin tail pipes running along the side or underneath the fuselage. A ring of wire with short lengths soldered on for the tail pipes can be used for this type (see Fig.



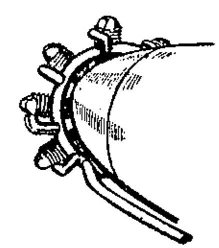


Fig. 18. Cylinder (filed bolt), with pin for valve-rod casing and wire representing exhaust stub and induction pipe.

Fig. 19. Exhaust collector ring at rear of engine.

19). Induction pipes were set at the rear of each cylinder, and can be formed from wire set into the wooden crankcase and bent at a right-angle and soldered to the top of each cylinder (see Fig. 18).

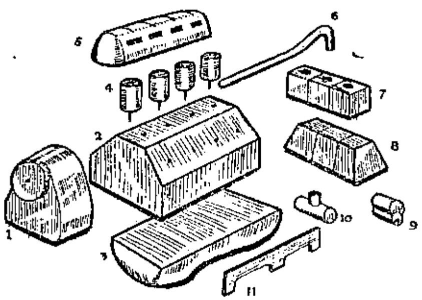
As an alternative to building up the engine on the fuselage or nacelle nose, a length of wood dowel can be used to form the central crankcase and the engine can be built up separately on the end of the dowel rod. When complete the engine is cut off the rod and fitted to the model. This method is useful when a number of engines of the same type are being made for a multi-engine aircraft. A hard-wood dowel should be used for this work.

LIQUID-COOLED ENGINES

Uncowled liquid-cooled engines are much less common, but the modeller may encounter such types, one example being the Napier Lion engine of the Super-

Fig. 20. Napier Lion engine built from wood, pins, wire, and cardboard. Only one of the three banks of cylinders is shown.

1. Front cover
2. Crankcase
3. Sump
4. Cylinders (12 required)
5. Cylinder cover (3 required)
6. Induction pipe (3 required)
7. Carburettors
8. Air intakes
9. Magneto (2 required)
10. Pump
11. Engine bearers (2 required)



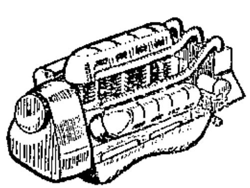


Fig. 21. Complete Napier Lion engine for a one-seventy-second scale model. This engine is $\frac{7}{8}$" long, $\frac{9}{16}$" wide, and $\frac{1}{4}$" high.

marine Southampton flying boat in service in 1925. These types of engines are best built up in wood, the small parts required to be shaped and fitted forming an excellent exercise for deft finger work! The modeller will invariably find that a fine pair of tweezers will be a useful aid. The crankcase will form the basis for the engine, and on the top of this part faces are filed at the correct angle for the banks of cylinders. The cylinders can be cut from match stems and the cylinder heads are small shaped pieces of wood which are glued on the top of each cylinder bank. Such items as carburettors and magnetos are also shaped in wood or slices of match stem and induction and exhaust pipes can be made from lengths of wire, although on many of these engines no exhaust pipes were used and the exhaust ports can be represented by very small rectangles of thin card glued to the cylinder heads above each cylinder. When building up this type of engine, the points of fine pins can be used to reinforce the glued joints. Figs. 20 and 21 illustrate the modelling of this type of engine.

ENGINE COWLINGS

In many cases radial engines were enclosed in a circular cowling, the earliest examples of which were short-chord cowlings known as Townend Rings. These cowlings fitted closely around the engine and are best represented in model form by a circle of wire to which is soldered a narrow ring of sheet tin, as shown in Fig. 22, the complete cowling being made to form a tight fit when slid on to the radial engine. Subsequently, cowlings of deeper chord, known as N.A.C.A. cowlings, became popular, and this type is best shaped in wood as part of the nacelle or fuselage. Examples of this latter type of cowling are found on the Sunderland and Empire flying boats, the Stirling bomber, and on more recent types such as the Hermes air liner, Bristol Freighter, Airspeed Ambassador, Hawker Sea Fury, and many others. The method of shaping and drilling out these cowlings has already been described in Chapter 3 in connection with fuselages,

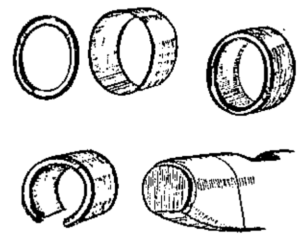


Fig. 22. Circular cowling made from a wire ring and tin.
Fig. 23. Wire and tin cowling for rotary engine.

and where the cowlings are formed on a wing nacelle the sequence of working will be identical. Note that often small "gills" were carried at the rear of these nacelles, these gills being adjustable to control the amount of cooling air. They are represented by scoring lines on the cowling.

Cowlings for the rotary-type engines used on very early aircraft were generally similar to the N.A.C.A. type, and can be shaped in wood as part of the fuselage nose, provided that the modeller does not wish to install a fully detailed engine. Where, however, a detailed engine is to be used, sufficient space must be made inside the cowling to allow the engine to revolve with the airscrew, and to provide for this the cowling must then be constructed in metal similar to the Townend Ring type. As a rule, rotary cowlings were not complete circles, the lower portion being cut out to provide an outlet for the exhaust gases. For fitting such cowlings, a small rebate will have to be filed in the fuselage nose over which the rear end of the cowling is a tight fit (see Fig. 23). Rotary engines were generally similar to radial types and can be built up in the same way, they must, however, be able to revolve freely inside the cowling when they are fitted.

CHAPTER EIGHT

Undercarriages

Up to only a year or two before the second World War all aircraft, except for a few experimental types, were fitted with an undercarriage which was not arranged to retract when the aircraft took the air, and on models of these types it is quite obvious that the undercarriage must be included.

With the advent of the retractable undercarriage new problems arose for the model maker, problems as to how the undercarriages of these types should be represented. The ideal, of course, is to contrive a working model of the undercarriage, one that can be moved from the extended to the retracted position, and with the simple early types of retracting undercarriages it was sometimes possible to produce a good working model. As time went on, however, these undercarriages became more and more complex, so that unless the modeller possessed exceptional skill and was able to work to very fine limits a retracting undercarriage became an impossibility.

For the average amateur, therefore, either of two alternatives may be adopted, depending on his personal preference. He may decide to model these types as in flight, that is with the undercarriage permanently retracted, or he may reproduce the undercarriage fixed in the down position. The former method certainly saves a lot of trouble, but many modellers may feel that this easy way out is not very satisfactory. Certainly, the modern aircraft is a much more beautiful piece of engineering when it is in flight with the undercarriage stowed away and covered by smooth fairings, but a model constructed on these lines loses a good deal of interest through lack of the extra amount of detail which a visible undercarriage can give, and for this reason models with undercarriages fixed in the down position give a much more realistic effect. It is certainly better to see a model standing "on its own legs" rather than heeling over on to one wing tip like a sailplane, and in any case even when the undercarriageless model is suspended on thread or wire or supported on a stand the effect is not very pleasant.

The modeller is advised, therefore, to construct all his models with the undercarriage fixed in the down position, and the notes which follow are based on this practice.

FIXED UNDERCARRIAGES

Model undercarriages of either the fixed or retractable type are made of wire, sheet metal, or sometimes wood. Undercarriages will, of course, take many different forms and it would be impossible to describe every variation in detail. We may, however, examine several different types, and from the examples given the modeller will find sufficient guidance for most of his requirements.

Dealing first with the fixed undercarriage proper, the most common type consisted of two V-struts with the axle running across the angle of the Vs. This type is encountered on most of the first World War aircraft as well as many aircraft which appeared between the two Wars. On first World War types the axle was usually bound to the angle of the V-struts with rubber cord which acted as a shock absorber. This type can very easily be constructed with wire, two lengths being bent into the form of Vs with the axle bound on with fine wire. Even with these early aircraft, however, the struts were given a stream-line form, so that after the wire has been bent the two arms should be hammered flat and filed to a stream-line section in the same

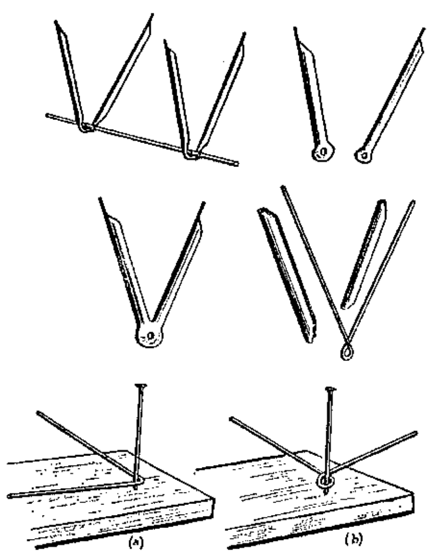
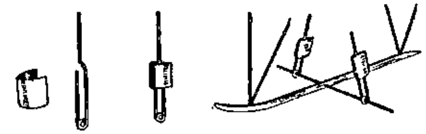


Fig. 1. Vees formed in bent wire and axle bound on.
Fig. 2. Vee formed from two lengths of flattened and filed wire.
Fig. 3. Vee cut from sheet metal and filed to stream-lined shape.
Fig. 4. Vee formed in plain wire and paper fairings.
Fig. 5. Forming axle loop in plain wire.

way as has already been described for making struts. Small shanks should be filed at the ends of the arms of the V for fitting into holes drilled in the appropriate positions in the fuselage of the model (see Fig. 1). After the axle has been bound on, the binding should be touched with a spot of solder to fix the joint. As an alternative, the arms of the V can be constructed separately of flattened wire with fine holes drilled at the lower end to carry the axle, and this method will be more appropriate on aircraft where the axle was carried in bearings instead of being bound on with rubber cord (Fig. 2). Another method is to cut the Vs from a sheet of metal of the appropriate thickness, the undercarriage legs then being filed to stream-line shape, holes again being drilled to carry the axle (Fig. 3). Yet another method is to use plain wire for the Vs and to fit small paper fairings to obtain the stream-line shape. With this method the wire should be formed into a small loop at the apex of the V to provide a bearing for the axle (see Fig. 4). In all cases projecting shanks must be allowed for at the tops of the struts for fitting into the fuselage. To form the axle loop, first bend the wire to a right-angle with pliers. Then place the bent wire against a pin or small nail of the same diameter as the axle, driven into the bench or into a piece of scrap wood as shown in Fig. 5(a). The wire can then be pressed round the pin or nail with the pliers to form the loop, as shown in Fig. 5(b).

Some aircraft may use a single main strut with the shock absorber contained in a stream-line fairing, the famous Avro 504K is one example. Here a piece of thin plain wire should be used for the strut and this wire is curled into a loop at its lower end to provide an axle bearing, the end of the wire then being taken about half-way up the main leg, as shown in Fig. 6. A small paper fairing is then glued approximately half-way up the strut so that it covers the end of the bent-up wire as illustrated. This undercarriage was supported by a pair of V-struts, one in front of and one behind the main leg, and at the lower end of these V-struts a wooden skid was carried which was designed to prevent the aircraft from nosing over on the ground. The skid can be made of flattened wire with the front end bent upwards in a slight curve and filed to a blunt point. This wire should be soldered to the ends of the V-struts and either a small hole should be drilled through which the axle can run or the axle can be soldered to the top of the skid. The complete undercarriage is shown in Fig. 7.

Fig. 6. Single leg undercarriage formed from one length of wire. Paper fairing for shock absorber.
Fig. 7. Central-skid undercarriage for Avro 504 K.



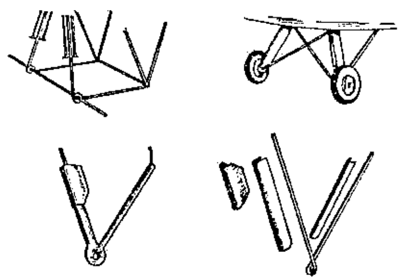


Fig. 8. Wire undercarriage for Avro 504 N.
Fig. 9. Split-axle undercarriage.
Fig. 10. Alternative methods of making faired oleo undercarriage in sheet metal (left) and wire with paper fairings (right).

A modified form of this undercarriage is found on a later variation of the 504, known as the Lynx Avro, and this type is illustrated in Fig. 8. The main legs, the rearward extensions, and the rear cross-axle are formed from one length of wire. Each of the two rear Vs is made separately and the shock absorbers consist of two small pins on each leg, the heads of the pins being hammered flat. Small paper fairings should be rolled round the upper portions of these pins. This type of undercarriage, either with a rearward or forward extension, is found on several types of aircraft produced in the 1920s, the Armstrong Whitworth Siskin and Fairey Flycatcher being two examples.

A later modification of the plain V-type of undercarriage made use of a split axle designed to minimize the risk of the aircraft turning over when landing or taxying in long grass. In this case the Vs can be made by either of the methods previously described, but instead of a cross-axle, two separate wires or small pins must be used, these being bent up to fit into the fuselage near the top of the main legs (see Fig. 9). This type of undercarriage is found on the Gipsy Moth and Tiger Moth aircraft. For a neater job, the wire or pins should be filed to fit into one another at the intersection. In some cases the split axles were taken up to the centre line of the aircraft forming an inverted V.

In later developments of the V-undercarriage an Oleo shock-absorbing unit was usually incorporated in the main leg on each side, well-known examples being the many Hawker biplanes produced round about the year 1930. In these cases, as the main leg carrying the shock absorber is wider than the secondary leg, it is best to cut the Vs to the correct shape from sheet metal, the legs then being filed to a stream-line section. Alternatively, plain wire with looped axle bearing and paper fairings can be used (see Fig. 10).

Towards the end of the fixed-undercarriage era the single-strut cantilever type was developed. One of the first aircraft to make use of this type was the Gloster Gladiator. This is a simple form to model either in flattened wire, sheet metal, or plain wire or long pins covered with paper fairings. A single-strut undercarriage, fitting vertically up into the wing, is found on many monoplane types, the Chipmunk being an example. In such cases a small pin can be used for each leg, the wheel being threaded on the pin first so that it is held by the pin head and the pin then being bent at right-angles and the top end fitted into the wing. A paper fairing is used to give the stream-line shape to the top of the leg. When bending the pins for this type of undercarriage a very small "nick" should be made with the edge of a fine file on the point of the bend so that a clean bend is obtained.

Auster aircraft make use of a small V-undercarriage with the Vs completely faired in. These are best reproduced by cutting a triangular sheet of metal and drilling a hole at the apex for the axle bearing. Allowances should be made, when cutting the triangle, for filing shanks at the upper end for fitting the undercarriage to the fuselage (see Fig. 11).

"SPAT" AND "TROUSER" WHEEL FAIRINGS

On many types of aircraft which appeared just before retractable undercarriages became common, the wheels were partly enclosed in stream-line fairings which acquired the descriptive titles of "spats" or "trousers", according to

their shape. Both the Handley Page Harrow and the Fairey Long-range Monoplane had spatted undercarriages, whilst many of the Miles types, such as the Hawk Major and Falcon, wore trousers. Where the spats are large enough they can be made of wood and hollowed out to take the wheel. A fairly hard wood of fine grain should be used and a block should be cut large enough for a pair of spats to be made from it. The thickness of the block should be a little greater than the finished thickness of the spat. The construction begins by marking a centre line on the bottom edge of the block and then the plan outline of the spat as seen from underneath is marked. The positions of the cut-out for the wheels are also marked and lightly scored in (see Fig. 12). The wheel housings are then hollowed out by drilling a hole on the centre line of the wheel and then working this hole out to the size of the wheel with a small chisel. By making the original block wider than the finished spat size, the danger of splitting the wood during this operation will be minimized. When the wheel housing has been hollowed out, holes are drilled near the bottom of the spat to take the wheel axle. The block is now planed or filed down to the maximum thickness of the finished spat and the side elevation is plotted on both sides. Each spat is now cut out with a fret-saw (Fig. 13), and filed to plan shape, which will consist of rounding the front end and tapering the rear end to a knife-edge or point. The spat is then filed to its correct stream-line section and any necessary holes for fitting struts are drilled (Fig. 14). The axles should be a tight fit in the holes drilled for them and, when they have been inserted and the wheels threaded on, any projecting ends of the axles should be filed down flush with the side of the spat.

Again, where the model is large enough, trousered undercarriages can be made in wood in exactly the same way as spats. Where the width of the fairing is narrow, however, it may be impracticable to use wood and in these cases the fairing can be made from sheet tin, the outline being marked out on the metal which is

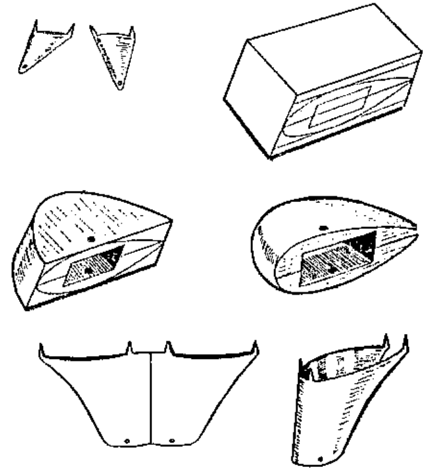


Fig. 11. Faired-in Vs for Auster undercarriage made in sheet metal.
Fig. 12. Making wheel-spat in wood. First stage.
Fig. 13. Making wheel-spat in wood. Second stage.
Fig. 14. Finished wooden spat.
Fig. 15. Trouser fairing made in sheet metal.

then cut out and bent to shape and the trailing edge soldered. Shanks for fitting the fairing to the wing should be allowed for at the top of the fairing and holes are drilled in the lower ends to take the wheel axle (see Fig. 15). On very small models the width of the spat or trouser fairing may be so small as to make it impracticable to hollow out a wheel housing when the part is made of wood, and in such cases the modeller will have to resort to dummy wheels and construct the wheel fairing and wheel in one solid piece. The sequence of operations commences with the planing of a block to the maximum thickness of the finished spat, the side

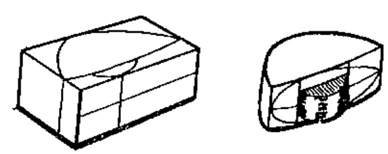


Fig. 16. Small spat with "solid" wheel. Marking out wood block.
Fig. 17. First stage in shaping spat and wheel.

Fig. 18. Finished spat and wheel.

elevation is then marked on the block, and must include the segment of the wheel which projects below the fairing, as shown in Fig. 16. The part is then cut out with a fret-saw, the width of the wheel is marked on the underside, and the wheel segment filed down to its correct thickness, as shown in Fig. 17. The spat is then shaped to plan and finally to stream-line form (see Fig. 18).

RETRACTABLE UNDERCARRIAGES

Retractable undercarriages will range from the simple single-leg to the complicated multi-wheel and bogie units of the modern large commercial and military aircraft. Again, with such wide variety it would be impossible to describe every variation in detail within the space of a single chapter, but the general methods of construction described for the examples which follow can be adapted to suit all the possible contingencies with which the modeller may be faced.

Turning once again to our Spitfire illustration, we find an example of the most simple single-leg type of retractable undercarriage. This type can be formed in much the same way as the fixed undercarriage described for the Chipmunk by using pins on which the wheel is threaded and by bending the pin at right-angles and fitting the upper end into holes drilled in the wing surface. In most cases pins alone will have too small a cross-section to represent accurately the undercarriage leg and, therefore, a sleeve of either rolled paper or, better still, small brass tube of the correct diameter must be threaded on the leg before it is fitted into the wing. Small brass tubes in various sizes can be obtained from any model or handicraft

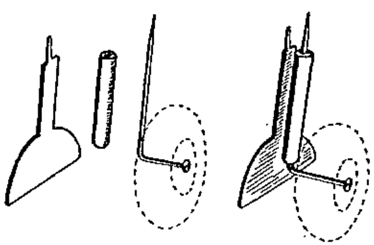
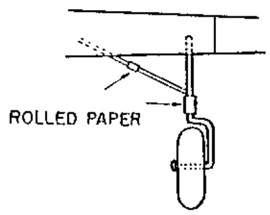


Fig. 19. Spitfire undercarriage parts and method of assembling.



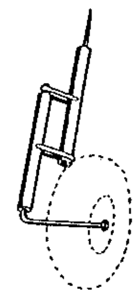


Fig. 20. Pin bent to form a half-forked leg.
Fig. 21. Wyvern undercarriage formed from two pins, two small brass tubes, and two tin "straps" soldered on.

shop. It will be noted that with retracting undercarriages there is no need to make the legs and struts in a stream-lined shape since they are stowed within the aircraft structure during flight. The majority of retractable undercarriage legs will, therefore, be of circular section.

In addition to the retracting leg and wheel, most of these types of aircraft carry some form of metal fairing which covers either the whole or part of the undercarriage when it is retracted and preserves the smooth outline of the aircraft's surface. For model purposes these fairings can usually be cut to shape from sheet tin or aluminium and provided with small prongs or shanks at the upper end for fitting into holes made in the wing surface. Fig. 19 illustrates the various parts for the Spitfire undercarriage. This basic type is used on a large variety of modern aircraft, including the Sea Hawk, Swift, and Hunter, but on some types, such as the two latter aircraft mentioned, the main leg is positioned vertically over the centre line of the wheel when viewed from the front, so that after the pin has been bent at right-angles at the axle position it must be curved round the top of the wheel and then bent back to the vertical to form the main leg (see Fig. 20). It will be noted, too, that in many of these undercarriages the joints are formed from slightly larger-diameter material than the leg itself and on a model these joints can be reproduced by gluing a narrow strip of paper round the leg in the appropriate positions. On many

types the retracting jacks are also visible, running from a point somewhere on the leg up into the wheel housing. These are represented by separate lengths of wire or short pins plugged into holes drilled inside the wheel housing and soldered to the main leg, as shown in Fig. 20.

One modification of this single-leg type of undercarriage can be mentioned, namely, that of the Westland Wyvern carrier-borne strike aircraft. In order to provide for the landing of this heavy aeroplane on carrier decks a levered suspension type of undercarriage was evolved making use of two separate main legs one behind the other and connected by pivoted arms. On this type the two main parts of the leg can be joined by short narrow struts cut from tin and soldered to the main legs, as shown in Fig. 21.

Another common type found on the larger aircraft used during the second World War, such as the Wellington and Lancaster bombers, consisted of two main legs carrying an axle and wheel at their lower ends. These can be reproduced with one length of wire to form both legs and the axle, the wire being bent at right-angles, the wheel threaded on, and the wire bent again at right-angles to form the second leg. Any necessary fairing tubes are then fitted and the upper ends of the legs are plugged into holes drilled in the undercarriage housing. The retracting jacks and any other struts are made from separate pieces of wire with the upper ends plugged into the wheel housing and the lower ends soldered to the main undercarriage legs. Both with this and the single-leg type of undercarriage allowances must

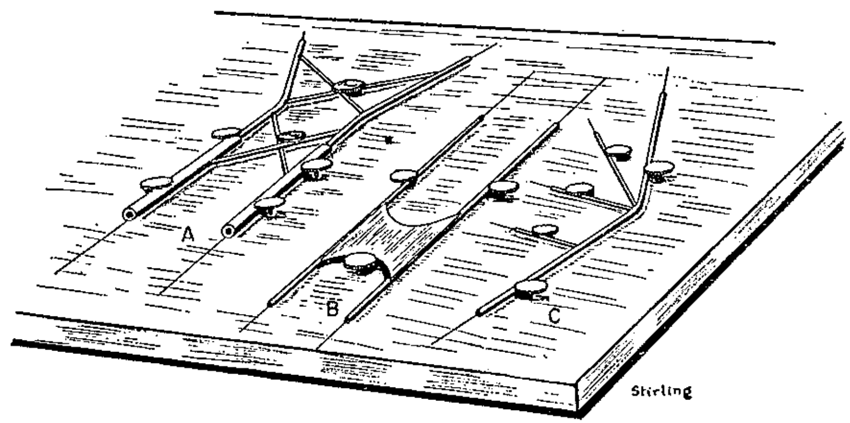
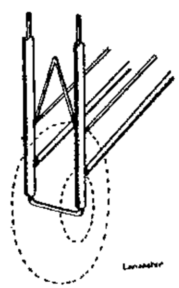


Fig. 24. Building up an undercarriage on a block of wood. Drawing pins serve to locate parts until soldering is completed.

be made for plugging a length at the top of the main leg and any bracing struts or retracting jacks into the wing or undercarriage nacelle, so that when making them the struts should be cut longer than will be required for the finished undercarriage (Fig. 22). Mention might be made of the undercarriage of the Halifax bomber on which the main legs consisted of a massive metal forging which on a model can be reproduced in hard wood. Holes can be drilled at the lower ends



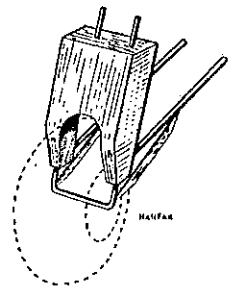


Fig. 22. Typical undercarriage for heavy bomber type.
Fig. 23. Halifax undercarriage. Main leg made from wood block.

into which a flattened U-shaped piece of wire forming the wheel axle can be inserted (see Fig. 23).

One of the most complicated undercarriages a modeller is likely to come across is that which was fitted on the Short Stirling bomber, where an involved double-action sequence of retracting was employed, and even to reproduce this type fixed in the down position on a model requires a considerable amount of skill, particularly in the use of a soldering iron. With such types the complete undercarriage has to be constructed in several sections being finally brought together on assembly to the model. One method which has been used consists of building up the main legs by drawing the outline on a block of wood, placing lengths of wire and brass tube on this outline where they can be held in position with drawing pins and then soldered up (see Fig. 24(a)). The main radius rods and fairings can also be fitted together and soldered in a similar way (Fig. 24(b)), the stone guard being soldered on after this part has been removed from the wood block (Fig. 25(a)). The girder system of bracing struts, shown in Fig. 24(c), is also soldered up separately on the wood block, two of these parts being required. Finally, the undercarriage side and front fairing doors cut from tin are soldered to a length of wire, bent as

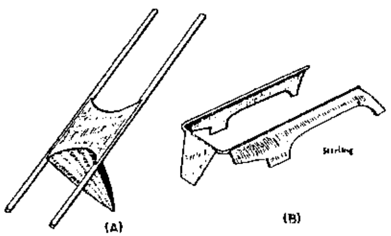


Fig. 25. Stone guard and undercarriage doors soldered on.

shown in Fig. 25(b). The main legs and radius rods can then be fitted into holes drilled in the undercarriage housing in the engine nacelle and the lower ends of the radius rods soldered to the main leg. The girder bracing pieces are then soldered to each of the radius rods and, finally, the fairing doors are fitted by soldering to

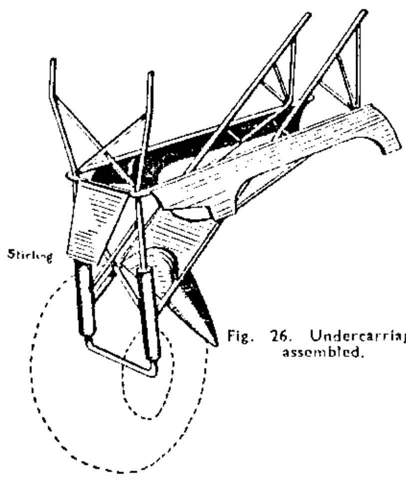


Fig. 26. Undercarriage assembled.

the main legs and radius rods, as shown in Fig. 26. This system of prefabricating the various component parts of an undercarriage is a useful method to employ on complicated types, and, with a little study of the undercarriage layout, even the most complicated type can be broken down into a number of separate parts and its construction thereby simplified to a great extent.

The modern bogie undercarriages can be a source of trouble although they are probably less complicated than that of the Stirling. Taking the undercarriage of the Comet as an example, the component parts can be separated into a main Y-shaped leg which can be filed from a piece of flat brass curtain rod. To the bottom of this Y-piece is soldered an-

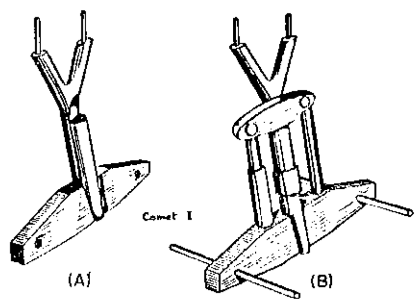


Fig. 27. Building up a bogie undercarriage.

other piece of brass which has been filed to the shape of the bogie beam, this piece being drilled at each end to take the wheel axle (Fig. 27(a)). A seating is filed near the upper part of the main leg into which is fitted and soldered a third piece of brass shaped to represent the upper anchorages of the two shock-absorbing legs. The latter, cut from pieces of brass or copper wire, are soldered in position on this beam, the lower ends being soldered to the bogie beam (Fig. 27(b)). The thickened joint fairing near the lower end of the main leg is formed with a narrow strip of paper glued round, and two small circles of thin card are glued to the upper beam to represent the pivots of the shock-absorbing legs. Holes are drilled in the wing of the model to take the fitting shanks at the upper ends of the Y-shaped main leg and, after this has been fitted, the twin retracting jacks formed from short lengths of brass wire are plugged into holes drilled in the undercarriage housing in the wing, and the lower ends are soldered to the main leg. Bogie undercarriages for other types, such as the Bristol Britannia, the Avro Vulcan, and Handley Page Victor, will, of course, vary in detail construction, but the general principles of reducing the undercarriage to a number of comparatively simple components, as in the case

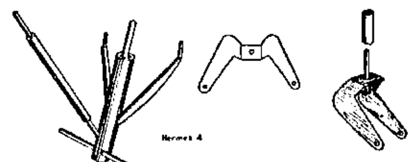


Fig. 28. Undercarriage for twin wheels.
Fig. 29. Nose-wheel fork. Method of cutting metal and assembling.

of the Comet undercarriage, can still be followed. The modeller will undoubtedly find that he will have to supplement the information given in the general arrangement drawings with photographs which show the undercarriage of the particular type in greater detail. The advertising pages of aeronautical magazines often give very clear illustrations of the undercarriages of different aircraft types.

Multi-wheel undercarriages in which the wheels are carried on a common axle, such as on the Hermes, Viscount, Ambassador, and Brabazon, are less troublesome to the model maker and normally consist of a single main leg, for which a piece of brass rod or brass tube can be used, the lower end being drilled for the axle fitting. As a rule, the only other parts will consist of two splayed-out bracing struts and a retracting jack, which again can be made of either brass rod or tube (see Fig. 28).

NOSE WHEELS

Nose wheels fall into two main types, the single leg, carrying a single wheel in a fork fitting, and the single leg with twin wheels, one on each side. Brass or copper wire, small brass tube, and in some cases ordinary pins, together with forks cut from thin tin are the materials from which these can usually be made. The single-leg single-wheel type is usually found on the smaller aircraft and all follow much the same pattern, although they will, of course, differ in detail for each type of aircraft. Invariably, however the main leg can consist of an ordinary pin with a sleeve of brass tube to give the leg the required thickness. The fork, which, as a rule, incorporates a system of levered suspension, can be cut in one piece from a sheet of thin tin with holes drilled at the end of each fork to take the wheel axle and another hole drilled on the centre line of the fork through which the pin, forming the main leg, can be threaded and soldered; Fig. 29 illustrates the method of marking out such a fork. The holes should be drilled before the part is cut out and they can usually be started by piercing the metal with the sharp point of a pair of compasses or dividers. For cutting out the fork a pair of old scissors can be used. The part should then be held by a pair of thin-nosed pliers placed over the central hole and each side bent down at right-angles, as shown in the illustration. The pin for the main leg is then threaded up through the central hole and a piece of brass tube is threaded on over the top so that about a ¼″ of the pin is left free at the top for plugging into a hole drilled in the undercarriage housing. If brass tube is not available, thin paper can be rolled and glued round the leg, but before this is done the pin head should be soldered securely to the fork. Narrow strips of paper can be glued round to represent any thickening of the joint of the leg. The assembly is completed by fitting a length of pin or wire to represent any retracting jacks which are visible; this part can be fitted into an appropriate hole drilled in the undercarriage housing and the lower end soldered to the main leg, or, if a paper fairing has been used on the main leg, a spot of glue can be used to make this joint. Such aircraft as the Hunter, Sea Hawk, and the Avro 707 deltas use this type of forked nose wheel.

For the twin-wheel type, which is usually found on the larger aircraft, a piece of brass tube should be used for the main leg, into the top end of which is soldered a short length of wire for plugging into a hole drilled in the nose-wheel housing. At the lower end a fitting will be required to carry the wheel axle. Where the axle is carried immediately beneath the main leg the brass tube can be drilled at its lower end and the axle threaded through and soldered. In most cases, however, the wheel axle lies slightly behind the centre line of the main leg

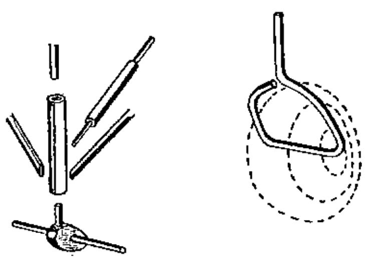


Fig. 30. Twin nose-wheel assembly with bracing struts and retracting jack.
Fig. 31. Tail-wheel fork formed in wire.

and when this is so a small piece of brass must be filed to the required shape, including a shank to fit up into the end of the brass tube. The axle hole is drilled and the axle threaded through and soldered. Any bracing members or retracting jacks can be formed from wire or pins (see Fig. 30). This type is found on such aircraft as the Hermes, Comet, Viscount, and Ambassador air liners.

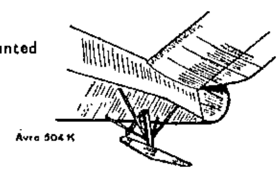
TAIL WHEELS

Tail wheels are also usually carried in a forked fitting, but as a general rule they will be much smaller than the nose-wheel types, and in many cases can be formed from a single length of wire, the wheel being threaded on and the wire then bent round to form the fork and leg, as shown in Fig. 31.

TAIL SKIDS

Tail skids for the earlier types of aircraft can, almost without exception, be made from short lengths of wire. In some cases the wire will need to be hammered flat and filed to the particular shape required, as, for instance, on some early De Havilland types, the D.H. 4, 5, 6, 9, and 10 being examples. In other cases the skid may be supported on an inverted pylon of struts, examples being the Avro 504 and B.E.2.C. In this case the central main strut and four bracing struts can be

Fig. 32. Pylon-mounted tail skid.



built up on the fuselage and a separate piece of wire filed to the appropriate shape can be soldered to the apex of the pylon. For greater realism a tiny coil of fine fuse-wire can be added to represent the spring (see Fig. 32).

Most nose-wheel types of aircraft carry a small shock-absorbing bumper under the tail end of the fuselage. These can usually be shaped in wood and fitted with a pin point and glue.

UNDERCARRIAGE DOORS

To complete the undercarriage assembly for retracting types, the doors which close over the wheel housings when the undercarriage is retracted will have to be represented. These can be made either

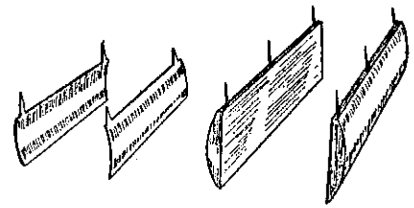


Fig. 33. Undercarriage doors in sheet metal.
Fig. 34. Undercarriage doors shaped in wood. Pin points used for fitting.

from sheet metal, in which case the metal must be cut with shanks for fitting into the undercarriage nacelle or fuselage, as shown in Fig. 33, or for the larger types of aircraft the doors can be made from thin strips of wood and are fitted by inserting pin points in the top or hingeing edge which can be plugged into the nacelle or fuselage. The joint should also be glued (see Fig. 34). When making these undercarriage doors, notice that they are usually slightly curved in shape so that when closed they take up the contour of the undercarriage housing.

WHEELS

Wheels are the one item which most modellers will find it best to purchase. A wide selection of wheels for scale-model aircraft are available and the use of these certainly saves a considerable amount of trouble. Occasionally, however, the modeller may find that he cannot obtain wheels of the exact size he requires and he will be thrown back upon his own resources to produce these parts. Wheels can be made by cutting slices off a wooden dowel of appropriate diameter, the treads then being shaped by filing. The wheel hubs should be indented slightly either with a drill or by rubbing with a circle of sandpaper glued to the end of a piece of wood dowel of the appropriate diameter. Wheels can also be cut out in wood with a fret-saw, the shaping of the treads and the hub being carried out as described. Small wheels, such as tail wheels, can be cut from sheet aluminium, the axle hole should be drilled before the wheel is cut out and, after cutting, the wheel is cleaned up to true circular shape with files. For filing these small wheels, hold the metal firmly at the end of a pair of fine-nosed pliers. Sheet perspex of the appropriate thickness also makes an excellent material for wheels, the construction being the same as for making wheels in wood.

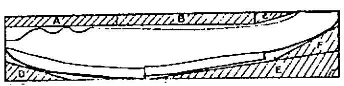
CHAPTER NINE

Hulls and Floats

Flying boats make particularly attractive models, but unfortunately this type of craft introduces many difficulties for the modeller and, therefore, it is advisable to leave them severely alone until sufficient experience has been obtained on landplane types, both small and large. When the modeller feels confident that he can tackle a flying-boat model, he should choose a simple type and one having as few unusual characteristics as possible. If a number of large models have already been built the Saunders Roe Lerwick should provide a good starting point for flying-boat work.

HULLS

The main differences and also difficulties will lie in the shaping of the hulls of these models, but here again, if the modeller works to a definite sequence of shaping, these difficulties will be minimized. In general, the shaping of a flying-boat hull follows the sequence of shaping already described for fuselages, that is after the block has been planed down to the maximum depth and breadth of the hull a datum line is marked on each side of the block, the hull profile or side elevation is plotted on, and the block shaped to this elevation. In many of the older types of flying boat the stern is raised some way above the main body of the hull. The Supermarine Southampton of 1925 and many of the Short biplane flying boats, such as the Singapore, had raised sterns and on such types the lines of the hull will involve the shaping of concave as well as convex curves and a large amount of waste wood will have to be removed from the rectangular block. To avoid prolonged and tedious work with a file, as much of this waste wood as possible should be removed by sawing. Let us take as an example the hull of the Southampton flying boat and follow the sequence of shaping through step by step, for this type will cover the majority of problems the modeller might come up against in flying-boat work. Having set out the side elevation, the shaping is commenced by sawing off as much of the waste wood as possible, the illustration in Fig. 1, shows how cuts can be made to remove the waste pieces A, B, C, D, E, and F. Notice that, as usual, the saw cuts are made just outside the outline so that the small margins of wood remaining can be removed gradually with files. The sweep of the top line of the hull up to the raised stern must be shaped with a half-round file. For the rest of the outline, normal methods as for



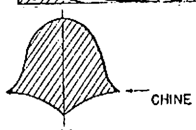


Fig. 1. Preliminary rough shaping of hull block.
Fig. 2. Cross section of hull with flared chines.

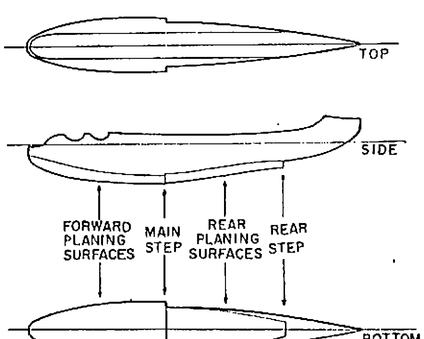
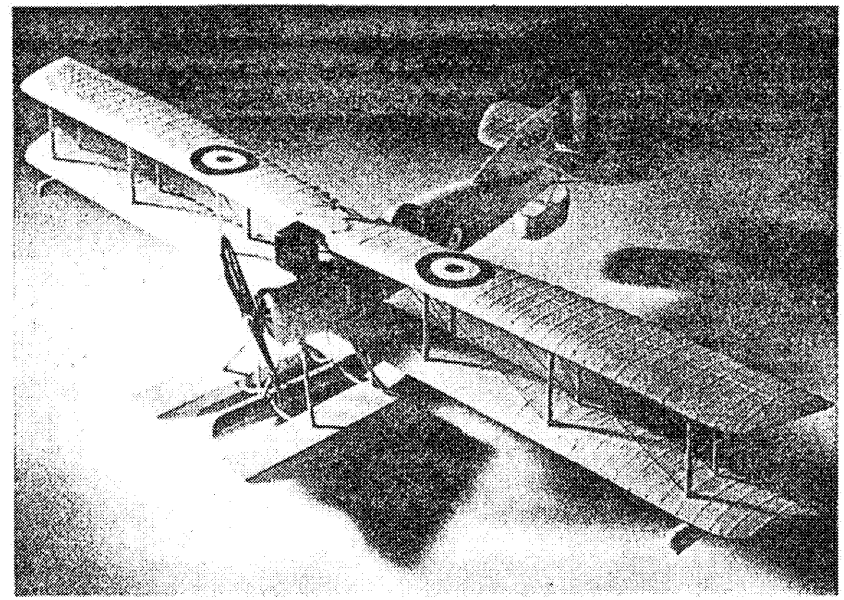
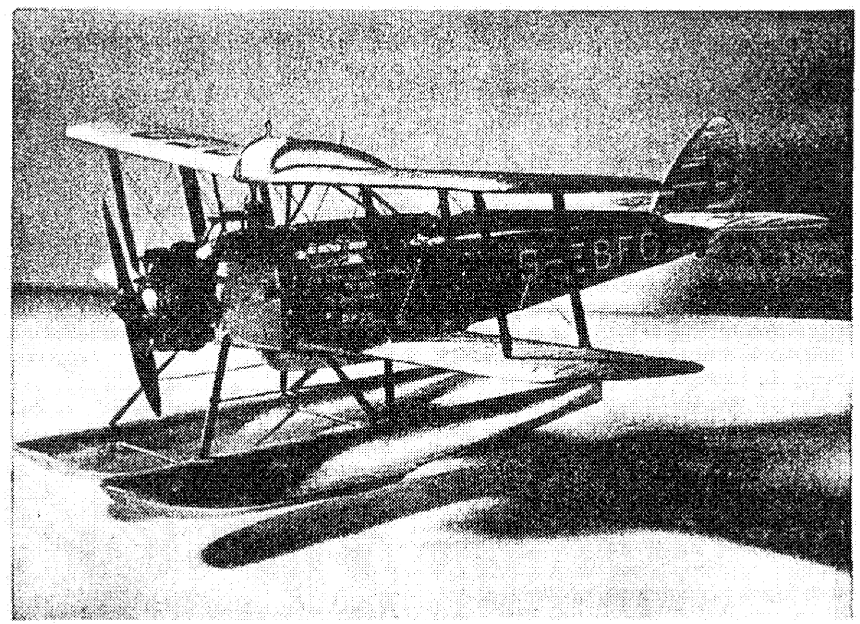


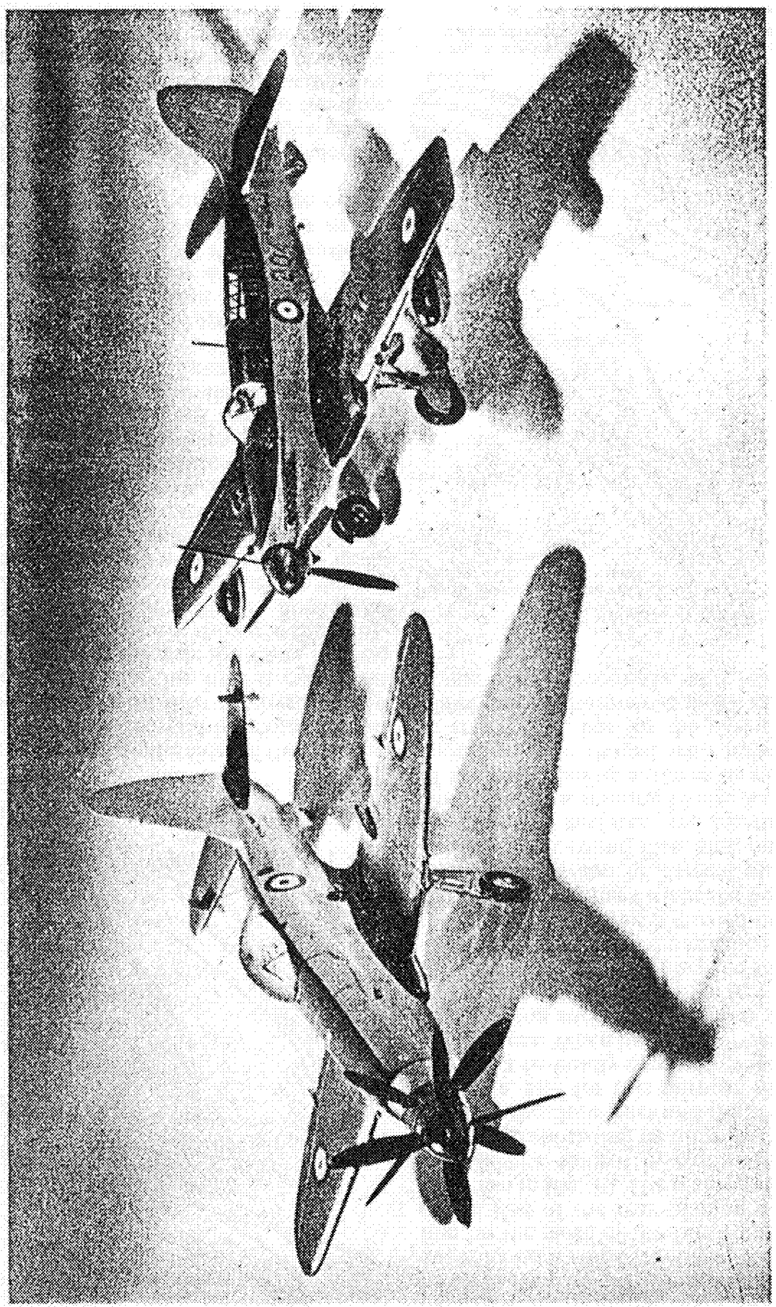
Fig. 3. Setting out shapes of hull.



Short 225

De Havilland D.H. 50J





Westland Wyvern and Fairey Firefly

a fuselage can be used. The plan is now plotted on both upper and lower surfaces, using the centre line in each case as a basis, and the surplus wood removed by sawing and filing.

We now come up against the greatest difficulty and difference between fuselages and hulls, that is the shaping of flared chines. From a glance at the typical cross-section shown in Fig. 2 it will be seen that the narrow upper portion of the hull is flared out to a much wider underside or planing bottom. The edge of the chine is shown in the side elevations of general arrangement drawings. In Fig. 3, these are the lines lying just above the bottom lines of the hull. This flare is usually greatest at the main step, from there forward to the bows it gradually decreases and it also decreases generally from the main step aft to the rear step, where in some cases the planing surfaces are narrower than the hull immediately above. The marking for the plan shaping will, therefore, differ on the top and bottom sides of the block, as shown in Fig. 3.

In shaping these complicated hull sections, gouges of one or two sizes will be essential tools, and careful checking of the work against templates will be necessary. In flying-boat work the templates for each section should be made in two parts: an upper portion, giving the shaping down to the edge of the chine; and a lower portion, giving the shape of the V planing or under-surfaces (see Fig. 4).

The upper portion of the hull should be shaped first, and this is carried out in two stages, the first stage being the filing of the sides of the hull on a flat slope from the upper surface out to the edge of the chines (see Fig. 5). The chine line will form the guide at the lower end of the slope and these lines should be boldly marked before the filing commences. For guide lines on the upper surface of the block the cross-sections given in the general arrangement drawings are used and on each of these sections sloping lines are drawn from the chines up to the top of the hull, as shown in the section drawing in Fig. 5. This will enable us to plot on the block the points of the upper edge of the slope at each section station by taking measurements from the centre line of the section out to the angle of the slope. These measurements are shown as X in the section drawing in Fig. 5. When the points have been plotted for each section they can be joined up to give the upper guide-lines. The hull is then filed on a flat slope between these lines, as shown in the illustration. The second stage consists of shaping the flare out to the chine. The forward portion of the hull, from the main step towards the bows should be shaped first, the surplus wood being carefully pared away with a gouge of the appropriate size, working in all cases from the main step towards the bows, as shown in Fig. 6. This work should be checked at frequent intervals against the templates.

Where the rear planing surface becomes narrower than the body of the hull towards the rear step, this surface must next be tapered down to its correct width. The marking for this part of the work is shown in Fig. 7(a) and the mark-

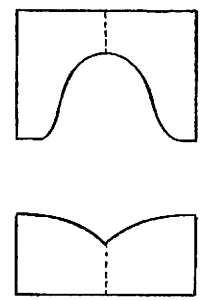


Fig. 4. Templates for checking hull section.

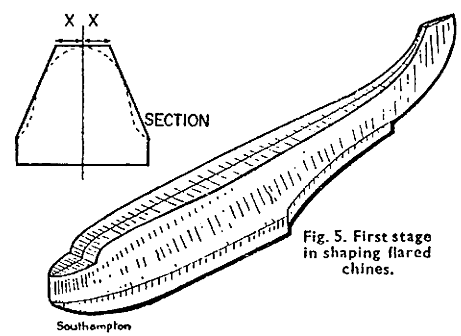
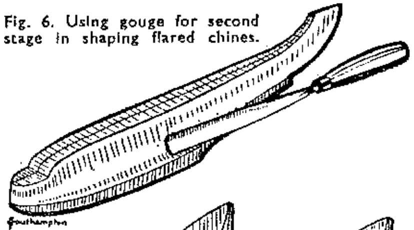


Fig. 5. First stage in shaping flared chines.

Fig. 6. Using gouge for second stage in shaping flared chines.



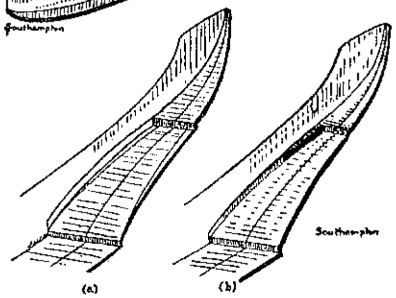


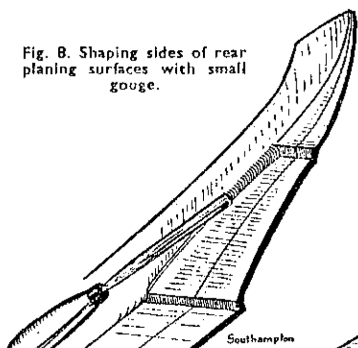
Fig. 7. First stage in shaping rear planing surfaces.

ing lines, both on the sides of the hull and on the bottom, should be scored in and the surplus wood then removed with a small chisel, working in this case from the main step towards the stern, leaving the planing surface as shown in Fig. 7(b). The hull sides immediately above the rear planing surface must then be shaped in on a hollow curve, as shown in Fig. 8; a smaller size gouge will be required, and again the cuts should be made from the main step towards the stern.

Attention is then turned to the top of the hull block, the shapes of the cockpits and gunners' positions are marked and drilled out and the whole of the top surface is then filed to its correct cross-section as shown in Fig. 9. The final smoothing off of the shaped upper portion of the hull is now carried out with half-round or small round files and finally with sandpaper. During all these operations, care must be taken not to cut into or file away the lines marking the edge of the chines.

The underside or planing surfaces are next shaped to section, usually a gentle curve from the keel line out to the edge of the chines. Before commencing this shaping, however, transverse saw cuts must be made with a fret-saw or small hack-saw to form the main step. The block is sawn so that the bottom of the cut runs on a slope from the rear chine line on the sides of the block up to the centre line of the rear planing surface, as shown in Fig. 10. The planing surfaces are likewise shaped in two stages, the first stage consisting of filing flat slopes between the chine lines and the centre or keel line, and for this purpose the keel line must be boldly marked before filing commences. When both the forward and rear planing surfaces have been shaped to these flat slopes, as shown in Fig. 11, the second stage of shaping the surfaces in a gentle curve from the keel line out to the edge of the chines is carried out. On the forward planing surface the whole of this operation can be carried out with half-round or round files, and, on completion, the surfaces are cleaned up smooth with a sanding block. As much of the rear planing surfaces as possible should also be shaped with half-round or round files, but for the parts immediately aft of the main step the use of a gouge will be necessary, and here care

Fig. 8. Shaping sides of rear planing surfaces with small gouge.



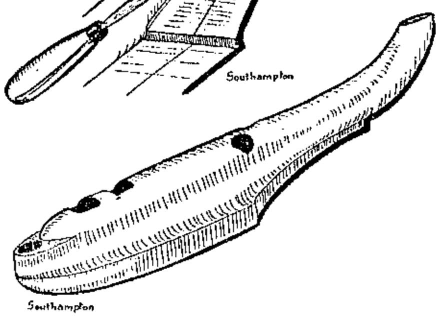


Fig. 9. Cockpits drilled and section shaping of upper part of hull above chine lines completed.

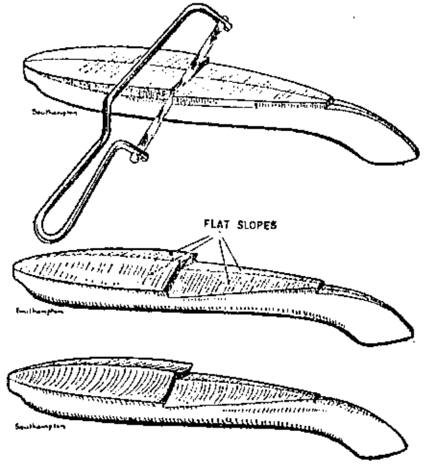
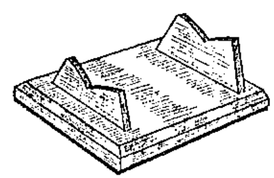


Fig. 10. Sawing main step as preliminary to shaping planing surfaces.
Fig. 11. First stage of shaping planing surfaces.
Fig. 12. Underside shaping completed.

must be exercised so that the gouge does not slip forward and cut into the step. Finally, the shaping of the underside of the raised stern aft of the rear step is carried out by filing, leaving the hull as shown in Fig. 12.

During subsequent work on the flying-boat model, the keel and planing surfaces might easily become dented or damaged when the hull is placed on the working bench, and to avoid this it is a good plan to make a cradle similar to that illustrated in Fig. 13 on which the hull can stand. Incidentally, a cradle of this type serves as an excellent stand for the completed model.



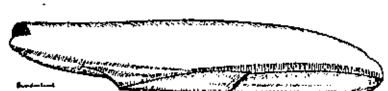


Fig. 13. Cradle for flying-boat hulls.
Fig. 14. Hull with plain chines, V-shaped main step and knife-edge rear step.

This type of hull with flared chines will be one of the most difficult which the modeller is likely to come across. In later types of flying boat, such as the Lerwick, Sunderland, and the Empire flying boats, the planing surfaces are never wider than the main lines of the hull and shaping is, therefore, much more simple (see Fig. 14).

FLOATS

The sequence of shaping a seaplane or wing-tip float is exactly the same as for a hull, but on the whole the job is much more simple to execute. Flared chines will never be encountered, and, in general, float sections will be similar to that shown in Fig. 15, with plain V under surfaces

Fig. 15. Example of stream-lined floats.

and upper surfaces curved and almost semi-circular in section. Practically all the shaping can be done with flat and half-round files, except again for the portion of the rear planing surface immediately behind the step, where the use of a gouge will be necessary as with hull shaping. Notice that with floats only one step is used and the keel runs throughout the whole length of the float. Generally, the V planing bottom is slightly increased in depth towards the heel or stern of the float, this must be carefully noted from the general arrangement drawings and copied accurately. Some floats are fitted with small water-rudders at the heel which are connected to the rudder bar in the cockpit to facilitate the handling of the seaplane on the water. These are best reproduced by cutting their shapes out of thin tin and fitting them into vertical slots cut with a fine fret-saw in the heel of the float. It is best to cut these slots before the plan shaping of the rear of the float is carried out. Wing-tip floats for flying boats follow exactly the same general lines of construction as main floats for seaplanes, the only difference being in their relative propor-

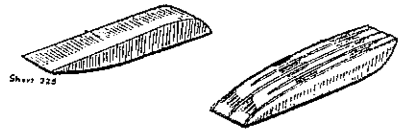


Fig. 16. Example of early-type floats.

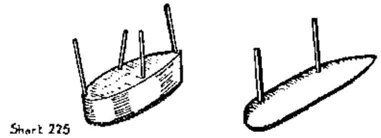


Fig. 17. Tail- and wing-tip floats for early type of seaplane.

tions, wing-tip floats being much shorter and more "tubby" in appearance but still having V-shaped planing bottoms and a single step.

Floats for the very early types of seaplane are much more simple structures. Usually, they were of rectangular section being constructed mainly of wood and, after the shaping of the profile, or side elevation, and the plan, little more will need to be done (see Fig. 16). In some cases, however, strips of metal were fixed to the undersides of these floats to prevent damage if the seaplane ran aground. These strips, or strakes, can be represented by gluing narrow strips of thin card to the underside of the float, as shown in Fig. 16, which illustrates a float for the famous Short 225 seaplane of the first World War.

Often these early seaplanes carried a tail float as well as wing-tip floats. Again, the tail floats were usually of rectangular section and wing-tip floats were often simple metal canisters with shaped fairings at each end, as shown in Fig. 17. These are best represented by cutting a length of wood dowel and filing each end to shape.

It might be repeated here that when constructing two identical parts for a model, such as seaplane floats or wing-tip floats, each stage of the operations should be carried out on each block in turn before proceeding to the next stage so that the two parts can be made exactly alike.

When fitting main, wing-tip, or tail floats to a model by means of struts, it is easier to build up the struts on the floats first and then fit the whole float assembly to the model (Fig. 18). Notice, too, that with the majority of seaplanes, spreader bars, corresponding to the axle of a wheel undercarriage, are used to maintain the floats the correct distance apart. These should be fitted first and the floats adjusted to the correct track before the main undercarriage struts are fitted. When assembling the floats on the model, always make sure that each float is set truly vertical in front view. Any of the methods of making struts described in Chapter 6 can be used for the undercarriages of floatplanes.

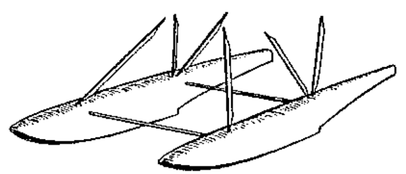


Fig. 18. Float undercarriage assembly.

CHAPTER TEN

Details and Accessories

Thus far we have dealt with the construction of all the major components that go towards the making of a solid scale model, but something more than the major components are required if a first-class model is to be produced, and this extra "something" takes the form of numerous small details which make all the difference to the appearance of the finished article. It is in the reproduction of these small details that the majority of modellers fail, either through portraying the detail incorrectly or, as is more often the case, through including detail which is badly out of scale. One so often finds evidence of lack of care and attention in this part of the work and many a model has been spoilt by such items as bracing wires and aerials carried out in a material which, if scaled up, would provide excellent cables for mooring the *Queen Mary*, or exhaust-pipes which would be more appropriate as drain pipes, or interplane struts which would serve well for fencing a doll's house! Small details on a model should be there to be seen but they should not be obtrusive, and the only way to ensure this is to make certain that they are exactly the right scale size. One must remember that when working to one-seventy-second scale for instance, $\frac{1}{24}''$ on the model represents a measurement of 3″ on the actual aircraft, and an exhaust pipe 3″ in diameter is quite a substantial piece of ironmongery. If the modeller finds it impossible to reproduce any detail exactly to scale it is far better to leave it out altogether.

In the following pages suggestions are put forward for the making of a wide range of detail fittings and these will include most of the items which the average modeller will consider to be necessary. Many details should be fitted at some definite point in the finishing stages of a model and, where this is so, the stage at which the particular detail should be fitted is also mentioned.

AIRSCREWS

Wood or metal may be used for model airscrews and the airscrew may be made either in one piece or built up with separate blades which are fitted to a spinner or hub. Wooden airscrews, with either two or four blades, were invariably used on the older types of aircraft, and for modelling purposes these airscrews are also best made in wood. A fairly tough wood should be selected as this will lessen the risk of splitting or other damage during the shaping and will also enable a better finish to be obtained. For a two-blade wooden airscrew a rectangular block is cut out and planed down to the maximum thickness of the blades when viewed from the side. A datum line is then marked on the face of the block and the centre point marked on this line. The circle of the hub is then scribed with a pair of compasses and the shape of the blade is set out as shown in Fig. 1(a), which illustrates a typical airscrew shape for aircraft of the first World War.

The first operation is to drill a small hole through the centre of the airscrew through which eventually a pin can be inserted to fix it to the model. The airscrew is then cut out with a fret-saw and the outline cleaned up with a small file.

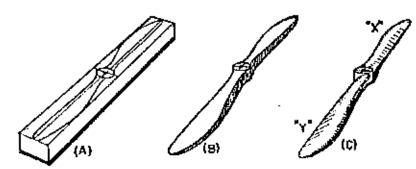


Fig. 1. Shaping airscrew with plain hub.

Each blade is then tapered in thickness from the hub to the tip by means of a file, an equal amount of taper being filed off the front and rear of each blade, as shown in Fig. 1(b). This filing should be done with the blade held at the hub between the thumb and forefinger and resting flat on the bench. Each blade is now filed to the correct pitch, and here it is important to take into consideration the direction of rotation of the airscrew. The leading edge is always towards the front of the blade, and the blade is filed in a slight curve down to the trailing edge. Fig. 1(c) illustrates this stage, the blade marked X being sloped downwards from left to right, the leading edge being the left-hand edge, the opposite blade Y will be filed down from right to left. The slope should decrease towards the centre of the airscrew where the blade shape merges into the circular hub. The block is then turned over and similar curved slopes are filed on the opposite side, also in the same direction, that is down from left to right on blade X and down from right to left on blade Y. The airscrew is then rubbed over lightly with a fine sandpaper to complete the job.

In some cases wooden airscrews have a small conical spinner instead of a flat circular hub. The Hawker biplanes so prominent in the 1930s mounted this type. When making these types, the thickness of the original block must be sufficient to allow for the projection of the spinner in front of the airscrew blades. The airscrew is marked on the block in the same way as before, and, after the centre hole has been drilled, the shape is cut out with a fret-saw and cleaned up with a file. The first operation is to file the block on each side of the spinner down to the thickness of the blade root as shown in Fig. 2(a). Each blade is then tapered from root to tip and filed to correct pitch. The spinner is next filed to cone-shape in profile and plan, as shown in Fig. 2(b). Finally, the diameter of the rear face of the spinner is marked with a pair of compasses on the back of the airscrew, and the corners are filed off the spinner to complete its conical shaping (see Fig. 2(c)). For all filing work

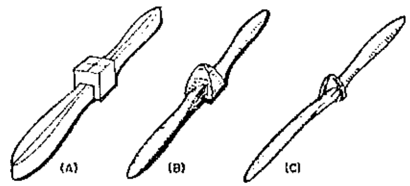


Fig. 2. Shaping airscrew with spinner hub.

on these airscrews a small half-round tapered file will be needed.

Where a four-blade wooden airscrew is required the complete airscrew is made in two parts, each part being shaped as a two-blade type. A joint is then made by filing each hub down to half of its original thickness and the two parts are then glued together, any gaps in the joint being filled with plastic wood and cleaned down with fine sandpaper when set. When making this joint, always remember to file all the blades for the same direction of rotation (see Fig. 3).

Three-blade airscrews, whether in wood or metal on the original aircraft, are best made in metal for models and the same sequence of marking and shaping is followed. It should be noted, however, that on aircraft fitted with early types of three-blade metal airscrews, such as the Fairey Battle, the hubs were much smaller in diameter and each blade tapered to a circular section at the root. These airscrews were of the variable-pitch type and each blade in fact fitted into a cylinder of slightly larger diameter than the blade root itself. This can be represented by rolling and gluing a narrow strip of paper round each blade root as shown in Fig. 4. In addition, a cylinder which contained the pitch-change mechanism projected from the centre of the airscrew and this can be represented by a short length of brass tube, as shown in the illustration.

Later on, the pitch-change mechanism

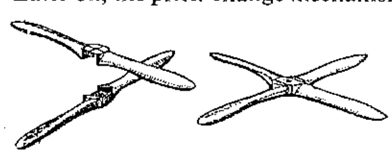


Fig. 3. Jointing four-blade wooden airscrew.

of these variable-pitch airscrews was faired over with a large spinner, and for modelling purposes this type of airscrew is best represented by shaping the spinner in wood and the blades in metal, the latter then being fitted into small holes drilled in the spinner. We have already seen in Chapter 3 that where this type of airscrew is employed on a single-engine aeroplane the spinner should be shaped as part of the fuselage for the first stages, and after the spinner portion is cut from the fuselage, it must be shaped to its conical form for which the following method is used. First, a small hole for the fixing pin is drilled through the spinner block, a piece of wire is then inserted

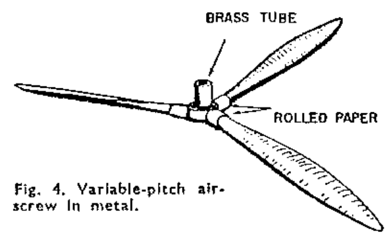


Fig. 4. Variable-pitch airscrew in metal.

close to the corner of an odd scrap of wood of about ½″ thickness and about 3″ square, the spinner is then placed nose downwards on this wire when it can be easily held between the thumb and forefinger whilst it is filed to shape with a small flat or knife-edge file (see Fig. 5). When the rear of the spinner has been filed to its circular outline the spinner is reversed on the wire and the shaping of the nose of the spinner is finished off. Small holes are then drilled in the circumference of the spinner to take the blade roots. Each blade is made separately in metal, preferably aluminium which is soft and easy to work. To ensure that each of the blades is identical a rectangular blank is cut from the aluminium for each blade required and the shape of the blade is marked on one of these blanks. The blanks are then placed one behind the other and inserted in a vice with the marked blank at the front. All the blades can then be filed to the correct shape at the same time, the top half being shaped first, and then the blanks inverted in the

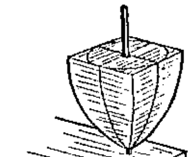


Fig. 5. Method of mounting spinner block on wire on corner of scrap of wood for filing to final shape.

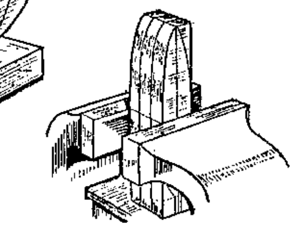


Fig. 6. Method of filing a number of metal airscrew blades to shape at the same time.

vice whilst the lower half of the blades are filed. Allowance must be made for small shanks at the root end of the blades for fitting into the spinner. This method is illustrated in Fig. 6.

For contra-rotating airscrews the spinners must be made long enough to take the two sets of airscrew blades plus a small allowance for the saw cut when the two parts of the spinner are separated. This type of spinner will almost invariably have to be constructed separately from the fuselage and the sequence of operations will be as follows. First, a block is planed to square section, centre lines are marked on two sides, and the profile shape of the spinner is set out (Fig. 7(a)). The block is then filed to

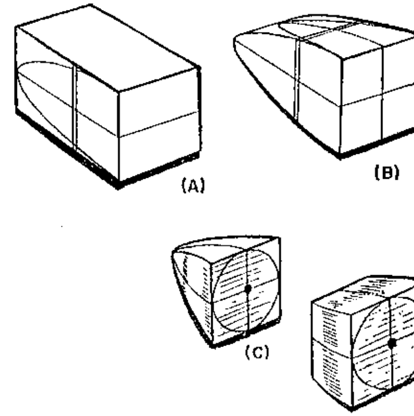


Fig. 7. Stages in shaping double spinner for contra-rotating airscrew.

profile shape, centre lines are marked on the filed faces, and the plan shape marked out and filed (see Fig. 7(b)). The two parts of the spinner are then separated, as shown in Fig. 7(c), and circles are marked on the three flat faces. Each part is then drilled for the fixing pin and the final shaping is then carried out in a similar manner to that already described for single spinners.

Airscrews should be painted separately from the rest of the model and should not be fitted until all the painting and lettering of the model has been completed. They are fitted on a pin and a most important point is that they must be made to revolve freely. One of the first things your friends will do when they examine your model will be to flick the airscrew blades. If the airscrew is at all stiff the results will be disastrous and yet another beautiful friendship may be ruined!

RADIATORS

On most of the older types of aircraft powered by water-cooled engines, the radiator was of the car type and formed the front end of the engine cowling, as on the De Havilland 4, Bristol Fighter, and Handley Page 0/400. With these types the radiator will be shaped as part of the fuselage or engine cowling. In some cases, however, the radiator was mounted as a separate unit, such as on the Short Singapore III flying boat, and where this is so or where the radiator was fitted at the front of an uncowled engine, as on the Supermarine Southampton flying boat, these parts will have to be made separately. A block of wood of a thickness equal to the depth of the radiator is used and the front view shape is marked on the face of the wood and the part cut out with a fret-saw. Any radiator shutters or honeycombs are represented by scoring lines on the front of the radiator with a chisel or penknife.

On later types the radiator was contained in a fairing and mounted either beneath the fuselage or under the mainplanes, this system being used on numerous aircraft, ranging from the Hawker biplanes of the 1930s to the Spitfire, Hurricane, and Defiant monoplanes of the second World War. Where it is not possible to make these radiators as part of the fuselage they must be made from separate pieces of wood. Turning once again to our Spitfire IX illustration, this type carried two radiators, one underneath each wing. With these types the usual sequence of shaping, namely, profile, plan, and section, is carried out in that order. Openings should be made at the front and rear of these radiators to obtain the "tunnel" effect, and this can be done by filing out the openings with a small half-round file after the part has been shaped. This shaping should not be continued right through the block, but each opening should be filed on a slope up towards the centre of the radiator, as shown in Fig. 8. The top of the radiator may need to be curved slightly to fit the wing or fuselage contour and the part is fitted with pins and glue.

Under-wing radiators are fitted to the wing after the wing has been shaped and before it is assembled to the fuselage. Radiators positioned under the fuselage are fitted after the wing and fuselage have been assembled.

AIR-INTAKES

Carburettor air-intakes are found on most aircraft. They vary considerably in size, but in general they consist of an L-shaped pipe fitted either above, below, or on the sides of the engine cowling. For small intakes a piece of wire can be used which is filed flat on one side and then bent at right-angles with a small shank filed for fitting into the engine nacelle, as shown in Fig. 9(a). Larger intakes should be shaped in wood and, where the size of the part permits, a hole should be drilled in the front of the intake, as shown in Fig. 9(b). For ease of shaping, these parts are best made one at a time on the end of a length of stripwood, as shown in Fig. 9(c), so that the stripwood can be held in the vice whilst most of the shaping is carried out. These parts are glued on to the engine nacelle, a small pin point being used to strengthen the joint. In some cases on multi-engined aircraft the air-intakes are set into the wing leading edge on each side of the engine nacelle, as on the Handley Page Hermes. Again, the intakes should be shaped one at a time on the end of a piece of stripwood and shallow cut-outs are made in the wing leading-edge into which the intakes can be glued (see Fig. 10).

Fig. 8. Under-wing radiator.

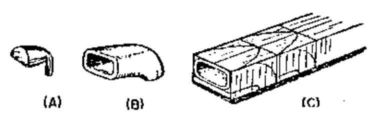


Fig. 9. Air-intakes in wire (a) and wood (b and c).

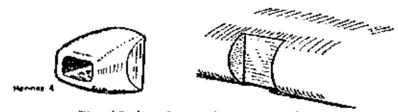


Fig. 10. Leading-edge air-intakes.

Air-intakes should be fitted before painting the model and, where they are set in the leading edge of the wing, they are fitted after the wing has been cambered.

EXHAUST PORTS AND PIPES

Wire of appropriate diameter is used to represent exhaust ports and pipes. In some cases only short exhaust stubs project through the engine cowling and, where this is the case, holes are drilled in the cowling, one for each exhaust stub, and pieces of wire are inserted so that only a small section projects (Fig. 11). The outer end of the wire must be filed flat or at a slight angle, whichever is appropriate to the type of aircraft being modelled. Where the exhaust stubs are connected into a tail pipe which is taken along the fuselage to discharge somewhere at the rear, as on the Bristol Fighter, Hawker Demon, and Hawker Audax, the holes are drilled in the cowling and short stubs are fitted for all except the front port. Into this one is fitted a length of wire which has been bent at right-angles. The wire is pushed in until it rests on the stub ports. The tail pipe is then bent to the appropriate shape and carried along the fuselage and the open end filed flat (Fig. 12). In some cases, as on the Spitfire, each stub exhaust was flared out into a fan shape. This effect can be obtained by hammering an end of wire flat on a vice, filing the end to shape, and then bending the wire at right-angles to fit into the holes drilled in the engine cowling. When fitting this type, fit the rear stub first so that each succeeding stub in front can slightly overlap the one behind it, as shown in Fig. 13. Exhaust-pipes for uncowled in-line engines are fitted by soldering them to the tops of the cylinders, as described in Chapter 7, the front end of these pipes should be rounded with a file. Exhaust rings for radial engines are formed by bending a piece of wire into a circle and then soldering to this circle any tail pipes that may be required as shown in Fig. 19 in Chapter 7.

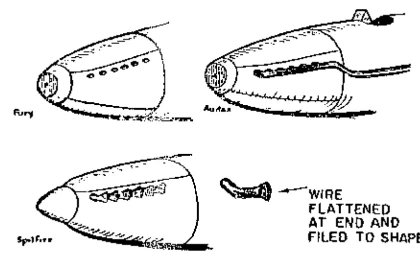


Fig. 11. Stub exhaust-pipes.
Fig. 12. Long exhaust-pipes.
Fig. 13. Short exhaust-pipes with fan-shaped flame-traps.

Exhaust-pipes are best fitted after the basic paint coats have been applied to the model, but any holes needed for the fitting of the pipes should be drilled before painting starts, and, in fact, before the various parts are assembled.

FUEL TANKS

Under-wing or wing-tip fuel tanks are a common feature on modern aircraft, but external tanks were frequently used

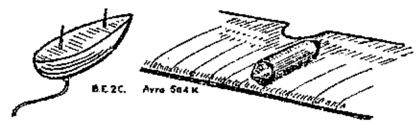


Fig. 14. Under-wing fuel tank.
Fig. 15. Fuel tank on top of wing.

on the older types. Many biplanes of the first World War carried tanks beneath the top mainplane, the B.E.2.C and D.H.4 being only two of the many examples. These tanks were usually of stream-lined form, as shown in Fig. 14, and the normal profile/plan/section sequence of shaping is used in their construction. The top of the tank will need shaping to the contour of the under surface of the wing and the tank is fitted with pins and glue before the mainplane is assembled to the model. On other types, notably the famous Avro 504, a cylindrical tank was mounted on short struts above the upper mainplane. For these tanks a piece of wood dowel can be used, the front and rear ends being filed to conical shapes (see Fig. 15). Pins or wire can be used for the mounting struts, and it is best to fit these types after the basic painting of the model has been completed. Between the wars many biplanes mounted a fuel tank in the centre section of the top wing, the D.H. Moth and many other De Havilland aircraft are examples. Normally, this type of tank was of thickened aerofoil section, as shown in Fig. 17, and they can be made as part of the top wing, when allowances must be made for the depth of the fuel tank when planing the wing block. After cutting the plan shape of the wing the block must be filed down on either side of the centre-section tank to the thickness of the mainplanes themselves (Fig. 16), and the mainplanes are then cambered. This method involves a considerable amount of filing and the modeller may prefer to make the centre-section tank as a separate unit and to fit wire dowels to the sides of the tank on to which the port and starboard mainplanes can be fitted as shown in Fig. 17. Filler caps and a float fuel gauge were often features of this type of tank. Filler caps

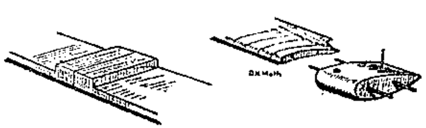


Fig. 16. Centre section fuel tank built integral with wing.

Fig. 17. Centre section fuel tank built as separate unit.

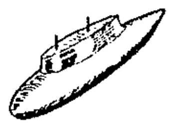


Fig. 18. Under-fuselage fuel tank.

Fig. 19. Under-wing pylon-mounted fuel tank.

Fig. 20. Bending pin at right-angles to fit wing-tip tanks.

can be represented on a model by a pin head pushed into the top of the tank, whilst the fuel gauge can be formed from a short length of wire which was usually fitted towards the trailing edge of the tank where the gauge was visible from the pilot's cockpit, as shown in the illustration. In addition a flexible fuel line often ran from underneath these tanks into the engine and this can be represented on the model by a short length of thin wire, one end of which is plugged into a hole drilled underneath the tank and the other end into a hole drilled in the engine cowling. The holes should be drilled before the model is assembled, but the wire should not be fitted until the basic painting has been completed.

During the second World War, Spitfires frequently carried an external fuel tank under the fuselage. These tanks were shaped to aerofoil section, as shown in Fig. 18, the small cut-out at the front fitting round the air-intake beneath the rear of the engine. Again, it is only necessary to shape the block to aerofoil form and it is fitted to the fuselage with pins and glue. On modern aircraft the tank is either carried on a stalk or pylon fairing beneath the wing, as on the Vampire, or fitted to the wing tip, as on the Venom. In both cases the tank is of fully stream-lined form and the normal method of profile, plan, and section shaping is used, a separate piece of wood being used for the supporting pylon, the whole being assembled with pins and glue (see Fig. 19). When fitting wing-tip tanks, as the wing at the tip will be thin, it will often be necessary to bend the fitting pin at right-angles, as shown in Fig. 20, so that it will run into the span of the wing. The wing-tip tanks often have a

guide vane at the tail, and for these a piece of thin tin should be used which is fitted into a slot cut into the tail of the tank with a razor-blade. All under-wing, wing-tip, or under-fuselage tanks should be fitted before the model is painted.

HANDLEY PAGE SLATS

Between the wars many aircraft were fitted with a patent device designed by the Handley Page Company which took the form of a short slat of aerofoil section fitted on the leading edge of the top wings of biplanes near the wing tips. These slats opened automatically at low air-speeds, forming a slot which smoothed out the air flow over that portion of the wing, and thus enabled the ailerons to remain effective near the stalling speed of the aircraft. When closed, the slats fitted close to the wing surface, and on models they are best shown in this position when they can be represented by strips of thin card glued to the leading edges, as shown in Fig. 21. The operating mechanism for these slats was often contained in small triangular fairings just beneath the wing leading-edge, as shown in the illustration. These are best represented by very small pieces of wood glued to the wing. In other cases operating rods, usually in the shape of an inverted V, projected above the leading edge on each end of the slat. This type is also shown in the illustration and is represented on a model with thin wire. These parts are best fitted before the painting of the model is commenced.

MASS BALANCES

In order to make control surfaces easier for the pilot to operate, the weight of these surfaces is often balanced by adding weights which project forward of the hinge line. These weights are known as mass balances, and take the form of a stream-lined piece of heavy metal supported on a sloping strut, as shown in Fig. 22. For models, the balance weight should be filed to shape on the end of a piece of brass or copper wire, as shown in the illustration, and before the part is cut from the wire a small pin is soldered to it as shown. The wire can

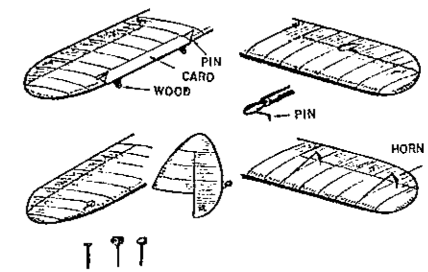


Fig. 21. Handley Page slat, operating rods, and fairings.

Fig. 22. Mass balance, showing method of shaping on end of length of wire.

Fig. 23. Flattened and filed pin heads for external navigation lights.

Fig. 24. Control operating-rods. Wire with one end flattened and filed to shape of horn.

be held in a vice and the pin in a pair of fine-nosed pliers whilst the solder is applied. The part is then fitted by pressing the end of the pin into the control surface in the position shown on the general arrangement drawings. These mass balances will be very small, and to avoid damage they should be fitted when the painting of the model is complete.

NAVIGATION LIGHTS

The small external navigation lights carried at the wing tips and trailing edge of the rudder of the earlier types of aircraft can be represented by using a large-headed pin, the head being hammered flat and filed to the shape shown in Fig. 23. The pin is then cut so as to leave a short stem for fitting into a hole drilled in the wing or in the trailing edge of the rudder. In the latter case the hole should be drilled after the rudder has been cut out and before it is filed to stream-line section. The navigation lights themselves should not be fitted to the model until all painting and lettering has been finished.

CONTROL RODS

Control rods can be made from wire and, for better effect, a short section of the end of the wire should be flattened by hammering on the edge of a vice to form the control horn, a small shank being filed for fitting into the control surface, as shown in Fig. 24. These parts should also be fitted when the main painting of the model has been completed.

WING-TIP SKIDS

The semi-circular skids fitted under the wing tips of many early aircraft can be represented by thin wire. The exact shape of the skids will be shown on the general arrangement drawings and the ends of the wire are inserted in small holes pierced in the under surface of the wing.

AIR BRAKES

Air brakes are found on most modern high-speed aircraft and are fitted either on the wing surfaces or on the sides of the fuselage. The exact positions and shapes of air brakes will be shown on general arrangement drawings, and they are best fitted on the model in the closed position when they lie flush with the surface. The shapes should be cut from thin paper which can be glued flat on to the wing or fuselage. These should be fitted after the model has been assembled and has been finally rubbed down for the first painting coats.

WING FENCES

Many modern aircraft are fitted with wing fences, and for models these fences can be cut to shape from a sheet of aluminium and fitted into slots cut in the leading edge of the wing in a similar manner to the auxiliary fins on tail-planes, described in Chapter 6. Where the fence continues across the upper wing surface, as on the Venom, a slot can be cut in the top surface of the wing with a fine fret-saw.

FLAP GUIDES

Aircraft having the Fowler type of flap, which moves rearwards and downwards in operation, are usually fitted with fairings which contain the flap-operating mechanism, the Wyvern and Firefly V are two examples. These fairings are shaped from a small peice of wood and glued to the trailing edge of the wing in the positions shown on the general arrangement drawings. Small pin points should be used to strengthen the joint.

PRESSURE HEADS

Pressure, or pitôt, heads which operate various instruments are found on all aircraft. On biplane types the pitôt head usually took the form of two tubes projecting into the air stream, and they were fitted, as a rule, on one of the interplane struts away from the slipstream of the airscrew. This type can be formed from a length of thin wire bent as shown in Fig. 25(a) and soldered to the strut.

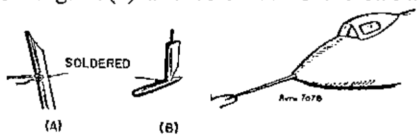


Fig. 25. Pitôt and pressure heads for mounting on interplane strut (a) and under wing (b).
Fig. 26. Instrument boom.

Later, the two tubes were placed one inside the other and shaped something like a small torpedo. This type was usually mounted beneath the wing on a short strut. Two pieces of wire can be used for this type, one piece being filed to the shape of the pressure head and the other being flattened and filed to shape for the mounting strut, the two then being soldered together, as shown in Fig. 25(b). A shank should be filed at the top of the strut for fitting to the wing. These parts can be fitted during the assembly stages of the model.

INSTRUMENT BOOMS

Instrument booms are a feature of many modern aircraft and take the form of long rods projecting forward either from the leading edge of the mainplane or from the nose of the fuselage. Pins or wire can be used to represent these booms and are fitted into holes drilled in the leading edge or fuselage nose. Those fitted in the nose of a fuselage are often tapered off towards the front so that the wire or pin must be filed to the same shape. In some cases they terminate in a fork fitting at the front end, as on the delta-wing Avro 707B, and this fork can be represented by soldering a thin piece of wire to the front of the boom, as shown in Fig. 26. To avoid damage these parts are best fitted during the final painting stages of the model.

VENTURI TUBES

Venturi tubes are frequently used to provide suction to operate gyro instruments. These tubes, which on the actual aircraft are about 6″ long, are shaped as shown in Fig. 27, and for a model this

Fig. 27. Venturi tube, showing method of shaping on end of length of wire.

shape can be filed on the end of a piece of wire held in a vice, a small fitting pin being soldered to the narrow portion of the tube, as illustrated.

STEPS AND HANDHOLDS

These were often prominent on the fuselages of open-cockpit types of aircraft, the steps taking the form of a small inverted U with the ends of the arms joined across the bottom by a straight line. A small gouge can be used to impress the U-shape on the fuselage and a small chisel used for the straight line. Handholds are usually small rectangular shapes which can be scored with a small chisel. Projecting steps or stirrups can be formed from fine wire bent to the shape required. Steps and handholds should be scored during the final stages of the construction of the fuselage, and projecting steps should be fitted after the main painting of the model has been completed.

RADIO MASTS

These can be shaped from a piece of flattened wire and fitted into holes drilled in the fuselage. These masts are usually of stream-lined section and are often tapered from the base towards the top, the exact shape will be shown on the general arrangement drawings. Larger masts can be shaped from a strip of thin wood, a small pin being inserted in the base for fitting to the fuselage. These parts should be fitted after the main painting of the model has been finished.

WHIP AERIALS

Very fine wire is used for whip aerials. They are inserted into a small hole in the fuselage and should not be fitted until the painting of the model has been completed.

DIRECTION-FINDING AERIALS

The older type of direction-finding aerial took the form of a plain loop fitted on top of the aircraft. A piece of wire bent into a circle with a projecting end for fitting can be used for these parts (Fig. 28(a)). They should be fitted after the model has been painted. On later types these loops are contained in a stream-lined "acorn" fairing which is filed on the end of a wooden rod, as shown in Fig. 28(b). A small wooden strut can be shaped to support the fairing above the fuselage, the whole being assembled with pins and glue after the model has been painted.

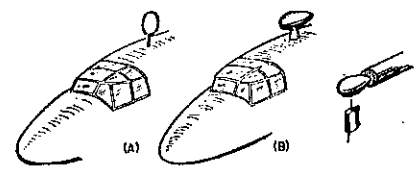


Fig. 28. Direction-finding loop aerial (a) and faired D/F aerial (b).

HOMING AERIALS

These aerials, resembling small television aerials, are sometimes seen fitted on each side of the nose of large airliners or bombers. Thin ⅛″ pins can be soldered together for these aerials on models. Two pins should be fixed down on a waste block of wood by bending a short section of their points at right-angles. A third pin, bent in an L-shape, can then be held on the fixed pins with a pair of thin-nosed pliers whilst the parts are soldered, as shown in Fig. 29. The aerials

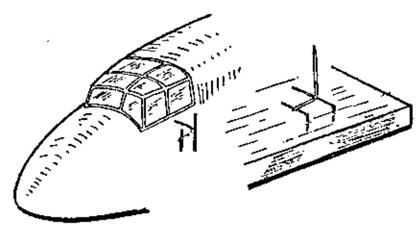


Fig. 29. Homing aerial showing method of soldering on scrap-wood block.

are fitted to the model by inserting the arm of the L-shaped pin into a small hole drilled for the purpose.

RADOMES

For modelling purposes these fittings are exactly similar to under-wing or under-fuselage fuel tanks and the same methods of shaping and fitting can be employed.

MESSAGE PICK-UP HOOKS

Before the second World War, specialized Army co-operation aircraft types were fitted with a retractable hook which was used to pick up messages slung on cord between two posts on the ground. These hooks were usually hinged to the centre of the axle, and on models the hooks can be shaped in plain or flattened wire, depending upon the shape on the actual aeroplane, and soldered to the centre of the wheel axle, as shown in Fig. 30. These hooks should be fitted during the assembling of the under-carriage of the model.

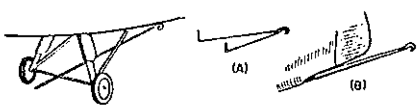


Fig. 30. Message-pick-up hook mounted on undercarriage.
Fig. 31. Two types of deck-arrester hook.

DECK ARRESTER HOOKS

Naval aircraft carry retractable hooks beneath the fuselage which engage on landing with cables stretched across an aircraft carrier's flight deck and thus slow up the aircraft in a short space. These hooks on earlier aircraft took the form of a pair of V-struts with the hook at the apex, and these can be formed from a single piece of wire shaped as shown in Fig. 31(a). Modern naval aircraft usually carry this hook at the extreme tail of the fuselage when it is best represented by a piece of flattened wire filed to the shape of the hook, a shank being filed at the forward end for fitting into the fuselage, as shown in Fig. 31(b). This can be fitted before the model is painted.

CATAPULT POINTS

Aircraft operated from the older types of catapult usually carried small spool fittings for engaging in the catapult supports. These spools can be represented by very short lengths of wire plugged into the sides of the fuselage, resembling the small stub exhausts described earlier. In general, they were, however, of larger diameter than the exhaust-pipes. Catapult spools should be fitted during the construction of the fuselage.

STROP HOOKS

Aircraft used on the modern flush-deck catapults have a small rearward-facing hook under the forward part of the fuselage into which the catapult strop is fitted. These hooks can be represented by filing the shape in a flattened piece of wire which is made with a shank for fitting into a hole drilled in the underside of the fuselage. These parts are best fitted before painting of the model is started.

GUNS AND MOUNTINGS

Two types of machine-gun were used on British aircraft during the first World War and up to the middle of the 1930s. A Vickers water-cooled belt-fed type being employed as a fixed gun for operation by the pilot, and a drum-fed Lewis gun being fitted on a movable mounting for the observer or gunner. The Vickers type was usually mounted on top of the fuselage in front of the pilot's cockpit, sometimes with its breech enclosed within a fairing, as on the Sopwith Camel and Dolphin aircraft. On models this type of gun can be represented by a piece of brass or copper wire $\frac{1}{16}$" in diameter for one-seventy-second-scale models and about $\frac{1}{2}$" in length. The only shaping that will be required is to file a short length at the rear end into a rectangular section and to file a short projecting muzzle at the lowest point on the front of the gun, as

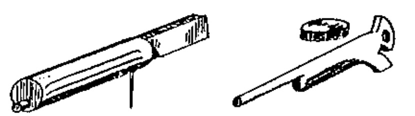


Fig. 32. Old-type Vickers gun.
Fig. 33. Lewis gun.

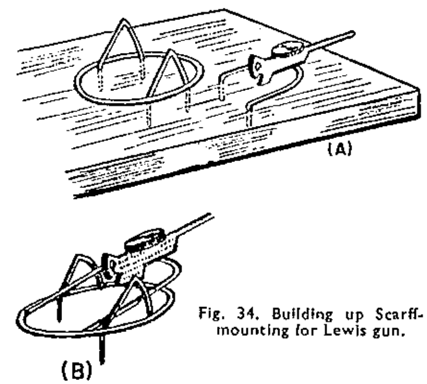


Fig. 34. Building up Scarff-mounting for Lewis gun.

shown in Fig. 32. A small pin must be soldered to the gun to provide for fitting to the fuselage.

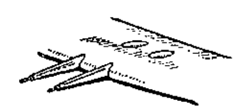
During the late 1920s, the fixed Vickers guns were sometimes mounted on the sides of the fuselage, as on the Fairey Flycatcher, and with these later types of gun the barrel was of considerably smaller diameter than the rectangular breech. Later still, these guns were almost totally enclosed within the fuselage with only a short length of the barrel projecting into a shallow blast channel formed in the fuselage. The position of these channels should be marked on the fuselage after it has been shaped to section and a V-shaped portion of wood cut out. The V-channel is then filed to semi-circular section with a small round file. This type of blast channel was used on many of the Hawker biplanes, and a shorter channel is used on many of the present-day types, such as the Hunter and Sea Hawk.

Lewis guns can be filed to the shape shown in Fig. 33 from a piece of fairly thick copper wire which has first been hammered flat. A small circle of metal is soldered to the top of the gun to represent the ammunition drum. This type of gun was usually fitted singly or in pairs on what was known as a Scarff mounting in the gunner's cockpit to provide for elevating and traversing the gun. This type of mounting should be built up with wire, a wire circle equal to the diameter of the top of the gunner's cockpit forming the base. This circle should be placed on a block of waste wood and the elevating ratchets built up with wire in the form of two inverted Vs, one leg of which is bent to a curve as shown in Fig. 34(a). These wires should be pressed down into the wood block on the inside of the wire circle to which they are then soldered. The gun should be soldered to a flattened U-piece of wire which is then also soldered to the ring. The complete gun and mounting is then lifted carefully off the block and two of the projecting wires should be cut off short, the other two can be used to fit into holes drilled in the inside walls of the cockpit to hold the mounting firm on the model (see Fig. 34(b)).

Additional pilot-operated Lewis guns were sometimes fitted on the top centre section of fighters of the first World War, the S.E.5 being an example. In such cases the gun was usually mounted on a rail fitted on the top of the wing and curving down in front of the cockpit so that the gun could be lowered for changing the magazine. This rail can be represented by a piece of wire to which the gun is soldered. In a later type of mounting for Lewis guns the elevating ratchets were omitted and replaced by two small metal drums to which the flattened U-shaped gun-mounting rail was fitted. This type is again built up on a circular wire base to which the gun-mounting rail is soldered, and the drums can be represented by small circles of card fixed with glue or by circles of metal soldered to the gun ring.

Fixed guns for the later monoplane types of aircraft projected from the leading edge of the wing, as on the Spitfire, and, normally, the barrels were contained within a tapered fairing, as shown in Fig. 35. This type of gun can be represented by filing a length of wire to a taper and fitting the part into a hole drilled in the wing leading-edge. These holes

Fig. 35. Guns mounted in leading-edge of wing.



are best drilled before the wing is cambered, and in all cases guns should be fitted in the final stages of painting the model. On many aircraft, having guns mounted in the leading edge of the wing, a small "blister" fairing is found on the top of the wing surface a little way behind the leading edge. This fairing covered the ammunition drum of the gun. These "blisters" are best built up in plastic wood after the outline has been marked on the wing surfaces. When the plastic wood has set the "blister" is cleaned up to its correct shape with fine sandpaper. The representation of gun barrels for turret-mountings has been dealt with in Chapter 4.

Separate gun packs are coming into frequent use on modern aircraft, and these take the form of a stream-lined fairing which is fitted beneath the fuselage. These fairings resemble under-fuselage fuel tanks and their construction and fitting are carried out in a similar manner.

GUN SIGHTS

Ring-and-bead sights can be made of very fine wire, the ring being formed by coiling the wire round another piece of wire of larger diameter and then bending a mounting shank for fitting into a hole drilled in the fuselage, in much the same way as for loop aerials described earlier. A vertical piece of thin wire can be used to represent the bead sight.

Telescopic sights can be represented by using a piece of wire of appropriate size, around which is fitted two thinner pieces of wire resembling ring sights for mounting the part on the fuselage. A tiny spot of glue on the ends of the mounting wires will strengthen the fitting.

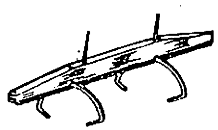
BOMBS AND MOUNTINGS

Most modern bombers carry their bombs inside the fuselage, the bomb compartment being covered by bomb doors which can be represented on the model by scoring the shapes of the doors underneath the fuselage. Earlier types of bomber and the modern fighter bombers, however, carried their bombs externally, usually beneath the wings, so that the

Fig. 36. Bomb made from wood with tin or paper fins.

modeller may have occasion to represent bombs and mountings on his model. The bombs will vary in shape according to their type, but usually will be of stream-line section with rounded nose and pointed tail. Fins are fitted to the tail of the bomb and sometimes these fins are enclosed in a circular sheet of metal. For models, bombs can be filed to shape from a piece of wood dowel and the fins can be made from two pieces of tin shaped as shown in Fig. 36(a) and slotted together. The fins are then fitted into cruciform slots cut into the tail of the bomb with a razor-blade. These slots should be cut before the tail of the bomb is filed to shape. The circular metal shroud can be soldered to the tips of the fins. Where the bombs are small it may not be possible to cut slots for the fins, and in these cases the fins can be made from a strip of paper bent to the shape of a star, as shown in Fig. 36(b), and then glued to the shaped tail of the bomb.

Bomb racks on earlier types of aircraft took the form of a metal beam to which the bomb was attached by a release hook and the bomb was steadied on its mounting by means of two semi-circular-shaped crutches. The illustration in Fig. 37 shows a typical bomb rack which, for modelling purposes, can be made from a piece of wire flattened and filed to shape for the beam, the crutches being made from a thinner piece of wire and soldered on. The ends of the crutches can be bent inwards to fit into holes drilled in the bomb to hold it in place. Pins



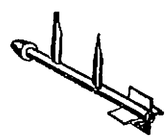
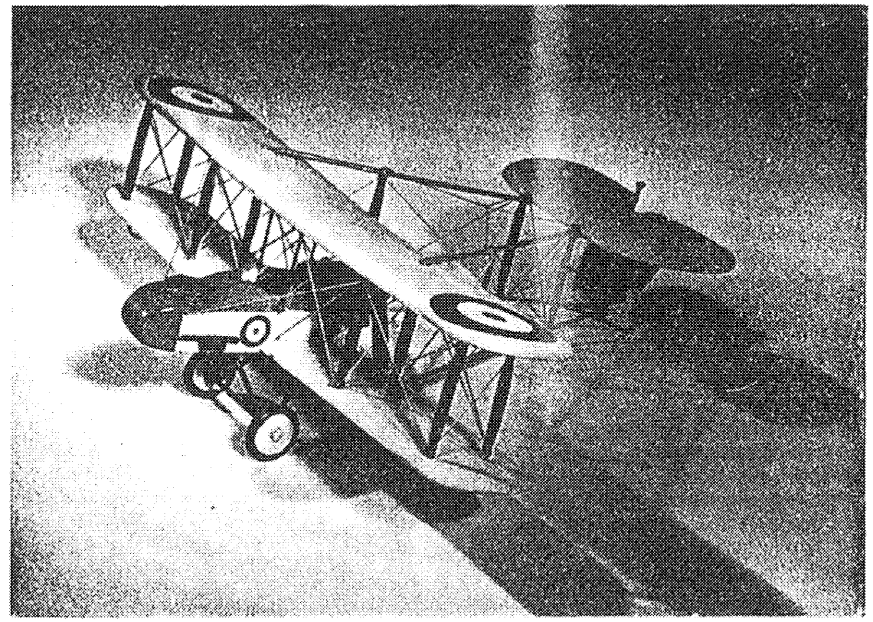
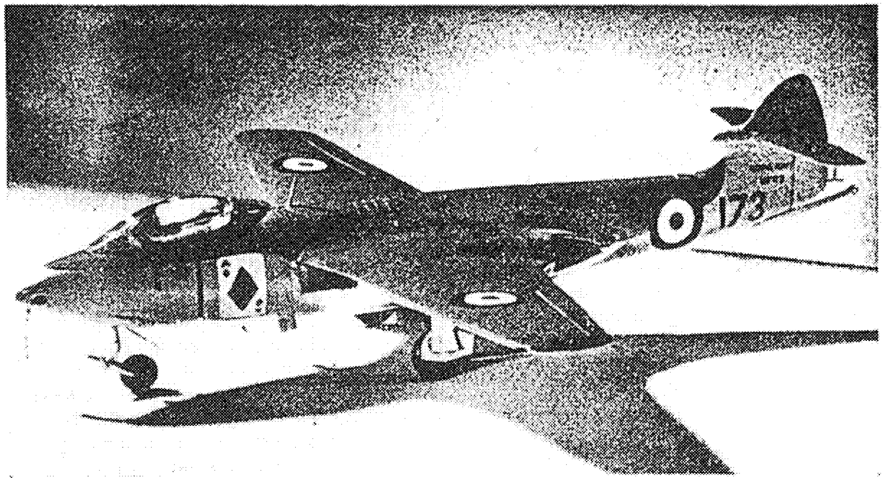


Fig. 37. Bomb rack.
Fig. 38. Under-wing rocket.



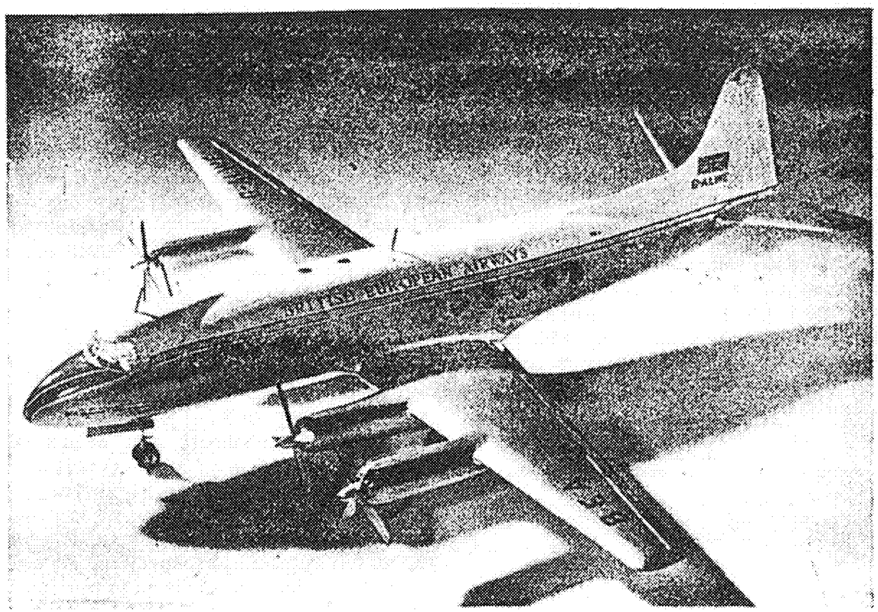
Vickers F.B.9

Westland S.51



Hawker Sea Hawk

Vickers Viscount



should also be soldered to the top of the beam as shown in the illustration for fitting the bomb rack to the wing. The top of the beam should be slightly below the wing surface. On modern types of fighter bomber which carry bombs externally, the bomb rack is enclosed in a stream-lined fairing similar to the fairing used for under-wing fuel tanks.

TORPEDOES AND MOUNTINGS

Torpedoes can easily be shaped from a piece of wood dowel and for one-seventy-second-scale models $\frac{1}{4}''$ dowel will give the correct size. Tail fins are fitted in a similar manner to the tail fins of bombs and in addition very tiny slivers of metal should be fitted to represent the propellers. The method of mounting torpedoes will vary on different aircraft types and details of the mountings must be obtained either from the general arrangement drawings or from photographs. The mountings are sometimes contained within a stream-lined fairing, as on the Blackburn Firebrand, and this type can be made from wood. Two pairs of pins or fine wire can be used to fit the torpedo to the fairing, the pins or wires representing the crutches. On other types, the pins can be inserted directly into the fuselage. In some cases additional guide vanes are mounted on the tail of the torpedo, being carried at the ends of a transverse beam. These vanes can be made from thin sheet metal between which is soldered the transverse beam and this in turn is soldered to a small pin which can be inserted in the tail of the torpedo.

The thin metal seals found inside tobacco tins provide excellent material from which fins and vanes for bombs and torpedoes can be made.

ROCKETS AND MOUNTINGS

Rockets can be made from short lengths of brass or copper wire of a diameter sufficient to provide for the rocket head. The wire must be filed down for the stem of the rocket, and for this work a makeshift lathe can be formed by clamping a drill brace in a vice when, with the wire held in the chuck of the brace, it can be turned and filed down to the size required. The portion of wire held in the chuck will then form the rocket head and should be filed to a domed shape at the front. The tail fins will be extremely small and should be made from paper, as already described for bomb fins. The mounting struts should be made from short lengths of flattened wire which are soldered to the rocket stem, shanks being filed on the upper ends of the struts for fitting into the wing (see Fig. 38).

In passing it can be mentioned that the method of using a wheel brace for turning small parts in either metal or wood can be usefully employed in the construction of many detailed fittings for models.

CHAPTER ELEVEN

Special Applications

The normal methods of constructing the various component parts of a scale model, as described in the foregoing chapters, will serve for the majority of aircraft types likely to be encountered, but occasionally the completely unorthodox type crops up, demanding individual treatment either in the whole or in part of the work. Such types include aircraft with girder or tail boom construction, delta-wing aeroplanes, and autogyros and helicopters. To give the reader a complete guide to all the aspects of model aircraft construction, these types, in so far as their treatment differs from the methods already described, are dealt with in this chapter.

GIRDER TAIL BOOMS

Many early aircraft, dating from the original Wright Brothers' biplane, were without the luxury of a fuselage, the tail surfaces, and in some cases front elevators, being carried at the ends of an open girder structure. This tendency prevailed up into the beginning of the first World War when, however, some form of protection was provided for the crew by placing them in a small nacelle which carried no more than the cockpits, fuel tank, and engine. Notable examples were some of the first aeroplanes designed by Captain Geoffrey De Havilland.

Models of these aeroplanes are rather more difficult to construct than the more orthodox types, and though they offer a good deal of interest to the modeller and are, of course, important historically, they should not be attempted until a fair amount of experience has been gained.

The only satisfactory way of representing this type of construction in a model is to use plain wire for the booms and flattened and filed wire for the bracing struts. This entails a good deal of work with the soldering iron, and to make the job easier these parts should be prefabricated as far as possible in much the same way as has already been described for certain types of undercarriage. Each of these girder structures should be made in two parts, the port and starboard halves. The positions of the booms and vertical connecting struts should first be drawn on a piece of scrap wood, and lengths of brass wire of appropriate diameter should then be pinned down over the outlines of the booms. The struts, made either from brass or copper wire and previously flattened and filed to shape, are cut to the exact length and pinned on the board between the booms, as shown in Fig. 1. When cutting the wire for the booms, allowances must be made for fitting one end of each boom

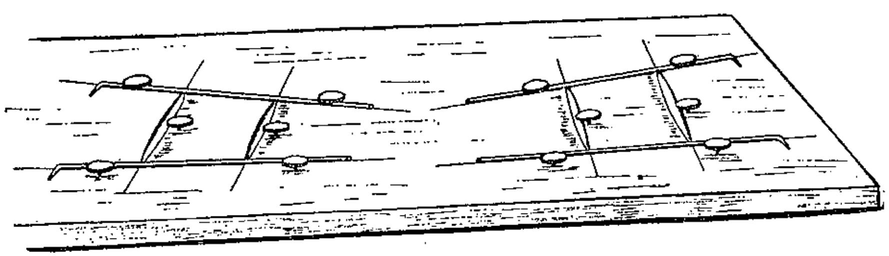
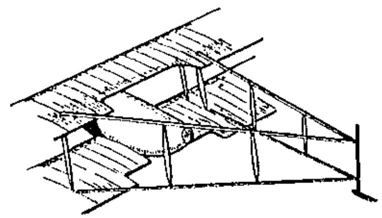


Fig. 1. Tail booms pinned out on board for soldering.

into the mainplanes of the model, which will, of course, be made of wood in the normal manner. This fitting can usually take the form of bending a short section of the end of the boom at right-angles to fit into holes drilled in the wings. Where the girders form a V in plan view on the aircraft no interconnecting strut should be fitted at the tail end at this stage. Having pinned out the parts firmly, the joints between struts and booms can be soldered. The mainplanes, nacelle, and main undercarriage of the model should then be fully assembled. The girder booms can then be fitted into the upper and lower mainplanes and the tail end of the booms brought together and held temporarily in position by binding near the end with a few turns of thread or a light rubber band. The stern post can then be soldered in position, as shown in Fig. 2, short projections being allowed



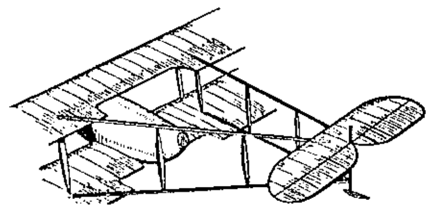


Fig. 2. Booms fitted to mainplanes and tail end soldered.

Fig. 3. Alternative fitting for rear end of booms.

at the top and, if necessary, at the bottom, so as to provide for the fitting of the tailplane, rudder, and tail skid. On some types the upper booms extend only as far back as the leading edge of the tailplane, and in such cases the top booms are cut off short with just sufficient projection to insert into holes drilled in the tailplane leading edge, as shown in Fig. 3.

Booms extending forward from the mainplanes to carry a front elevator are constructed and fitted in exactly the same way.

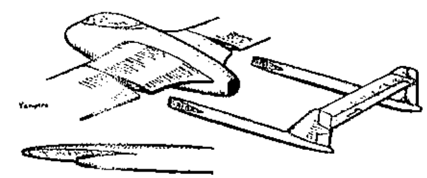


Fig. 4. Fitting "solid" tail booms.

Fig. 5. Alternative fitting for "solid" tail booms.

The construction of nacelles for these models will follow the same sequence as for an orthodox fuselage.

STREAM-LINE BOOM TAILS

Boom tails are not the sole prerogative of the early aircraft types for, as the reader will know, the De Havilland Company have repeated their preference for this type of construction in their latest types—the Vampire, Venom, and D.H. 110. These later types of tail booms are, however, much different in form and far less troublesome for the model maker.

For models, this type of boom is made from wood, using the normal sequence of profile, plan, and section shaping, but provision should be made after the plan shaping stage for the fitting of the booms into the mainplane. Where the booms extend the same distance forward from the trailing edge on both upper and lower surfaces of the mainplane, simple V-shaped cut-outs are made in the trailing edge of the wing, and the front ends of the booms are shaped to fit into these cut-outs as shown in Fig. 4. Where, as on the D.H. 110, however, the boom extends further forward on the upper surface of the mainplane, the forward end of the boom must be shaped as shown in Fig. 5 and the cut-out in the mainplane is then made only deep enough to take the lower portion of the boom. In both cases a pin or wire dowel inserted in the front end of the boom will help to strengthen the joint, which should be made with glue and faired in where necessary with plastic wood.

Generally, the modeller will find it more convenient to make the fins and rudders separately and to fit them on the ends of the booms with pin dowels, but in some cases, where the parts are small, it might be advantageous to shape the booms together with their fins and rudders from a single block of wood. Accurate construction of the interconnecting tailplane is necessary to ensure that the booms will lie at the correct distance apart throughout their length.

DELTA-WING MODELS

As a general rule, delta-wing models will follow the basic sequence of construction previously described, but in models of very large aircraft of this form, such as the Avro Vulcan, which is virtually a flying wing, the modeller is faced with the problem of forming a neat joint between wings which have a very thick root section and a fuselage of circular section. This can be accomplished quite simply, however, by filing a seating on the sides of the fuselage to the plan shape of the wing roots. This must be done after the profile and plan shaping of the fuselage has been carried out, when the position of the mainplanes and the plan shape of the wing roots are plotted on the top and bottom of the fuselage, as shown in Fig. 6. The seating is then filed to shape, as shown in Fig. 7, after which the fuselage can be shaped to its correct section. During the section shaping, the wing seating will be brought down to the shape of the camber of the wing root. The root ends of the wings are cut with a fret-saw to the same plan shape and then jointed on to the fuselage with paired wire dowels and glue, the joint being faired in with plastic wood.

AUTOGYROS

The main sources of difficulty with models of autogyro types lie in the representation of the rotor hub and in making the rotor blades thin enough to be accurate in scale. The complete assembly will consist of a rotor hub into which are fitted three or four rotor blades. The hub is best made in metal and the blades of wood.

The form taken by the rotor hub will, of course, vary for different types of

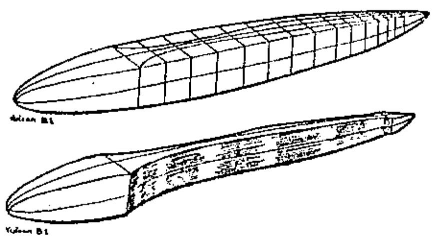


Fig. 6. Marking out wing seating for large delta-wing type.
Fig. 7. Wing seating filed to shape.

autogyro. On early types, the blades, usually four in number, were disposed around a simple vertical pillar. A short length of small brass tube can be used for this pillar, and the blade fitting should be cut in one piece from thin sheet metal and a hole drilled at the intersection of the arms sufficiently large to take the brass tube. The ends of the arms should be filed down thin enough to be inserted into small holes drilled in the ends of the blade roots. The complete fitting should then be threaded on the brass tube and soldered. The hub can then be fitted to the model by means of a small pin inserted in the brass tube and plugged into a hole drilled in the top of the rotor mounting (see Fig. 8). This mounting usually took the form of a single, fairly large, stream-lined section pillar or strut, mounted vertically on the fuselage centre line and supported by a pyramid of four smaller struts. For model purposes the central pillar should be made of wood so that a hole can be drilled in the top for the pin fitting, the supporting struts being made of flattened and filed wire.

For the blades, use a strip of wood about twice the thickness of the finished blade and wide enough for all the blades to be set out side by side, with a small allowance between each blade for cutting out. The plan shape of the blades should then be marked out on one face of the block and the marking for the root ends carried down over the edge of the wood, as shown in Fig. 9. Holes should then be drilled in each blade root for fitting on to the hub, as shown in the illustration. When these holes have been drilled, each

blade is cut out with a fret-saw and then filed down to its finished thickness, an equal amount being filed off the top and bottom surfaces. Each blade is then filed to its correct aerofoil section, usually a symmetrical camber on both upper and lower surfaces, as shown in Fig. 10. The blades are then carefully fitted on to the dowels formed on the rotor hub, a spot of glue on each dowel helping to make a firm joint. The assembly should then be checked to ensure that the blades lie at right-angles in the case of a four-blade rotor, or at 120 degrees to each other on a three-blade rotor.

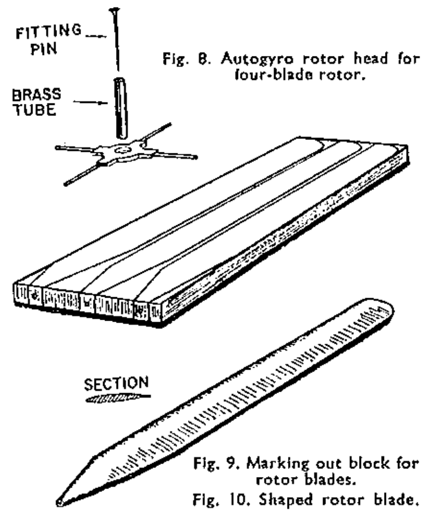


Fig. 8. Autogyro rotor head for four-blade rotor.
Fig. 9. Marking out block for rotor blades.
Fig. 10. Shaped rotor blade.

Each blade was usually braced to the top of the rotor hub pillar by wire and, for this bracing, very fine wire should be used, one end of which is plugged into a fine hole pierced in the top of the blade in the appropriate position, the other end being fixed to the top of the brass tube with a spot of solder. These wires must not be fixed to the pin head, otherwise the rotors will not revolve freely.

On later types of autogyro each blade-fitting incorporated a friction damper in the form of a circular metal plate when viewed in plan. This type is best represented by filing the fitting in one piece from sheet metal, as shown in Fig. 11, a hole being drilled at the centre for the pin pivot. Thin wire dowels for the blade fittings can then be soldered beneath the circular dampers, as shown in the illustration. Alternatively, the ends of the dowels can be flattened and drilled, and holes can be drilled at the centre of each of the circular dampers, the dowels then being riveted to these dampers, as shown in Fig. 12. This method can be used where it is desired to incorporate folding blades, when two of the blades should be riveted slightly loose so that they can be folded back alongside the firmly riveted third blade. Many of these later autogyro types made use of blade folding and it is a worth-while feature to incorporate in a model, particularly if the model is to be frequently transported for the purpose of exhibitions, as the thin blades are far less liable to become damaged if they can be folded neatly for packing.

The rotor-mounting of these types usually took the form of a stream-lined fairing, somewhat resembling a fuel tank, supported above the fuselage by a system of struts. The fairing should be shaped in wood, the usual profile, plan, and section sequence of shaping being employed, and the supporting struts, as usual, can be made of flattened and filed wire. Notice also on these later types that the spinning of the rotors was often started by connecting them by means of a clutch to the engine, and in such cases a torque rod

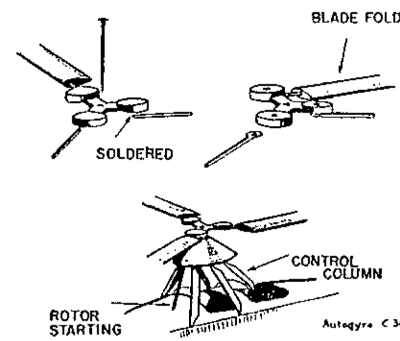


Fig. 11. Rotor head for later types of autogyro.
Fig. 12. Rotor head for folding blades.
Fig. 13. Complete rotor assembly for Autogyro C.30.

ran from the rear of the engine up to the front of the fairing. This should be represented by a length of wire. In addition, control of the autogyro was obtained by tilting the whole rotor head, and a control rod for this purpose ran from beneath the fairing down into the cockpit; this can also be represented by a short length of flattened and filed wire. These features are illustrated in Fig. 13.

For the rest of the model, that is the fuselage, tail surfaces, undercarriage, and in some cases stub wings, the normal methods of constructing these parts will apply.

HELICOPTERS

Rotor hubs are again the main difficulty with helicopter models and in general they are rather more complicated than the rotor hubs for autogyros. Similarly, their exact construction will vary according to the different types of helicopter, although they will all follow much the same general pattern.

Taking the Westland Sikorsky S.51 as an example, Fig. 14 shows how the hub can be built up on a small triangle of brass, $\frac{1}{16}''$ thick, which is drilled at the centre for the fitting pin (Fig. 14(a)). Faces are filed for half the length of each side of the triangle to which can be soldered short lengths of brass tube of $\frac{1}{16}''$ outside diameter (Figs. 14(b) and (c)). Into the ends of these tubes short lengths of pin points are soldered to provide for fitting into the blade roots. The control spider is formed from three small bent pins, the top ends being soldered to the central brass triangle and the lower ends being soldered to a piece of tin cut to the shape of the control arms, as shown in the illustration (Fig. 14(d)), and then bent into a triangle.

The whole assembly is fitted to the model on a pin. A further short length of $\frac{1}{16}''$ brass tube being threaded on the underside of the hub to keep the assembly the correct distance above the pylon mounting on the fuselage. The thickened joints on the blade fitting can be represented by rolling thin strips of paper round the brass tubes.

The construction of the rotor blades follows the same sequence as blades for autogyro types. In general, however, helicopter rotor blades will be rather larger in size.

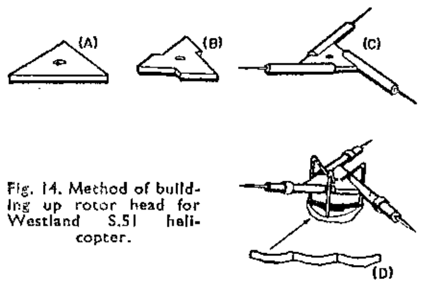


Fig. 14. Method of building up rotor head for Westland S.51 helicopter.

Tail rotors are best cut from sheet metal and filed to shape and are fitted to the model on a pin with a small brass sleeve if required.

Again, the construction of the remainder of the model will follow the normal procedure.

BALLASTING

With the exception of delta-wing types, ballasting will be necessary on all solid models of nose-wheel aircraft, to make the model sit in the correct attitude on its undercarriage. To make such models nose heavy, weights must be inserted in the fuselage as far forward as possible, and, as has been mentioned previously, the pilot's cabin, or cockpit, and the nose-wheel housing offer themselves admirably for this purpose. Small scraps of lead are best used for ballasting models and the cockpit or wheel housing should be hollowed out sufficiently to take the ballast that will be required. When the model has been completely assembled it should be placed on a level surface and small pieces of lead placed in the cockpit cavity or, where the nose-wheel housing is to be used, balanced on the nose of the fuselage until the model sits firmly on its nose wheel and resists any attempt to hold its tail down. The lead should then be removed and melted down a small piece at a time, the molten metal then being run into the cavity provided. The melting can be done in the lid of a cocoa-tin which has been slightly folded

to provide a pouring lip, the tin lid being held over the source of heat by means of a pair of pliers. When pouring the lead into the model, place a small scrap of wood on the fuselage so that the hot tin lid cannot touch and burn the model itself. When all the lead has been melted and run in, check the model again on a level surface and add a little more weight if this is found to be necessary. Ballasting in a nose-wheel housing can be sealed off by inserting a piece of thin wood into the housing so that the lead cannot be seen.

SEQUENCE OF ASSEMBLING

Whilst we have considered the construction of all the component parts, no mention has yet been made of the full sequence of assembling the different parts into the complete model. The final assembly will generally follow the order in which the various components have been dealt with in the separate chapters of this book. However, to complete the picture we can briefly follow the sequence here.

The two main components, namely, the fuselage and mainplanes, are fitted together first of all. In the case of mainplanes on which are mounted wing engines it is, however, preferable to fit the engine nacelles on to the mainplanes before the latter are cut for fitting to the fuselage. In this way it is much easier to line up all the nacelles correctly. For biplane models the lower mainplane is fitted first, with the exception of types such as the Handley Page Heyford, where the upper mainplane was fixed to the top of the fuselage and the lower mainplane was carried on struts beneath the fuselage. In this case the top wing should be fitted first. Any fairing of the wing roots with plastic wood should then be carried out, following which the tail surfaces can be fitted and faired in with plastic wood where required. Care must be taken to ensure that the tailplanes are exactly horizontal or where a dihedral tailplane is used that each side is set at the same angle. Fins and rudders must be checked for correct alignment. On small models this can usually be checked by eye, but on larger types the model should be placed on a level surface and a try-square, with the thin arm vertical, set up exactly on the centre line of the aircraft behind the fuselage, the fin and rudder can then be lined up accurately against the vertical arm of the try-square. The last of the main components, the undercarriage, is then fitted, the main legs being adjusted for correct length and checked by measurements taken of the height of each wing tip above a level surface.

There follows the addition of such details as can be fitted before the model is painted and then, after painting, the final details are added. These final details will consist of perspex or celluloid windows and any small items fitted on the top of the model. They must be left until last because, during painting, the model will frequently have to be placed upside down for working and damage would then result to any of these small details if they had already been fitted. This liability of becoming damaged during subsequent working is the main point to consider when deciding at which stage to fit the various small parts on a model. Airscrews should be fitted last of all as these are particularly vulnerable during the painting stages.

CHAPTER TWELVE

Painting and Lettering

The final work of painting and lettering a model is a separate and complete art in itself. In all phases of aircraft modelling, practice will make perfect, but this is nowhere more true than when it is applied to the painting operations. The same care and attention which have been urged throughout this book in all the constructional work must be exercised to the full in these final stages. In fact, even more stress can be laid on the need for careful painting for, having brought the model up to this point, there is always a tendency to rush the final job so as to be able to see how the finished product will look. A good model maker must resist this tendency and carry out the various stages of painting and lettering steadily and progressively, for only in this way will he be able to stand back when it is completed and admire his handiwork as a fine example in all respects.

We have seen in the previous chapters that there is always a definite sequence in which the various constructional operations should be carried out, in the same way the painting and finishing are also carried out in a methodical and progressive order as explained in the following notes.

First of all, let us outline the materials which will be required.

Models will be finished in either high-gloss or dull-matt paint. High-gloss finishes occur on the present-day military types and on modern and pre-war civil aircraft, dull-matt finishes were used on the camouflaged or shadow-shaded military aircraft of the last War and also military aircraft of the first World War. For gloss finishes use a good enamel, many brands of which are on the market which can be obtained in a wide range of colours. Those who are making a start with the hobby will naturally only acquire the one or two colours needed for their first model, and in any case it is better not to purchase a whole series of colours to start with, but to obtain the paint in any particular colour as and when the need arises. Buy only the small tins of these enamels—those sold for about 1s. or 1s. 6d.—as only comparatively small quantities will be used at a time, and if large tins are used the frequent exposure of the paint to the air will cause it to go thick and lumpy, when it becomes useless for carrying out a good painting job. Paint should be stirred frequently when it is in use. Turpentine is used for thinning these enamels and for washing the paint brushes.

The dull-matt finishes on camouflaged aircraft are, of course, obtained on the full-sized aeroplane with cellulose dopes. These dopes can be obtained in small quantities for model work, but being very quick drying they are difficult to apply with a brush and, as the dopes act as their own solvent, they cannot be worked on to the surface in the manner of ordinary paint or enamel since, once a layer of dope has been applied, any further brushing over the same place will tend to remove the dope already there. On full-size aircraft, of course, these cellulose dopes are sprayed on, but spray painting is impracticable for most small-scale models. However, cellulose dopes can be applied with a brush with a little practice and, if the modeller prefers these materials, their use is described later. For thinning dopes and for washing brushes used with this material special dope thinners are needed.

As an alternative to the use of cellulose dopes for matt finishes, poster colours can be used. There is a range of poster

colours now obtainable which takes well on a prepared wood surface and gives a very close imitation of dope finishes. These colours can be thinned with water and, whilst they are not always produced in the exact colours required for camouflaged aircraft, the colours can be mixed to produce any shade required. For the amateur they provide an excellent and much more manageable substitute for cellulose dopes.

For applying any of these types of paint, ordinary artist's water-colour brushes are suitable. The cheaper brushes should be avoided because the hairs quickly come out and embed themselves in the paintwork all over the model. Use a good camel-hair or sable brush. For one-seventy-second-scale work a No. 6 brush is suitable for all the basic painting, whilst for lettering, lining, the painting of roundels, and other small work a No. 1 and No. 0 size brush will be required. For very fine work a No. 00 brush can be used.

Brushes should be treated with as much care as any other tools which the model maker includes in his kit. They should always be cleaned thoroughly after use and stored flat in some suitable container. Never leave them standing in a jar of cleaning fluid. A brush will give many years of use if it is looked after well. If one is careless, it will not last very long, and if one has to be frequently renewing brushes, it can become an expensive business. Furthermore, one gets used to particular brushes and comes to regard them as old friends—knowing their capabilities and recognizing their limitations. One always knows exactly which brush to choose for any particular job. A new brush needs to be used for a long time before it becomes familiar.

Cleaning is important and should be done immediately painting is finished. Any surplus paint should first be removed from the brush by squeezing the hairs through an old cloth reserved especially for this purpose. Two containers of cleaning fluid should be used, one for washing the brush and then, when the brush is thoroughly clean and has been dried on a piece of clean cloth, it should be lightly rinsed in the second container and dried again. Particularly make sure that the paint is cleaned away from the base of the hairs. If it is allowed to accumulate here the brush will soon lose its shape and become useless.

Before the painting commences all the surfaces of the model should be smooth and free from grease, dirt, or glue smudges. All the wood parts of the model will have been sanded to a smooth finish during their construction, but the whole model should be well rubbed over with fine sandpaper after it has been completely assembled.

Much is heard of the use of grain fillers for preparing a model aircraft for the paint coats and expert opinion varies so much as to the effectiveness of the grain filler produced by this or that firm that the poor amateur is left completely perplexed and without any clear idea as to how he should even start his paint work. Grain fillers are undoubtedly required on models which have been constructed in balsa wood, when numerous applications have to be made before a suitable surface is obtained for the colour coats, but in hard-wood models, if the wood has been carefully chosen, there is little or no need for any special preparation work and an ordinary wood primer of good quality and applied thinly will be all that is required.

Before any painting work takes place some method must be arranged for holding the model whilst these operations are carried out. For small light models a pin or piece of wire can be inserted in some convenient place on the model, either in the hole drilled to take the airscrew fixing pin, or a jet air-intake or tail pipe. The model can then be held by this pin or wire and each coat of paint can be applied to the whole model in one operation. Where the weight of the model makes it impracticable to use such a method, the wings and fuselage should be painted in separate operations and at different times so that one part of the model will always be dry enough to handle whilst the other part is being painted.

The first step, as has already been

mentioned, is to clean the model thoroughly, finishing with a rubbing of fine-grade sandpaper—odd scraps of partly worn sandpaper are very useful for this work. All particles of dust left after this operation must then be removed with a clean dry brush—a special brush should be marked and kept solely for this purpose. A thin coat of primer is then applied to the model. If the model is small and the coat can be applied to the whole of it in one operation, the various surfaces should be painted in the following order so that at all stages a sufficient "hold" can be obtained on some unpainted part of the model. First, the paint should be applied to the under surface of the mainplane. In the case of biplanes the under surface of the top wing is painted first and then the under surface of the lower wing. Next, the upper surfaces of the wings are treated—on biplanes the upper surface of the lower wing first, followed by the upper surface of the top wing. During these stages, the model can be held quite firmly by the fuselage. Next, the paint is applied to the underside of the fuselage, then the sides, and finally the top. During this stage, the model may be held by the tailplane or the fin and rudder—a good test of the strength of the tail unit! Then the tailplane is painted, first, the underside and then the top surface, the rudder being used as a "hold". Finally, the model can be steadied on the bench by means of the holding pin or wire whilst the two sides of the rudder are painted. This sequence should be used for all the basic painting stages.

If the model is large and each coat has to be applied in two stages, the mainplanes should be treated first in the same order as described above, the model being held by the fuselage. When the wing coats have dried hard, the wings can be used as a "hold" whilst the fuselage and tail unit are painted.

When dry, the priming coat is rubbed down thoroughly with fine-grade or worn sandpaper and the model is then painted with a flat finish undercoat, a cream or light-grey colour being most suitable. Again this coat is rubbed down with sandpaper when dry and the surface of the model should then be examined for evidence of any grain still showing or any other blemishes and, if so, a further thin undercoat should be applied and again rubbed down.

A coat of dull-black paint should next be applied to any cockpit or cabin openings, the inside of any recessed windows, the inside of radiators, air-intakes or jet tail pipes, and the insides of wheel housings for retractable undercarriage models. When this has been done and the undercoat surfaces are perfectly smooth, the first coat of the basic colour can be applied. This, as well as all other coats of primer, undercoat, or basic colours, should be applied thinly and the modeller should not be alarmed if after this first colour coat the finish is somewhat streaky as this will be covered up with subsequent coats. The best method of applying the paint on the wings is to work from the wing roots towards the tips and when the whole wing surface has been covered, rapidly brush over the paint with a dry brush, the strokes being made from the leading to the trailing edge working again from the wing root out to the tips. Make sure that the paint does not run round the edges of the wing—particularly the trailing edge—and form a ridge on the other side. If a ridge of excess paint has formed this can be removed with a stroke of a dry brush. Fuselages are best painted with strokes from the nose towards the tail. When it has dried hard, this first colour coat should be lightly rubbed over with sandpaper, the model being dusted off before the second colour coat is put on. At least two basic colour coats will be needed and after the second coat has dried the model should again be examined. If the paintwork is smooth and even, the modeller can proceed to the detail painting. If necessary, however, a third or even fourth coat of the basic colour may be required, each one, except the final coat, being lightly rubbed down when dry. It is emphasized that each of these coats must be applied very thinly, otherwise there will be a build-up of paint on the surfaces which will destroy

any sharply defined or clean-cut edges on the model as well as making the model prone to finger marking when handled. If the coats are applied too thickly the paint will also be liable to "run" and form thickened blobs or to "craze", or form wrinkles. It is important to let each coat dry thoroughly hard before applying a further coat. Most enamels when fresh will in fact dry in a matter of four to six hours, but at least twenty-four hours should elapse between coats so that the paint can harden thoroughly.

If the model is being painted with enamels, after the final coat has been applied and has dried hard, all the surfaces should have a smooth glossy appearance and it should be impossible to distinguish whether the model has been built of wood or metal. An absolutely smooth finish will not, however, be obtained if the basic colour is either silver or aluminium. These colours when dry are always slightly rough to the touch. The surfaces can be improved, however, if a thin base coat of gloss paint—light-grey being the best colour—is applied immediately after the undercoats and allowed to dry hard before the first silver or aluminium coat is put on. On many models the silver or aluminium coats will represent doped fabric surfaces when no treatment is needed after the final coat of paint, but where it is required to represent a polished metal finish, as on many modern types, particularly air liners, a very thin coat of clear varnish should be applied over the silver or aluminium paint. The so-called clear varnish is not absolutely colourless, so that if this is not applied very thinly the model will be given a slightly brownish tinge which will look more like tarnished metal. Clear varnish should not be applied until all the detail painting and lettering have been carried out, and then it should be brushed over the whole of the "metal" surfaces of the model, including any detail lettering or marking which has been painted on the basic colour.

Many models will have to be painted in two or more basic colours. Modern air liners, for example, such as the Comet, Viscount, Britannia, and so on, are mainly finished in polished metal, but the upper part of the fuselage and the fin and rudder are painted white. On most of these types, too, a cheat line or lines of yet a third colour usually divides the white top from the rest of the fuselage. Where these multi-colour schemes are employed, a coat of each colour must not, of course, be applied in one painting operation, but one colour must be put on and allowed to dry before the other colour is used. Other aircraft with multi-colour schemes will be military types painted in camouflaged patterns. With these types, no matter whether gloss enamels, cellulose dopes, or poster colours are being used, one of the camouflage colours should be treated as a basic colour and painted over the whole of the camouflaged surfaces to the requisite number of coats. The second camouflage colour can then be painted in its appropriate pattern on top of the basic colour, when usually only one coat will be necessary, particularly if the basic colour chosen is the lighter of the two shades. Where the under surfaces of such camouflaged models are in yet a third colour—the dull-black of heavy bombers or the medium-grey of other types for instance—these surfaces should, of course, be treated separately.

The foregoing notes apply generally to any of the three types of paint which have been mentioned, that is gloss enamel, cellulose dope, or poster colours, but a few words need to be said concerning the application of these two latter types of paint.

Reference has already been made to the difficulty of using cellulose dopes, and modellers, particularly beginners, are strongly advised to use poster colour paints where this type of matt-finish is required. If cellulose dopes are used, however, their use should be confined only to the smaller models. The one-seventy-second-scale model of the Spitfire and models of similar size can be painted with cellulose dopes if a little practice and experience have been obtained, but it will be much more difficult to obtain a good finish on larger models where bigger surfaces have to be covered. A clear cellulose dope provides a better undercoat for this type of paint and the colour coats should be applied fairly thin, but not too much so. These dopes are just about the right consistency for use when they are newly bought, but they are inclined to thicken after a while and then thinners must be added, a few drops at a time and stirred well in until the correct consistency has been restored. As with gloss camouflage finishes, choose one colour, preferably the lighter, as the basic coat and apply all the necessary coats in this colour before putting the second colour on in pattern. These dopes dry very much more quickly than enamels and they must be applied to the surfaces rapidly with a fully charged brush, care being taken never to brush over the same place twice. When sufficient coats of the basic colour have been applied and a good surface obtained, the second colour can be applied in pattern over the top, one coat usually being sufficient.

Poster colours are much more simple to use, they are normally sold in small jars and they will need to be mixed with a little water so as to bring them to the right consistency for working. This mixing should be done in a palette or a saucer, a small quantity of the colour being taken from the jar with a penknife blade or something similar and water being added, a few drops at a time, and mixed thoroughly into the colour with a brush. The first coats should be applied a little wetter than normal. It should be noted that poster colours in most shades other than black, white, and possibly yellow always appear to be darker when mixed in the palette than when they have been applied and have dried on the model, so that rather more coats may be found to be necessary before the exact shade is obtained. Despite this, the painting of models in poster colours is not nearly so lengthy a business as when enamels or even cellulose dopes are used, for the colours, being water mixed, dry very rapidly, taking only a matter of minutes to do so, and, even though several coats of each colour may be needed, a model can be painted completely in all its camouflaged colours in an evening's work. The same process of choosing the lighter of the colours as a basic paint and applying the darker colour in pattern over the top should be used.

Lettering, lining, the painting of roundels, Squadron markings, and other small details will offer plenty of scope for the artistic talent of the model maker. This part of the work is possibly the most difficult of all. It is a relatively simple matter to draw or paint well-formed letters and other devices on a sheet of paper pinned securely to a drawing board or resting flat on a table, but when this painting has to be done on a model one will often be working on curved surfaces and will have to contend with all manner of projections on the model itself, the wings, tailplane, rudder, and the undercarriage, which somehow or other always manage to get in the way. Of course, for much of this detail transfers can be used and the need to spend many patient hours with a paint brush can thus be avoided. However, the person who wants his model to be entirely hand produced, as a good model should be, will scorn these aids and will insist on painting all these details himself. There is a danger, too, when using transfers that the letters, roundels, or other decorations may not be exactly the right size or colour for the particular job in hand. This is an important point, because if a model is being made, not only of a particular type of aeroplane but of some individual aeroplane of that type, the lettering and markings must be copied just as accurately, particularly with regard to size, as are all the component parts of the model. One should always aim to produce a model so that if it were photographed and the photograph placed alongside a picture of the original it would be impossible to distinguish one from the other. Letters which are wrongly shaped or incorrectly spaced, or roundels which are either too large or too small will immediately betray the model.

Because of this the modeller should aim to carry out all the detail markings by hand and even though he may be tempted because of his lack of skill with a paint brush to use transfers on his first models, he should not allow this temptation to rob him of practice in the art of hand finishing the model, for only by practice will he be able to develop his own skill in this part of the work.

One of the main essentials to success in detail painting is a comfortable working position, and for this reason the work is better done when seated at a table than when standing at the work bench. For much of this work the model will have to be held in one hand whilst the painting is done with a brush held in the other; this will be particularly so when the detail is being painted on the fuselage, and in such cases the model or some part of it should be rested against a firm object to steady it. As an example, if one were painting the blue cheat line on the starboard, or right-hand, side of the fuselage of a B.O.A.C. airliner, the model could be held (assuming that the modeller is right handed) by the starboard wing tip with the port wing tip resting in the lap and the tip of the port tailplane resting on the table, or, better still, with the tailplane resting on a pad of cloth so as to prevent any damage and to avoid any possibility of the model slipping. A pile of books or some other suitable support should be placed near the model on which the wrist of the right hand can be rested and the height of this support should be adjusted until the brush is comfortably in position on the model. This set-up should, of course, be tested with a dry brush. The painting of this and all similar decorative lines running along the length of the fuselage should commence at the point furthest away from the modeller and the painted line should be worked gradually towards him—in this case from the tail to the nose. For painting the line on the port side, the nose of the fuselage can be rested on a pad of cloth on the edge of the table, and the model should be held with the fuselage as near as possible parallel to the table edge so that the right arm and wrist can be rested on the table.

It will be obvious from these instructions that the painting on one side must be allowed to dry before the painting on the other side can be carried out. This may seem to lengthen the proceedings considerably but the modeller is well advised to carry out all the finer detail painting in a number of short stages rather than in a few long sittings. With his model in this almost finished state, a slip of the brush can spoil the whole job, into which will have gone many hours of patient work. A high degree of concentration is required in detail painting which is tiring; hands and arms can become uncomfortable through holding the model still in one position for a long period and when this happens mistakes are very easily made. So do not spend too long at a time over any stage of the detail-painting work.

The painting of letters, roundels, or other markings on mainplanes will not be nearly so difficult, as the model can be stood on the table on its own undercarriage or rested upside down for any painting of details beneath the mainplanes.

Before the painting commences, the shapes of the letters, roundels, or other markings must be set out on the model. The outlines of cheat lines or any similar decorations on a fuselage can be drawn with a sharp, soft black pencil, a flexible straight-edge being used as a guide. Small marks should be made at each end of the line and then joined up. A strip of thin transparent celluloid about ½" wide makes an ideal straight-edge for this purpose but care must be taken to see that the edges are absolutely straight and true.

Roundels are best scribed with a pair of compasses, the point of the centre of the roundels first being measured and marked on the model. In the case of fuselage roundels the points must be set out exactly opposite one another on each side. Compasses with a fine needle point should be used so that no large hole is made at the centre. A very small hole is easily covered by the paint.

It is inadvisable to mark guide lines on a model for setting out registration letters, Squadron codes, serial numbers, and similar details, as these lines may be difficult to remove after the details have been painted. Some form of guide is required, however, if letters and numerals are to be kept even and uniform in size and shape, and the following method has proved to be a very effective means of setting out these markings.

The various groups of letters or markings are first drawn in pencil on a sheet of paper exactly to the size and style in which they are to appear on the model. If desired, this setting out can be done on the general arrangement drawings. The letters are then traced on to a piece of tracing paper with a fairly hard pencil. The tracing paper is then reversed and the outlines on the other side are marked over with a softer—HB or B—pencil. The various groups of letters for fuselage and mainplanes are then cut into strips. As a rule, one set of letters will suffice for both sides of the fuselage and one other set for the upper and lower surfaces of the mainplanes. The strips are then placed on the model and adjusted until the letters come in exactly the right place, when the strip is secured with rubber bands or with a few turns of a length of thread. The paper is then steadied on the surface of the model with the hand whilst the outlines of the letters are again traced over with the hard pencil. This will transfer the soft-pencil marks on the back of the paper on to the model in a very clear outline of the lettering. If the same strip is to be used on another part of the model, the back should be marked over again with the soft pencil and the transfer repeated. Not only letters and numerals but also fighter squadron markings and other insignia can also be set out on the model by this means. One big advantage of this method is that, with the aid of photographs of the aircraft, the modeller can work out the exact sizes and proportions of any markings on the flat surface of a sheet of paper before applying them to the model. This is particularly advantageous where the markings occur on curved surfaces, as in many cases they will.

Either a No. 1, 0, or 00 artist's brush will be needed for the painting of details and lettering, the actual size depending upon the thickness of the characters. One very important point to observe is that only the very tips of these small brushes should ever be dipped into the paint. In this way only a very small amount of paint will be transferred to the model at a time and the work can be kept under perfect control. Moreover, if the brush is immersed too deeply, the paint will gradually congeal at the top of the brush causing the tip to spread, thus making it impossible to obtain a fine point.

Before painting commences, the brush should be dipped in the appropriate cleaning fluid—either turpentine, water, or dope thinners, depending on the type of paint being used—and then dried on a pad of clean cloth. To dry the brush, it should be drawn lightly across the pad and, at the same time, turned between the fingers to produce a fine point. The painting should commence at the centre of the marked outline, the paint being worked towards the outline on the left. When the first half of the outline has been painted the model is turned up the other way and the second half is filled in, again working from the centre towards the left. This assumes that the modeller is right handed, left-handed persons should reverse the direction of working.

When painting yellow-edged roundels on dark surfaces, such as camouflage, it is often easier to paint the lighter colours, that is the yellow and white rings, first. A more easily visible guide will then be available for painting the darker blue and red colours.

It will frequently be necessary to hold the model in one hand when painting details, but in any case some part of the model should be rested on a firm surface and protected by a cloth pad. It is often wise to use a cloth pad also for holding the model, thus avoiding any possibility of finger marks showing. The little finger of the brush-holding hand should be extended and rested firmly on the model to act as a "steady", and the wrist should also be comfortably supported.

If the painting is carried out under artificial light, use a table lamp and place it so that the maximum illumination can

be directed on to the model whilst leaving the eyes shaded.

Finally, all detail painting should be carried out free from any distractions. Even though no one may be near enough to jolt one's elbow, the slightest movement in the far corner of the room may be sufficient to cause one's attention to stray for a moment away from the model, perhaps with disastrous results. This phase of the work should, therefore, be undertaken when one is alone, for if a slip of the brush does occur, one's involuntary utterances are best unheard!

Many books which set out to explain how a thing is done end by listing a whole series of "Don'ts". In scale-model aircraft work this negative advice can be summed up in one sentence! Don't try to run before you can walk. For his first few models, the novice should select aircraft which are as simple as possible in form and finish. From the experience thus gained, skill will develop, technique will improve, and the modeller will become his own greatest critic. He will have learned to take a craftsman's pride in the accuracy of his constructional work, in the neatness of details, and in the excellence of a finish. Then, increasingly complicated types will roll off his production line with far less trouble than his first hesitant efforts and each model will represent a work of art. When that stage has been reached, one will find it difficult to abandon so fascinating a hobby.

FINIS

G—continued

GUNS, VICKERS 94

H

HANDHOLDS 93
HANDLEY PAGE SLATS 91
HELICOPTERS 102
HIGH-GLOSS FINISH 104
HOMING AERIALS 93
HULLS 80

I

INSTRUMENT BOOMS 92

J

JET PIPE 23

L

LANDING LIGHTS 46
LETTERING 104, 108
LIQUID-COOLED ENGINES 68
LINING 108

M

MAINPLANE, ATTACHMENT OF 21
MASS BALANCES 91
MASTS, RADIO 93
MATT FINISH 104
MESSAGE PICK-UP HOOKS 94
MODEL, CHOICE OF A 7
MONOPLANE WINGS 39

N

NAVIGATION LIGHTS 91
NOSE WHEELS 77
NOSE WHEELS, TWIN 78

O

OBECHI 9
OLEO SHOCK-ABSORBER 72

P

PAINTING 104
PERSPEX 10
PINE 9
PLANE 10
PLANING SURFACES 82
PLASTIC WOOD 10
PLIERS 11
POSTER COLOUR 104, 108
PRESSURE HEADS 92
PRIMING COAT 106
PROFILE, FUSELAGE 18

R

RADIAL ENGINES 67
RADIATORS 88
RADIATORS, LEADING EDGE 46
RADIO MASTS 93

R—continued

RADOMES 94
ROCKETS 97
ROTOR MOUNTING 101
ROUNDELS 109
RUDDER FITTING 60
RULE 11

S

SAW 10
SCALE 11
SCOPE OF THE HOBBY 7
SKIDS, TAIL 78
SKIDS, WING-TIP 92
SLATS, HANDLEY PAGE 91
SOLDERING IRON 11
SOURCES OF INFORMATION 15
"SPATS" 72
SPINNER 17, 87
STEAMING 42
STEPS 93
STROP HOOKS 94
STRUTS 55
SUPERMARINE SPITFIRE MK. IX 14

T

TAIL PIPES 24
TAILPLANE FITTING 59
TAIL SKIDS 78
TAIL SURFACES 48
TAIL WHEELS 78
TEMPLATES, USE OF 22, 41
TIN 10
TORPEDOES 97
TRANSFERS 108
"TROUSER" WHEEL FAIRINGS 72
TURRETS 29

U

UNDERCARRIAGE BOGIE 76
UNDERCARRIAGE, DOORS 78
UNDERCARRIAGE, DOUBLE ACTION 76
UNDERCARRIAGE, FIXED 70
UNDERCARRIAGE HOUSINGS 43
UNDERCARRIAGE, LEVERED-SUSPENSION TYPE 75
UNDERCARRIAGE, MULTI-WHEEL 77
UNDERCARRIAGE, RETRACTABLE 70, 74
UNDERCARRIAGE, V-STRUTS 71

V

VARNISH 107
VENTURI TUBES 93
VICE, USE OF 20

W

WHEELS 79
WHEEL FAIRINGS 72

W—continued

WHEELS, TAIL 78
WHIP AERIALS 93
WINDOWS, CUT THROUGH FUSELAGE 34
WINDOWS, RECESSED 33
WING FENCES 92
WING RIBS 47
WING-ROOT AIR-INTAKES 44
WING SHAPING SEQUENCE 43
WING-TIP SKIDS 92
WIRE BRACING 57