Advanced Ship Modelling

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Acknowledgements

It would have been beyond me, I think, to have produced this book by myself.

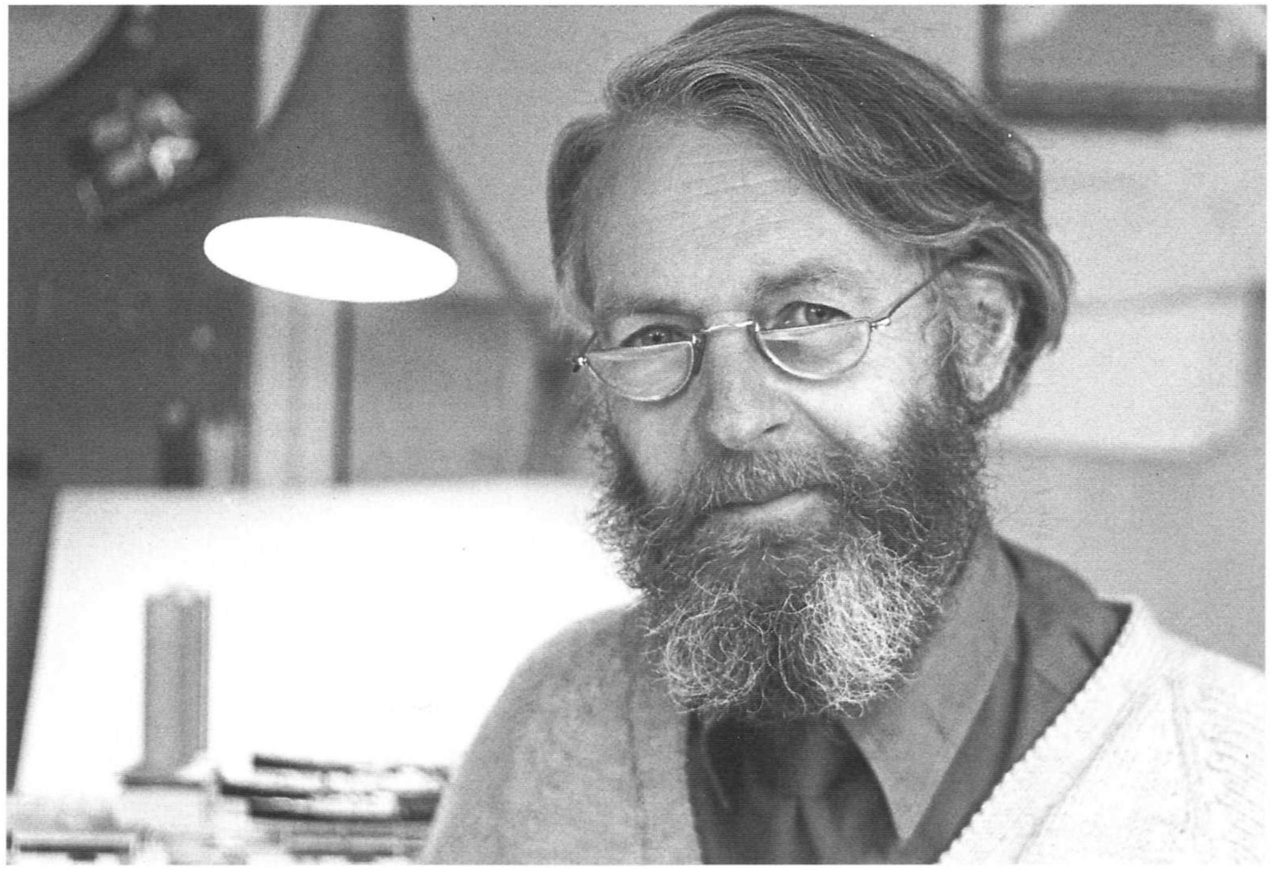
My greatest amount of thanks must go to Azien Watkin who has typed all 52,000 words and done many of the drawings. This, after teaching herself the skill of drawing on a computer and picking up the skills of a draughtsman or should it be draughtswoman?

If you don't like this book blame it on David Watkin who first proposed how it should be put together. "Buy a computer" – he said, and that's how it all started. However, he has also stood by with much helpful advice throughout this project particularly when things went wrong as, for example, when the hard disc packed up.

My thanks must also go to my very old friend Ray Brigden for permission to use his photographs. Unless otherwise stated the photographs are by the writer or Azien Watkin.

Some of the better models shown in this book are the work of two of our finest craftsmen, Alex MacFadyen of Vanguard fame and Jimmy Wood. The latter's large models of commercial vessels have dominated exhibitions for some years now, often at the writer's expense!

Brian King



Preface

I began model making under the guidance of an old shipwright who had served his time in a wooden boatyard in the 1890's. I received at the age of three a block-plane, two chisels, a hammer and a hacksaw and as much kindling wood as I wanted and over the next few years we built a pond yacht and whole firewood fleet - a carpet convoy of merchant vessels, warships and naval auxiliaries.

I was too young, however, to know the right questions to ask my mentor and although I learnt as much as I could there was much that I missed, particularly as the old man was a skilled builder of model open boats. Consequently when I returned later in life to serious modelmaking I had to expand my techniques largely by trial and error and by reading as much as I could about model makers whose standards I envied. It was in the pages of 'Model Shipwright' that I first learned of Brian King and at successive Model Engineer Exhibitions that I marvelled at his creations. We met by chance and when later we became neighbours I always hoped that I might have the chance to pick his brains, particularly as I now knew the questions I wanted answered.

By making a permanent record of his life's experience in this book Brian, has taken great delight in giving everyone the chance to make use of his knowledge. Here you will find proven solutions to the practical problems of building a scale ship model and answers to many of the questions you might have asked had you thought of them, enabling you to put your manual dexterity to its best use.

Your delight will be in the models this book will help you to build.
Dave Watkin

Dedication

This book is dedicated to all those who strive for perfection knowing they will never achieve it, but who struggle on just the same.

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Chapter One

Introduction

No. 1. Never think you <u>can't</u> achieve something.

Water and ships have always fascinated me. I remember being taken by my Grandma to Abington Park in Northampton when I was very small, certainly pre-school, and seeing the model boating lake therein. It was an uphill approach so that suddenly the whole shining water surface appeared at eye level with sundry model boats sailing about. Even after nearly 70 years that magic moment stays with me, as does the Canoe Lake at Southsea where in 1935 I saw for the first time a large steam driven model warship in action.

By today's standards these models were probably very crude. One has only to look at early ship model books by Percival Marshall and the like, published in the 1930's, to realise how far we have come. But all that is in hindsight. At that time all I had was a little clockwork driven Hornby speedboat, the smallest in the range, to compete with such magnificence.

At that time Southern Railways were running paddle steamers along the south coast and at the pier head of, I think, Southsea pier a beautiful model of one of them was displayed in a glass case. It was probably of the paddle steamer Southsea and I guess made by Bassett Lowke. What I would not have given to own that model! A mess of pottage does not come into it.

In those days you could go below in Southern Railways steamers and stand in the passageway that ran each side of the engine well and watch the two pistons working on the atharwtships crankshaft. Being a passenger paddle steamer this was in one piece, as Board of Trade regulations did not allow independent working of each paddle. The smell of hot metal, steam and oil has never left me. I smelt the same smell on board Swiss paddlers when in Switzerland last year. It was also the first time I had seen heavy engineering in action - large lumps of ground steel, polished brass oil boxes, eccentrics operating the valve gear and best of all the big ends flying around. What fascinated me was the way the big ends were lubricated. Above them was suspended an oil box with a cloth wick hanging down which at every revolution wiped its oil onto a piece of upstanding brass in an oil box carried by the big end. The oil in that box lubricated the crankpin.

In 1935, the family holiday coincided with the Navy Week so for the first time I saw a Royal Naval dockyard. This is where I suppose I caught the love of warships; it was a magic place for a 10 year old. As it is now sixty-three years ago my memory is somewhat dim but aided by the programme, which I still have, I see we went aboard 'the mighty 'Ood' (HMS Hood), the battleship HMS Nelson and the aircraft carrier HMS Courageous as well as many other smaller ships. I also remember seeing a torpedo launched in one of the basins. With hindsight all very sad as in only four years Courageous was to be lost on a fools errand hunting 'U' boats off the West coast of Ireland and the battle cruiser Hood sunk in the 'Bismarck' action a couple of years later. If the truth be known both ships were probably obsolescent at the time but we mourned their loss. All this tempted me into trying, with very little resources and limited skill, to try and produce some sort of working model.

The only source of propulsion was the little clock work motor in the Hornby model speedboat. From some source, long forgotten, I had a two view plan of the destroyer HMS Fury (F class destroyer circa 1934) to a scale, probably 1/16in to 1ft; giving a model 20in long. This was basic, with very little detail, but so was I in those days, basic, I mean. A suitable (?) piece of wood was found and with a great deal of very hard labour a hull was hacked out from the solid. To carve out the interior a half-inch wood drilling bit was available, the only one my father possessed. A series off half-inch holes were drilled about half an inch in from the edge and the isolated central mass hacked out with the only chisel I had.

You could say I was keen, or mad, but I did it. Most of the all-wood super structure was thin plywood stuck together with balsa cement, the only waterproof glue available. The clockwork motor was swapped over, a shaft and propeller begged from somewhere, suitable grey paint scrounged and the whole lot put together. It worked. Floated to waterline and apart from a limited voyage time, owing to the clockwork, it was a great success. A photo of this triumph is shown in **Fig.1.1** This

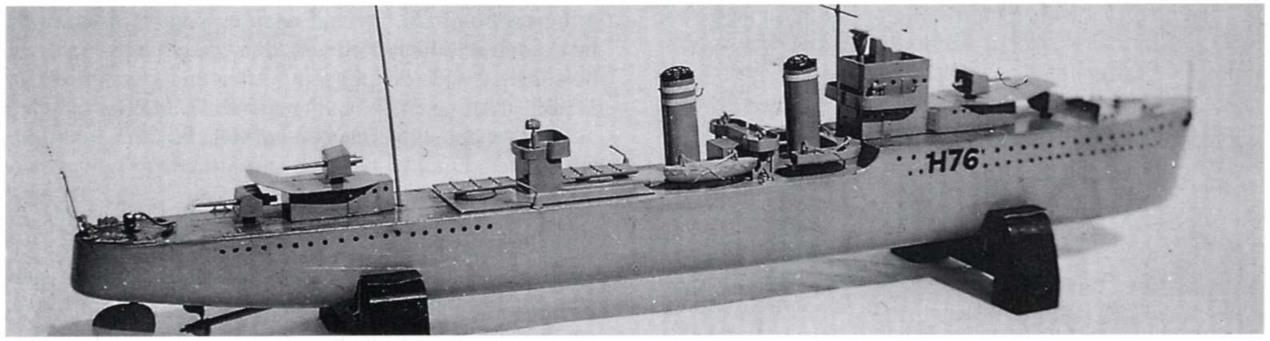


Fig. 1.1 Destroyer HMS Fury, clockwork driven

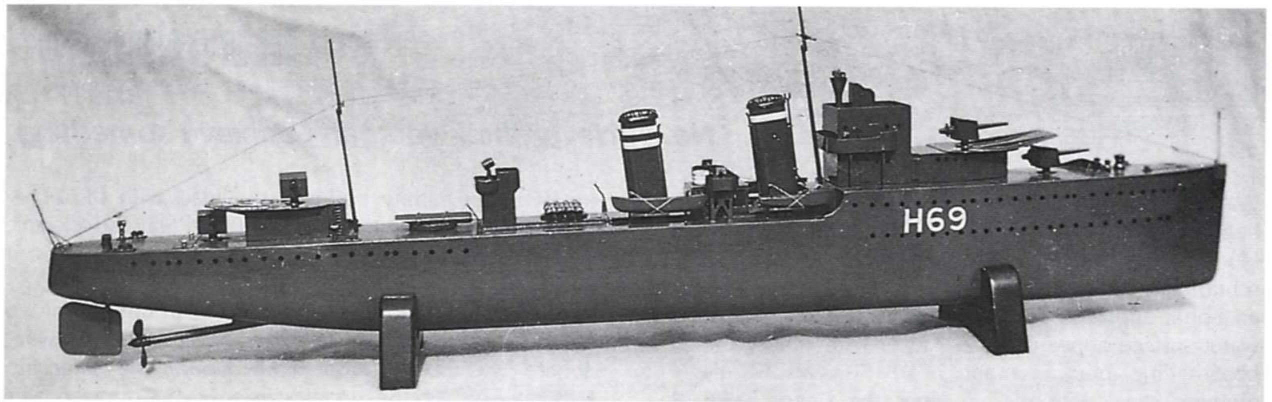


Fig. 1.2 Larger electric driven model of Destroyer HMS Fury

model was built about 1939. Without another plan available I decided to build another destroyer twice the size of the clockwork one with better propulsion (see **Fig.1.2**) for my little clockwork motor would not drive a 40in model. By this time the war had started and we were in the midst of the Blitz. The local Baptist Church Hall got blown down and, knowing the vicar, I managed to scrounge a large piece of pitch pine roofing beam. It was so large I had to cut it into two pieces to get it home. One piece is still used; my Myford lathe sits on it! A more unsuitable wood than pitch pine would be hard to find with its hard and soft grain but it was that or nothing. The best piece selected for the model still had a large knot on the edge.

By this time I had graduated to Twickenham Junior Technical School where one of the subjects taught was engineering pattern making. Here I learnt not only how to handle wood but how to work accurately and to a drawing. Mr. Bales was the lecturer. 'Basher' Bales we called him owing to his tendency to hurl blocks of wood, chalk, or what came to hand at the head of any recalcitrant student in his workshop. If only I had been allowed to do that when I became a lecturer. As I had chosen to do woodwork and not metalwork as part of the entrance exam to the aforesaid Technical College, I had come under his notice at an early stage. Basher became one of those teachers, we all have them, who you remember for the rest of your life. I recall him with very great affection. A great big bear of a man but somehow he saw in me some promise. He helped me all he could. I manhandled the great lump of pitch pine to college and had the offending knot cut out on the big bandsaw and a new piece dovetailed in which was glued in with casein glue, which I was told was waterproof but I have since found is not. He also cut out the profile, which saved some sweat.

Although I was doing technical drawing at the college, drawing boards and drawing had long since become familiar to me as my father was a draughtsman and had worked at home for some time. My task was to redraw the plans of Fury at twice its original size. For some reason I did this in ink on tracing paper. I should have scrounged a piece of blue tracing linen from my dad and got some prints taken. Of course at that time blowing up drawings was not the simple job it has become.

Anyway, the model was built and an engine was required. We were originally a Northampton family which those 'small boys' amongst you will know was also the home town of that wonderful firm of Bassett Lowke, purveyors of fine models for the delectation of the afore-mentioned small boys! If the name of Bassett Lowke stirs in you what it stirs in me, be you 9, 90 or 100 you are still a small boy. My mother knew the sales manager of Bassett Lowke. I had also met him just before the war. A letter was penned, pulling respectful rank, and in due course I obtained a "Marine" electric motor and a six-volt Exide accumulator with a case either of celluloid or acetate rather than the more common glass which was thus lighter and very suitable for the job in hand.

This model was a success. It was tried out during the winter on the open-air swimming baths at Twickenham. This involved carrying it six miles, there and back in its box but it was worth it. I still have the technical report on its performance that I wrote up afterwards. I was very much into technical reports both at college and work at that time. The date was the 23rd of January 1943 and there was fog! One of the problems I encountered was keeping the model upright. It was not 'tender' although its narrow beam (being a destroyer) made it sensitive to loading problems. My father, who normally did not share in my interests, thereupon invented the 'King Balancing Disc' (patented throughout the world) which was a disc of sheet lead mounted in the hull on the centreline by a screw, not in the centre of the disc but near the edge. This enabled the eccentric to be turned to add its weight to one side or the other. It worked perfectly. After this I was given a steam-oscillating engine but I needed a boiler. Try as I may I was never able to get one and despite building a hull for this projected model it was never finished.

It is very difficult, I suspect, for present day modellers to realise how hard those times were. Apart from all round shortages of plans, materials, paints, and glues etc. nobody was model minded in the sense they are today. Since World War II the variety of materials has

Fig. 1.3 Working model of RNLI 48' 6" Oakley Class lifeboat

mushroomed together with plans and kits, the best of which have largely killed off scratch building. This is a great pity, you can still get a Gold Medal for putting a kit together at the International Model Show but kid yourself not, you are not really a master craftsman in the sense that my generation knew it. Most of the thinking, and a very great deal of the work, has been done for you.

When you obtain an original warship plan from the National Maritime Museum, sort it out, and then build everything from scratch then you can say "I am a master craftsman".

After the abortive steam model I had a very serious illness which kept me on my back, on and off, for five years. Then marriage, a home, more study and pressures of a career, postponed my active ship modelling for a considerable time. I took it up again in my forties. I had changed my job becoming a lecturer in a technical college. This resulted in a six day a week working schedule comprising teaching and lecture note preparation, particularly the latter. I found out it is only when you have to teach a subject that you really begin to understand it. To offset this pressure I decided putting plastic boat kits together would help, one day of peace and relaxation as it were.

This did not satisfy me for long. Too much of the work was already done by someone else which is always the problem with kits. So I turned to model lifeboats and built a working model of a 48ft 6inch Oakley (**Fig. 1.3**). I think that this large Oakley was the most handsome of the traditional lifeboats. This won me my first award the Mercantile Cup at the Hanwell show in 1977. This model was inspired by a visit to the Isles of Scilly where I bought a paper cut-out model of this boat. I obtained a set of plans from the Royal National Lifeboat Institution (RNLI) and I was set to go. Because of the very complicated double curves in the screw tunnels I decided on a glass reinforced plastic (GRP) hull, this with no knowledge, or previous experience, of the technique. I soon learnt, and GRP work will be dealt with in a separate later chapter.

The model was radio controlled, first with one motor (Decaperm) with a gearbox driving twin screws and later with two Decaperms with independent control. I had bought a book on radio control from Model and Allied Publications (MAP), which proved to be 20 years out of date on technique. I had to mug up on proportional control.

In all I made five lifeboats, two of which were for an RNLI commission, together with three sets of Arun parts for someone else to make up (see **Fig. 1.4**). All this was mainly GRP work.

Following this I made a working model of HMS Dreadnought in GRP (see **Fig. 1.5**) from the drawings by John Roberts. This did not win any awards at the Model Engineer Exhibition but taught me an awful lot about what not to do. The original Dreadnought hull was of a new design, which proved very efficient. It is said that the naval architect, Froude, produced seven tank-towing models before he was sure his figures were correct. This hull was driven by a quadruple screw arrangement. I had a decision to make; use four screws on the model and face

Fig. 1.4 Static model of RNLI lifeboat 54' round stern 'Arun' class

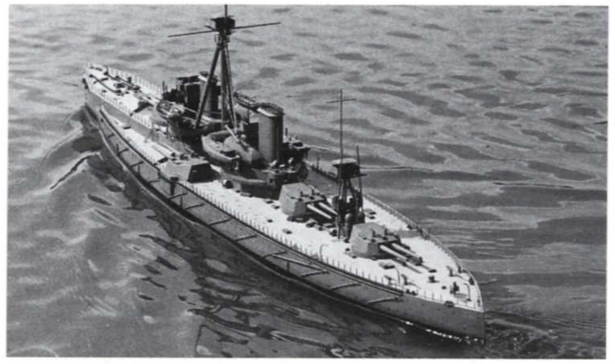


Fig. 1.5 Finished model of HMS Dreadnought under way

Fig. 1.6 Dreadnought - hull testing

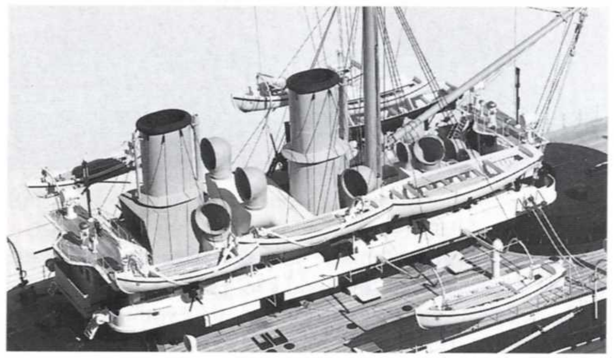


Fig. 1.7 Devastation

up to gearbox troubles, or use only two propellers. As I had made a master GRP mould it was easy to make up two hulls. One was equipped with two screws on one side (the quadruple arrangement) and one on the other (the twin arrangement). I built a test tank in the garden from heavy gauge polysheet and breeze blocks to enable me to measure the bollard pull using a spring balance. I found the simpler twin arrangement was much more efficient. So the actual model only had twin screws. **Fig.1.6** shows the test hull running free.

After this I started on a series of four Victorian battleships of 1870-90 vintage. A period of naval history largely ignored by even the cognoscenti. A time of great change and interest. Being the old traditionalist that I am, these ships embody, to me, the power of the Pax Britannica under which the world was a safer place than it is now. These models HMS: Devastation (**Fig.1.7**), HMS Empress of India (**Fig.1.8**), HMS Victoria (**Fig.1.9**) and HMS Magnificent (**Fig.1.10**– see colour plates) were made to the original drawings held by the National Maritime Museum (NMM). These were very complicated models, well-equipped with ship's boats (always models in their own right, and tackled as such almost as a separate job). This was the first time I had used photo-etching and it seemed the only solution to a very difficult problem. This was the

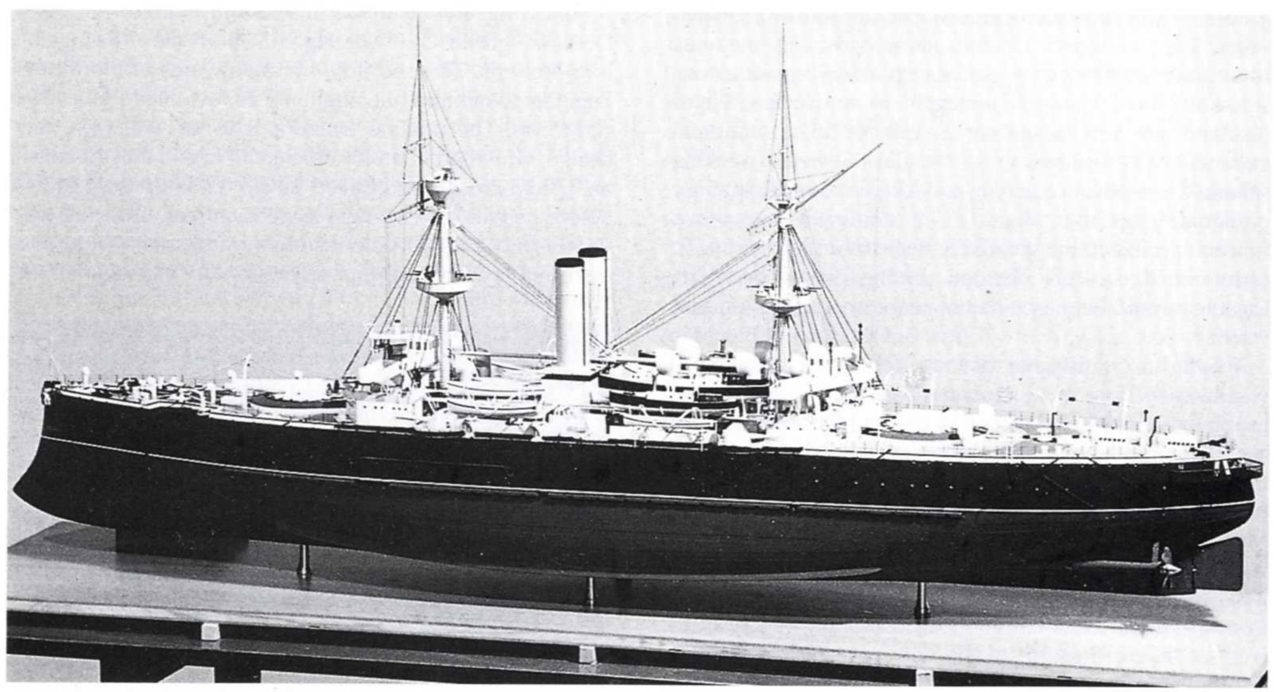


Fig. 1.8 Empress of India

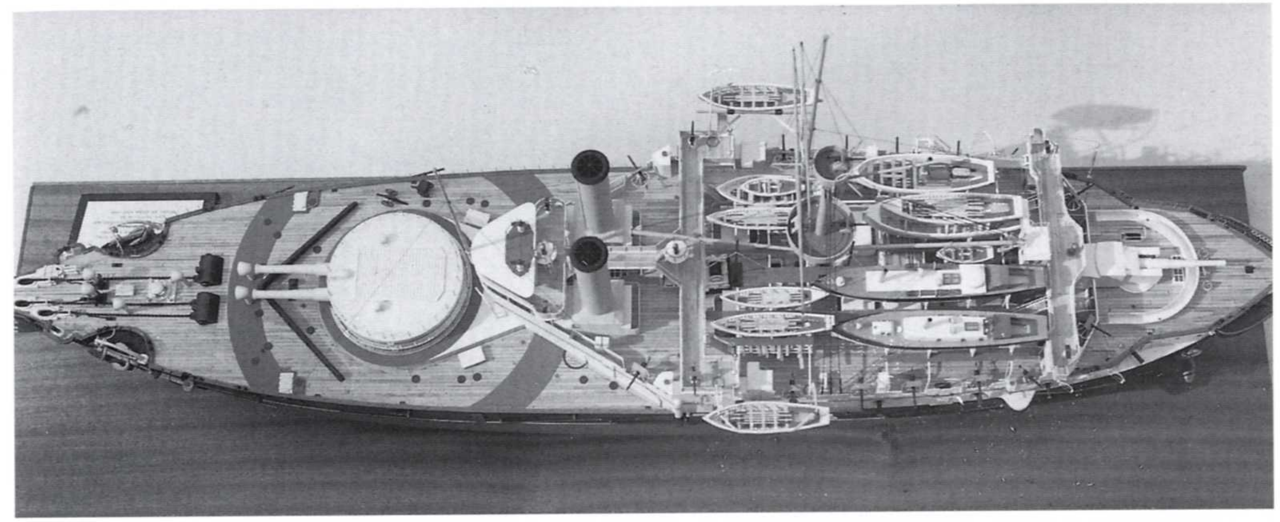


Fig. 1.9 Victoria

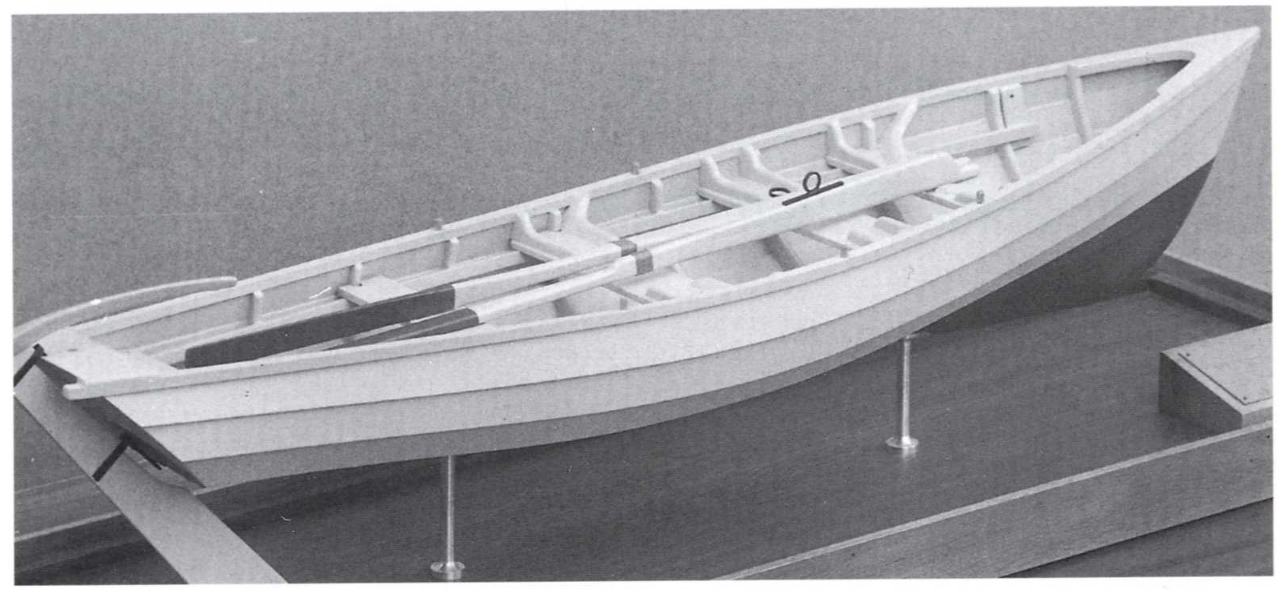


Fig. 1.15 Grace Darling's Coble

fabrication of the cast-iron (?) railings around the admirals stern walk. These consisted of diamond pattern railings with a diamond or star motif at the intersection. Etching did provide the complete solution to the problem and pointed the way to further exploitation of this technique. The model railway people have embraced this method of producing parts but we in the model boat world seem reluctant to do so, although some kit manufacturers, at least at the top end of the market, have now shown an interest.

The trouble with building Victorian battleship models was the lack of detailed knowledge. There were plenty of general shots with pictures of the forecastle and quarter-deck but very little of the waist between the two bridges. The trouble with Victorian photographs is that they are dominated by groups of brave sailors obscuring all the wanted detail! This state of affairs was universal across the range. I therefore decided on a change of direction, and to build something extant that could be viewed, pictures taken, and generally crawled over. HMS Belfast was chosen and the model built as she was in 1959. It was a pleasant change to be able to check on the detail rather than having to guess. Following Belfast (**Fig.1.11**– see colour plates), HMS Queen Elizabeth (**Fig.1.12**– see colour plates) was tackled, then the aircraft carrier HMS Glorious (pre World War 2) (**Fig.1.13**– see colour plates) and finally HMS Anson (King George V class) (**Fig.1.14**– see colour plates).

With that lot under my belt the techniques I used have largely been settled. Not that other methods and techniques are being ignored and I am continually searching for better ways of doing things, even if I have previously found a satisfactory method; the challenge is all pre-eminent! During this time smaller vessels were also tackled. Grace Darling's coble (**Fig.1.15**) was constructed; the research on that was fascinating. Two models were built,

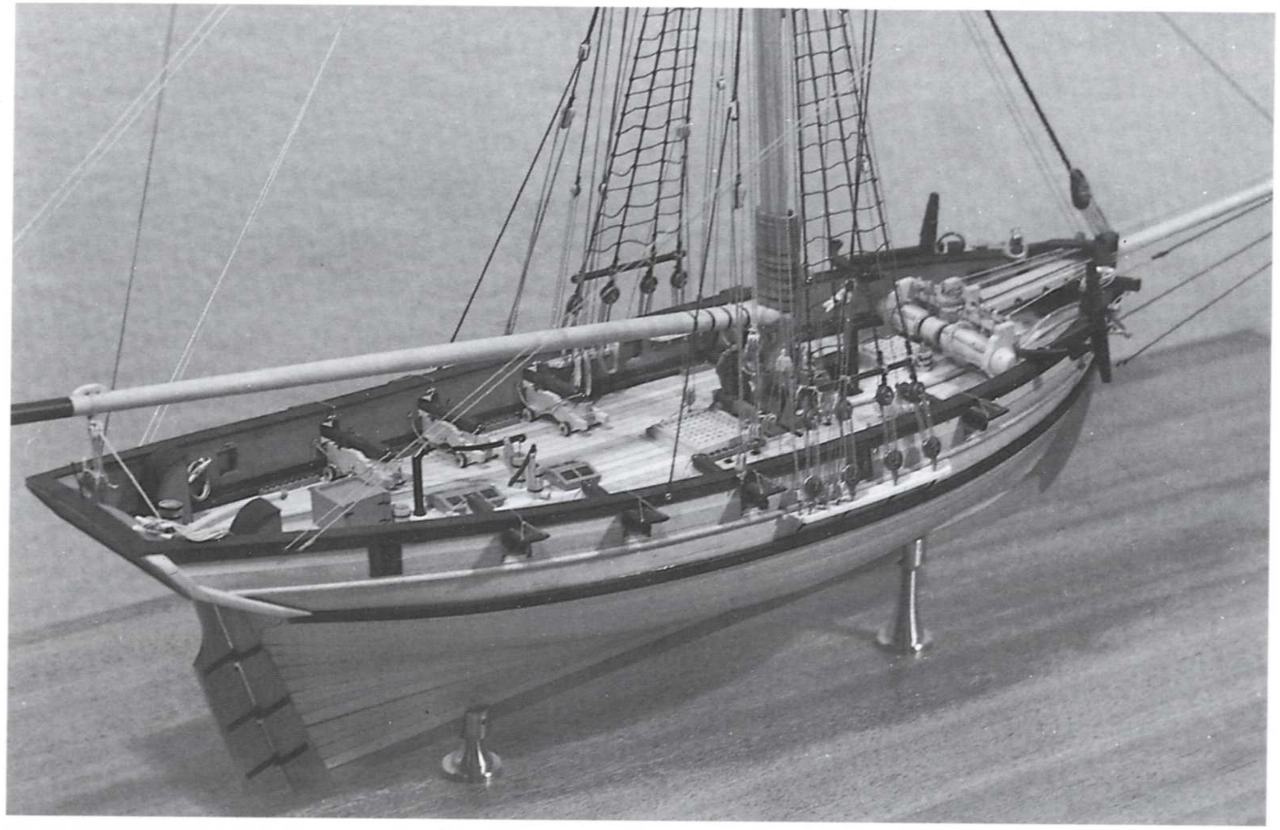


Fig. 1.16 Speedy - naval cutter

one for the RNLI and one for myself. Bill Shoulder's naval cutter Speedy (**Fig.1.16**) and a life gig of 1872 (**Fig.1.17**–see colour plates) were also constructed. The latter was a nice exercise in clinker construction, built as the original not using the Draper method.

The chapters that follow are really an exposition of my methods and techniques. In my case, largely directed towards complicated static glass-case models. However, their application is universal and can be applied to working models ships and, come to that, to models of all kinds. I do not profess that these are necessarily the best, or the only methods, just those that I use. Having spent 20 years teaching others it has become obvious that how one tackles a job, builds a model, or whatever, depends on many things. Perhaps primarily it is your previous training which is why I have mentioned mine. This must bias the way you look at a problem and the way you are likely to tackle it; the way your experience leads you.

In the present ship model world we have exponents of what, for a better description, one could call the card and balsa School of Modelling. No equipment, apart from simple hand tools, a miniature drill and a card table and really wonderful models have come out of that unpromising environment. The vast number of club modellers probably have reasonable facilities and then there are people with well-equipped workshops. I must confess I fall into the latter category having a power drill, lathe and milling machine. However, I intend to discuss workshops and tools in a later chapter.

I can hear the voices now; "Of course he can build good models, he has a good workshop". Yes and no. Tools mainly help the process rather than determine what can be done. If one tool, beyond all others, is the first choice, then that is a lathe. It is very difficult to produce accurate and properly finished off cylindrical parts without one. Miracles can be achieved with a power drill clamped in the vice but the results will always be sub-standard compared with lathe work. Unless you have a lottery win, workshops do not come complete, they just grow over time. Buy what you need and can afford. The good workshop pays for itself in time anyway with all the jobs, other than modelling, which can be done. Avoid buying tools that claim to do a number of things. They usually do none of those things well. Always buy the best you can afford and look after them and do not let rust get its teeth into your equipment. However, do not allow your workshop to become a fetish - a thing in itself where work is never done, no swarf ever defiles the floor and the only time anyone goes in there is to dust it or to admire it. Unfortunately there are such places, the proud, very proud, owner is always talking about his big new project. A project that will never see the light of day because that would involve work, blood and tears and messing up the aforesaid workshop.

One other aspect of modelling needs to be discussed. Most of us are capable of far more than we normally achieve. To realise this a certain amount of pumping up of

Fig. 1.18 Name plate on stern of Victoria

the psyche is required to convince yourself that you *can* do it. An example: the name Victoria, encased in a ribbon scroll, had to be painted in gold on the stern of my model of that ship (**Fig.1.18**). To add insult to injury this had to be done around the point of a canoe stern. The base coat being matt black caused further trouble. There was no chance of doing the job twice as once the gold pigment was applied to the relatively rough matt black surface there was no chance of cleaning it off. The thought of having to do this, to me, seemingly impossible job, occupied my mind for a long time. I eventually persuaded myself it had to, and could, be done. The model was set up at the correct height and in a good light. With my best brush selected and the paint mixed the job was attempted. After a couple of test runs on a spare piece of wood it was finished in about five minutes. Now I knew I could not do this job, it just required a change of mind on my part to convince myself it was possible. A similar problem occurred on the bows of the same ship when a Union flag had to be painted on Britannia's shield, which was about a quarter of an inch in diameter.

Well that's it. You are probably sick of all this first person singular but I have tried to show you what pushes me on and how I work. To tell you the truth there are times when I do not like ship modelling very much, it just requires too much sweat and toil. What I do like is the finished model - the realisation of a dream. All good work requires a modicum of dreams mixed in with all that physical stuff. What I can never get over, when looking at the finished model, is where all the problems have gone. The ones you have gone to bed mulling over; they have all disappeared like the dawn mists. Incidentally I have found that leaning on problems long enough, always solves them even if the solution is not to do that anyway.

In case any of you think it's all mega-modelling a bit of light humour sometimes intrudes. **Fig.1.19** shows a matchstick model of an Arun lifeboat for which I designed a kit. It was sold as a fun thing but I wonder how many were actually put together?

I do hope you enjoy reading the rest of this book if, that is, you have got this far! If it helps you at all I shall be very pleased.

Fig. 1.19 Matchstick model of Arun lifeboat

Chapter Two

Sources of Information

No. 2. Get the feel of your drawings before cutting any metal

Before any model can be built a desire to build that model must exist. A rather fundamental statement you might say but it pays to be really sure that that is what one really wants. You hear so many tales of models that were never finished all of which adds up to a lot of time, money and materials not to mention the disappointment in not achieving ones desires. What makes anyone want to build a particular model varies from individual to individual; it is a very personal thing. Why the Americans build some of the awful things they write up in their magazines is beyond the writer but, presumably, they enjoy it. But it pays to be sure that is what you really want. It pays to mull it over for a few weeks before you start as you may find you lose the desire. If you wish to win a major prize at a prestigious competition then the model must be fairly complicated for it to obtain sufficient marks.

Drawings

Unless the model is freelance and you make up the drawings yourself a set of drawings will be required. At the least you will need a sheer drawing (side elevation) and a plan drawing together with a set of lines and sections. These latter define the shape of the hull. If the prototype is obscure then finding these drawings may well prove to be a headache and may involve much research and tracking down with no certainty that anything will be found. If no drawings can be unearthed there is always the possibility of making up drawings from photographs. Difficult, and you need a great deal of knowledge to be successful but it has been done. Of course there will never be any certainty that what you produce is accurate but you knew that when you started and it can all be great fun. In some ways such a project can produce greater satisfaction than working from a set of original drawings. Do not fall into the trap of making the research so fascinating that the original end result, the model, never sees the light of day. It is the same syndrome as the magnificently equipped workshop without a scrap of swarf!

Drawing information that exists is of two types. Original prototype drawings and drawings especially drawn for modelmakers. Both types can vary in quality from superb to very dubious. Even drawings prepared by that doyen of modellers, the late Norman Ough, have mistakes. (The writer built a model of an Algerine class minesweeper only to be told on completion that Norman got the length wrong). (see **Fig.2.1**) These mistakes can be actual errors in design such as the one just described or drawing errors i.e. the length being drawn to two different sizes on two views. It pays on receiving drawings to check say, the beam and/or length on all appropriate views. If there are errors then beware you may end up in trouble. In this instance you need to establish which view you are going to consider the datum. With Admiralty drawings, which may consist of up to ten or more drawings for one ship - some of them nine feet long, this can really be a problem particularly if they are old and have stretched or shrunk over the years. It is best to get these reduced to your working scale as soon as possible.

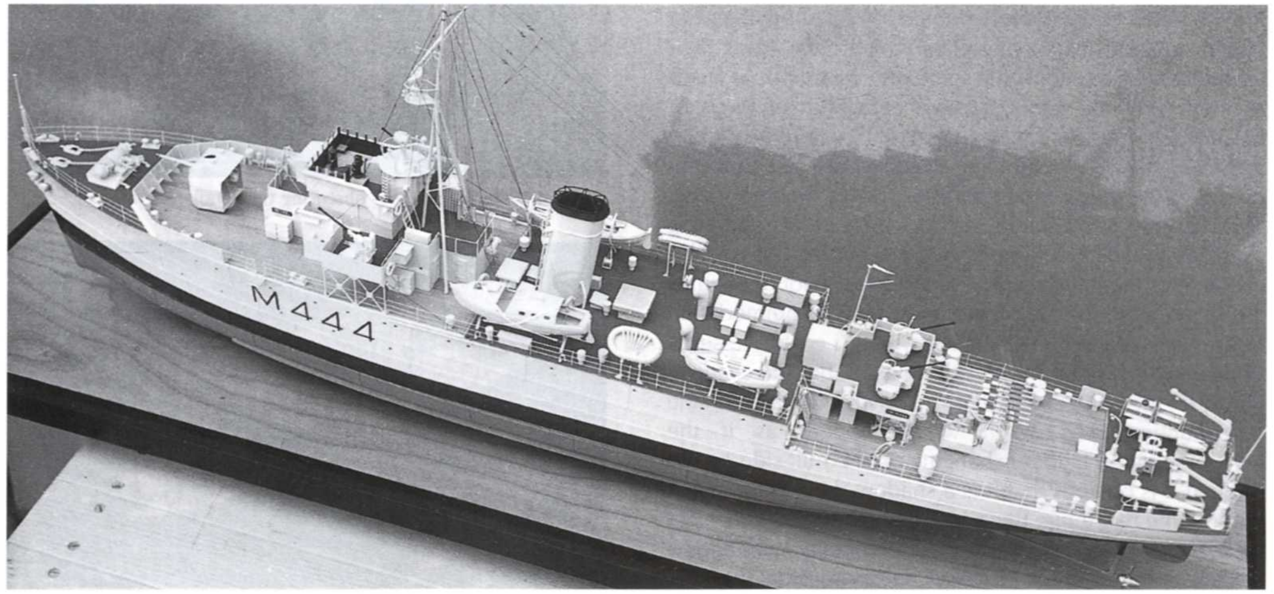


Fig. 2.1 Algerine minesweeper HMS Michael, built from Norman Ough's plans

Building from original prototype drawings is usually more difficult than using drawings especially prepared for the modelmaker. They will contain much information which you do not require and lack a lot of information that you need. It must be remembered that the shipwright will have had detailed drawings to work from which the modeller is denied. Further, these drawings will provide no help at all for the modelmaker in that he will have to interpret the drawings, work out his constructional methods etc. without the help that modelmakers plans usually give. In effect you need experience to use such material but, at least, the sense of achievement is greater. With original plans the modeller can chose how much detail he can incorporate in his model as the plans will show the vessel 'as fitted'. With modellers drawings the degree of detail may be limited.

Ship's details, winches, deck clutter and the like or, with warships, standard Marks of such things as fire control directors can often be found on drawings of other ships.

Most of the houses that publish model magazines, e.g. Nexus, also have model plans catalogues which often include specialist sets drawn by experts such as John Lambert and Norman Ough. These specialist lists deal with such things as weapons systems, fire control, ship's boats, deck details, etc. and are usually very good. The general lists vary from superb to very poor.

In addition original ship's plans are available from a number of sources: Warships from the National Maritime Museum, Imperial War Museum and Science Museum which may be able to supply plans of commercial ships as well. Foreign archives and the Internet are also sources of plans. Owing to the US Freedom of Information Act it seems that drawings of American ships are more easily obtainable than British ones.

Photographs

Real photos as opposed to printed pictures in magazines are probably the best source of detailed information for the modeller. Unfortunately printed photos show their dot pattern under a magnifying glass which often limits their usefulness. One snag is that some photos are not as sharp as they could be either through being out of focus or blurred as a result of bad processing. If, when the picture was taken, the sun was shining, shadows can be a powerful clue as to the shape of components or even their presence. This can be a valuable aid but beware of allowing shadows to indicate things which are not really there. An example of the interpretation of shadows: a lot of pictures are taken at about deck level and, if an accommodation ladder is triced up level with the deck i.e. the vessel is underway, it is often impossible to see it but the shadow, if any, on the hull's side will give it away. Although on the reproduction, **Fig.2.2**, it would appear as if the accommodation ladder is hanging on the hull side on the original it is obvious that it is a shadow we are looking at and not the real thing. Because warships would rather not be seen, or if seen, like to confuse the enemy, camouflage is used and care must be taken not to confuse shadows with camouflage.

Fig. 2.2 Use of shadows

There is no doubt that a good collection of photos of the vessel you are going to build is of enormous help. If the prototype exists you may be able to photograph it and even go on board. (**Fig.2.3** is one of my photos of Belfast moored at Tower Bridge – see colour plates). You ought then to be able to get it right. This was one reason that the writer built this model. (**Fig.2.3A** shows the model of Belfast – see colour plates). After trying to sort out four long since vanished Victorian battleships to be able to actually look at something existing was a great change.

Members of the crew draping themselves all over the detail and thus obscuring what you want to see usually ruin Victorian on-board photos. (**Fig.2.4**). In the mid 1890's Hudson and Kearns/George Newnes Ltd published a fortnightly magazine called 'The Navy and Army Illustrated' (Vol. 1, No. 1 was published on Dec.20th 1895). It was a large magazine (10 x 12in) and there must have been a book binding service available because bound volumes of these magazines are still around. Of those that I have seen Vol.1 is the most useful as it contains a large number of pictures of Victorian warships. I inherited my copy from my Grandad. It finally fell to bits owing to its age and to much use on my part and had to be re-bound by a friend. It is now one of my most treasured possessions, all those lovely Victorian battleships, the physical form of the Pax Britannica!

Fig. 2.4 Victorian sailors - obscuring the detail

Fig. 2.5 Dave Watkin's Paddle Tug - John H Amos

Building up a library and lists of where information can be found is a must for the serious modelmaker. Collect wider than your present interest as interest's change and you may be glad of it later. It is also useful to exchange information with fellow workers. **Fig. 2.5** & **2.6** (see colour plates for 2.6) are photos of a model made by Dave Watkin who has an encyclopaedic collection of ship information.

Trigonometry of Tapers

When using your lathe for taper turning it is useful to know how to work out the angles of tapers of gun barrels, etc. You can, of course, draw out the problem to scale and measure it with a protractor but it is easier, more accurate and certainly faster to do it using trigonometry, particularly if you have a calculator with trig. functions.

This is how you do it. Take a typical taper as in **Fig.2.7** The triangle you need to solve is shaded. (see **Fig.2.8**)

Then tangent $A^\circ = \dfrac{\frac{D-d}{2}}{L}$ trig. ratio = $\dfrac{opp}{adj}$

Or tan $A^\circ = \dfrac{D-d}{2L}$

Therefore A° = angle whose tan is $\dfrac{D-d}{2L}$

Take an actual example:

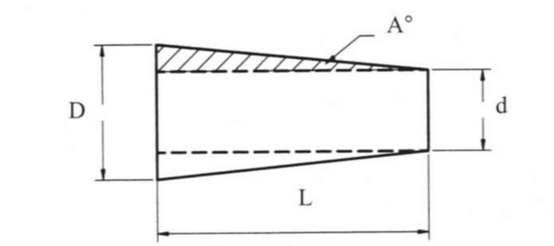
Where D = 6; d = 3 & L = 30

Then tangent $A^\circ = \dfrac{6-3}{2 \times 30} = \dfrac{3}{60} = 0.05$

Therefore A° = 2.862

If you have a scientific calculator the angle can be read directly by putting in 0.05 and pushing the inverse button followed by the tan button. Alternatively you can look it up in trig. tables or interrogate your CAD programme.

Fig.2.7 Typical taper



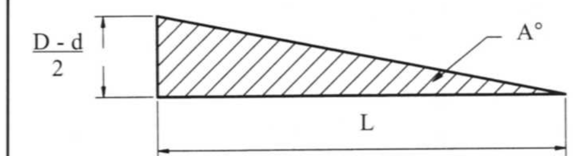


Fig.2.8 Worked example of taper calculation

Workshops

No. 3. Remember machine tools 'bite'

Probably one of the delights of ship modelling is that you come across people of many backgrounds who often have had no real training in the practical arts. From the results seen, this would, at least to some, seem to provide no real obstacle to making models. These people just have a natural talent. In this chapter, however, some attempt will be made to explain not only some of the basic requirements of workshop practice but also what special tools are available for the advanced worker. For his sins the writer spent the last twenty years of his working life inculcating, amongst other things, the elements of good workshop practice to sometimes reluctant students.

SAFETY

This is paramount to the modeller's welfare both when using hand tools, where any injury sustained may be minor, and machine tools where the loss of a limb is a possibility. Make sure when using edged tools, chisels, scalpels, knives, etc. that hands and any other parts of your person are behind the cutting edge. Remember that sharp tools cut more easily, requiring less force, than blunt ones. Forcing a blunt tool often causes slipping which is when the damage is done. Likewise do not expect machine tools to do jobs bigger than their capacity.

The eyes are probably our most vulnerable, and valuable, assets. Wearing some sort of proper eye protection in the workshop even when not using a machine tool is an excellent idea. When using a machine tool or when flying particles are likely it is a must. Proper eye protection is usually available at DIY shops together with dust masks. Make sure the mask will do what you require, as there are different kinds. These are essential when performing dusty operations e.g. sanding, sawing, and grinding.

Make sure your clothing is suitable, close fitting garments and no jewellery are the ruling principles. Cover long hair, as this can be very dangerous near rotating machinery.

Before starting up any machine make sure you know how to stop it!

Always turn off unused motions on machine tools. Stop the lead screw and/or feed shafts on lathes if they are not being used. Get it into your thought patterns that any moving part of a machine tool is dangerous. Likewise remember the danger areas on machines e.g. the chuck and tool area of a lathe, the drill chuck and tool area on a drill, the blade on a circular saw, etc. All machine tools have these and you need to be automatically aware of them. You can confidently ignore belt drive, gear trains, etc. only if they are completely guarded. Always make sure the machine is turned off before plugging in to avoid involuntary start up.

Do not wear gloves when operating machine tools particularly drilling machines. Twist drills will pick up cloth in an instant and their speed ensures a complete wrap up before you are aware anything is wrong.

Remember - machine tools bite!

Fix machine tools down securely.

Fire can be a hazard anywhere but workshops have lots of volatile, flammable liquids about. Store them safely and if any operation requiring heat is to be attempted clear the area. A fire extinguisher is really a must but get the right type. Flames are not the only source of fire. Shorting in electrical gear is another. If you are contemplating building or equipping a workshop from scratch put in an isolator that can break all electric circuits in the workshop and switch off when leaving. Keep an eye on your electrical leads - their condition and their position. Tripping over electrical cables can raise mirth in onlookers but is likely to raise bumps on you if not worse. Fires can also be started chemically. I had a small fire in my own workshop caused by a rag soaked with fibreglass resin accelerator thrown into a waste box. Luckily it was seen before any damage was done. Some chemical reactions produce much heat and in this case enough to cause a fire.

Safety depends on knowledge of the danger and a measure of common sense. Do not use machine tools when tired, emotionally upset, or under the influence of drugs which may blur your vision and/or slow your reaction times. Do not hurry and stay alert. Keep the workshop tidy particularly the floor. Round pieces of off-cuts provide ready made banana skins!

Workshops can be very dangerous places. Discourage visitors especially children and keep the door locked when you are not there. That also stops the rest of the household from nicking your tools. It has been known!

As a starting point it would be nice to be able to write out a set of tools required. Several times this has been attempted with a view to writing a magazine article but has always failed because every modeller has different requirements, ideas, methods of working, facilities, etc. the list of variables is endless. There are, however, some tools which are extremely useful and may not be known to the average worker.

HAND TOOLS

Files

Almost certainly, a set of files will be required particularly if metal or hard plastics are to be worked. From experience the best files are probably Valorbe files made in Switzerland. These appear to be only available over here in the finer grade but these are usually the ones required. A set of needle files will also be required for the fine work. (see **Fig.3.1**). These are usually sold in a set of six in a plastic packet: rectangular parallel, rectangular tapered, square, triangular, round, and half round. They are not usually sold with handles but plastic ones are available. Very small files of various sections about 0.04in diameter x 3in -long are very useful indeed for opening out small holes. For the same use, opening out small holes but only round holes in this case, are sets of watch or clockmakers broaches. These look like old-fashioned hatpins (see **Fig.3.2**). They too are tapered in length, of square section and fitted with plastic handles. They are used by inserting into predrilled holes and twirling the broach between thumb and forefinger. They are ideal for increasing the size of small holes just a tiny amount. This is often required particularly if using the next larger sized drill would produce a hole much too large.

Special Files

Two more types of files are available. The first of these are special files called rifflers (see **Fig.3.3**) which are double ended and have a central built-in handle. These were originally made for die sinkers who make the dies for plastic and metal mouldings. Their curved shape is highly useful for model work as they can be used in areas in which ordinary flat files are useless. They are made in the usual cross sections and cutting grades but a good set is expensive. If you aspire to the highest standards acquire at least one set. Not a very glamorous present but once used you will wonder how you made anything without them.

A second file has the appearance of a round wire and fits into a normal hacksaw frame and is available under the trade name 'Abrafile'. This wire is equipped with circumferential teeth and, therefore, will cut in any direction. This may be an advantage or a disadvantage according to the way you use it. Because it will cut in any direction it lacks the directional stability inherent in a hacksaw blade but this is a requirement very useful at times.

Drills

Whilst talking about drills; if you are contemplating buying some, get a set of metric drills from 1mm diameter to 5.9mm diameter in steps of 0.1mm. These can be obtained in a metal box all drills being size labelled. With these each drill is 0.1mm (0.004in) larger than its smaller neighbour. A perfectly logical system. The old English Number drills were not logical and may not now be obtainable anyway. If found necessary a further metal boxed set can be obtained containing drills from 6mm diameter to 10mm diameter giving a total range from 1mm to 10mm in steps of 0.1mm.

Below 1mm diameter (and in the kind of modelling this book is about plenty of these will be required) plastic Microboxes are available. These contain drills from 0.3mm diameter to 1.5mm diameter again in steps of 0.1mm. The drills are held in size labelled grooves which can only be exposed one at a time so you are not likely to get a floor full of drills to sort and measure! Drills below 1mm diameter are not always easy to find and one reason

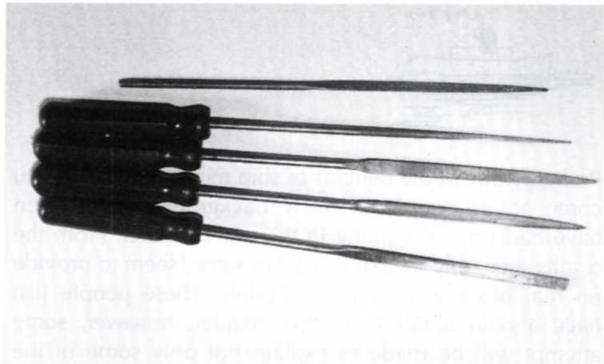


Fig. 3.1 Needle files - the handles are supplied separately

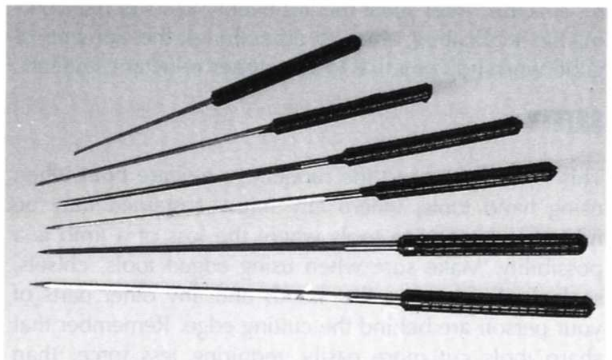


Fig. 3.2 Watch maker's broaches

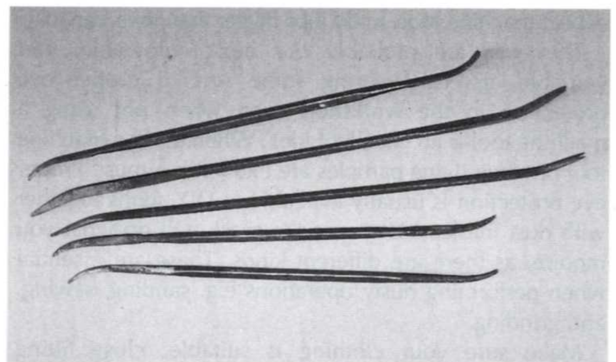


Fig. 3.3 Riffler files

for visiting Exhibitions is to replenish ones stocks of these. Incidentally, very small drills are usually ground from preheat treated stock rather than being machined before heat treatment and grinding which is the usual method of producing larger drills. For this reason they are usually quite expensive. It is possible to re-sharpen these but it is extremely difficult. If one of these tiny drills becomes blunt they are best discarded otherwise they have the disconcerting habit of breaking off in the work particularly when breaking through and this often ruins the workpiece. Normally 0.3mm diameter is about as small a drill that can be obtained through commercial channels. Experience teaches that holes below 0.5mm diameter are best avoided from the practical point of view. The drills are very likely to break and can be difficult to hold. These

small drills are held in collet chucks (see **Fig.3.4**). Unfortunately some collets are badly machined as regards centring and are not very good at gripping small drills.

If you find a good one guard it with your life; its price is beyond rubies!

If possible, very small drills are best used in a drill press (**Fig.3.5** – see colour plates). These provide more favourable conditions for the drill as they remove side loading always likely to be present when using hand held drills. Lubrication of the drill is very desirable. Drops of water can be used but these tend to rust any steel or cast iron parts of the machine. A better bet is to use a commercial machining coolant such as Cimcool but access to this may be difficult unless you have an engineer friend.

It is normal to buy HSS (high-speed steel) drills but ordinary carbon steel drills would probably suffice for our class of work. You find drills with a black or golden finish. These are anti-corrosion and anti-friction coatings.

For opening out larger holes in sheet materials, say above 1/4in, a tool known as a Conecut (sheet and tube drill) is available. This is simply a cone with a cutting edge as shown in **Fig.3.6**. It can be used in a hand drill or power tool. It can also be used to machine wood or chipboard but produces a tapered hole of course. If used from both sides it can be quite effective even on fairly thick material. All the above can be obtained at specialised stands at the Model Engineer Exhibitions or by mail order.

Forceps

You cannot have too many of these. A collection of various sizes and shapes should be got together (see **Fig.3.7**). Ones with curved points can be more useful for doing some jobs rather than the straight-legged types. A pair of nylon forceps is useful when holding painted surfaces, as they are unlikely to damage the finish. Most forceps are made of stainless steel which is useful when holding things whilst soldering as, without special flux, solder is reluctant to tin stainless steel. More of this in the section on soldering. However, some forceps are of plated brass or steel and these will solder given half a chance so should not be used for this purpose!

They also vary in the force required to close them. It pays, therefore, to keep at least one pair of very light pressure forceps for use on delicate work.

One aggravating problem when using very pointed forceps is that, when gripping work, the points can 'turn over' with the result that the work pings out and is lost. This action may cause strong language which is to be deprecated!

Reverse action types are very useful as these remain gripping the work after you release them.

Other tools which are extremely useful but in the holding rather than cutting role are artery clamps (Spenser Wells) as shown in **Fig.3.8**. These are plier-like tools which lock as you close them. They have a rack device between the handles which engages when gripping. The normal opening hand action disengages them. They are obtainable with either grooved or plain jaws. Their main use is to grip very firmly and quickly and retain that grip when

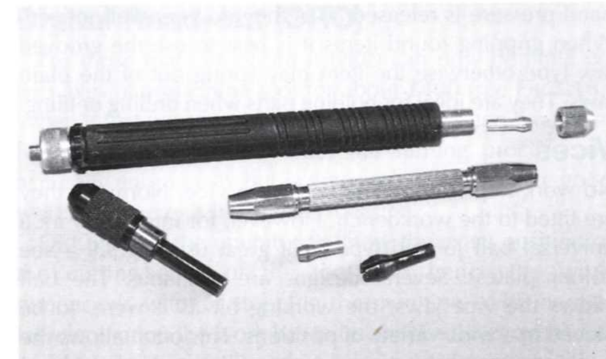


Fig. 3.4 Collet chucks

Fig. 3.6 Conecut

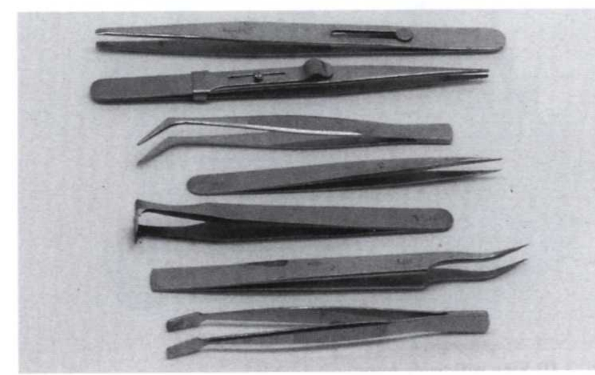


Fig. 3.7 Forceps

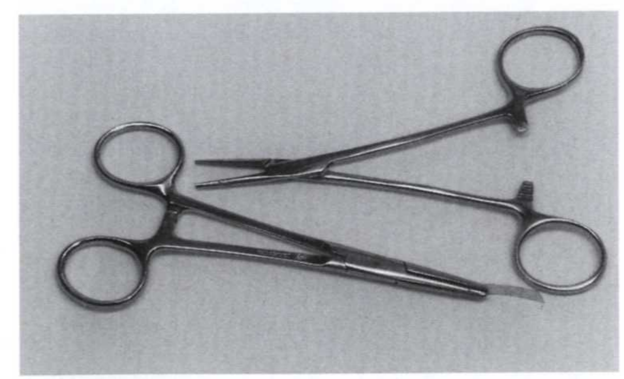


Fig. 3.8 Spenser Wells clamps

hand pressure is released. This they do very well indeed. When gripping round items it is best to use the grooved jaw type otherwise the item may spring out of the plain jaws. They are ideal for holding parts when drilling or filing.

Vices

No workshop is complete without a vice. Normally they are fitted to the workbench. However, for intricate work a universal ball jointed type is of great use (**Fig.3.9** – see colour plates). Several designs are available. The ball allows the vice jaws, the working bit as it were, to be placed in a wide variety of positions. This often allows the working area of the piece you are filing to be held level regardless of the rest of the piece. This is the most efficient position for filing of course. If the vice comes with several different kinds of jaws (see **Fig.3.10**) so much the better - a pair of rubber jaws is very useful for holding very delicate pieces. This type of vice is not suitable for heavy work as it lacks the rigidity of the fixed jaw type but, for light, intricate use, they are unsurpassed.

Another type of vice is the device called Helping Hands (see **Fig.3.11**). This device is equipped with two crocodile clips mounted on a universal stand. Its use is to hold two components in the correct position for gluing, soft soldering, etc. it is also equipped with a magnifying glass for observing the juxtaposition of the components. It is a most useful device especially if time and care is spent on setting up.

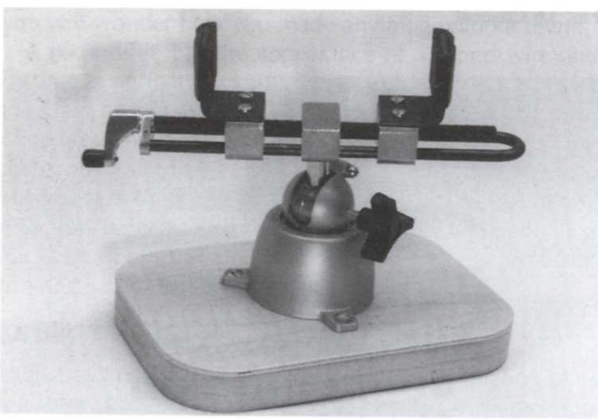


Fig. 3.10 Vice with wide jaws

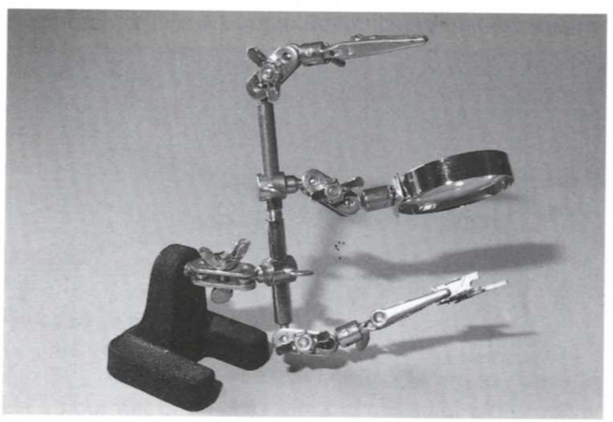


Fig. 3.11 Helping hands

Adjustable Mouth Plane

One very useful hand tool is an adjustable mouth plane (**Fig.3.12** – see colour plates). These are quite small, about 6in long. They have no backing iron on the blade unlike conventional planes, but the blade is fitted upside down so the bevel on the cutting edge acts as a backing iron. However, the main feature is that the part of the base plate that forms the front edge of the mouth is adjustable so it can be set very close to the blade's cutting edge making the mouth as small as possible. This prevents tearing when planing against the grain and can be very useful when cleaning up laid decks.

MACHINE TOOLS

Drill Press

The use of a small drill press (see colour plate **Fig.3.5**) for miniature drills (say below 2mm) has already been mentioned. Drill presses ensure perpendicular holes and relieve side loads on the drill bit. A larger drill press will also be required for bigger holes. This can be provided by using a portable drill held in a custom-made stand, which is not so good as the proper machine, but it may be an adequate solution. If a vertical milling machine is available this can also be used as a drill press.

Lathes

Probably the one essential tool for the dedicated modeller. If you have one you are for ever relieved of the task of sorting out lengths of nesting tubes for making gun barrels and the like. The lathe enables you to make proper barrels with correct tapers and exact dimensions. No more compromises on available tube sizes. Once acquired the number of jobs which can be turned become endless. The ability to turn parallel cylinders with geometrically flat ends can be exploited on so many jobs in ship modelling, not just gun barrels (the obvious first use that comes to mind) but mast bits, capstans, bollards, etc.

A large number of small lathes are available, which are useful up to a point. Many are too flimsy which limits their use to very small jobs. They nearly all lack the essential rigidity of a good machine tool. That is the first requirement of all machining: rigidity of the machine tool itself and rigidity in the work and tool set-up as well. You will not succeed in using form tools to produce profiles on very small lathes. All you will get is chattering and disappointment should you try. You do see the most ambitious profile jobs shown in magazines. Believe me they are pie-in-the-sky.

A larger lathe, say a 3-1/2in Myford, is probably a good buy (**Fig.3.13** – see colour plates). If bought second hand check for general wear particularly the main head stock bearing (the one nearest the chuck). A lathe of this size is sufficiently large to accomplish the sort of work most ship modellers require and, if in good condition, is capable of very delicate work indeed. You also stand a chance of doing some profile work using form tools on non-ferrous metals and plastics, at least, such as reinforcing rings on cannon barrels and the like.

However, it should be said that any lathe is better than none.

Three-jaw Chucks

If possible, buy a three-jaw chuck of the adjusting kind (see **Fig.3.14**). Although all three jaws operate together slight adjustment of the jaws is catered for. In this case, given that the vast majority of work contemplated is below 1in the jaws can be adjusted when gripping say a piece of 1/2in diameter (average diameter) stock to run true using a dial test indicator (DTI). You will then get accuracy of run-out akin to that obtained by using a set of collets. DTI's are known in the trade as 'clocks' because they look like a clock. They usually consist of a circular calibrated dial fitted with a plunger. Deflections of the plunger register on the dial. They are used for measuring run-out on lathe work, for setting things parallel on machine tools and measuring small dimensions in general. They are usually calibrated in thousandths of an inch or 0.01mm.

Three jaw chucks are supplied with two sets of jaws. One set for holding work externally and one set for gripping bores, etc. When fitting chuck jaws they must be fitted in numerical order (they are marked 1, 2, & 3) so that the tightening scroll picks up each jaw in turn otherwise they will end up incorrectly meshed. Check this by tightening up to minimum diameter!

A set of collets will cost you a King's ransom, as each collet is limited to gripping its nominal diameter only, a considerable number are needed. They are probably not for the likes of you or me, or should it be I?

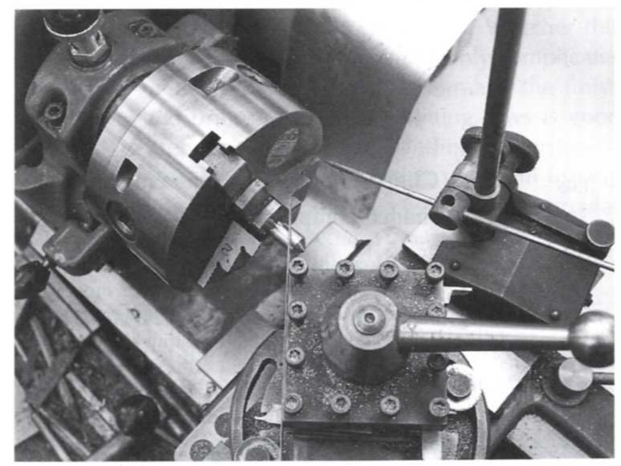


Fig. 3.14 Three jaw chuck

Four-jaw Chucks

A four-jaw chuck (**Fig.3.15**) has limited uses. Unlike three-jaw chucks whose jaws move in unison four-jaw chucks have four independently operated jaws. Their main use is for holding square stock but they can also be used for holding irregular shaped work and for holding circular work off-centre. Jaws can be reversed in the chuck body for holding work externally or internally whichever is more convenient. They are indispensable for some types of work but for most ship modellers they may prove to be an expensive luxury.

Digital Read-out (DRO)

For those that can afford it DRO can now be fitted on two axes of a machine tool for about £400 (see **Fig.3.16**). When it first became available the price was ten times that figure! DRO speeds up both the turning process and accuracy enormously but is not essential to produce good work, of course; it just makes it easier.

DRO allows the operator to know the exact position of the cutting edge of the tool and hence the work dimensions without stopping the machine. With normal lathe operation the work has to be checked after every cut, and lengths measured with a rule and diameters with a Vernier or micrometer (mic).

The system works by having a sensor measure the movement of a machine slide and displaying the result on a digital display. There are various ways of achieving this. One system uses a wire which is attached to the slide at one end; the other end of the wire is wound round a grooved drum in the sensor unit. On the end of the drum an encoder disc is mounted. The unit reads this as the wire unwinds or winds up on the drum under the influence of slide movements. The direction of the movements is coded positive or negative.

Another type uses a pair of gratings to measure movement. The former is usually easier to fit.

Lathes normally have two axes: X (across the bed) and Y (along the bed). Milling machines have an extra axis: Z (vertically).

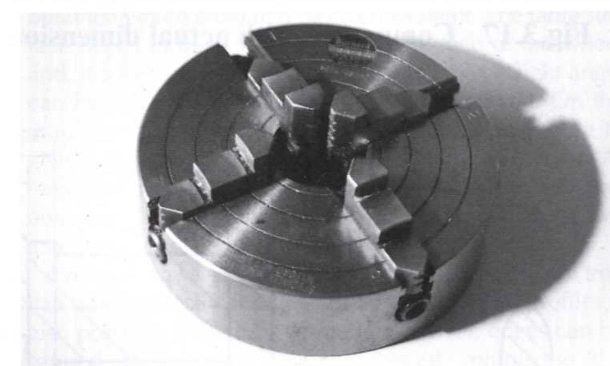


Fig. 3.15 Four jaw chuck

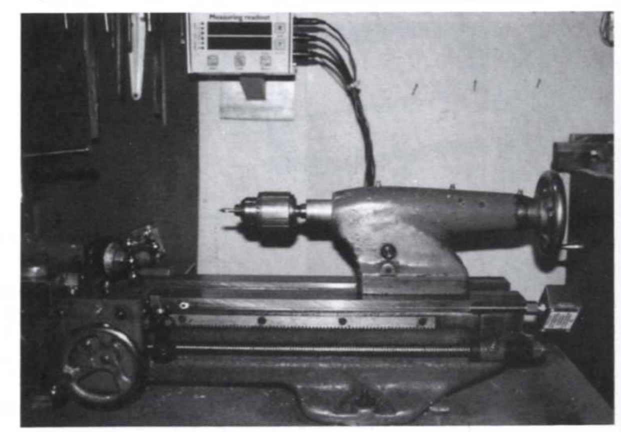


Fig. 3.16 Digital readout on Myford lathe

By actually measuring slide movement and not lead screw revolutions, back-lash (i.e. lost motion) is eliminated. When using the machine's indexing dials to measure movement you are bedevilled by back-lash problems, of course.

When turning a large number of identical pieces a chart, or drawing, can be prepared of the various readouts which enable the pieces to be turned without stopping the machine except to pull out more stock from the chuck (see **Fig.3.17**).

Milling Machines

Although flat surfaces can be produced on a lathe a milling machine does a better, more flexible job. A small vertical milling machine can be a great, but expensive, asset in the workshop. If you already possess a lathe it is sometimes possible to fit a drilling/milling attachment to it, which is a cheaper alternative.

There are kits available to build the Dore-Westbury vertical milling machine (**Fig.3.18** – see colour plates). All the difficult machining jobs have been done and assembly can be done using only a small lathe. However, this may be beyond the average ship modellers skill although I have seen engineering work of outstanding quality from mature people who have had no training or previous experience. A case of some people have IT and some have not! Perhaps the possession of a milling machine is one of those things to which you hitch your star.

Power Saws - Circular Saws.

Unless you are happy to buy pre-cut lumber strips from your local model shop you will need a circular saw or probably two saws: one for fine work and one for larger work. In the early days of Model Shipwright Dr. Rose described a very small circular saw that could be built by an amateur (see **Fig.3.19**). The writer built one and has used it ever since. This saw is ideal, nay essential, for cutting the small section timbers required in ship modelling. It uses high speed steel (HSS) metal cutting, slitting saws for sawing which, although producing a first class finish, are limited in their depth of cut due to low side clearance.

I will explain: when cutting wood, a kerf (groove) considerably wider than the saw blade thickness is required. This is necessary to stop the blade from binding in the cut. This is obtained by offsetting each alternate tooth to produce this wider kerf. With saws this is known as 'set'. When cutting metal the same principle applies but much less clearance is required; only a matter of a few thousandths of an inch, which is obtained by hollow grinding the side of the cutter so that the body of the cutter is thinner than the tooth. This avoids the necessity for setting the teeth. When cutting wood this very small amount of clearance limits the depth of cut. If the saw is forced, too much heat will be generated when the saw binds in the cut. The other secret of cutting small section timber is that the blade must be surrounded by wood or plastic leaving no gap down which the pieces being sawn can disappear. In

Fig.3.17 Component with actual dimensions

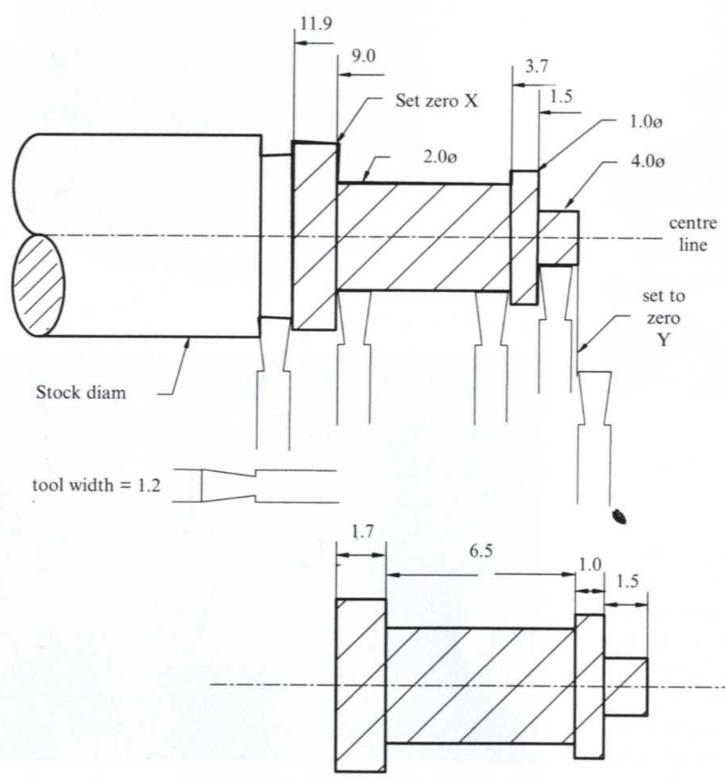
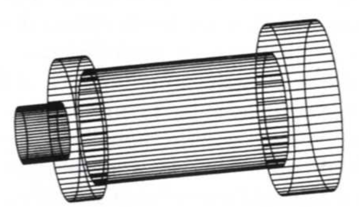


Chart of DRO for producing shaded component

Note: Lengths are calculated from the RH end of the component: either from a facing cut or previous part-off operation. This is zeroed on the Y (along the bed) axis. It will be noted that some movements are the addition of the component dimension plus the width of the tool (e.g. the 3.7 & 11.9)

Diameters (note unit is set to read diameters - not radii)

Zero is set on maximum component diameter on the X axis.



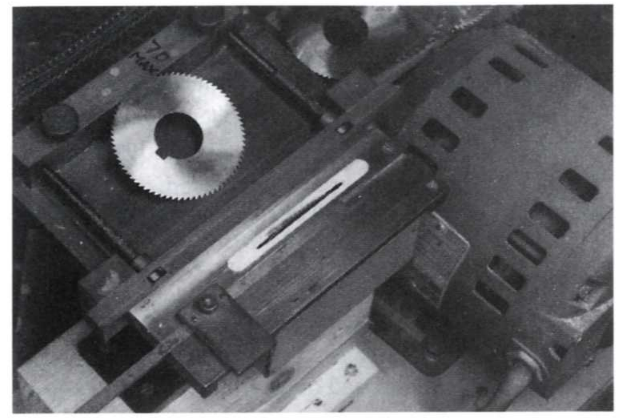


Fig. 3.19 Circular saw

the Rose saw a 2mm deep recess is machined around the saw slot into which a piece of 2mm plywood is fitted.

The saw blade is allowed to make its own slot in this eliminating all gaps. If a commercial saw is bought check this feature. If there is a large gap around the saw blade you will have difficulty in cutting very small section material.

If large section lumber is to be cut, involving deeper cuts, a woodcutting saw, with set teeth, can be mounted. In which case the plywood "seal" can be dispensed with. This type of saw blade is more efficient in cutting wood but it produces an inferior finish compared with metal slitting saws.

Some commercial saw benches have swivelling tables which allow angled cuts to be performed. Whether this facility is desired you must decide; it certainly complicates the gap around the blade problem. Normally the finish obtained when using metal cutting slitting saws is good enough to render any further sanding superfluous. However, wood cut with wood cutting saws will usually require sanding or finishing in some way. A larger circular saw bench can be an asset if your work necessitates cutting larger pieces of lumber.

Band Saws

A band saw of the three pulley type is almost a necessity and will save much work in cutting out lifts and the like (**Fig.3.20** – see colour plates). Band saws will also cut thermoplastic materials such as acrylic sheet (Perspex) and the like where some types of power saw will not. Cutting such plastics which melt when heated can be difficult as, if the saw blade heats up, the plastic will melt and weld up again after the blade has passed. Wood and thermosetting plastics such as Bakelite do not exhibit such characteristics, of course, as heat will not soften them. The length of the band saw blade of the bench mounted three wheel type of saw is about 70in which allows the blade to cool down before it encounters the work again. With vibro-type saws, using fret saw blades, this cooling down cannot occur as the same part of the blade is in contact with the work all the time. They are fine for wood and rigid, non-melting materials but no good for thermo-plastic plastics.

Sanders

Disc Sander. One of the most useful tools in any modeller's workshop is a disc sander: the larger the better. It is not impossible to build one. All you need is a motor to drive the disc and a lay or table to support the work and to present it to the disc squarely. The table can be made of wood, Perspex or metal. The latter is preferable as it affords maximum rigidity which is important. **Fig.3.21** shows the sander built by the writer.

The metal discs on which the abrasive paper/cloth is fixed can be bought but you will need an adapter to fit these to the motor. The abrasive discs used to be glued to the metal but now Velcro or self-adhesive discs can be obtained which are much more convenient. The table surface needs to be at right angles to the face of the wheel and, if a right-angled lay is fitted to the table, a right angle can be achieved in the horizontal plane as well. On the machine illustrated in **Fig.3.21** the table is reversible to give a plain surface for 'freehand' sanding of curves. At least two metal discs are required for coarse and fine abrasives. Experience has shown that only those two grades do most of the work required.

With such a set-up machining faces square, flat and true can be done easily and quickly. Sanding around profiles is also possible. If the table is made to swivel, edges can be sanded at an angle but this would complicate the mechanism considerably.

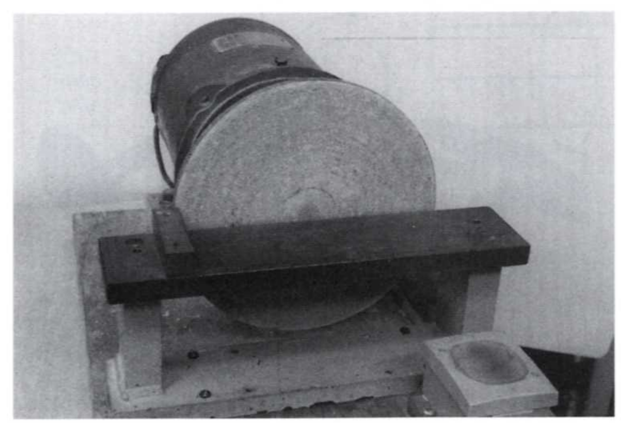


Fig. 3.21 Disc sander

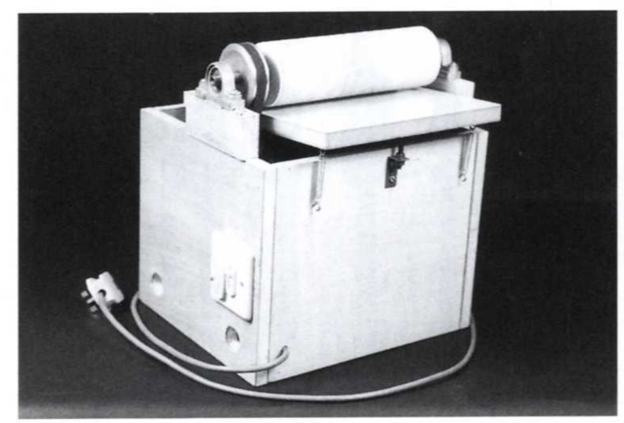


Fig. 3.22 Drum sander

Fig. 3.23A Minicraft low voltage hand held drills

Another use of the sander is for machining 45°(mitres for glass cases, stands and the like. (**Fig.12.11**). If a fixed or temporary 45°(lay is fixed to the table, very geometrically accurate mitres can be achieved. An added bonus is that the surfaces are sanded making ideal gluing conditions. Sanded surfaces are more porous thus allowing glue penetration. If the sander is used in this way the mitres are first sawn, either freehand or using a mitre block, with the sander being used to finish to size and angle.

Analogous to disc sanders are belt linishers which are mainly designed for metal work. For the uninitiated these use an arrangement of pulleys running an abrasive endless belt but they have two disadvantages. They usually have only a relatively narrow belt which has a lapped joint which is not so convenient as the uninterrupted face of the disc sander. The linisher can be arranged to have the working face of the belt either vertically or horizontally.

Drum sanders can be obtained or built. Essentially these are a power driven cylinder covered with abrasive paper or cloth running over a flat bed. The clearance between bed and cylinder can be adjusted. The work is fed through this gap, the cylinder revolves against the work, of course, otherwise it would pull the work into the gap. These work fairly well but produce an enormous amount of wood dust and, for this reason, are not recommended for the home workshop where normally dust extraction is not catered for! (see **Fig.3.22**)

Miniature Tools

A range of small power tools sold under the names of Minicraft, Proxon or Bohler is currently on the market. This series includes several low voltage electric drills, sanders, saws etc. together with stands, mounts and attachments.

If these tools are used within their capacity they are ideal for the ship modeller. To drive some tools transformer control units are necessary. With the Minicraft range two units are available: one is a single outlet, the other is a variable speed control box with three outlets (**Fig.3.23** – see colour plates). This enables the modeller to steplessly control the speed of the drill, or whatever, from just turning over to maximum speed. The torque at low speed is still considerable. Some machines in the range are self-powered.

Miniature tools of this nature are often rubbish but the above mentioned types are of the highest quality. A small drill with a set of collets for very small drill bits and a larger keyless chuck equipped drill for drill bits, say over 1mm, is ideal. With very small drill bits it is important to use a lightweight drill. Small drill bits in heavy drills usually have a very limited life owing to the inadvertent side loads imposed on them by the weight of the drill. (**Fig.3.23A**)

A set, or sets, of dental type burrs are also essential (**Fig.3.24**). Their shapes and sizes are infinite. They are ideal for some types of work, i.e. carving and cleaning up. They are mainly used in hand held drills and their use needs some practice as because of their rotation they have a habit of "walking" off the surface or edge being machined. As this can end up machining where no machining is required care must be taken. Increasing the speed tends to prevent this phenomenon. As well as tool steel burrs, small grinding burr-like stones are available, especially useful if hard materials are encountered. Thin abrasive cutting discs as well as small very thin circular saws can also be used when mounted on special mandrels (see Fig.3.25). abrasive discs are very useful for cutting thin tubes; any other method usually results in the tube becoming squashed and ruined.

So much for tools.

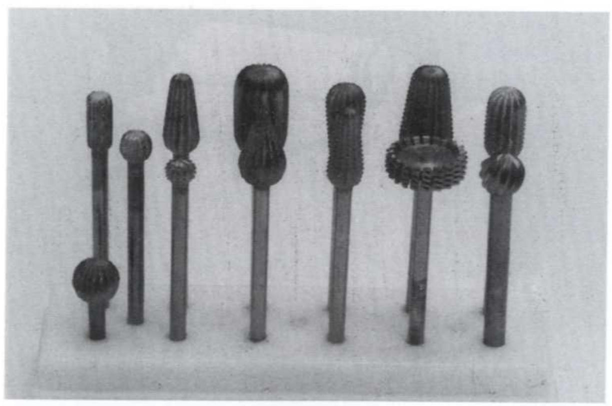


Fig. 3.24 Selection of large rotary burrs

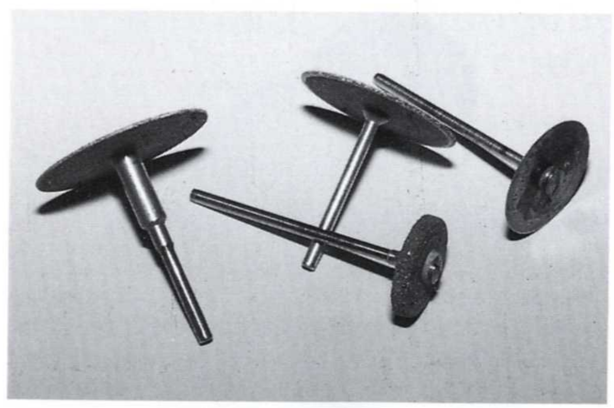


Fig. 3.25 Mandrels with abrasive discs and saws

Marking Out

The secret of good work is accuracy and the secret of accuracy starts with marking out. With some materials pencil can be used but for metals or plastics scribed lines are used. Normally a scribed line does not show very well on metal and the surface needs to be coated with lacquer of some type to allow the lines to show. For small jobs an easier way is to use a felt tipped pen and scribe drawing lines on the coloured surface. The ink can be easily removed with methylated spirit afterwards.

Special blue lacquer is sold for marking-out purposes but care should be taken as engineers use two sorts of engineers blue. One has just been described. The other is used for producing witness marks on metal surfaces when fitting parts together; it is the first kind you need for marking out. Remember you can only work to one line. Do not try and attempt high-class work with poor marking out: more than one line, indistinct marking, etc.

SOLDERING

Soft soldering

This jointing technique uses relatively low temperature tin/lead alloys to join metal parts together. Various alloys are used but the most useful is the sixty/forty electrical type (60% tin/40% lead) with or without resin cores. As this is a book for advanced modellers it is presumed that normal soldering techniques have been mastered.

However, a few points need to be stressed. The basic requirements are:

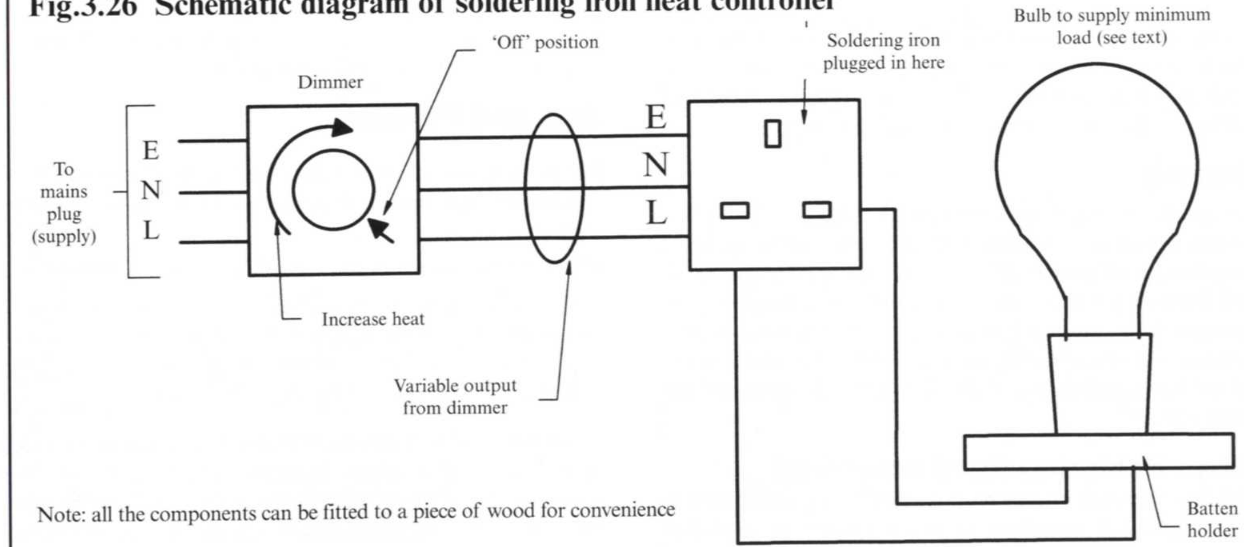
1. Clean the surfaces
2. Enough heat (at least two soldering irons are required - 15 watts for light work; 75watts for heavy stuff)
3. Correct flux. Flux can be of two types: active and passive. Active fluxes such as Baker's Fluid and zinc chloride (also known as "killed spirits") actively attack the oxide film but are corrosive and need to be removed as soon as possible after soldering to prevent further unwanted chemical activity. Therefore restrict their use unless necessary. The passive fluxes, such as resin, can only do their job if removal of the oxide film is easy; on brass and copper for instance. But they are safer for the model maker. However, a touch of Baker's Fluid can work wonders at times and should not be espoused but do clean off afterwards. Baker's Fluid does make solder run extremely well.

The other point to remember is that conveying cored solder on the iron to the job usually results in the flux boiling away giving a poor joint. The so-called 'dry joint' syndrome. So far we have discussed using solid solder but, in a large number of cases, it is probably best not to use solder but to use solder paint or cream instead. With solder in this form very accurate application and amounts can be judged before any heat is applied. The other problem with complicated build-ups is preventing those parts already soldered from falling off when adding further pieces. Modern warships latticed masts packed with radar, etc. are a case in point.

Planning is the key to success plus the cunning use of heat sinks. Heat sinks are relatively heavy metal parts strategically placed to absorb the heat which would otherwise run along members and melt off previously attached bits.

If at all possible try and arrange a mechanical fixing before attempting to solder. However, this is far from always possible. The sequence is to solder the larger parts together first, as their heat requirement will be the greatest. It may then be possible to fix further components, applying the hot iron for as short a time as possible. If the previous soldering is watched it is possible to see the line of melting advancing across the solder and to stop in time. Otherwise put a heat sink, a Bulldog clip or whatever, in the way to absorb the heat. Burying parts into the surface

Fig.3.26 Schematic diagram of soldering iron heat controller



of a raw potato also works well. Not only does the potato remove the heat but also supports the assembly. It needs to be cleaned off afterwards, of course - chips with everything but not with radar aerials!

Supporting parts with adhesive tape, the previously described 'Helping Hands', wire (particularly aluminium wire which will not solder) are all possible.

With etched parts tags can be added at the design stage to ease assembly which can be cut off afterwards if not required. It should also be remembered that not all parts need to be soldered as bits can be added afterwards using epoxy or cyanoacrylate adhesives.

One of the problems with using an electric soldering iron is that they tend to over-heat and destroy the tinning on the tip. This excess of heat is required to heat up the work, of course, but if the iron is kept in its stand for any length of time the tinning will turn yellow and be destroyed. You can buy expensive heat controllers thermostatically operated or you can build one yourself:

Buy a simple light dimmer switch, a three-pin socket, and a batten light bulb holder from the local purveyor of such trifles. You will also need plastic surface mounting boxes to house the dimmer and socket and probably a piece of wood as a base. Wire up as shown in **Fig.3.26**. The socket is wired across the variable output of the dimmer together with the batten holder (both in parallel) and the soldering iron plugged into the socket. Now you have heat control of the iron. You will find that to protect the tip, the dimmer will have to be turned down about 20° to 30° (from maximum), by movement of the knob controlling the dimmer - mark this point. The batten holder in parallel with the iron is there to protect the dimmer as they usually have a maximum and minimum load rating. When using a small wattage iron insert, say a 40watt bulb into the batten holder to get the total load within the dimmer's rating. You also reap the benefit of a bit more light on the scene. Using this controller will stop overheating and it can be turned down when the iron is not going to be wanted for some time. If you are not happy with electrics please find someone who is, to do the wiring for you.

The only real problem with soft soldering is the low tensile strength of the joint. Soft solder is only about one ninth as strong as mild steel (ultimate tensile strength of solder is 3 tons/sq in, mild steel is 27 tons/sq in).

Brazing

For greater strength brazing can be adopted. The alloy used is about 50% copper and 50% zinc, and requires a temperature of about 875°C which requires a gas torch and borax-type flux. This will produce a tougher and stronger joint on most ferrous and non-ferrous metals (ferrous = of or containing iron) so long as the metal being joined has a melting point above 900°C otherwise the job will melt!

Silver Soldering (hard soldering)

This lies somewhere between soft soldering and brazing, strengthwise. A selection of silver solders is available having a range of melting points from about 800°C down to 630°C. In theory, if a number of joints on a job is required, the highest temperature type could be used first followed by the lower melting point solders for subsequent joints. A torch will be needed capable of reaching the temperature required and for light work the normal hand held propane canister type works quite well. However, for large jobs such as boiler soldering much larger equipment will be required. Special borax fluxes are also required. These are usually supplied as powders which have to be mixed with water to a smooth paste before being applied to the joint before heating. Joints for silver soldering need to be close fitting as the solder runs by capillary attraction on melting. Usually the main problem in executing the joint is holding the parts in correct relationship. Refractory blocks are available which are soft enough to allow pins to be used for supporting parts, etc. Asbestos used to be used but this is now considered too dangerous. Needless to say all care must be taken to prevent a fire when using torches. Before lighting up remove all combustibles from the area.

The flux changes to a glass like substance and can be chipped off but alternatively pickling solutions are available. Both brazing and silver soldering give much stronger joints than soft soldering but have one great disadvantage. Most metal sheet and wire are produced by cold rolling or drawing processes which harden the metal and make it stronger. This in turn imparts springiness. This improved strength is often desired in modelling but if this work hardened material is bent it may crack and, on bending, will spring back somewhat which can be a nuisance. To prevent this these materials can be annealed, that is heated to a temperature at which the disturbed material (structure disturbed by cold working) reverts to a more stable condition. For brass this temperature is about 650°C. It can be seen that brazing and silver soldering need a temperature above the annealing temperature so the joint may be stronger but the job overall will be weaker. You pays your money and you takes your choice.

For non-working models the writer prefers soft soldering which is easier to do and retains the strength of un-annealed materials. You can also 'fillet' soft soldered joints, which is not really possible with silver soldering. It is also easier to dismantle if necessary.

Jigs and Fixtures

Jig: A mechanical device designed to hold and locate a component during machining and to guide the cutting tool.

Fixture: A device to secure a workpiece in a machine tool.

The main difference is that a jig guides the tool as well as holding the work, whereas the fixture only holds the work. In practice the two names do get confused and we talk of jigs when really they are only fixtures.

However, there is no doubt that both have uses in model work particularly where quantity and/or accuracy are required. Time spent on their manufacture is often well spent, both in time taken to actually do the job and in the accuracy of its execution.

Fig. 3.27 A simple jig

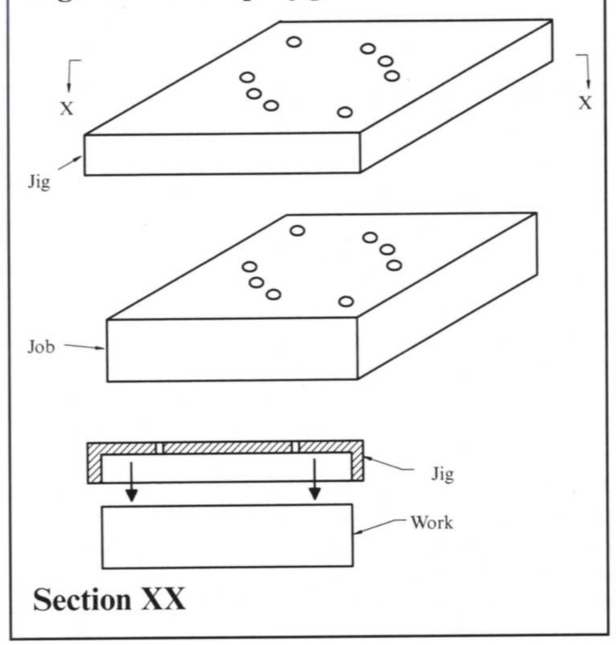
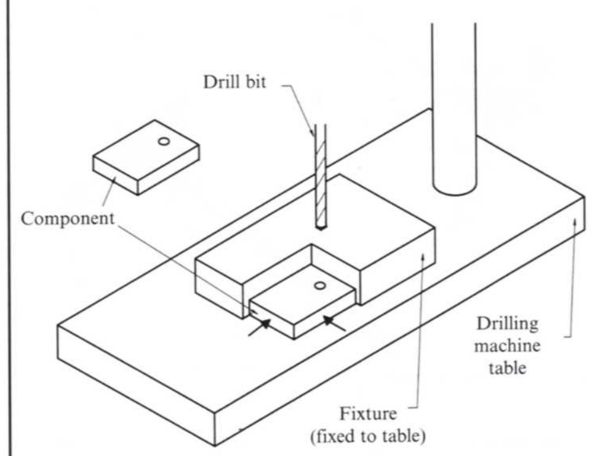


Fig. 3.28 A Simple Fixture



An example: **Fig.3.27** shows a typical problem. A number of holes are required in a plate. If twenty of these are required the time taken to mark out each piece and drill will be long. If a simple jig is made as shown; a flat plate folded to embrace the work and carefully marked out and drilled, the time taken to drill twenty plates is reduced to a minimum. It should be noted that the jig can be carefully checked before use and rejected if it is not accurate enough. Note that it holds the work and guides the tool hence it is a jig. All the jig and tool designers amongst you will be throwing up their arms in disgust murmuring about redundant locations, hole wear, etc. but it were ever thus. We are talking about simple aids to production.

Fig.3.28 shows a very simple fixture for drilling a hole in the correct position in a block. The 'L' shaped fixture is clamped, or fixed in some way, to the table of the drilling machine to ensure that the drill is positioned correctly. The component fits into the 'nest' and is held in position with the thumb of the left hand, the right operating the drill head. The component could be clamped into the fixture of course and this may be necessary for heavy work but normally hand pressure is adequate.

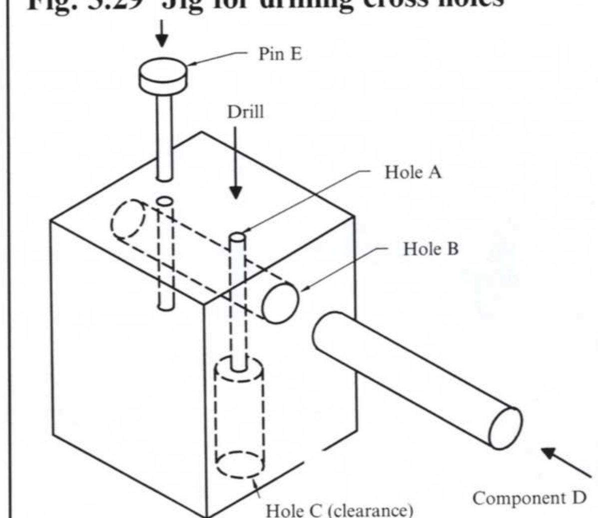
Fixtures can also be made up for gluing parts together. Miniature aircraft usually require a fixture for attaching wings etc. For biplanes the fixture can be extended to cope with the top wings after fitting the lower wings. The scope for jigs and fixtures is endless. The limitation is usually your own imagination and/or your laziness!

Another way that a simple jig can help is in drilling transverse holes through rods. This is often required in ship modelling. Trying to set up a rod in a 'V' block on a drilling machine is time consuming and usually very frustrating. **Fig.3.29**. shows a simple jig.

This jig consists of two holes, hole A for the drill and hole B for the component. If the hole is required at a fixed distance from the end of component D the depth of hole B can be used as a stop. Otherwise it can be drilled right through the block. Hole C is merely to allow drill swarf to clear. If hole B is blind it will be necessary to clear the swarf every time. A further improvement would be to drill hole B right through, as shown, using a removable pin E as a stop if a stop is required.

This sort of jig is perhaps best made from brass, especially if the transverse hole is small, to avoid breaking the drill in a steel block. Very careful marking out and drilling is required but before use it can be checked for accuracy and, if found wanting, two further holes can be drilled etc. As it supports the drill right up to the work surface accuracy will be assured and broken drills are unlikely. With this type of jig make sure the drill is sharp and either regrind or discard if necessary. A broken drill will ruin both work and jig.

Fig. 3.29 Jig for drilling cross holes



Propellers

On my latest models I have used propellers made by the lost wax process. (This casting process has a history lost in the mists of antiquity - it goes back a long way! The object to be cast is first made in wax together with gates and any vents required. This assembly is then invested with clay and fired. The firing sets the investment and melts out the wax. This leaves a hole the shape of the object to be cast. Molten metal is then forced into this space usually by centrifugal force). This gives a propeller with the blades cast integral with the boss - a proper propeller. These have been cast by Simon Higgins of Prop Shop but previously I have used built up props made by inserting and soldering brass blades into a turned brass hub. **Fig.3.30** shows the fixture that I built to make either three or four bladed propellers of this type. As can be seen the blades are held in the correct position relative to the boss both in pitch and position ready for either soft or hard soldering.

Fig.3.31 shows the final buffing process using a mop, polishing compound and a hand-held low-voltage drill. **Fig.3.32** shows the final result.

Fig.3.33 – see colour plates. This is a cast propeller which has had its boss shape changed which was necessary for my model of Belfast. The propellers, as cast, had the wrong shaped exit boss. This was machined off in a lathe using a slot drill. This exposed the bore which was used to locate the new exit cone. The whole thing was then lacquered to prevent discoloration.

Cutting thin sheet metal

When using thin sheet metal one perpetual problem is cutting of strips without distortion. They usually end up like barley sugar twists. One way is to use a vice and a cold chisel (see **Fig.3.34**). The latter needs to be sharp and the vice jaws fitting closely together with their top surfaces level. The method is to mark off the cutting line accurately and place the strip to be cut into the vice jaws with the cutting line just level with the top surface of the jaws. The cold chisel is placed on the vice jaws at an angle to the sheet both vertically and horizontally. The chisel is moved from right to left whilst being hammered. The angles to hold the chisel are formed by experiment quite easily. If the job is done correctly the piece wanted will be undistorted because of the support of the vice jaws and, with care coming from experience, the stock above the vice jaws will be only slightly distorted. This should be easy to correct and the operation repeated.

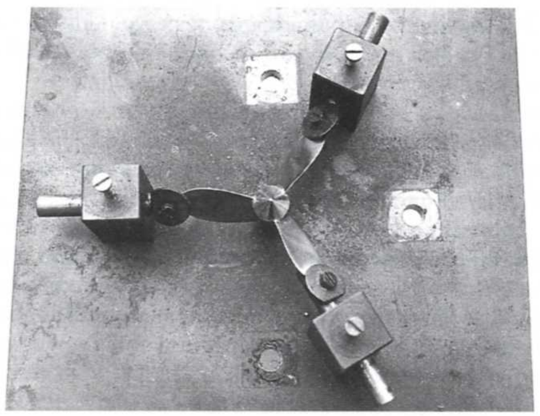


Fig. 3.30 Fixture for building propellers

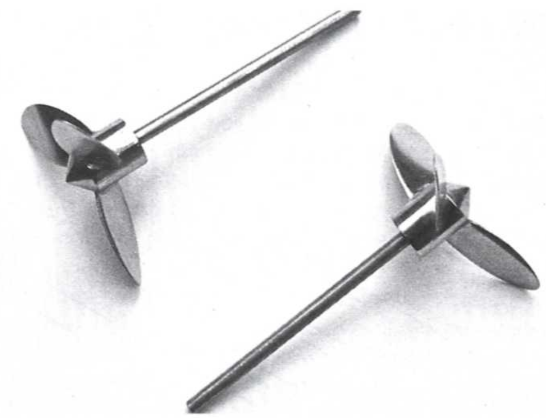


Fig. 3.32 Finished propeller

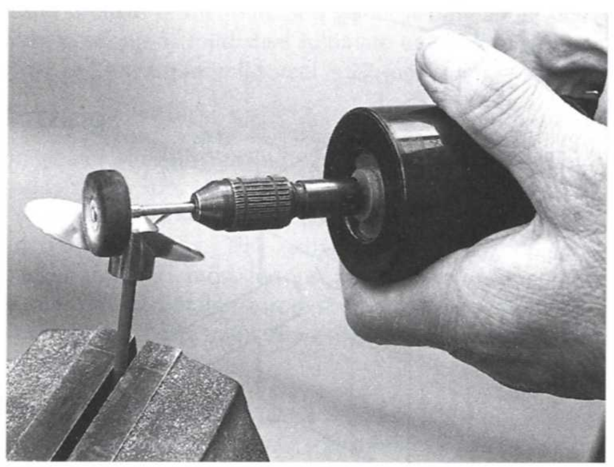
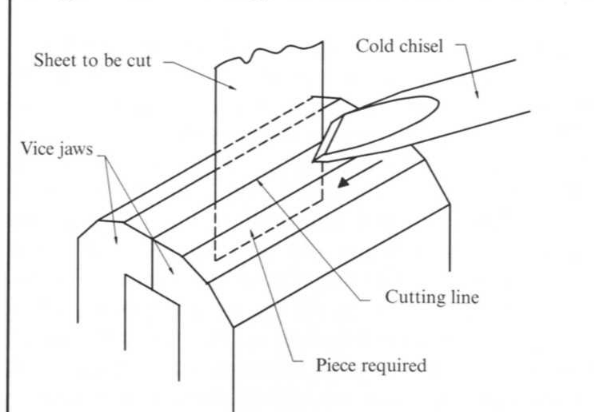


Fig. 3.31 Buffing up propeller blades

Fig. 3.34 Cutting thin metal sheet



Chapter Four

Materials

No. 4 . Keep tools clean and sharp

This chapter deals with materials likely to be used by the ship modelmaker with some added notes, a sort of *vade mecum* of the art.

Wood

Only those likely to be of use are described with their good and bad points noted. For further information a handy book on the subject is "What wood is that" (a manual of wood identification) by Herbert L. Edlin published by Stobart Davies. It also contains 40 actual wood specimens.

Apple (Malus sylvestris) A fruit wood which varies in colour from cream to deep brown. Like most fruitwoods it is useful in modelling as it has very close grain but is hard to work.

Balsa (Ochroma pyramidale) Known to all modelmakers particularly the aircraft types, as it is so lightweight. Although it is classed as a hard wood (botanically) it has no place in high-grade ship modelling owing to its softness. It is useful for packing and mock-up ship parts but little else.

Basswood (Tilia americana) This is the American equivalent of our Lime. It is very white in colour and can be obtained in clean, accurately cut sheets in this country. It tends to 'whisker' when cut but can be stabilised with sanding sealer. (The deck of my Anson was laid using 1/32" Basswood sheets).

Beech (Fagus sylvatica) Often used in furniture made for kitchens and schools. It is easily identified by the brown fleck in the grain. It is really too hard for modelmaking.

Boxwood (Buxus sempervirens) A yellow coloured, hard and dense wood in which is difficult to see the grain. It is very suitable for small details and turns well. Several timbers go under the name of Boxwood and have similar characteristics. It is the classic timber for Admiralty Board type models.

Cedar (Cedrus atlantica, C. deodar, C. libani) Unfortunately there is a number of related woods called Cedars. Cedar of Lebanon has a pleasant smell and appearance, being creamy yellow with a close grain. It carves very easily. (The fuselages of the aircraft on my carrier Glorious were carved from cedar being off-cuts of the case I made for Queen Elizabeth).

Hazel Pine (Liquidambar styraciflua) Often referred to in American magazines, Hazel pine is the white, silky sapwood of the American Red Gum. The reddish-brown heartwood is known as Satin Walnut. Both timbers work well although they are uninteresting to look at.

Holly (Ilex aquifolium) White in colour (the colour of scrubbed decks?) but very hard to work. It is ideal for small items and could be used instead of Box.

Jelutong (Dyera costulata) Visually a very uninteresting white to straw-coloured wood obtainable in large knot-free pieces. It machines and carves well and is now the preferred wood for hulls. It has replaced American Yellow Pine as the timber used by casting pattern makers. It has two disadvantages - it has open grain, which requires filling, and it exhibits resin ducts. These are slots about 13mm x 3mm containing dried up resin. They are easily cleaned out and filled with polyester filler or other wood filler and cause no trouble. With planning they can often be left in the waste anyway. This tree is a relative of the rubber tree - hence the ducts.

Lime (Tilea vulgaris) A pale timber which carves well hence its use by Grinling Gibbons and his like. It is an ideal timber for most, if not all, aspects of ship modelling but is harder to work than Jelutong and is probably more expensive.

Mahogany (Swietenia macrophylla) This is only one of the mahoganies and related timbers now being used. Its strong red colour and, in some species, very open grain does not suit it for all modelling purposes. The use of coarse-grained timbers in modelmaking is probably a mistake as the grain pits are too obvious. It is probably best to use a close grained timber and colour it instead.

Obechi (Triplochiton scleroxylon) Not a very satisfactory straw coloured timber which is brittle when cut. Often used for commercial mouldings.

Pear (Pyrus communis) Beloved of the 'stick and string' brigade and used on boats that are not painted as its colour looks like mahogany without the overscale grain pits.

Pine A large number of timbers are called pine. For the modeller clean pieces of white soft wood are useful but knots are frequent in most pieces. The Rolls Royce of pines is American (Western) Yellow Pine (Pinus ponderosa) which is the wood used formerly by casting pattern makers. It is now very expensive and very difficult to get hold of. If you can lay your hands on it you will find it the perfect timber for model work. (When the writer started pattern making training at the start of WW2 it was still being used. I can still remember what a beautiful timber it was and, unlike Jelutong, it has no open grain pits).

Sycamore (Acer pseudoplatanus) One of the Maples, it is very pale in colour, hard and close grained. If cut in a certain way the grain exhibits a watered silk effect. Although not easy to work (less hard than Holly) it makes fine deck planking.

Walnut (Juglans regia) For some reason beloved of continental kit manufacturers. It is a dark brown coarse-grained timber which is not all that suitable for high-class model work.

Lancewood (Guatteria virgata) Excellent timber for making masts and spars.

Degame As Lancewood but neither of these two timbers is likely to be available. They are included here in case you ever come across them. Degame is a wonderful material for masts and spars. I bought some years ago and all my wood masts and spars have subsequently been made from it.

Plywood Normally only used in the thinner varieties which are of the highest quality (WPB grade) usually glued with resorcinol resin glue which is waterproof and produces a dark red stained glue line.

METALS

Unless the strength of steel is necessary all ferrous (iron or iron containing) metals except stainless steel are probably best left off model ships owing to rusting problems.

Brass, aluminium and aluminium alloys are the most often used materials and are relatively easy to obtain. Visits to exhibitions are useful to top up supplies. The model press has advertisements for firms willing to supply the relatively small amounts of materials required by modelmakers.

Brass Being an alloy of zinc and copper, should give no real machining problems. However, the proportions of zinc and copper vary the properties enormously. Cartridge brass, an alloy of 70% copper and 30% zinc is very strong and ductile, and bends and draws easily hence its use for cartridge cases. At the other end Muntz metal is 60% copper and 40% zinc and does not bend well but is easily machined. The normal sheet brass you buy is known as Basis brass (about 63% copper and 37% zinc) and its properties are not guaranteed.

If it is brass it should machine with a discontinuous chip i.e. the chip breaks up. If the chip comes off as a continuous spiral like mild steel you are probably machining Sifbronze welding/brazing rod. Lengths of Sifbronze rod/wire are very useful for turning small parts.

Aluminium May give machining problems, as pure aluminium is almost impossible to machine as it builds up on the tool. Always check that any aluminium or aluminium alloy you buy is of 'machining quality' to avoid this problem.

Sheet metals, brass and aluminium may be sold in various tempers or hardness. This is a function of the rolling or drawing process that reduced them to their final dimension. If left very hard you may have trouble in bending them without cracking or, possibly, even breaking them. This can be overcome by annealing but this process is not easy to do at home, particularly with thin sheet without severe distortion taking place.

Stainless steel Is useful for propeller shafts and the like. As long as it is stainless its composition is not of much interest. But, for those interested, the 'standard' stainless steel is known as 18/8 (containing 18% chrome and 8% nickel) which is an 'austenitic alloy' which polishes well and resists corrosion by most relatively corrosive, organic and inorganic reagents. In plain language it means it don't stain! Most stainless steels are non-magnetic which is a useful test.

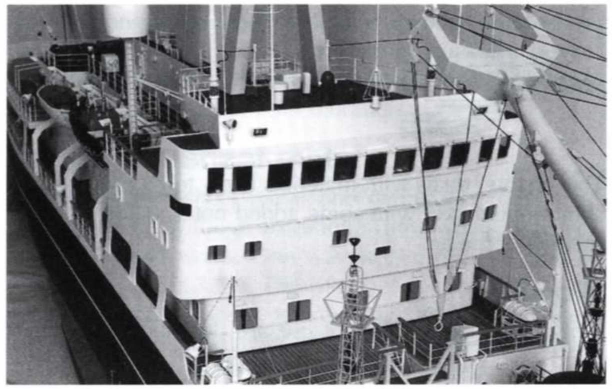


Fig. 4.2 Jimmy Wood - T.H.V. Patricia

Fig. 4.7 Jimmy Wood - M.V. Gueestbay

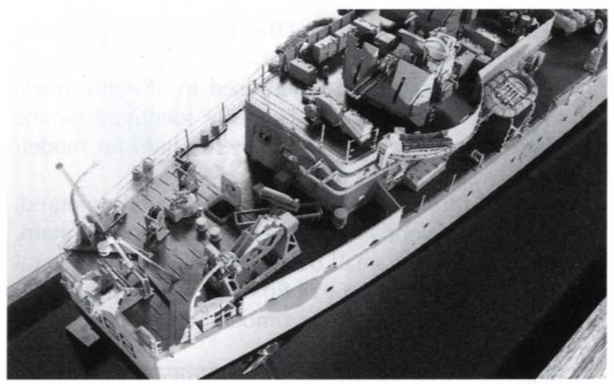


Fig. 4.10 Alex MacFadyen - Barrosa

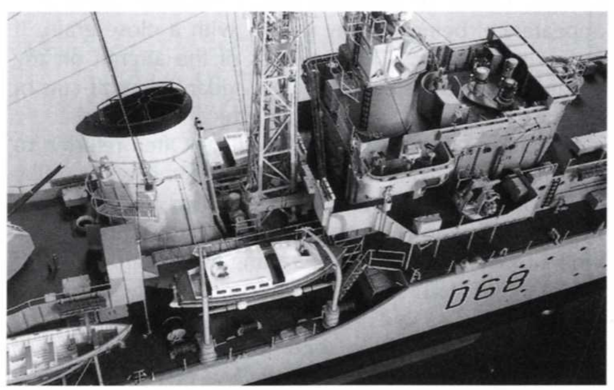


Fig. 4.11 Alex MacFadyen - Barrosa

Bending materials

It is important, especially when folding or bending materials, to recognise that the material has a grain and to use this to help. Let me explain further: all materials that are produced by some sort of rolling or drawing process possess 'grain'. Unlike wood, where the grain is usually pretty obvious, paper, cardboard, sheet metals, etc. have a grain but this is not obvious. To demonstrate this take a cereal box and cut from it a six inch square of material parallel to one edge and hold it between the palms and force the hands together. The card will buckle one way easier than when using the other two sides. The grain will lie parallel to the hands on the easier way. If possible always bend parallel to this direction because the grain then helps the fold. Just to impress this idea on your mind fold your square both ways - one way a neat fold and the other it tends to cockle and crack. A further illustration of this phenomenon is the sheet of paper from which you are reading. The grain runs from top to bottom as it does in all book pages. This enables the sheet to lie and turn properly.

The above is one use for cereal box cardboard but this is a most useful free material which can be used for all sorts of jobs in the workshop e.g. making templates, tryouts, etc. which can save a lot of expensive material.

PLASTICS

Since WW2 these have taken an ever-increasing place in model making as in most other fields.

ABS (Acrylonitrile butadiene styrene) has been the adopted plastic for vacuum formed hulls although GRP (glass reinforced plastic) probably makes a better job. This aspect will be dealt with in a separate chapter.

Acrylic (Methyl methacrylate) is another plastic with a slightly longer history. In fabricated form, sheet or as extrusions largely supplied by ICI it is known as Perspex. This is a nigh perfect material for high-class models. It machines well, takes paint well and is stable. It usually requires no support unlike styrene sheet. If the clear, transparent type is used portholes can be machined into the surface using a slot drill (a milling cutter producing a flat-bottomed hole). If these are masked during spraying perfect ports are the result with very little effort.

Phenol and Urea formaldehyde These are marketed under the names of Bakelite, Tufnol, etc. They are basically sheets of paper or cloth impregnated with the above chemicals and are very strong. They can be obtained in sheets, rods or tubes. They are useful but, being non-homogenous, can give trouble when machining.

PVC (polyvinyl chloride). PVC sleeving, as found on most electrical wiring, is often very useful for making small parts. Very thin slices can be used to simulate rigging blocks. Although soft and flexible, when painted this does not matter.

Sometimes lengths of plastic pipes can be used for such items as Victorian gun turrets. If adhesives are required they must be those made for the materials used as knowing what kind of plastic they are made from is not always obvious.

ADHESIVES

When the writer first entered a woodworking shop, apart from the perfume of wood, the smell that assaulted the nostrils was from the double-skinned glue pot simmering away in the corner. It contained hot fish or animal glue which was the main wood glue available then. It had a 'cold' partner (Seccotine) and a semi-waterproof glue made from curdled milk, casein (Casco) and that was about it. Not much chance of sticking ones fingers together permanently. Really no fun at all!

Today we have an arsenal of adhesives mostly based on synthetic resins.

Fig. 4.12 54' Arun lifeboat

Fig. 4.13 Rother class lifeboat

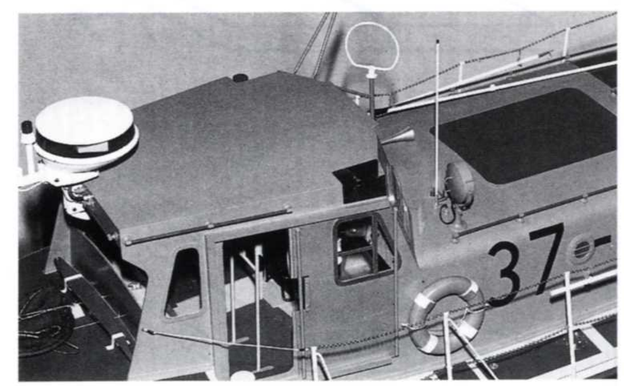


Fig. 4.14 Cabin of Rother lifeboat

As this is a book on advanced model making we should look behind the adhesives to the actual mechanism of attaching one bit to another. Adhesives join by one of two processes:

1. Mechanical adhesion. This occurs if the adhesive can penetrate the pores of the surfaces to be bonded and form a key.

2. Specific adhesion. This is different as, in this case, the adhesive reacts chemically with the surfaces and bonds through intermolecular attraction.

Mechanical adhesion fails if the surfaces are impervious to the adhesive, glass for instance, whereas specific adhesion works if the adhesive is capable of bonding specifically to that substance, even if no mechanical key exists. This is why gluing glass used to be so difficult - too smooth for mechanical adhesion and there were no specific glues available.

Even if specific adhesion is the main process in the jointing, roughing up the surfaces will add a proportion of mechanical help to the total strength. Needless to say, the surfaces to be joined must be dry and oil and dust free for either method to work properly.

Solvent glues

These supply another method of jointing but, in this case, a process of 'welding' takes place as the solvent melts the two surfaces. A typical example of this process is the use of MEK (methyl ethyl ketone) to assemble polystyrene aircraft kits and the like. Polystyrene cement is also sold for this job. Most cements consist of a solvent with some of the base material dissolved in it i.e. polystyrene cement is MEK (or possibly some other solvent) containing some polystyrene to give it body. However, its use is deprecated as any exudate will ruin the surfaces and detail will probably be lost.

The best way to fix two pieces of polystyrene together is to hold them touching in the correct position and quickly brush the joint with MEK. This will run into the joint by capillary attraction and weld the pieces together. Any MEK left on the surface will flash off without damaging the surfaces. Hence the word quickly. The brush must not remain on the surface long enough for the base material to melt. Cements do have gap filling properties whereas solvents do not, of course.

Trapped solvent

There is one danger when using solvents and that is entrapment. If two pieces of polycard, say 1.5 in square, are joined by brushing the flat surfaces with MEK and clapping them together entrapment will occur. The solvent around the edges will flash off but that in the centre will not. After some time the centre will go soft. This is a real problem with solvents and must be avoided.

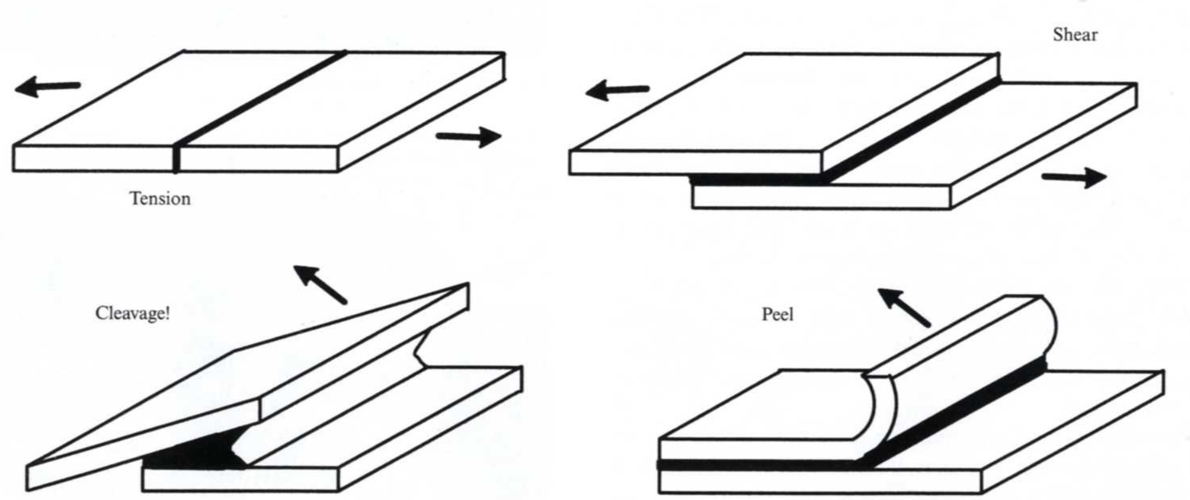
Joint Design

However the parts are joined the final strength depends on the design of the joint.
Four types of joints are shown in **Fig.4.1**. Most adhesives are good in tension and sheer but weak in cleavage and peel. If possible this should be remembered if there is any choice in the matter. Make sure as large an area as possible is provided for the adhesive.

Although there are many glues from many manufacturers available, it is best to use only a few, but get to know what they can do rather than experiment: for example this choice may be enough to virtually meet all your needs.

Epoxys - 1. Standard - where fast setting is not important.
2. Fast - where fast setting is important
Cyanos - 3. Thin - for 'wicking' applications i.e. using capillary attraction to get glue in.
4. Thick - for gap filling
PVA - 5. General wood jobs
MEK - 6. For styrene work although Cyano. could be used instead.

Fig.4.1 Four types of glued joints



For those interested a few notes on some of the adhesives available are now given. They are all based on synthetic resins.

Polyvinyl acetate (PVA) This is the familiar white creamy glue such as 'Evostick Resin W'. It is excellent for porous substances e.g. wood, fabric, paper. It produces a slightly flexible, shock-absorbing joint but has no gap filling properties. Because it does not go off hard like urea formaldehyde glue (see later) it causes no sanding problems. Wipe off any exudate with a damp cloth and avoid contact with steel/iron as this will stain the wood black. Setting and grab times used to be long but later glues are faster.

Urea formaldehyde (Aerolite, Cascamite) These produce a hard glue line which may crack under shock loading conditions. They consist of two parts - a resin and a hardener. The hardener may be a liquid (Aerolite) or a powder (Cascamite). Aerolite resin is in the form of a powder to be mixed with water and applied to the one surface and the hardener to the other. Cascamite is presented as a single powder which contains both resin and hardener activated by mixing with water. These glues are gap filling.

Epoxy and Polyurethane Two pack glues, the best known is probably Araldite (epoxy). Equal quantities are mixed together adequately to ensure complete curing. Araldite Rapid sets in minutes but Araldite Standard takes much longer. Heat speeds up the curing process. These glues are gap filling, waterproof and strong.

Cyanoacrylate (Super glues) These are the glues with the reputation of sticking flesh together at which they are super-efficient. Now they are made in several types from highly runny to an almost jelly like consistency which will gap fill at least slightly. They will glue almost any material almost instantly. It pays to keep the debonder handy in case of accidents.

The joints can be broken by boiling in water if the components are metal of course. The application of a hot soldering iron will also melt the joint seemingly without permanent damage. On removing the iron the glue rehardens. This can be useful if you wish to move something like a guard-rail stanchion just slightly.

It pays to remember that cyano's act by grabbing the water existent on/in most surfaces. This is contrary to most gluing practice where dryness is a prime necessity for a successful joint.

Chapter Five

Hulls

No. 5. Always keep your fingers <u>behind</u> the cutting edge.

Hulls are usually the first thing tackled when starting a model, even if it is to go out and buy one. Bought hulls are usually either vacuum formed ABS or glass reinforced plastic (GRP).

To make the former requires equipment not usually possessed by the average home model maker. To wit, a means of heating a large sheet of plastic and a vacuum pump to provide the necessary negative pressure to force the heated plastic into shape over a 'plug'. The plug is the shape of the boat. All in all, it's not a one-off operation and is probably best left to professionals making hulls for sale.

One-off GRP hulls can be made in a home workshop and these will be dealt with in the chapter on GRP work. GRP hulls have many advantages for the ship modeller and although, if only one hull is required, a great deal of what might be considered unnecessary work is involved in some cases it is worthwhile. However, GRP hulls might also be considered a production job best left to professionals.

Why some modellers prefer to buy a hull when they have the skill and facilities to build one is really beyond the writer. Hulls usually provide, for a given amount of time and effort, more return than any other aspect of ship modelling. The two main ways of hull construction left are carving and 'plank on frame'.

Carving

Carving from a solid block, without some help from machine tools, can be an exhausting task as a great deal of material has to be removed, particularly if the model is a working type requiring a hollow hull. Even static, glass case, models are best lightened by removing excess wood from their interiors. There are advantages in keeping any model as light as possible: ease of transport is one, supporting the model in its case is another. An alternative way to using a solid block is to use the 'bread and butter' method or, as the Americans call it, the 'lift' system. This consists of a number of planks or lifts glued together to form the block. With this method most of the excess material can be sawn away and the amount of carving is reduced. It is also much easier to remove the interior and this wood can be reused.

There is no reason why you cannot prepare the timber but it is usually easier to get the supplying sawmill to prepare the timber. They will need a cutting list to give the sizes and the numbers of the pieces required. Get the wood PAR (planed all round) but make sure they understand that the sizes you give them are *finished* sizes. Normally a piece 2in x 1in planed will end up as 1-7/8in x 7/8in, or even smaller, which will not be much use to you. It is also essential to emphasise that your specification, which says 15mm thick, means 15mm and not 14 or 16mm. The writer had a stack sent to him with all thicknesses 1mm too thin. Obviously the planer's scale was set wrongly. One millimetre does not seem a lot but on a stack of six lifts the accumulated error was 6mm, nearly a 1/4in! No way to start a model. All the water lines had to be re-adjusted.

One word of caution. Such preparation usually costs as much as the wood itself. The commonly used wood for hulls is the Malaysian timber Jelutong (Dyera costulata). A most uninteresting wood, virtually no knots, but it may show resin ducts. These are about 12mm long by 2mm wide with pieces of dried-up resin therein. These can be pulled out with forceps and filling in these ducts is no problem. Isopon is very effective. Other timbers can be used of course but most have some disadvantage: too hard, too many knots or wood faults, etc. For plugs, which do not end up as actual hulls, even pieces of knotty pine can be glued together and used. They will not produce a first-class job but probably will be good enough for a plug. Particularly if it is only for a one-off. **Fig. 5.1** shows the plug for the battleship Dreadnought roughed out. It can be seen that it is made up of odd pieces of pine.

Before describing how to carve hulls it is necessary to understand the lines drawings and what they are telling you. It pays to remember that somewhere in that block of wood, be it one piece or several glued together, lies the hull your soul lusts after. All you have to do is to find it! It is a shattering thought that when Michalangelo started on that great block of white marble that inside it was the form of his David. His challenge was to find it! Although it is usual to use the horizontal lifts there is no reason why vertical lifts cannot be used. In the first case the shapes of the lifts are called waterlines (see **Fig.5.2**), in the second, they are called buttock lines. For the sake of clarity buttock lines are not shown on this drawing but in essence, they are vertical sections lying parallel to the keel. At least one very well known model maker prefers to shape his hull using buttock lines, but it is more usual to use waterlines.

On the sheer drawing (side elevation) a series of horizontal lines indicate the position of the water lines.

Fig. 5.1 Dreadnought hull (roughed out plug)

(see **Fig.5.2a**) On the plan these are shown as curved shapes which represent the shape of the hull at that horizontal level (see **Fig.5.2b**). In essence the various lifts are cut out to their respective shape and then glued together. This is what all the books tell you. Very simple, very easy! Unfortunately a number of snags spoil this Elysian simplicity. The water line shapes refer, of course to the top surface of each lift (see **Fig. 5.2a**). When the hull is a simple tapering shape no trouble will be experienced if the lifts are cut to these shapes. However, if any tumble home (inward curve of the side of a ship as it rises from water line to upper deck) is present, or any reverse taper (such as occurs with a bulbous fore foot) cutting to this shape will be disastrous as extra material will be required at the bottom of the lift. **Fig. 5.3** will explain this. Therefore, it is imperative that the width of the lift at any transverse section is the maximum width in the depth of that lift. Look at the diagram, it is easier to visualise than describe. The bottom lift of course is solid. Half an inch thick is usually sufficient.

With the timber prepared, the water lines have to be marked out. Probably the best way is to prick through the line drawings on to the wood. Alternatively carbon paper can be used. You will need to mark the station lines as well, as these indicate the template positions. Needless to say marking out needs to be as accurate as you can make it (remember when checking with the templates they have to be offered up at right angles to the keel and not at right angles to the carved surface).

The lifts are best cut out using a small band saw, which is almost a necessity for this sort of work. If one is not available then a jigsaw can be used but failing that it is back to hand tools and a lot of hard work! A way-out method is to drill a series of adjoining holes all around the profile but you need an awful lot of holes and you still need to clean up the shape.

Cutting out the interiors is simplified if each lift is made in two parts glued together along the centre line (see **Fig. 5.4**). This can be done if two adjacent lifts are held together in their correct relationship and the outside of the smallest is marked on to the largest. About half an inch thick for the sides is satisfactory so a line some half-inch inside the marked outline should be drawn. You can produce a smooth curve or produce a series of straight lines to fit the contour. On working boats the former is probably best, as here the requirement is to produce as clean and uncluttered interior as possible. On static models the latter can be used, as here the point is to merely lighten the hull. Incidentally removing the interior will prevent any subsequent cracking as if the hull shrinks with ageing; it can do so without being inhibited by the central mass of wood. Carvers know this, if the heart is left in a block of carved wood it will almost certainly split in time.

One important point is that before cutting out the interior, put witness marks on the ends as shown in **Fig. 5.5**. This is because the bow-shaped pieces are unstable and they need to be glued together in their correct longitudinal relationship. With all the lifts glued together run a small plane over the joints to make sure the surfaces are clean and true. The whole surface may need to be smoothed. Machine planer blades often get small nicks in them, which leave little upstanding ribs on the surface. These are very small but are best removed. Record and other manufacturers make small adjustable mouth planes, which are ideal for this work (see **Fig.3.12**). With a well-

Fig.5.2a Waterlines

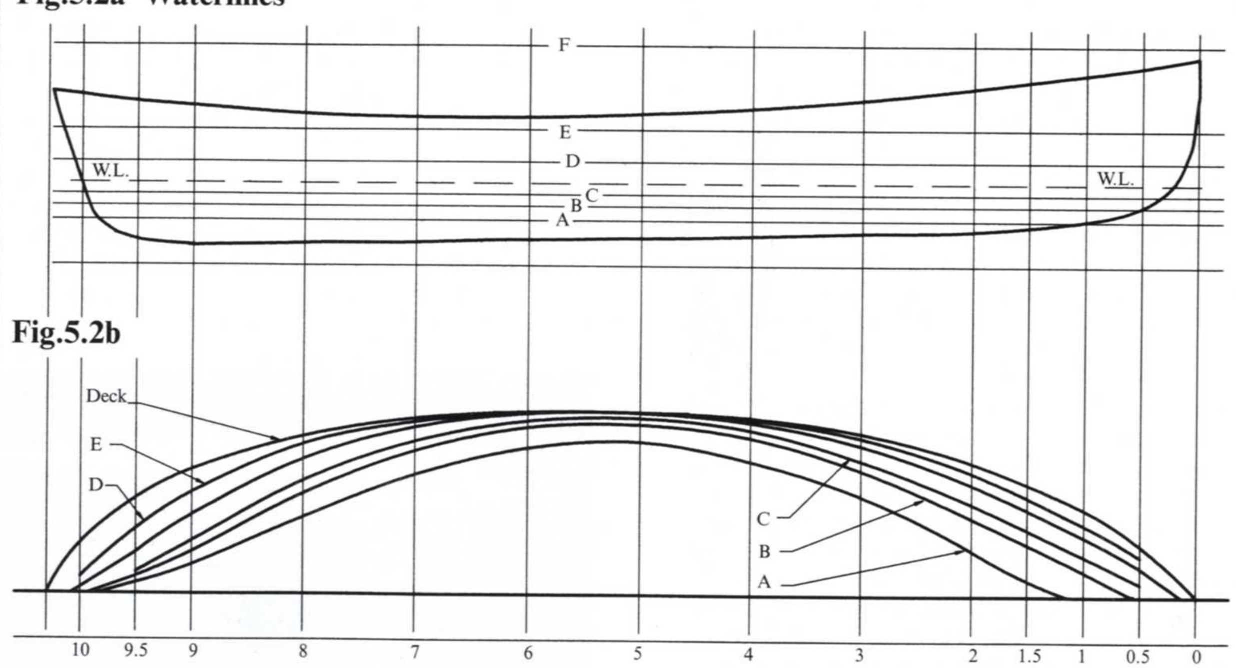


Fig.5.2b

Fig. 5.2b Section Lines

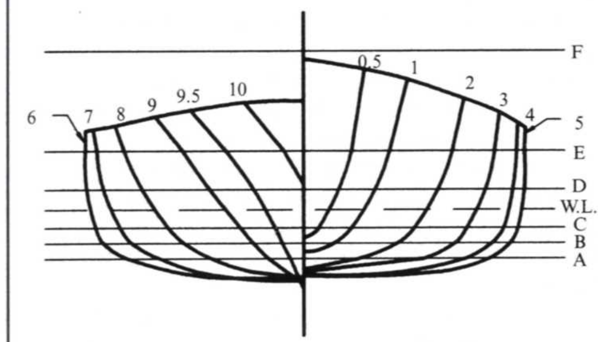
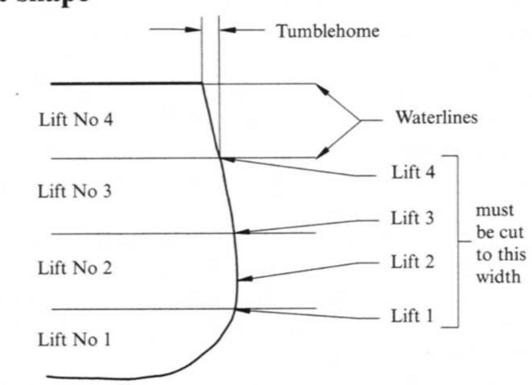


Fig. 5.3 showing effect of tumblehome on lift shape



sharpened blade and the mouth closed up these are ideal for this sort of work and also for cleaning up decks but more of this in chapter six. Closing the mouth of these planes as far as possible enables them to cut cleanly, even against the grain, without tearing up the surface.

If the model is to be static, now is the time to think of how it is to be supported on its base. You see models, usually made some time ago, with very elaborate turned or carved support pillars mounted in very elaborate glass cases. Whether or not this is a good idea you must decide. It can be argued that anything that takes the eye from the model is bad; the model should be paramount. One satisfactory way is to use four support pillars: bow, stern and two amidships set transversely. If it is possible to keep the amidships pair on the flat bottom of the hull it saves making difficult curved pieces to match the round of the bilge. A straightforward way, but not the only way, to fix the model, pillars and baseboard together, is to use hollow pillars with screws (bolts) passing up through baseboard, pillars and hull into fixed nuts attached to the top surface of the bottom lift. How this is done is not important but once the deck is fitted normally no access is possible to the fixings so they need to be very secure. It is possible to obtain captive nuts. These are nuts enclosed in a sheet metal case equipped with two or more screw holes for fixing.

An easier way is to tap a hole in a strip of metal say 1-1/2 x 1/2 x 1/8in and screw these inside the model. (See **Fig. 5.6**). For a model of up to 50in long, four 2BA (5mm) screws are sufficient. If larger screws are used the pillars will need to be of a larger diameter which may look clumsy. Looks are everything! It is a tragedy to see a first-class model in a poorly made and finished case. Or just as bad, the model mounted on unsuitable pillars. Obtaining long

Fig. 5.5 Use of witness marks & clamps

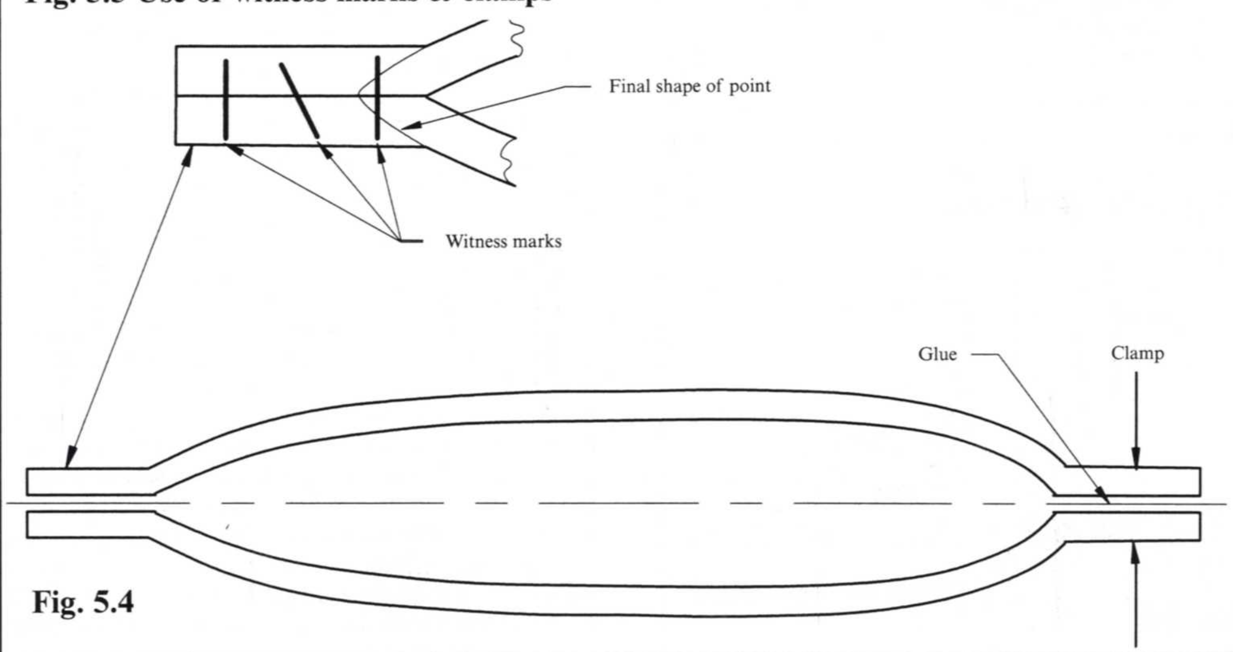


Fig. 5.4

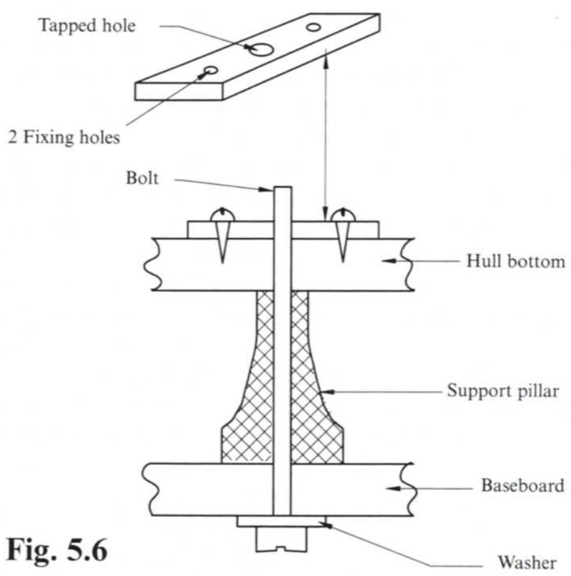
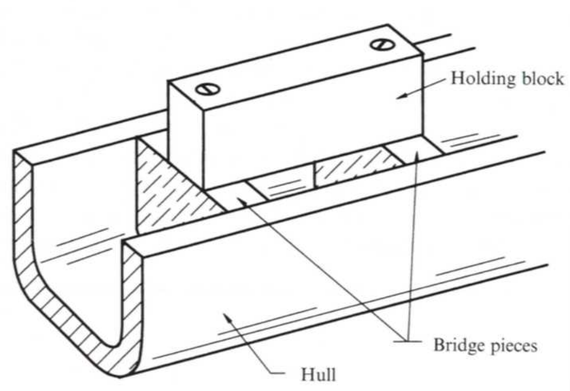
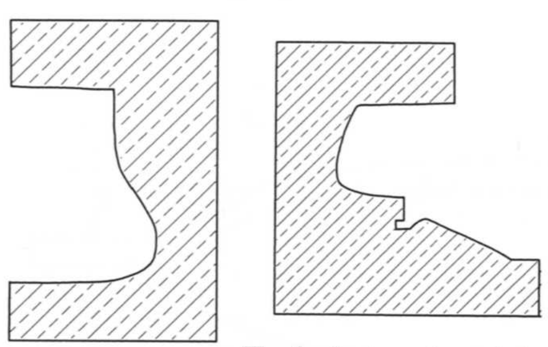


Fig. 5.6

Fig. 5.7 use of bridge pieces & holding block



Typical stem template



Typical stern template

Fig. 5.8

enough bolts may be difficult. In which case these can be made up from screwed rod (studding) with nuts soldered on one end.

Inevitably the weight of the model will sit on four relatively small areas, the tops of the pillars. One more reason for reducing the weight by removing the interior. If the weight is likely to crush the wood fibres, flood the area with a low viscosity cyanoacrylate adhesive that will soak in and harden the wood. This will prevent crushing. Alternatively, to take the load, a metal slug of the same diameter as the pillar can be let- in and glued with epoxy. This should effectively stop any damage to the wood of the hull.

With all lifts prepared the next stage is to glue them into a stack. Again all very simple say the books but great care is needed to produce the perfect job. If the methods explained previously have been followed you will have vertical centre lines provided by the glued joints in each lift and a longitudinal glued centre line on the base. These will provide perfect locating marks vertically and your pencil marked station lines will locate fore and aft. Unfortunately, although adhesive may be efficient at jointing, when wet it is also a first class lubricant. Just clamping two pieces of wood together usually results in one piece sliding on the wet glue out of alignment.

It is essential that this does not happen and to prevent it, use four wood dowels at the bow and stern and two amidships. With the centre of each lift removed they become rather flimsy and it is important that the beam dimension is maintained. It is a good idea to put witness marks for the beam dimension on each lift and check these before allowing the glue to set.

Start by sticking the lower two lifts together. The stability of the base, which is solid, is transferred to its neighbour by the dowels. It is best if this assembly is clamped to a known flat surface. If these two pieces are just clamped together, all sorts of errors can be introduced: 'out of flatness', wind (twisting), etc. and once established these cannot be corrected. With the first two lifts glued and set the rest can be assembled in the same manner.

Note: **wood** dowels. If metal dowels or screws are used you can be certain that sooner or later you will need to drill a hole in that position. Always place dowels in such a position that future carving will not expose them. In the writer's opinion with modern adhesives the use of screws is unnecessary if the workmanship is good, although for working models some may disagree.

When drilling dowel holes make sure that any wood dust is not left on the surfaces and the holes are clean before attempting to glue up. Also dowels should have a groove run along their sides to allow entrapped air to escape. Otherwise close fitting glued dowels tapped into blind holes will slowly be forced out by the entrapped air. The fit must be close otherwise the dowels are not doing their job. As to what glue to use, this is gone into at some length in Chapter Four.

The lift system produces a series of contour lines around the hull, which establish the correct shape at that point just as contour lines on maps show the height at that point.

In theory at least, the hull only requires to be cleaned up to those lines to produce the correct shape. However, holding the glued-up stack can be difficult. If two bridges are fitted and glued in about midships, a large wooden block can be screwed to these and used as a handle when carving. (**Fig. 5.7**). This avoids clamping the hull itself in a vice, which can damage the surface.

The sequence of carving is as follows:

1. Shaping the sheer, deck, bow and stern shapes.
2. Carving the hull's transverse sections using templates.
3. Cleaning up any bumps, hollows, etc. to produce a perfect shape.

Before shaping the deck you will have to decide how the deck is to be made and fitted. Do you have to allow for the thickness of the deck, etc? The height of the deck needs to be plotted at each station position. Take these dimensions from the top surface at each station position (draw a horizontal line on the plan to represent the top surface of the block if one does not already exist) with this series of plotted points a smooth line can be drawn through them. Remove the material above this line to produce the deck sheer which is the shape of the top of the hull. Use a chisel for this or whatever tool does the best job for you. The contours of the bow and stern are best shaped to a cardboard template. When carving from a solid block, this is easier as these profiles can be drawn on the flat surface of the block before you start to carve (**Fig. 5.8**). It is usual in this case to finish the sheer before plotting the deck shape and cutting it out.

Actually carving the hull is best started amidships working out to the difficult bits at bow and, more particularly, the stern. To get accuracy a set of half templates must be made, one for each station. These can be pricked off the transverse section line drawing (see **Fig.5.2b**) or carbon paper can be used or whatever. Cardboard is a good enough material but some modellers use metal, but that involves a great deal of work and cost. However produced, accuracy is required - the hull's final shape depends largely on the templates. Work the hull to shape at the section stations, getting these to fit the appropriate template. This will also rough out the areas between stations. The final stage will be to get these rough parts down to a smooth line.

How you do this is up to you. A large chisel or, at the concavity of the stern, a gouge can be used with a mallet to rough out the shape. A carver's bell mallet is a good buy. These are, as the name suggests, bell- shaped and therefore have no flat striking face, which might bias the tool when tool and mallet face meet. They are made in beech or lignum vitae in sizes 3 – 4in diameter. They can be obtained from suppliers such as Tiranti.

Surform tools (wood files) are useful in smoothing off the tool marks left by chisels and gouges. Surforms can be used against the grain to remove material quickly, although the purists will throw up at their hands in disgust, it works well but of course it does produce a rough finish. Some woodworkers use spokeshaves and/or draw knives for this. Spokeshaves do not work for me and I do not possess a draw knife!

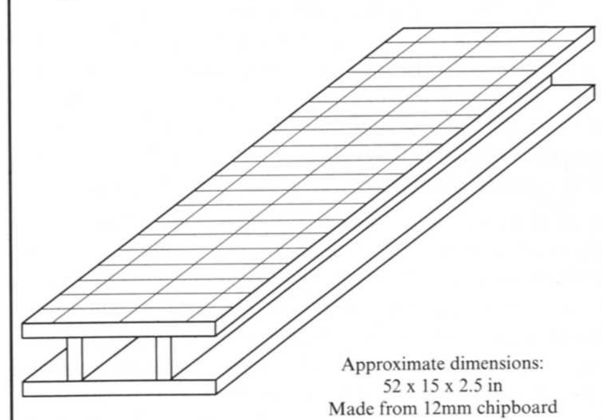
When getting near to the point when the templates fit, ease off the rough stuff and attempt to work up a smoother surface, using the Surform very lightly. At this point start looking at the shape you have produced from every angle to sort out any hollows, lumps or imperfections that must be corrected. The grain pattern will try and camouflage these inaccuracies and you cannot be really sure that perfection has been reached until you spray the hull one colour. One way of doing this is to buy a large aerosol can of car cellulose grey surface primer. This dries quickly and hides the grain pattern. Do not worry if, by the time you get things right, you have largely removed this coat. It was a sacrificial coat anyway and it has done its job.

At some point the still relatively rough surface will need to be sanded. This may be done before, or after the above sacrificial coat. Try not to sand before finishing tooling as embedded grit in the wood will blunt your tools. Always sand, using a block never with the fingers. Modern 'sand'papers are very advanced, non-clogging and with a life much in excess of the traditional papers. It is possible to buy blocks of foam, coated with two grades of abrasive: one face and one edge of each. These are very effective. Unlike the traditional cork block they have slightly more give. The usual sequence, coarse to fine etc should be adopted of course.

The lift system produces a stepped interior, particularly at bow and stern, like the outside before carving. With working boats this is probably best cleaned off to produce a clean inner surface to the hull.

Certainly, at least when building static models, once the hull is carved it should be set up on a stable building board. The emphasis must be on stable - flat and without twist. **Fig. 5.9** shows my building board that has seen the building of about eight models. It consists of two 1/2in thick chipboard pieces spaced about two inches apart. The use of chipboard is recommended as experience has shown that this is more stable than ply, block board, etc. Its construction is symmetrical so there is no tendency to warp. It will be noticed that the distance pieces are not set at the edges, but are inset which enables clamps to be

Fig. 5.9 Building board



used on the half-inch thick edge. The top surface has transverse pencil (ink) lines spaced one inch apart as well as a longitudinal centre-line together with a few parallel lines. These are extraordinarily useful for measuring and eyeing positions on the hull. The hull on static models is screwed on the board as previously described but with only about half inch high pillars. Shorter pillars increase the rigidity of the set-up, as you will undoubtedly want to work on the hull with, at times, considerable force. After setting up the model on the building board make sure the latter is still flat and has not been distorted. The girder strength of a large carved hull is very great and can easily distort the building board. If it does, adjust the height of the pillars until, with the screws tight, the board remains flat. In a similar manner check the flatness of the building board before marking waterlines and the like. The writer had a case where the boot topping was hogged; this was eventually traced to a distorted building board. It meant committing myself to hours of repainting!

Dealing again with static models. These will eventually have to be re-mounted on the base of the glass case. When you have decided on the position of your four securing screws (pillars) make a note of their spatial measurements for easy transference to the final baseboard. It can be really difficult to obtain accurate dimensions at a later date with the completed model sitting on the board. At this time close approaches to the model are best avoided! It is so easy to damage it.

With even a modest model the associated paperwork can mount up. All sorts of bits of paper accumulate. Make up a file or a loose-leaf book to hold these together. Make notes of what you intend. It is all too easy to forget what you intended to do six months later if you have to leave something, which you often have to if you are using etching, as there is always a delay in its production. It is even worse if the delay is 18 months.

Plank on frame

This term covers a lot of ground.

1. At one end there are Admiralty Board models 17th, 18th and 19th century warship models built to show my Lords of the Admiralty what a proposed ship would look like. This was necessary; as said gentlemen could not read drawings. For some reason these models were constructed in a special way, and not as the full sized ships would have been built. In any case they were rarely planked, again to enable the internal structure to be viewed. All such models that I have seen were planked fore and aft. They were held together using treenails (trennels) that is long wooden dowels and not conventional fittings.

2. Next there are models of wooden vessels built in the identical manner of their full size prototypes. Some lifeboat models of the early wooden boats have been built in this manner using the traditional very strong double diagonal planking system. That is with one layer of planking lying at approximately 45° to the keel with a second layer at approximately 90° to the first.

3. Lastly we have plank on frame models built, not as the full size prototypes, but in a simplified manner to achieve the correct outside view. These are 'model makers' models. Mostly, working models use this system. The planking can be of several kinds and often two layers are used.

If you are building types one or two this book is not of much help. Specialised books dealing with this type of work are available; the best of which, for commercial vessels at least, are the two classic volumes by Harold A.Underhill (Brown, Son and Ferguson) entitled Plank on Frame Models. These books also deal with scale masting and rigging. These are probably the definitive work on this type of model; being reprinted many times - Always a sign of worth.

If method two is adopted, the method of construction is laid down by the prototype. Some licence can be expected in that the model maker may substitute one piece of wood for several on the original, bearing in mind that the size of pieces on the prototype were limited by the timber sizes available.

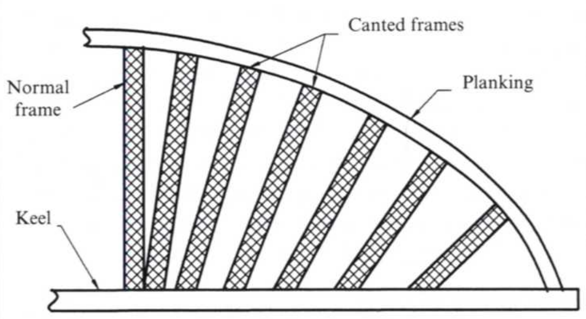
With method three the basic framework consists of a keel, stem and stern posts supporting a series of frames or ribs. (**Fig. 5.10** – see colour plates). With non-working boats the frames can be solid but for working models the interior needs to be clear and hence the frames become ribs.

A good building board is required to set up the framework structure rigidly and true. The final accuracy of the model depends on this. There are two schools of thought as to whether this kind of model should be built the right way up or upside down i.e. the keel uppermost. If the latter is adopted the frames or timbers must be lengthened to extend them to the baseboard for securing. Certainly with the model this way up the garboard strake (garboard strake: plank or line of bottom plating next to the keel) and its partners are easier to lay. With 'upside-down work', however, the job tends to end up looking better when looked at from underneath than from on top, which is the way it will finally be viewed.

Whichever method is adopted, before planking can begin, the frame edges must be faired in. From amidships forward the fore corners of the frames need to be removed; from amidships aft the aft edges of the frames need to be faired -in. This job is very awkward but must be done to allow the planking to sit properly on the edges of the frames. Use a spare plank, or similar straight piece of wood to fair in, making sure it lies in a fair curve at all points. Do not pull the planking round the frames. If you do, a series of flats will ensue; the planks must lie naturally in a curve. Some force may be required at bow and stern, of course, to make the planks fit the frames. It may be a good idea to add extra frames at bow and stern where the shape is changing rapidly to get extra support and a better shape. In full size ships the frames at bow and stern may be canted (**Fig. 5.11**) This eases the problem of fairing their edges but complicates the framework.

When planking, the planks or strakes should be fixed alternatively side to side to equalise the stresses on the hull. How they are fixed depends on your own technique. Brass pins are suitable for working models but for authenticity on some ships, trennels must be used. Some

Fig. 5.11 Cant frames



modellers use split bamboo, finished to size using a draw plate. This is simply a piece of steel, hardened and tempered, with a series of holes bored in it. The cane or wood strip is hammered or pulled through to size the trennel. This is then dipped into glue and tapped into a predrilled hole. The planks are usually glued and clamped as well as pinned. If planks have to be steamed to enable a tight curve to be achieved, do not finally fix them whilst they are still wet. If this is done they will shrink and you will end up with open seams. Fit them into position and allow to dry before finally fixing permanently. Soaking in ammonia will soften the wood fibres but the writer has no experience of this technique. Kit models often use two layers of planking, the first layer being sanded down before applying the second layer. This produces a better hull as any bumps or hollows can be cleaned up before the second layer of planking is applied. The second layer can be more easily clamped and pinned than the first layer, which has only the frames on which to be secured. A cheaper timber can be used for the first layer of course. With kits walnut is often the chosen wood for the outside planking.

Planking should be straightforward in the midships area but the ends, fore and aft, may be more difficult. Stealers may be necessary. These are relatively short planks fitted into the normal run of planking to aid the plank run. If the planking is 'expanding', that is covering a greater area, as may be the case at the bow or stern, a stealer may be necessary as shown in **Fig.5.12**. Alternatively, if the planking is 'contracting', as shown in **Fig.5.13** the plank width may become too narrow and weak to secure properly. In this case a stealer can be inserted as shown. In full size practice planks never come to a sharp point because flimsy points cannot be secured. Deck planks with a tapered end always stop short of a point for the same reason but this will be dealt with in chapter six.

The difficulty of shaping the ends can be avoided by using blocks of timber to form the actual bow and stern shapes. **Fig.5.14** shows a typical way of avoiding the difficulty of fixing planks to the stem post. The block can

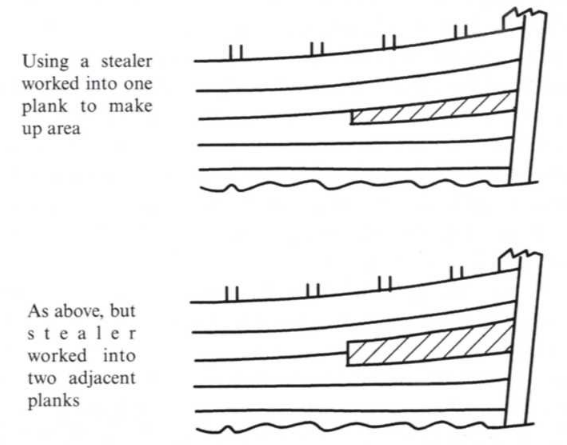


Fig. 5.12 Use of stealers on 'expanding' planking

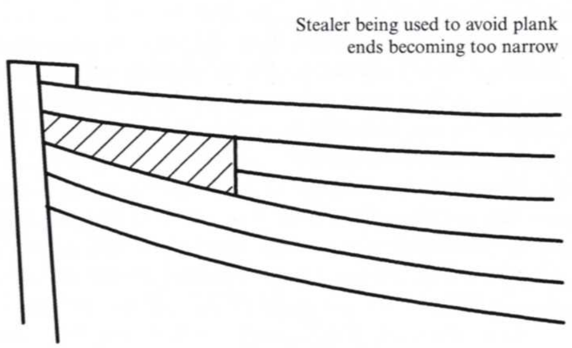


Fig. 5.13 Use of stealers on 'contracting' planking

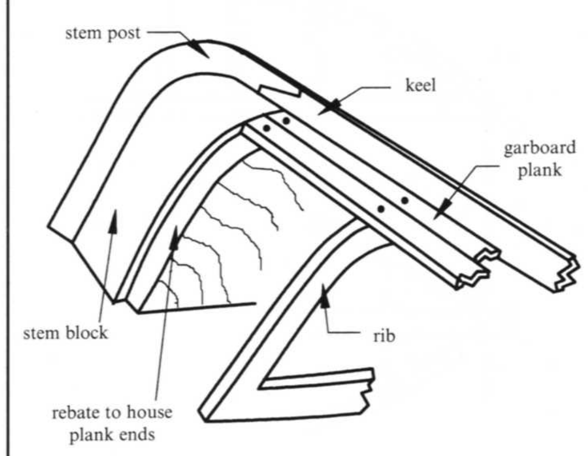


Fig. 5.14 Use of Stem Block

be shaped with a wide rebate on which to 'land' the planks. Alternatively **Fig.5.15** shows how the stem block can be used to support the run-out of the planking which can then be cleaned up before the stem post is added. With this method the block is completely hidden. Other variations on this theme can be dreamed up. Blocks can also be used in the other complicated areas, like the screw tunnels on lifeboats, always a headache and very difficult to plank. **Fig.5.16** shows a similar use of a block when building a transom stern.

With working models most modellers put a coat of resin and some fibreglass mat on the inside. This adds great strength and watertightness but can you call it a wooden hull afterwards? One might argue that you ought to be able to produce a satisfactory wooden hull without GRP.

Metal Hulls

As well as the previously discussed methods, a relatively small number of metal hulls have been built. These are built like the real thing using metal plates soldered together, usually over a wooden form. The favoured material is thin tin plate, garnered from food tins and the like. (Tin plate is sheet steel coated with tin). The problem with it is, once the tin coating is disturbed, rust will raise its ugly head. Unfortunately tin has no 'sacrificial' characteristics unlike zinc. Zinc will still give protection to the underlying steel even if it is scratched right through to the base metal. This is because the zinc coat will corrode before the steel. It's all to do with their relative positions in the electro-chemical scale but we modellers need not worry ourselves about that. Unfortunately there is no ready domestic supply of zinc coated sheet. In the writer's opinion a better metal for hulls would be thin brass sheet which will not rust, unlike tin plate. Articles have been written on this very specialised technique but they are outside the scope of this book.

Fittings.

Before leaving this subject mention must be made of fitting-out the hull: installing propeller shafts, rudder shafts, bilge keels and the like. Of these, without a doubt, installing a quadruple prop shaft arrangement must rank among the most difficult job there is in the model boat world. You can simply mark out the hull and drill but this usually results in many corrections before the correct position and angle is found, which is unprofessional and messy. However, the job can be tackled logically.

Propeller shafts

Let us assume a twin screw arrangement is wanted:

With the hull upside down make up two templates of thin ply, cardboard or polycard to sit on the stern of the hull. Two holes can then be drilled in each piece for the prop shafts. The position of these holes can be ascertained from the drawings. If two lines are drawn on the sheer and plan to represent the templates, the widths and heights (from some datum) can be measured off. With these templates in place the position of the hull entry holes can be located by sighting through the corresponding holes. All this sounds complicated but looking at **Fig. 5.17** (see colour plates) should make the principle clear, although the figure shows the worst case, a quadruple and not a twin arrangement. An improvement on this rig is to join the templates together. **Fig. 5.17** also shows the aft double 'A' frame and the two forrard 'A' frames. The former supports the outer ends of the inboard prop shafts; the latter the outer. Note also the bushes at the hull end of the shafts. These are cut off at an angle to fit snuggly against the hull. They need to be glued and radiused in with filler.

Rudder shaft

As no angles are involved, putting in the rudder shaft should cause no trouble.

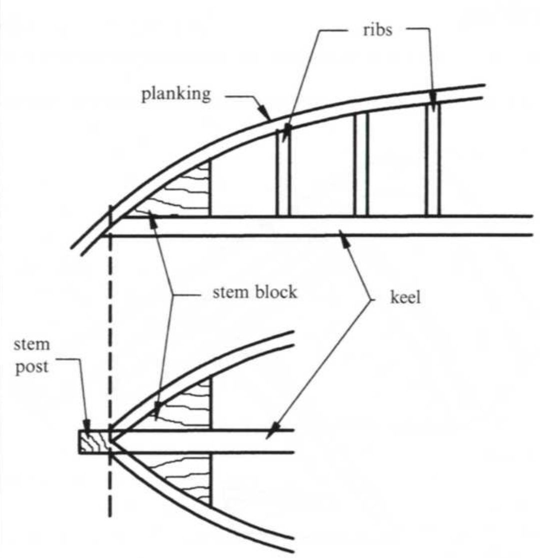


Fig. 5.15 Alternative use of stem block

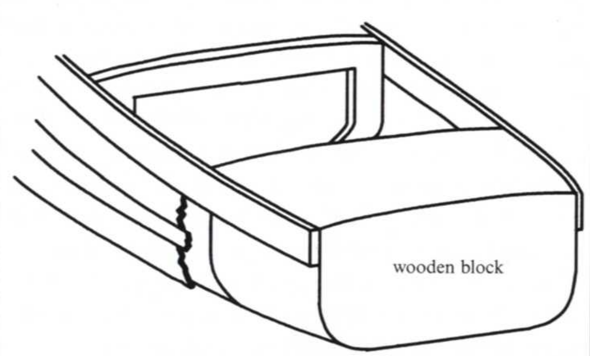


Fig. 5.14 Sternblock

Bilge keels

Fitting bilge keels can be a headache. Probably the best way is to mark out the position at every station involved. If the carving templates are marked with the bilge keels position from the section lines it is easy to transfer these marks to the hull. If, as sometimes is the case, the sections drawing does not show the position of the bilge keels you are in trouble and will have to seek further clues as to the bilge keels position. Once the positions are marked a fair curve through these points can be drawn. The longitudinal position i.e. where the keel starts and stops can usually be determined from the sheer drawing. Before cutting and wasting metal make a cardboard template and from this cut the actual keel. A number of tongues, say one every three inches, are required to fit into slots in the hull. With wooden hulls drilling a series of small holes and joining these up is the easiest way of doing this. **Fig. 5.18** shows two bilge keels with tongues and the matching slots in the hull.

Bilge keels are either of the blade type, which the metal strip mimics nicely, or wedge shaped in which case the body can be built up with Isopon. This sounds messy but it is fairly easy to strike off the shape with a putty knife rather like cleaning off the putty when glazing a window. A point to remember is that some bilge keels have a flat in the centre of their length to avoid fouling when docking.

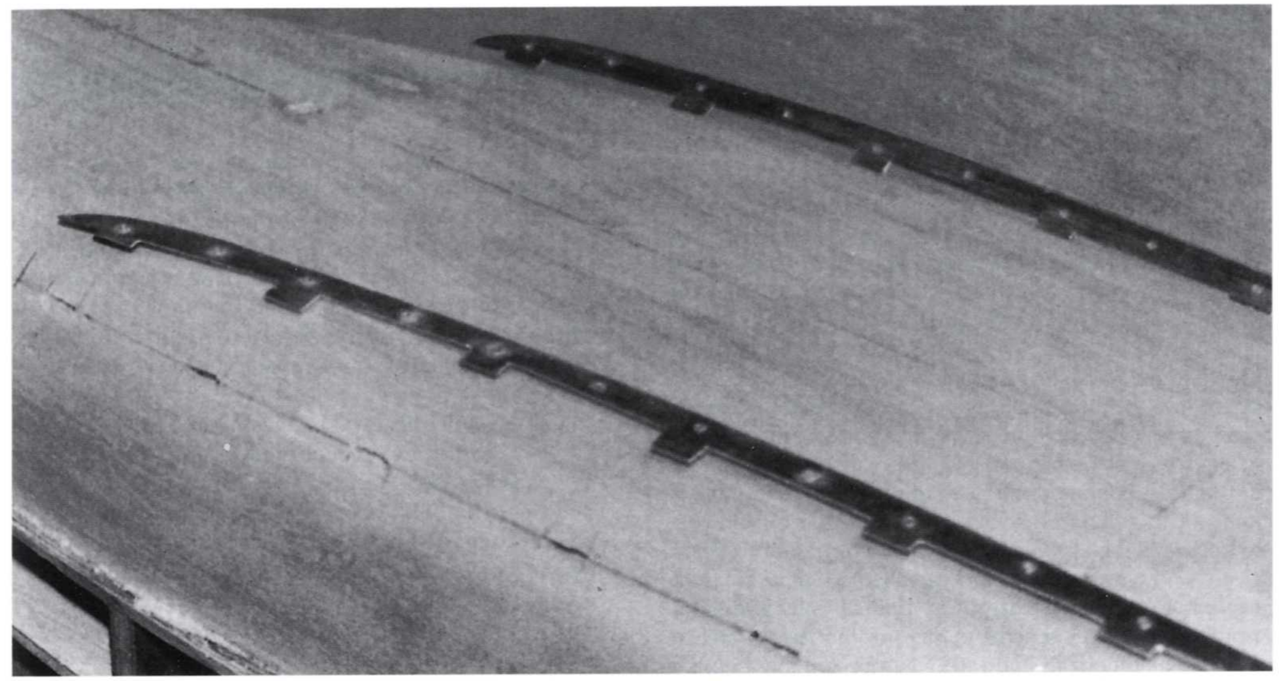


Fig. 5.18 Bilge keel and slot

Chapter Six

Superstructure and Decks

No. 6. Get to know what your adhesives can do

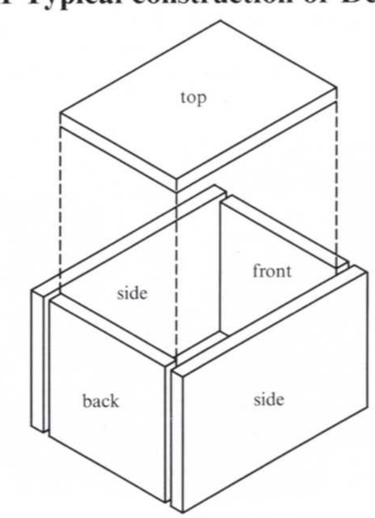
Most basic superstructure consists of a collection of boxes more or less rectangular in shape and these can be fabricated in wood, metal or plastic. With complicated models such as battleships often the main problem is trying to understand the drawings enough to prepare details of individual decks. The whole stack must be broken down into its constituent parts when it looks less difficult. Usually these parts, in themselves, are fairly simple but often the shape of deckhouses under decks is difficult to determine. Also the position of doors and, even more so ladders, may take some sorting out unless the drawings you have detail every deck individually which is rarely the case.

It may pay you to build a mock-up of balsa and card which may not need to be very accurate or take a lot of time. It will enable you to get the feel of the assembly. This technique is useful on other assemblies. If this is checked out and kept by you during construction it will help enormously. With a multi-deck stack accuracy in the height of each unit is important to avoid the total height not being widely out due to accumulated errors. Experience has taught that this is a very easy trap to fall into.

With warships the individual layers usually consist of a deck with restraining guard rails or, more likely, a solid bulwark all round them and a central deck house which supports the deck above and so on. The deck and bulwarks are probably best made from brass and soldered together. Polycard can be used but it results in a very flimsy assembly. If guardrails are used these can be etched and soldered or glued to the deck.

The deckhouse itself can be a fabrication of wood, metal or plastic. There are fors and againsts for all these

Fig. 6.1 Typical construction of Deckhouse



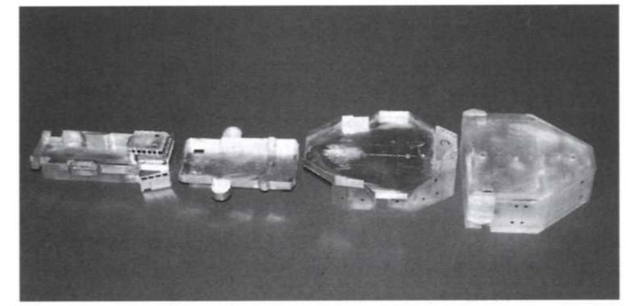


Fig. 6.2 Component parts of Anson bridge

materials. With wood you have the problem of grain filling and apertures will show over scale thicknesses but this can be overcome by thinning down locally from inside. With metal this over scale problem will not exist and painting will be no problem but fixing parts together may cause trouble and getting sharp folds at corners may be difficult. If polycard is used, unless the size is very small, it will need to be supported in some way - stuck to a balsa block or whatever.

If clear Perspex is used, either as a fabrication of five or six parts (**Fig.6.1**) or as a solid block, painting will be no problem and neither will any scuttles (port holes) as these can be machined in using a slot drill. This is a type of milling cutter that produces a flat-bottomed hole. If the slot drill is machined in a few thousandths of an inch deep and the resulting depression masked with a slug of masking tape, or better still insulating tape, you have a built-in scuttle. Failing the possession of a slot drill an ordinary twist drill bit can be sharpened with an almost flat end, not the normal 120° point (it should actually be 118°) instead. You will need to either shorten the bit or hold most of it in the chuck to stiffen the projection otherwise it will wander when it touches the work. To do this operation you need a drill press and the work firmly fixed for the same reason as neither the slot drill nor the flat drill has a stabilising point.

The assembled stack needs two long vertical bolts to hold it together. These can either fasten the stack to the deck or just the stack to itself in which case the lowest unit needs to be fastened to the deck. It is also a good idea to use two dowels to keep parts aligned. Again these can go right through the stack or just dowel two adjacent units together. In practice the later may prove more useful. These bolts and dowels need to be hidden under deck components of course. **Fig.6.2** shows the component parts of the bridge for Anson and **Fig.6.3** (see colour plates) the bridge assembled and painted.

Before finally assembling the stack make sure that any painting and/or fixing of components that will become inaccessible have been completed.

With the kind of passenger liner models that the late John McKay and Ronnie Lawson built, one of the problems lies in the long line of rectangular state room windows required on these models. These demand a very high degree of workmanship especially if they are small. One way out of this is to etch them in the necessary long strips. As the artwork can be drawn larger than life the errors can be reduced to an infinitely small amount. In the later models built by John McKay he used the etching technique.

Fig.6.3A shows a bridge assembly for a commercial vessel, NVG 6, made mostly of wood with some etching work: the diamond plate stair treads, etc. This is an excellent example of really clean-cut detail work for a working model built by Dave Watkin.

Funnels

These come in many forms. In recent warships they have become supports for many things rather than just a conduit for waste gases. If the cross section of the funnel is circular as were many on Victorian warships, they can be turned from the solid in which case the top and bottom flanges can be incorporated as can any rings or other embellishments on the funnel sides. Failing this, suitable pieces of pipe, either plastic or metal of the correct diameter, can be pressed into service. If solid plastic (Perspex) is used and the interior hole has to be drilled trouble will be experienced if your lathe has no pumped coolant. The drill will overheat and jam in the bore. In this case a piece of tube is a better bet. A different shaped funnel (**Fig.6.4** – see colour plates) shows the completed funnel for the cruiser Belfast.

However, the main problems occur with flat-sided funnels and trunked ones as sported by Queen Elizabeth before her final refit. You can, of course, make them solid just hollowing out the top but really this is no fun. Judges tend to look down on this kind of indiscipline!

To produce a proper hollow funnel really requires a lamination job built up around a solid removable former made to the interior size of the finished job. Either talcum powder this or rub all over with candle wax to stop any stray glue adhering which it will given half a chance. According to the size of the funnel use thin ply or even cardboard in two layers, vertical joints opposite running up and down the centre of the flats. **Fig.6.5** But first read Chapter Four, page 27 which discusses the orientation of

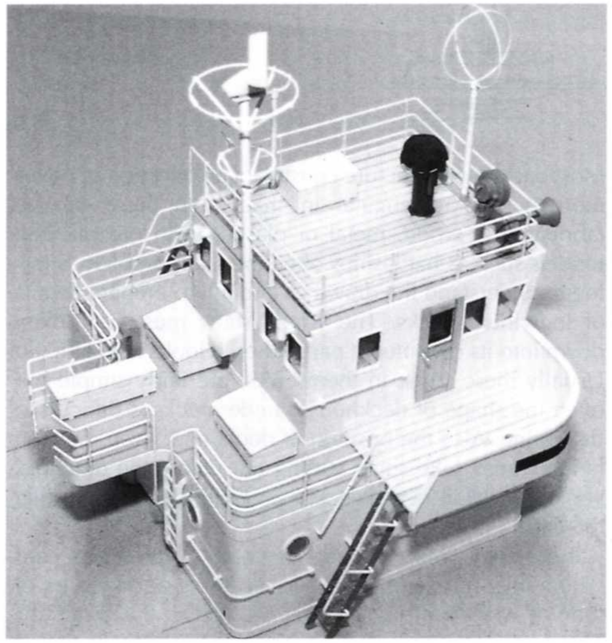


Fig. 6.3A Assembled NVG6 bridge

the grain to aid bending. After fitting, these layers can be glued and the whole assembly either taped up or wrapped with string whilst the glue sets. This is one case where flexibility of the glue line is not wanted. The more rigid the glue line the more stable the final funnel. The last thing wanted is the flat sides collapsing in, or bowing out, so you really partially rely on the rigidity of the glue line.

With this assembly dry, the final cladding can be put on. This can be made from aluminium lithoplate which can usually be obtained from your friendly jobbing printer. It is about 0.006in thick and is ideal for this job and many others in model work. Failing lithoplate the sides of aluminium beer cans also provides excellent material. Do not take this as permission to drink the contents first - sobriety in all things please! **Fig.6.6** shows the pair of laminated funnels for Anson.

Warships, at least, usually show a rivet pattern on their funnels. The use of aluminium sheet enables a rivet pattern to be shown. I use a gear wheel from an old alarm clock about one inch in diameter which has had the teeth

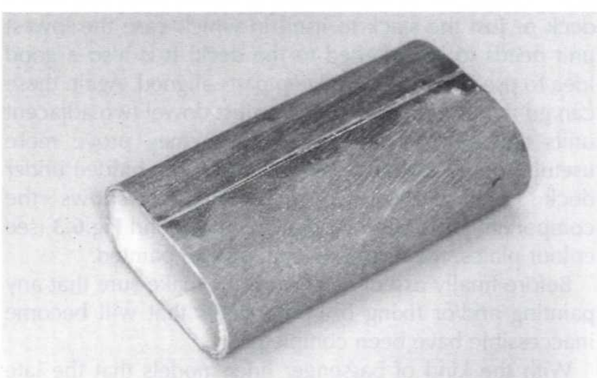


Fig. 6.5 Wood laminated funnel

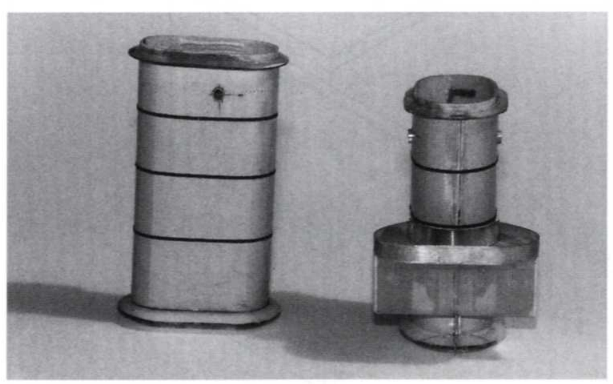


Fig. 6.6 Anson funnels - incomplete

modified to make pointed dents; left as made, it makes a lot of small parallel lines. This is mounted on a handle to make a pounce wheel (pounce - to emboss metal by hammering from the reverse side; it comes from Old French).

If the aluminium is laid onto a piece of medium-hard cardboard the pounce wheel can be traversed across it to leave a line of small indents (rivet heads). You need to experiment to get the pressure and the hardness of the backing card right but it is easy and quick to do. Use pencil lines as a guide. You also need to work out the number of lines of rivets to fit into the height and, more importantly, fit into the total periphery of the funnel. Obviously the vertical pattern should not end up with part of a space at the joint. Again make sure the grain of the metal runs the right way, up and down the funnel. This cladding can now be added to the laminated assembly using an epoxy glue. In this case the joint should probably be at the fore or aft sides as there are usually gantries in these positions which partially hide the joint. In any case, filler (Isopon) can be used to fill any gaps although care is needed to avoid ruining the rivet lines. The rivet pattern can be seen on the unpainted funnel in **Fig.6.7** (see colour plates).

Funnel flanges, top and bottom, are probably best made of Perspex. If they are made of wood they usually break. They are fiddly to make but repay careful work. Lastly to fully stabilise the funnel remove the former, cut half inch off it, and glue it into the base of the funnel. This is also useful for fixing purposes. Another slice, much thinner this time, can be placed about one third down the funnel to give extra support. In this case, the centre should be removed to leave only a ring. Alternatively a ring can be made for this purpose with the grain horizontal; the former usually has a vertical grain. Any pipes, etc. can be added afterwards.

I etch the funnel cap myself but it can be made from wire soldered over a former if you like doing it the hard way. If it is etched the ring needs to be etched separated from the transverse members, as these need to be domed before soldering to the ring. (see **Fig.6.8** & **6.9**)

If you try and etch in one piece the ring becomes distorted when attempting to dome the unit.

Masts

These are best made from brass tube, as tubing is easier to manipulate than rod. Aluminium can be used but then soldering is difficult. If it is a working model then the weight of metal may be prohibitive so either wood or plastic may have to be substituted. Masts vary from the simple masts carried by late 19th century warships, only complicated by fighting tops, through the massive tripods of WW1 and 2 battleships to the latticed masts of post WW2 naval vessels (see **Fig.6.10**). Should you be interested in between wars US navy ships you have the problem of weaving the very elaborate latticework. One can only wish you luck.

The method of construction will obviously vary. Where possible brass tube should be used as its ability to solder will be very useful. If aluminium tube is used it will usually need to be epoxied together - soldering being difficult. If weight is not a problem solid rod can be used but fitting rod requires more effort than tube as there is more material to remove.

Victorian masts

Fighting tops can be turned from Tufnol, Perspex or even close-grained wood. The main problem is fitting the bulwark. It is possible, if suitable tube material is to hand, to turn the bulwark in one piece. Otherwise shim or polycard will need to be bent around the fighting top base. A difficult exercise to get it right but very satisfying if you do. Do not forget the lubber holes on the underside of the tops. These are to enable the crew to get in to the fighting top and are usually closed by hatches. The quick firing guns, if they are carried, run on rail tracks. **Fig.6.11** – see colour plates.

Fig. 6.8 Funnel cap

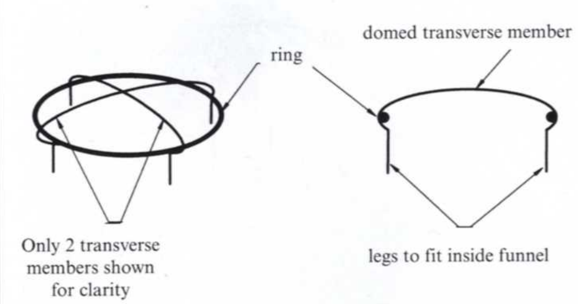
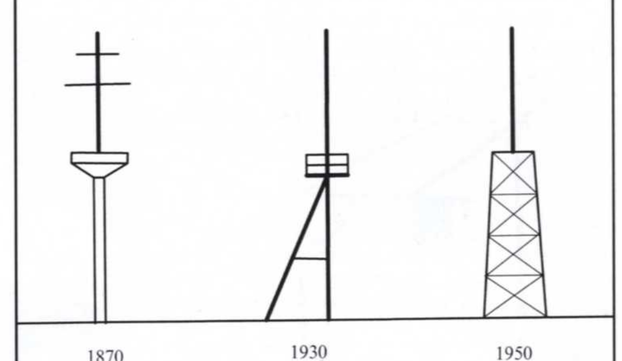


Fig. 6.9 Section through funnel cap

Fig. 6.10 Mast types



Tripod masts

These can be very awkward (**Fig.6.12** – see colour plates) as the sloping members of the tripod often pierce bridge decks and it is extremely difficult to arrange this. Drilling holes, if their position can be accurately determined, will not suffice as their shape must be elliptical owing to the slope of the tripod legs. One way out of this problem is to put much larger clearance holes in any decks being pierced by the tripod legs and then make very thin washers to fit the legs closely and let these cover the clearance holes. This sounds a bodge, but if done carefully, works very well. One point which may not be obvious to the unmechanically minded is that if the tripod is to be permanently assembled and yet requires to be removed as a unit, the locating pins at the bottom of the tripod must be vertical otherwise the unit cannot be lifted off. If the leg holes are drilled at the same angle as that which the tripod leg sits the angle will lock in the assembly. **Fig.6.13** shows a bent metal pin held into the leg with filler or glue (polyester filler or epoxy glue). **Fig.6.14** shows an alternative method of fixing the locating pin if a solid rod is used. More difficult than **Fig.6.13** which allows more latitude in accuracy. Please note, do not fix the pin into the deck instead, otherwise you are back to square one. It must be fitted to the leg.

Removal is important as further assembling, and even some rigging, is best done off the model and on the bench.

Platforms, guardrails and starfishes are usually straightforward but a plan of assembly needs to be worked out. **Fig.6.15** shows a starfish being assembled. Likewise the standing rigging needs to be borne in mind - can holes, fixings, be incorporated in the construction?

Some ladders are freestanding and attached to the mast at intervals. If you are using your own etched ladders incorporate these fixings. However, some ladders, particularly on the lower mast members, fighting tops and the like, comprise rungs let into the mast rather than being of the freestanding type. This presents two problems - making the U-shaped rungs and drilling the receiving

Fig. 6.13 Tripod masts

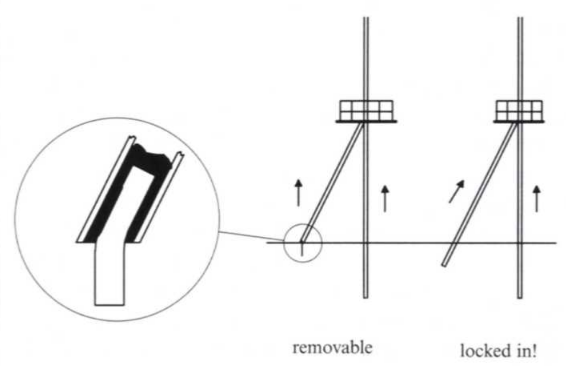
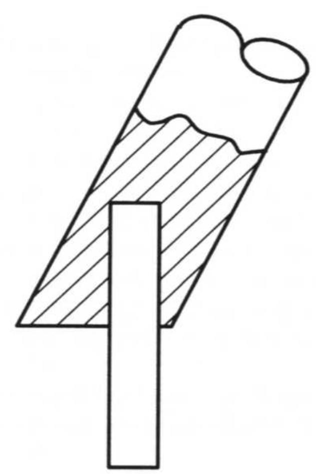


Fig. 6.14 Alternative leg fixing



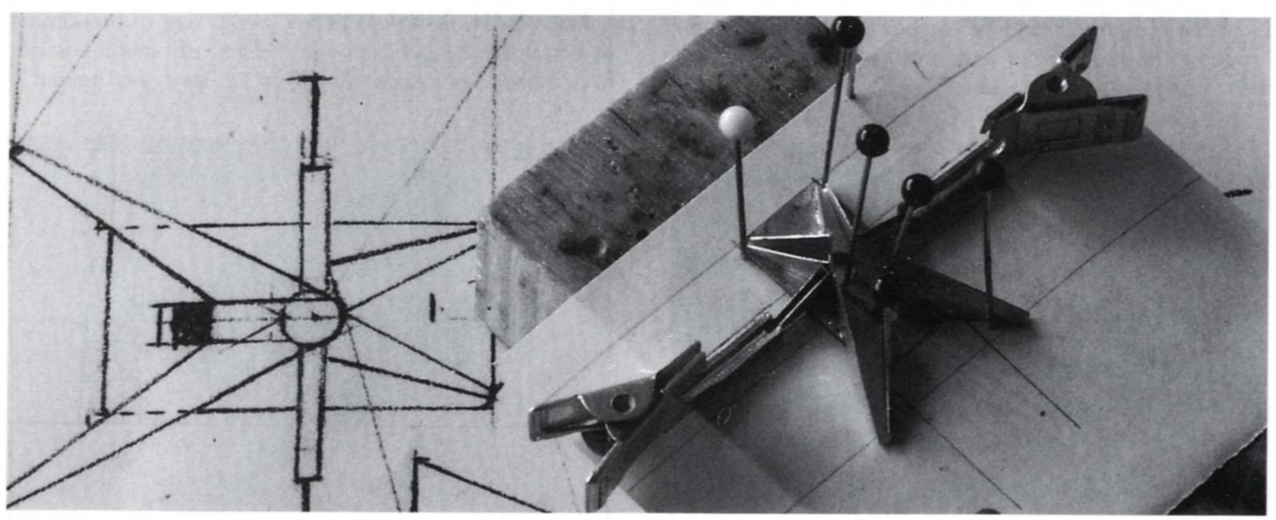


Fig. 6.15 Starfish assembly

holes accurately. A series of rungs which are not geometrically accurate stick out like a sore thumb.

A simple block to fold the wire round should solve the first problem or you could etch them and, if a milling machine is available, using the indexing dials to space out the holes should solve the latter. Failing this you must fall back on very accurate marking out. When drilling such holes keep the drill protrusion from the chuck to a minimum to avoid drill wander. If a number of rung layouts will be required a simple plate jig might be worth the time spent on making it. When using such a simple jig first drill the two holes furthest apart and use pins as dowels to secure it whilst drilling the rest. To get the rungs protruding the same amount put a length of wood or plastic between the tread and surface but make sure excess adhesive does not glue this in permanently. It is best to remove it before the adhesive has really set.

Lattice masts

These usually consist of four corner members with added strutting. One way is to etch the four faces of the assembly and etch each horizontal layer of strutting as well. Soldering these to the basic uprights will still be difficult but nowhere as troublesome as individually soldering in each separate member. If this is to be attempted read Chapter Three on soldering techniques.

Alternatively one of the plastic strut systems can be used. These systems comprise extruded plastic angles, I's, U's, etc. The main problem appears to be their lack of stiffness compared with metal systems. Of course, even with the latter it is not necessary to use solder all the time, some joints can be glued instead. **Fig.6.16** (see colour plates) shows the unpainted lattice mast of the cruiser Belfast (now moored at Tower Bridge on the Thames and open to inspection). This was built using four circular section main members with each face treated as a separate etching as described above. A wood former was required to stabilise the assembly which otherwise had a life of its own and geometrical accuracy flew out of the window. Liberal use of heat sinks was necessary to avoid the two on, one off, game.

Fig. 6.17 Mast and davit shaped block

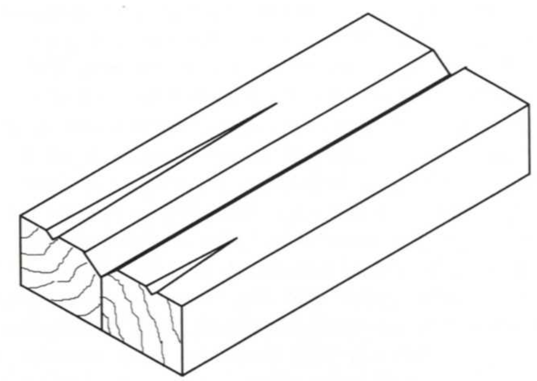


Fig. 6.18 Tool for cowl vents

Spars

The technique of making wood spars is well known but a resume may be useful. A square section of the largest size of the spar is first sawn or planed to size. Make sure this is slightly longer than the finished spar. Mark the centre of the ends. This can be done by eye or by using crossed diagonals. Next the square member should be reduced to an eight-sided cross section by planing off the corners. At this stage both ends can be tapered down using the marked centre at the ends as a guide. With some spars the eight-sided centre is left, in others these eight corners are taken off and the shape completely rounded off. If any transverse holes are going to be required put these in when the member is a square section, it is much easier than trying to drill the finished spar.

One of the problems with the above procedures is holding the component. A wood block with a vee-shaped groove (angle 90°) (see **Fig 6.17**) held in the vice can help. The shaping is best done with a small hand plane. Those who are expert with a well honed chisel can save time by roughing out with same but a plane is really necessary for finishing to get accuracy.

Continual eyeing the spar is necessary to ensure trueness.

The best wood for these spars is definitely Degame or lancewood. But failing these use straight-grained pine. The cognoscenti always split off the stock to ensure the grain runs cleanly along the piece and no cross grain exists along the length. Such spars (or masts) prepared in this way are most unlikely to warp. Do not attempt to use a timber such as Oregon pine or Pitch pine with resinous hard and soft grain. You need a wood with uniform textured grain. Oregon pine makes excellent masts/spars for full sized ships but for models leave it well alone.

Rigging

For information on naval rigging details consult Admiralty Manual of Seamanship Vols. 1 and 2. For commercial ships the two vols. of Plank on Frame Models by Underhill (Brown Son and Ferguson) are invaluable. The Manuals of Seamanship are often available as second-hand books. Their contents obviously vary with their age. Early issues still contain much Victorian navy stuff which is invaluable for modellers working in that period. How to stow stocked anchors on anchor beds or vertically on the hull side etc. As (this book is primarily not about 'stick and string' models no great explanation of rigging is called for.) However, a small amount of rigging is usually required on warships and liners. Over the years take every opportunity to build up an arsenal of suitable threads from natural cottons to synthetics, nylon, polyesters, Terylene, etc. One of the most useful items is a card of tights mending threads. These can be either of nylon (most useful) or Mercerised cotton (mercerise - to treat cotton yarn with an alkali to increase strength and impart a silky appearance). Visits to haberdashers shops can usually provide your wants but I always tell them that I build model ships which stops the queer looks mere males get if they penetrate largely feminist environments!

The problems are of two kinds. How to fix rigging to masts, spars, starfishes etc and where are the ends belayed to? It is usual to be able to sort out rigging on the parts of the mast silhouetted against the sky. The problem is where do the downhauls end up? It is usually very difficult to find where the lower ends of signal halyards and even standing rigging is fixed. If a rigging plan is available this will help enormously.

Otherwise it needs to be borne in mind that this problem will raise its head, usually when the model is largely complete, when a bit of forethought could have saved a lot of trouble. It ought to be possible to drill or etch holes in mast parts to aid rigging at an early stage if you have the forethought.

Davits

It is all too easy to make davits, at least at small scale, the same diameter all the way up. In real life they are tapered and producing them can be a problem. On the last model I made I found some brass dress making pins whose taper matched exactly to the drawing. These brass pins, as opposed to nickel-plated steel the usual variety, are made for lace making. Lace has to be pinned to a cushion during its construction.

Failing to find what you want, which is usually the situation, results in having to taper brass rod which can be difficult. Wire is usually too thin to use the lathe but the wood block shown in **Fig.6.17** helps. If the piece of wire destined to become a davit is held in a pin chuck with the other end laying in one of the grooves in the block a file can be used to taper the end. The pin chuck needs to be rotated as the filing proceeds. This block can be used for spars or anything that needs the tapering touch.

Cowl ventilators

If one strays into building ships of the late Victorian era onwards, in fact until the advent of forced ventilation, you will be brought to face the prospect of making a plethora of cowl ventilators. Late Victorian battleships had a forest of them sprouting up from the deck and super structure like trees.

There are several ways of making them. If they are not too large even gummed paper strip can be used. A former the size and shape of the interior will be required. Finish this smoothly with paint, sanding sealer or what have you and smother with candle wax to act as a non- sticking surface. Wind round a strip of gummed paper strip or ordinary paper. The width of the strip needs to be narrow enough to sit on the curve of the cowl without the edges sticking up too much. Follow this with another strip wound in a different way and this needs to be either wetted gummed paper strip or ordinary thin paper soaked in white PVA glue. Leave to dry and repeat as many times as necessary. Shape the paper with the fingers so that it hugs the former at every stage. When thoroughly dry it can even be sanded to shape.

It will need to be slit open along the underside to enable the former to be released. It can be glued back together again, more paper strip, and a piece of dowel rod fitted into the column to stabilise it. This can also be used as a fixing dowel. Additionally a brass wire can be used to bead the cowl and to add strength.

Crude though this method seems it is capable of producing decent parts for static models at least. The same method can be used to make ship's boats.

Metal Cowl Ventilators

Perhaps the best method, but certainly not an easy one, is to 'tin bash' them out of copper sheet and tube. The first thing to do is to rationalise the whole suite of ventilators. The Victorians had a habit of changing the size slightly for every one they made. These differences are tiny and can be ignored, in most cases. Careful examination will reveal that the whole suite can be made up in say three or four sizes and tools can be made up for these. The tools needed are shown in **Fig.6.18**. They consist of a male punch made to the interior size of the cowl and a female die which is only a hole in a piece of plate or cylindrical stock with the top of the hole radiused to help the material flow into it. The plate needs to be deeper than the cowl to avoid the cowl bottoming out at the end of the 'draw'. The hole diameter must be the size of the punch plus at least two thicknesses of the copper sheet being used. I have found old hot water tanks a good source of copper sheet. The technique is simple but long-winded and can be very frustrating. Firstly anneal the sheet which means heating it to cherry red and quenching out in cold water. Place the piece of annealed sheet over the die, centralise the punch over the hole (which you will not be able see) and tap with a hammer. As soon as you feel any resistance stop and re anneal. Continue until you have produced a deep enough draw to encompass the cowl you are making. You will need at least twelve annealings to do this - I said it was long winded! The frustration occurs when the punch splits the cowl. When this occurs another operation has to be carried out. This is known as 'hurling'- you hurl the defective part into the scrap bin. This is one time that strong language is likely to be heard in the workshop.

Instead of having a loose punch and die a lathe can be utilised to align punch and die. The die can be a short length of bar held in the 3-jaw chuck, faced off and drilled to the appropriate size with the leading edge rounded off. If the punch is held in the tailstock automatic alignment is assured. Instead of using a hammer the tailstock screw is used.

If you have enough perseverance you will eventually have enough pressings to manufacture the cowls by removing the waste flanges. These are then soft soldered to the columns which need to be contoured at their top ends to fit the cowls. Next the part of the cowl sitting over the column needs to be removed. A spherical burr in a hand held drill is probably best to make the initial hole up the column but ending up with a cylindrical burr to clean up the edges. Do not attempt to drill this out, disaster is sure to befall your efforts.

The column can then be slipped onto a rod for finishing off the soldered joint with a file and emery. Application of a polyester filler is usually also necessary to get a smooth flowing shape.

If the cowl seems a little fragile it can be filled with sealing wax to support it when filing. Wood's metal, if you can find it, is even better. (Wood's alloy melts at 71deg C and was used by my father's generation for fixing crystals into their holders in the cat's whisker days of wireless. Their source of heat was a match).

The above method is not easy but it produces a superb job. **Fig.7.19** (see colour plates) shows a collection of ventilators made in this way for the author's model of HMS Magnificent.

Another method exists of which neither the writer, nor any of his friends, have had any personal experience. How many problems the method gives is not therefore known. The method is to use electrolysis to deposit copper on to a lead casting of the component to a sufficient thickness to produce a freestanding component after the lead has been melted out. It is understood that parts of the big glass case liner models seen in shipping offices and the like were made in this way. Space prevents a description of the method but, no doubt, the technique can be found in books on electro-plating. The Model Ship Builder's Manual (of fittings and guns) by Captain A P Isard, Faber and Faber Ltd. (first published 1939 and long since out of print) gives the method in some detail.

DECKS

There are many ways of producing these, from putting pencil or ink lines on a piece of plywood to laying individual planks to Admiralty specifications. However, once you have put down a laid deck with separate planks you are not likely to revert to the former.

Ruled Decks

If care is taken with ruling the ink or pencil lines and the butts are put in correctly a fair job can be produced. What lets it down is the fact that the grain flows across the planking which it cannot do if separate planks are used. Care is needed to get the hardness of the pencil right to produce a realistic line of caulking. If ink is used a tubular draughtsman's pen is probably best. One possible trouble may occur if the deck surface is not sealed, as the ink may bleed into the grain. The surface should be sealed first and probably after the ink job as well. Needless to say, the whole job needs to be neatly executed which will involve a lot of work if margin planks, joggling and waterways are included. Some test work is indicated before starting on the decks proper.

Laid Decks

Several methods have been developed by various people particularly in how to show the pitch caulking.

The first process is to establish a false deck on which to lay the planks. If hardboard is used, which although quite good in that it provides a hard, stable surface, it cannot be pierced with pins easily and, if these are required for the subsequent planking process, this is a distinct disadvantage. Plywood could be used equally well and not have this last disadvantage. It is best to inset the false deck so that its edge is not seen. If the hull is carved put a rebate round the inside of the hull to let in the deck. **Fig.6.20** (see colour plates). If plank on frame is the method of construction bring the hull sides up round the deck. This false deck should be supported by the necessary deck beams and at least one longitudinal stringer. These should impart the necessary deck curvature (camber). An alternative is to lay the false deck flat, lay thicker planks and plane in the deck camber after laying.

Whatever the arrangements adopted make sure the false deck is firm and stable before continuing with the planking. It also pays to consider if any holes are required for companionways or the like or to fix anchor chain. Once planking has been completed cutting holes in the deck can be difficult.

One decision remains and that is how the deck furniture is to be fitted. Is it going to fit onto the uninterrupted surface or is it going to penetrate the false deck and sit on the deck beams? With my last model the barbettes penetrated the false deck and sat on the pre-levelled deck beams. This meant no curvature was necessary on the base of the barbette to accommodate the deck camber. It also meant the barbettes could be machined as a constant height cylinder. The rest of the deckhouses sat on the false deck but, to avoid camber problems, the false deck was chiselled off level over the area of their contact. With all the main parts screwed down the planking could start with all the margin planks being fitted around them.

One problem with laying separate planks is keeping them straight. It should not be a problem but it is. Pencil lines need to be drawn, say half an inch apart on the false deck parallel to the centre line as a guide. Where planks have to have angled ends to fit round a barbette the ends tend to 'fan' the planks. See colour plate **Fig.7.8**.

If the alternative method of sitting everything on top of the deck is adopted everything will need to have the deck camber impressed on its base. This can be done by putting a piece of abrasive paper on the deck and dragging the component to and fro until the requisite concave shape has been formed.

Try and get the plank widths to scale. You will have trouble with the judges if you plank Victorian warships with ten inch or twelve inch wide planks because they are used to modern ships with narrow planking. Nineteenth century ships had wide planks because wood of that quality was still available; it is not any more, hence narrow planks on modern ships.

The caulking can be simulated in a number of ways:

1. Black paper can be suck to one edge of the plank.
2. Soft pencil (2B) can be rubbed on one side and on one end of each plank.
3. The planks can be laid using white PVA glue that has been coloured with black poster colour powder. This makes a glorious mess (see **Fig.6.21**) but cleans up nicely. The only problem with this method is that the black glue exudate hides the joints and can make accurate plank laying a trifle difficult.

If this method is adopted do not attempt to sand the surface. Sanding will produce black dust which will get rubbed into the surface and ruin your pristine deck. Clean off most of the glue exudate with a sharp chisel and then plane the surface with an adjustable mouth plane with the mouth closed right up. A plane of this type is shown in **Fig.3.12**. Closing the mouth as far as possible will reduce any tearing of contrary grain to a minimum. It is impossible when laying a deck of this type to ensure the grain on all the planks lays one way!

For models at small scale probably the 2B-pencil technique is best.

Another technique can be used if the plank width is very small, say 1/32in. It becomes difficult to lay such thin planks individually as they bend and have a life of their own. In this case a sandwich of four planks can be made up and laid as one piece. It will be necessary to put the butts (plank ends) in afterwards with a pencil but on such thin planks this looks satisfactory. The way to make up the sandwich is to obtain sheets of a suitable wood (bass wood - American lime) of the thickness of the finished planks, in my case 1/32in and cut them to the same size, say 12in x 4in. Spray *one* side of each piece with grey surface primer and, when dry, stick them together one on top of the other. It will be necessary to lay them on a dead flat surface and put a similarly flat piece on top the object being to get an accurate, flat and consistent sandwich. Strips can now be sawn off 1/16in thick and laid on the deck in 1/4in wide pieces i.e. four planks. Note: the original sheet thickness has become the plank width. The accuracy of the last cut is not of any great importance as these will be cleaned up when glued down in situ. The length of the sandwich needs to be long enough to cover the longest length of planking on the model. You cannot butt four planks together, as this would contravene the Admiralty planking rules which state that there must be three unbroken planks between any two butts. The butts normally lie in a line transversely across the deck and not in a random pattern seen on some models. Some ships are laid with four unbroken planks between two butts and this is known as a four-butt deck. See **Fig.6.22**.

Normally planks are laid parallel to the centre line of the hull but exceptions do occur for a small area of deck or for bridges and the like. Luxury yachts, however, sometimes have the planks laid in a curve parallel to the deck edge and are joggled into the central king plank.

Normally the edge of the deck is margined by two planks. The outside plank is known as the waterway and between this and the planking proper lies the margin plank which is wider than the normal planking. Into this plank the ordinary plank ends are joggled where required. **Fig.6.23** explains this. Also at the extreme edge of the deck a spurnwater is fitted. This usually consists of a small upstanding bead.

It will be noted that no plank end is ever left as a point. A moment's reflection will show it could not be secured if it were. Instead the tapered end of a plank is cut off

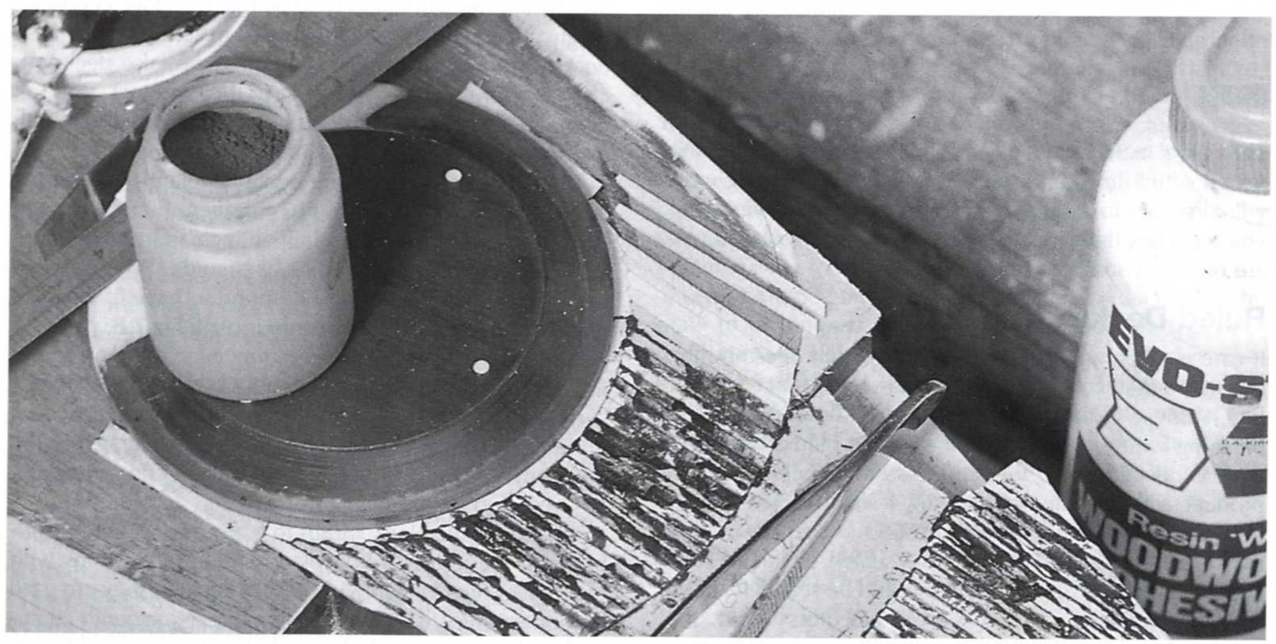


Fig. 6.21 Deck laid with black poster colour before cleaning off

Fig. 6.22 Plank butt pattern

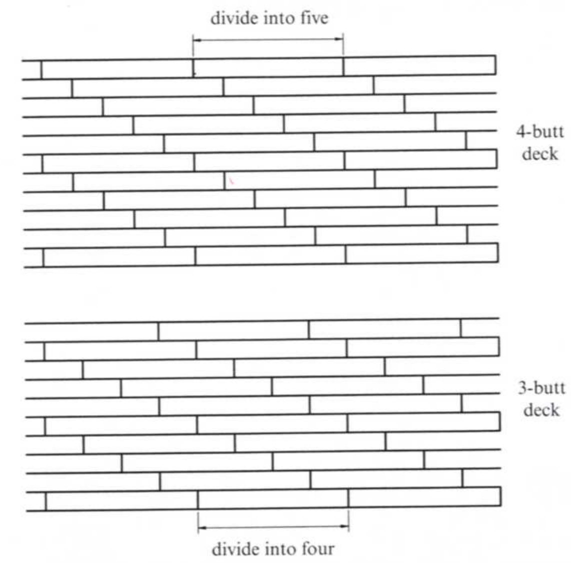
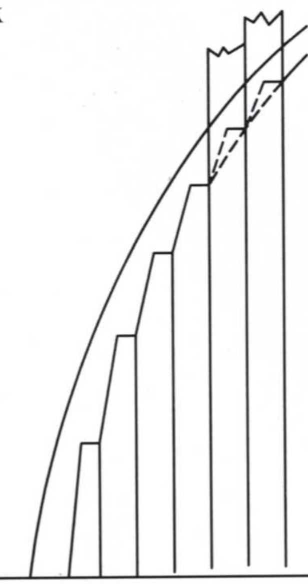


Fig. 6.23 Planking joggled into margin plank



square; the length of this must be half the plank width. The rule was that if the tapered end of the plank, the snape, was greater than twice the width of the plank it had to be joggled into the margin plank.

One of the most prolific sources of error and malpractice occurs with decks on models. You see two butts lying adjacent with the rest sprinkled like confetti over the whole deck area. You even see models with planks made from special trees (very, very tall ones!) with no butts shown at all.

One word of caution. With very narrow planks do not try to joggle as the result usually ends up as a mess - very untidy. It is best to shape the plank end first before laying it over the uncut margin plank as seen in **Fig.6.23**. The shape of the cut-out in the margin plank can then be marked. It can be done the other way round but the aforesaid method seems more practical.

Some early warships had freestanding bridges with little or no under supports. One way of making these is to bend them from brass sheet. Normal wood planking can then be epoxied onto the top surface in the normal way. However, if left in that condition the wood planking will slowly straighten out the curve in the brass. To stabilise the laminate you will need to attach a piece of wood veneer to the underside of the brass. If veneer, and your planking is a kind of a veneer, is glued to a sheet of plywood, Bakelite, etc. a balancing veneer is *always* needed to produce stability so, even if you decide the strength of brass is not necessary and you substitute 1mm ply instead, it will still need a balance veneer on the underside. Unless you have experienced the strength of veneer first hand it is difficult to comprehend this phenomenon.

Sequence of Deck Laying

It is usual to start by laying margin planks round objects like barbettes, hatches, etc. Following this the central plank lying on the centre line (the king plank) is first fixed. You will need to decide if a three-butt or a four-butt deck is to be laid and work out the position of the butts on each line of planking. Draw transverse lines across the deck at the butt lines as a guide. It is best to assume a plank length of twenty feet which, at a scale of 1/192 gives a length of 32mm (1-1/4in). Use PVA to secure the planks, preferably one of the fast grab types. This assumes the false deck is wood or hardboard. If it is metal an epoxy glue would be a better choice.

To ensure that the planks lie snugly together slide a piece of straight non-ferrous metal up against the free edge of the plank and secure it somehow. Use dressmaking pins or heavy weights and try and keep the free edge of the planks free from glue exudate otherwise, if this hardens, difficulty will be experienced when laying the next plank.

Bending Problems

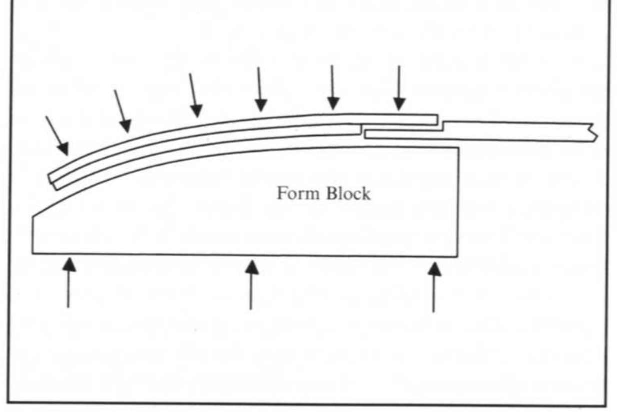
One problem continually occurring in model boat work is bending planks and the like. The classic ways are to steam, soak or use ammonia (of which the writer has no experience)

The problem with wetting is that the component swells and then shrinks on drying. If it is fitted whilst still wet, gaps, will in all probability, occur on drying out. In certain circumstances these methods may still be necessary.

A safer way, which keeps water out of the equation, is to laminate the parts and glue in the curve. If two or more layers are employed in producing a curve the laws of physics make them slide over each other; the length on the outside of the curve being longer than the inside. If they are glued up and held in that curve, whilst they dry, the curve will be built into the system and the result is likely to be absolutely stable.

The round -down on my carrier Glorious was made in this way. See **Fig.6.24**.

Fig. 6.24 Aircraft carrier round down



Allied to the above is the understanding of the role of the grain when making curved articles. This is gone into in some detail in Chapter Four, page 27.

Fig. 1.10 HMS Magnificent incorporated photo-etched parts, the first use of this technique by the author. Scale 1 : 110.

Fig. 1.11. Choice of HMS Belfast as a prototype enabled the author to examine the detail of a vessel at first hand.

Fig. 1.12. Substantial brass standoffs can be seen supporting authors 1 : 150 scale model of HMS Queen Elizabeth

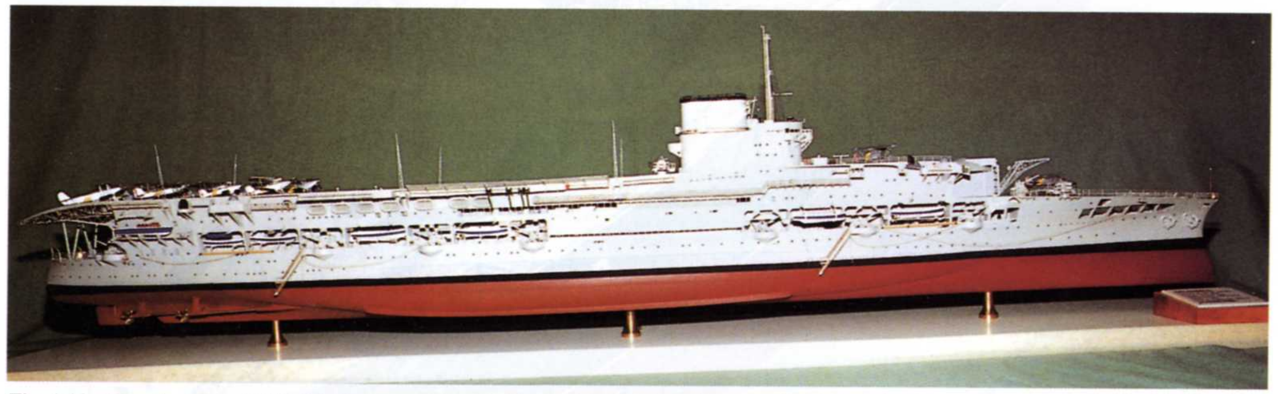


Fig. 1.13. Aircraft carrier HMS Glorious complete with highly detailed aircraft to a scale of 1 : 192

Fig. 1.14. HMS Anson, 1 : 192 scale, the most recent model to emerge from the authors workshop.

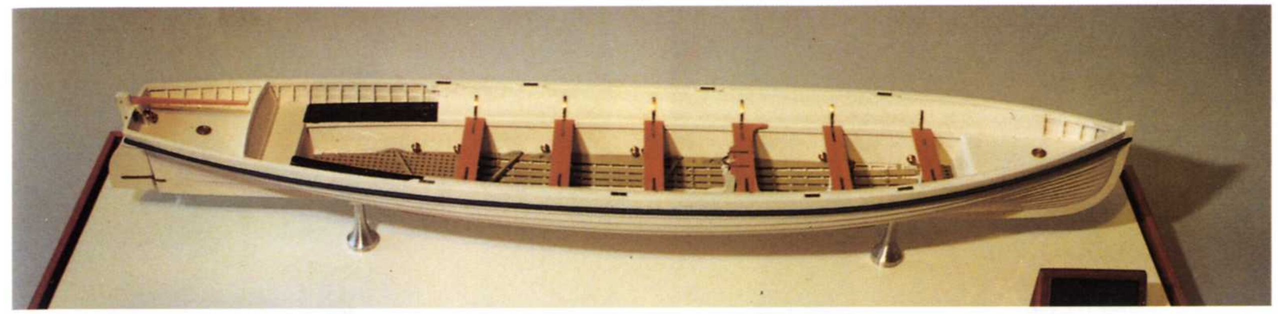


Fig. 1.17. Life gig of 1872 clinker built

Fig. 2.3A. Aft superstructure on author's Belfast model.

Fig. 2.3. The detail picked up from photographs taken during a visit to Belfast proved invaluable during building of the model.

Fig. 2.6. Paddle tug John H Amos under way. (Dave Watkin photo)

Fig. 3.5 Minature drill press. Top cover not shown

Fig. 3.9. Ball jointed vice.

Fig. 3.12. Adjustable mouth plane

Fig. 3.13 Lathe (3.5" Myford), probably the single most useful machine tool for fine model building to be found in the author's workshop.

Fig. 3.20. Bandsaw

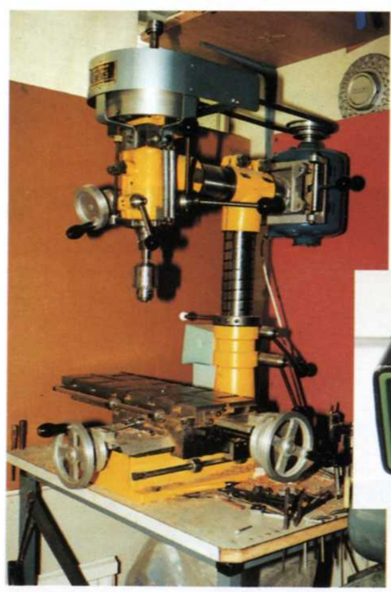


Fig. 3.18. Dore Westbury milling machine can be built from kit of parts providing lathe is available.

Fig. 3.23. Minicraft transformer/speed controller unit for low voltage hand-held tools.

Fig. 3.33. Cast metal propeller for Belfast with replacement machined exit cone.

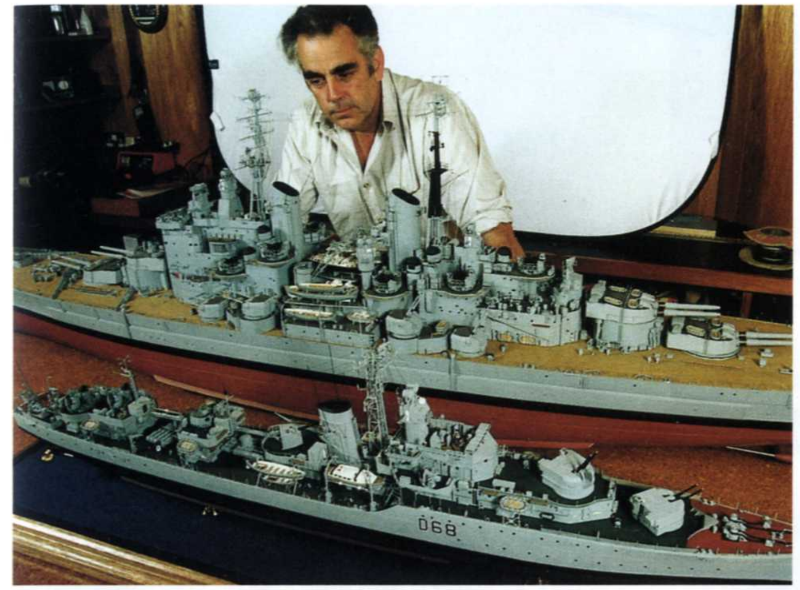


Fig.4.3. Alex MacFadyen with his models of the battleship Vanguard and the Battle Class Destroyer Barrosa. (Ray Brigden photo).

Fig. 4.4 Detail of starboard side - midships scientific gantry on RRS James Clark Ross by Jimmy Wood. (J Wood photo).

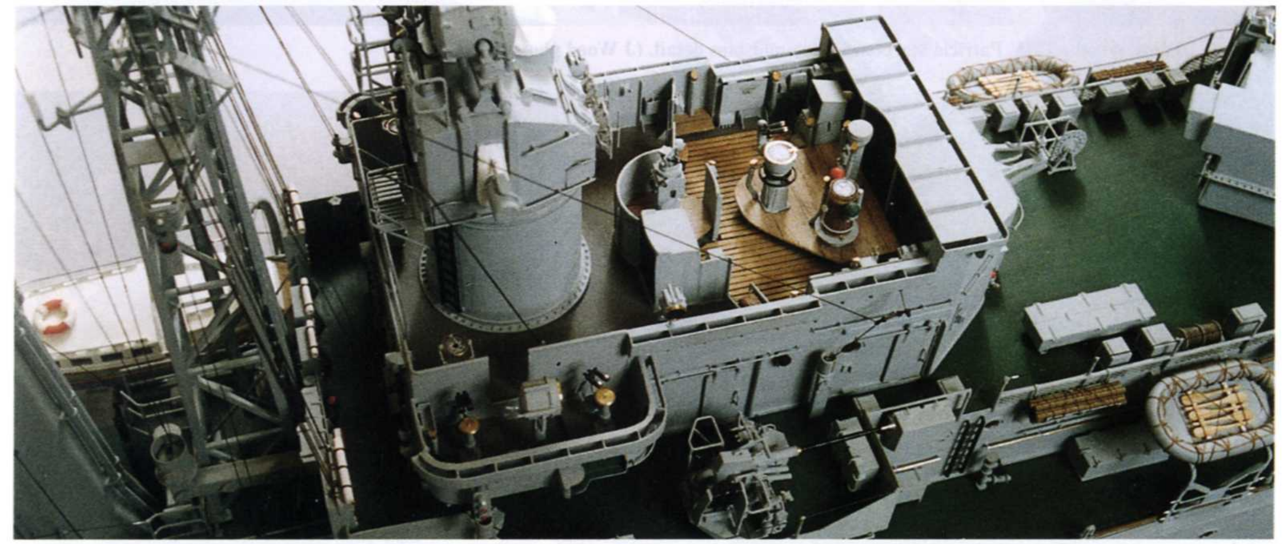


Fig. 4.5. Alex MacFadyen - bridge of Barrosa. (Ray Brigden photo).

Fig. 4.6. Jimmy Wood - CS Alert showing aft 'A' frame gantry in stowed position. (J Wood photo).

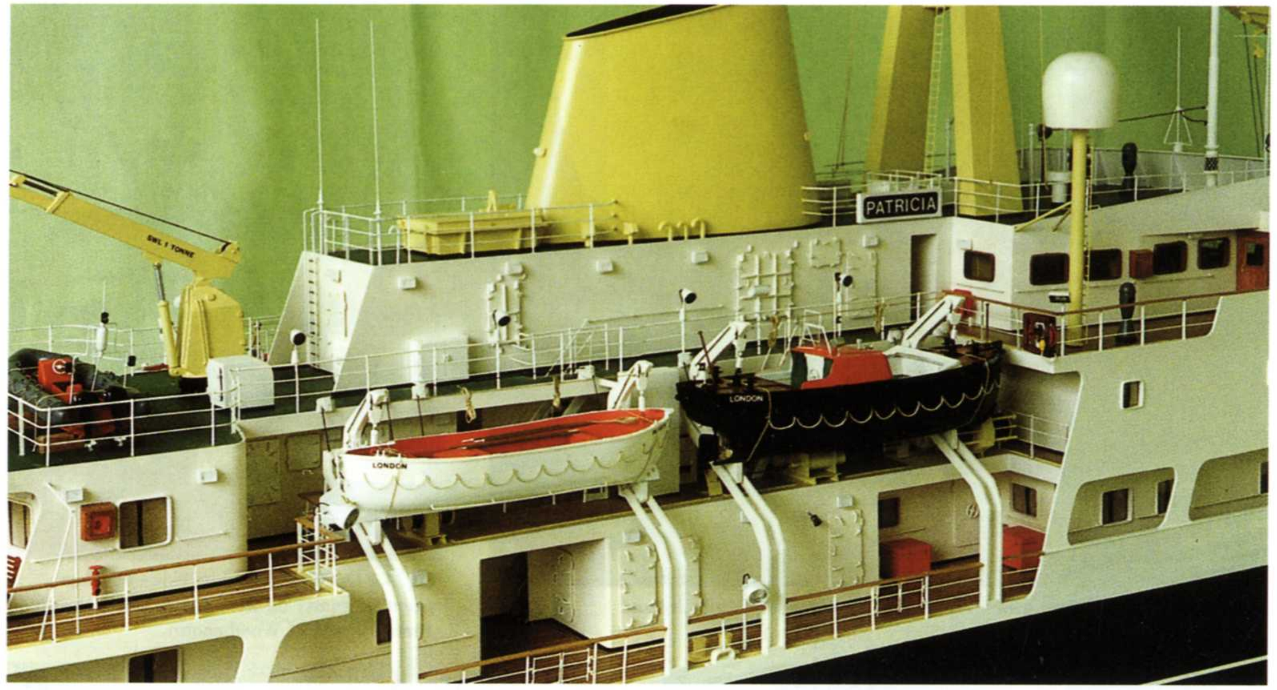


Fig. 4.8. Jimmy Wood - THV Patricia starboard side amidships detail. (J Wood photo).

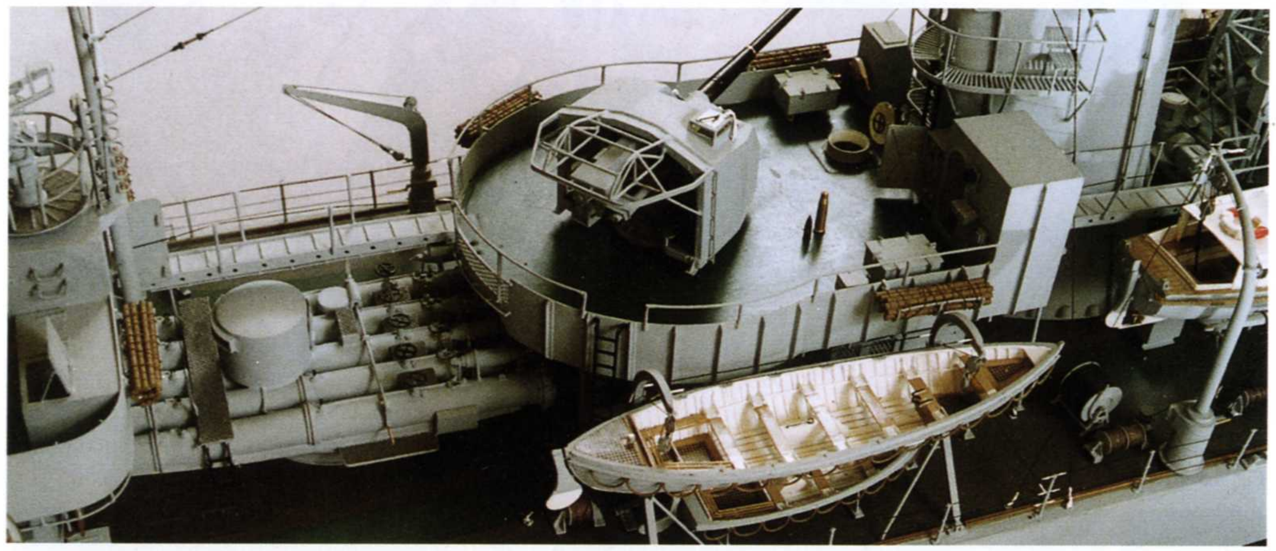


Fig. 4.9. Note the internal detail on the boat shown here on Alex MacFadyens Barrosa. (Ray Brigden photo)

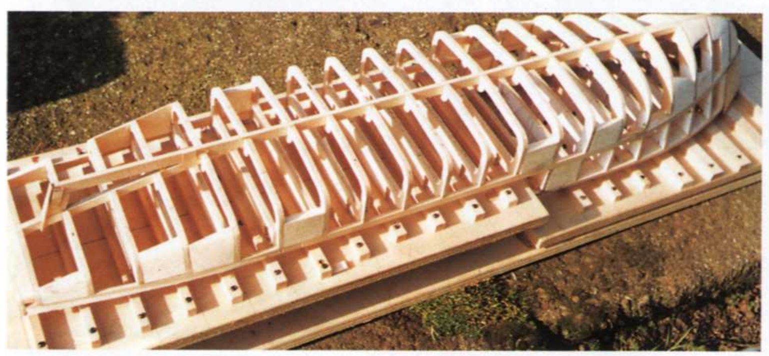


Fig. 5.10. The structure of a Plank on Frame model before planking. Note the two tier base board. (Dave Watkin photo).

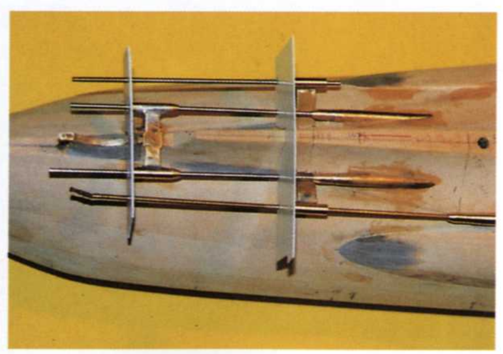


Fig. 5.17. Propeller shaft jigs to maintain alighnment whilst fixing the shafts and tubes into the hull.

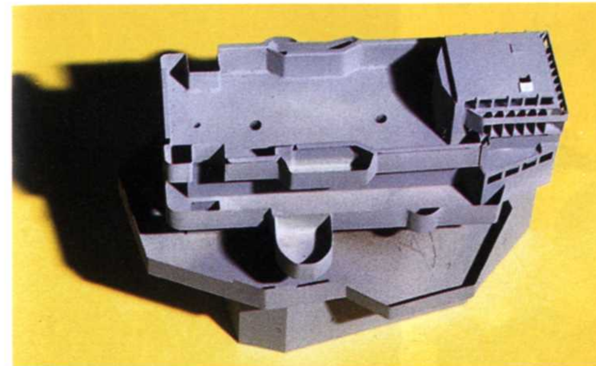


Fig. 6.3. Assembled Anson bridge.

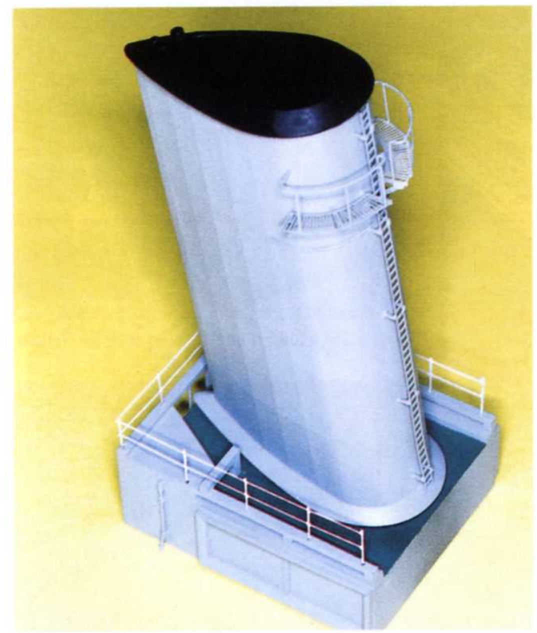


Fig. 6.4. Belfast funnel - complete

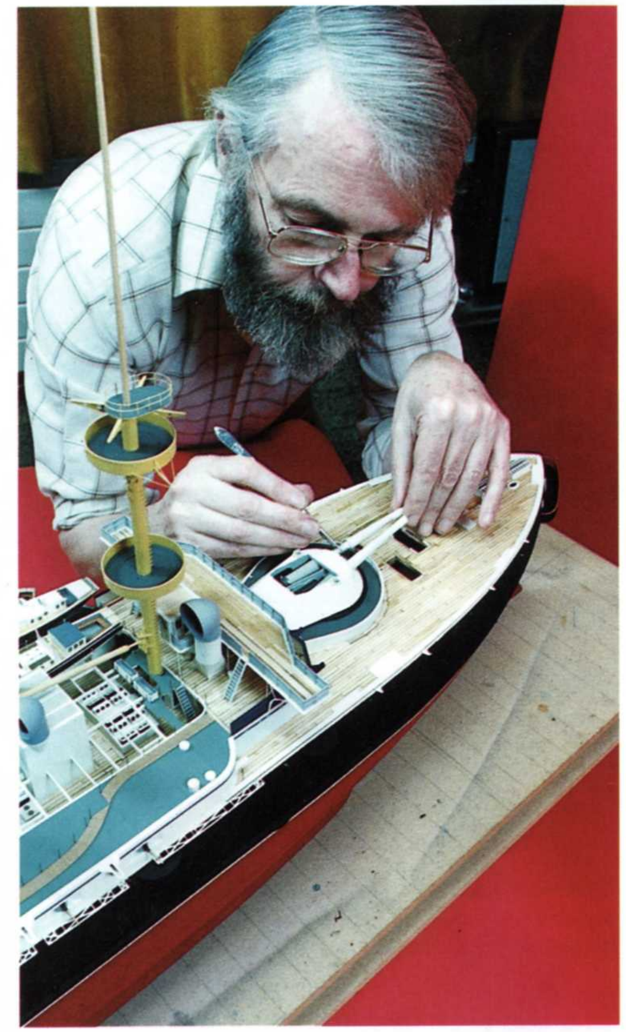


Fig. 6.11. Author at work on gun barrels - note typical late Victorian mast

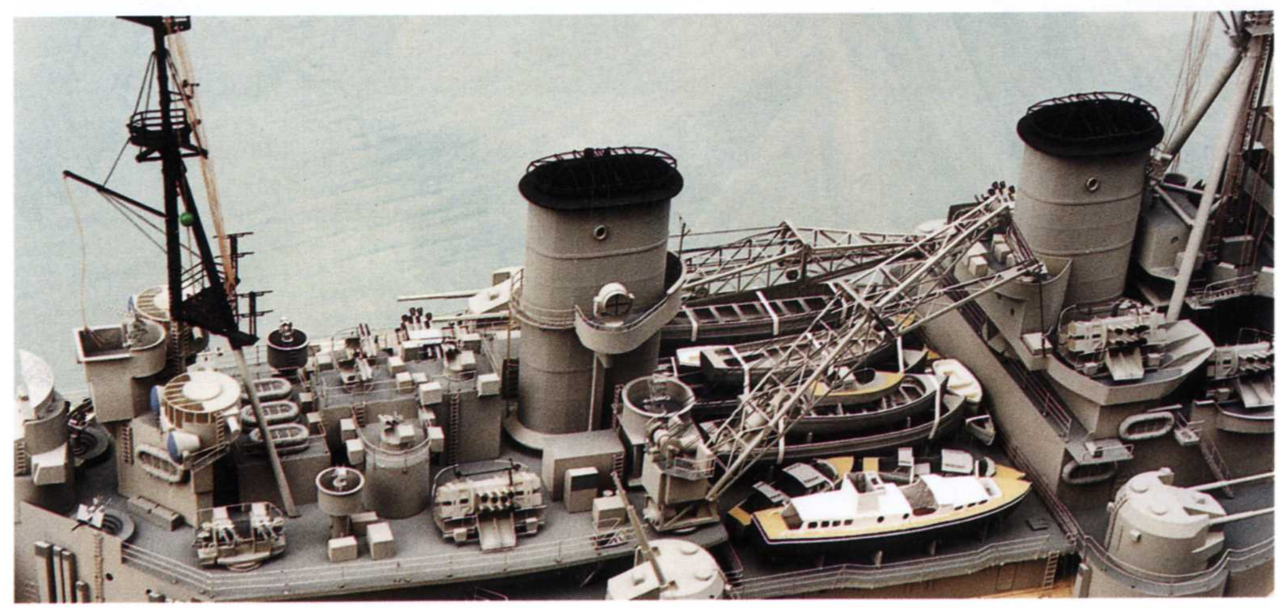


Fig. 4.12. 1930's tripod mast

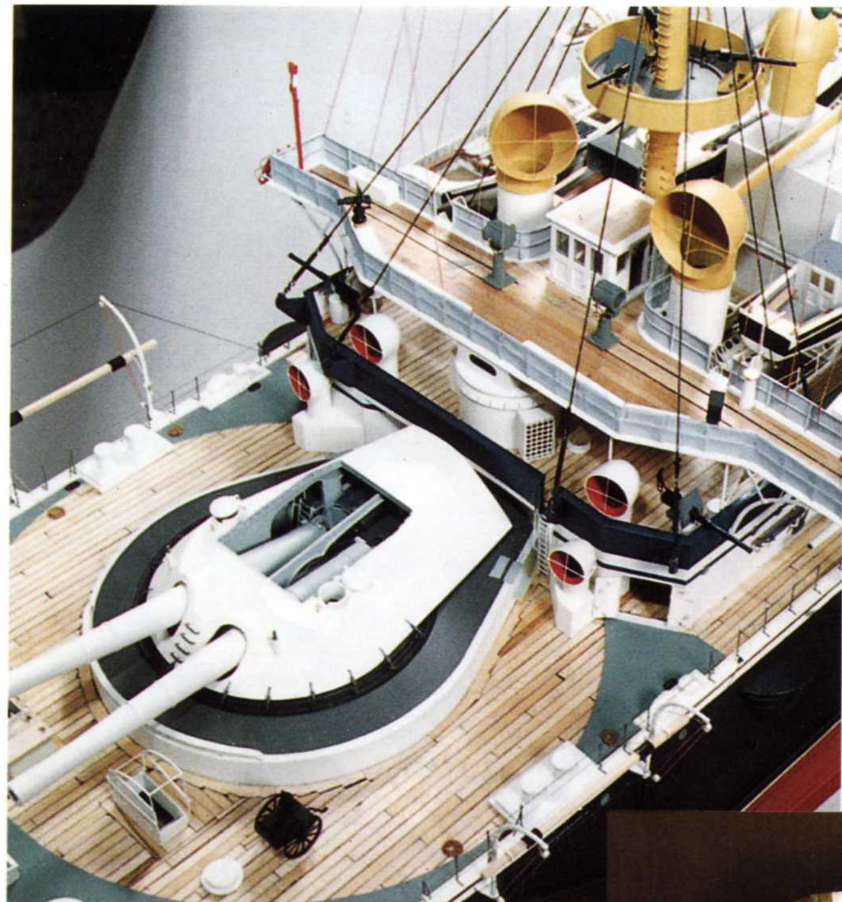


Fig. 6.19. A forest of copper cowl ventilators made by the 'tin bashing' method on the Victorian battleship Magnificent.

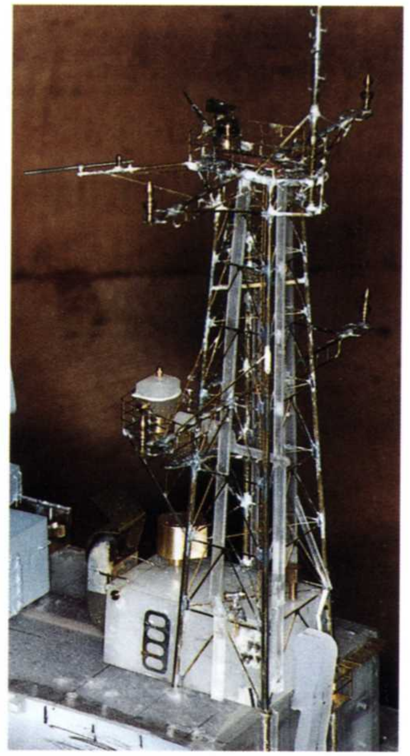


Fig. 6.16. Modern lattice mast seen on Belfast.

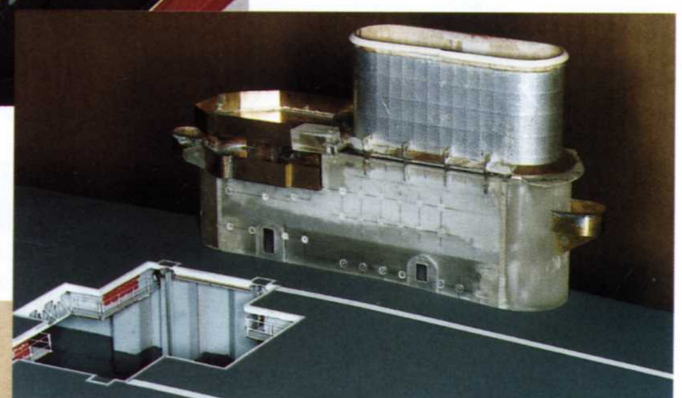


Fig. 6.7. Glorious - showing rivet pattern on funnel also machined in port holes and local thinning down on inside of door apertures.

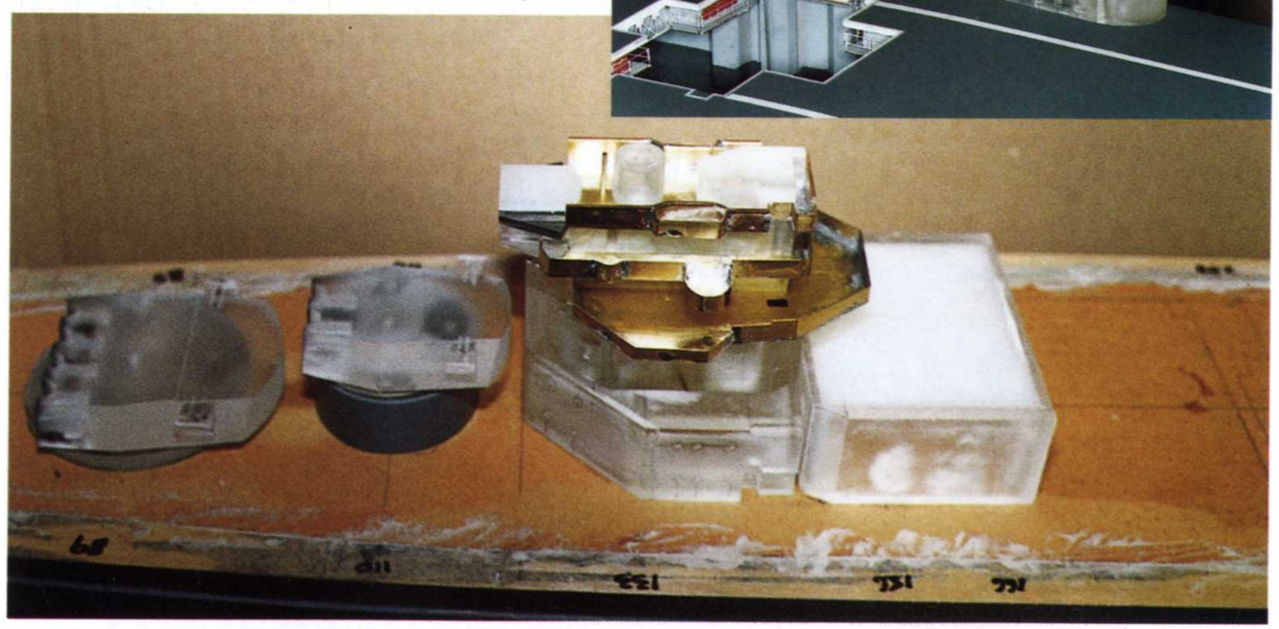


Fig. 6.20. Hardboard let in to top surface of hull. The numbers on the deck edge are frame numbers.

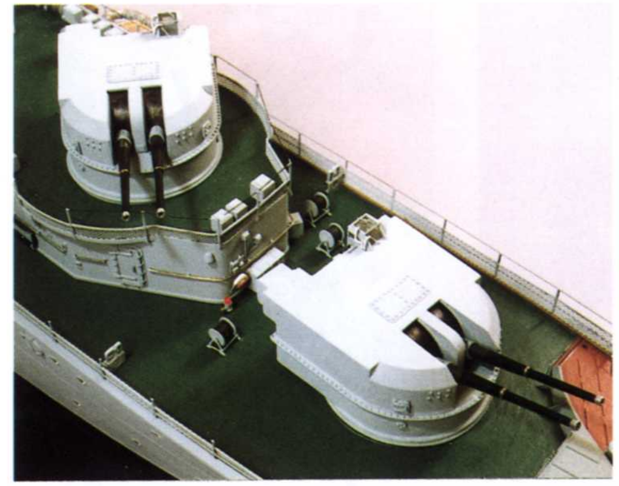


Fig. 7.3. A different shape of turret on Barrosa by Alex MacFadyen. (Ray Brigden photo).

Fig. 7.5. Belfast turrets (all 4 of them) in Dural and brass.

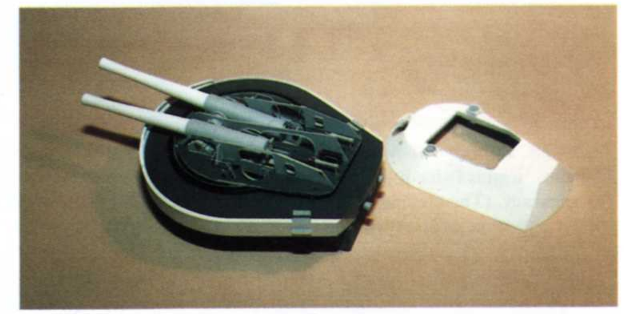


Fig. 7.7. Magnificent turret - the parts shown in Fig.7.6 painted and assembled with the turret proper made up from Perspex.

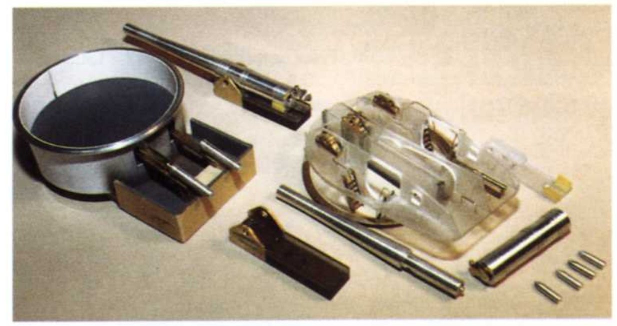


Fig. 7.6. Complete parts before painting for aft turret of Magnificent 1894. The round object on the left is the barbette with hydraulic rammers working through the side holes.

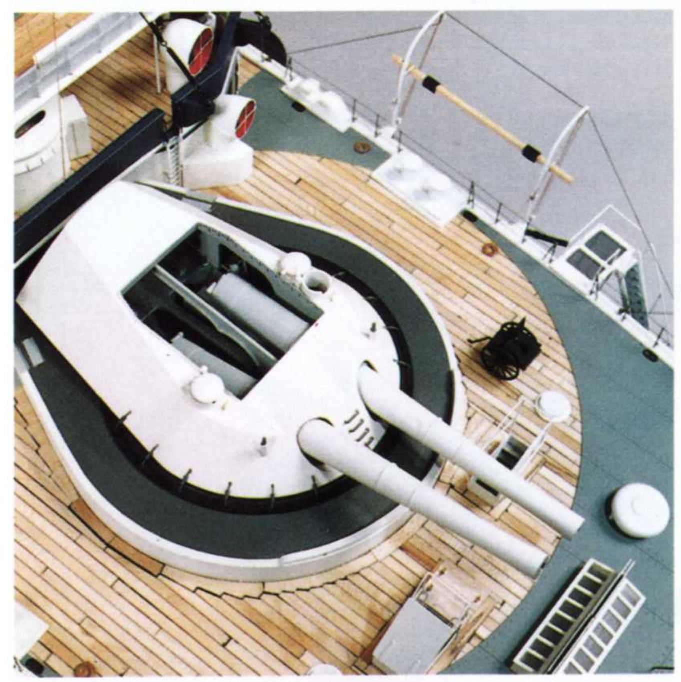


Fig. 7.8. Magnificent turret shown fitted to the ship. Note blast plates on deck to avoid powder burns on planking and planks joggled into margin planks around barbette.

Fig. 7.21. Four barrelled Pompom.

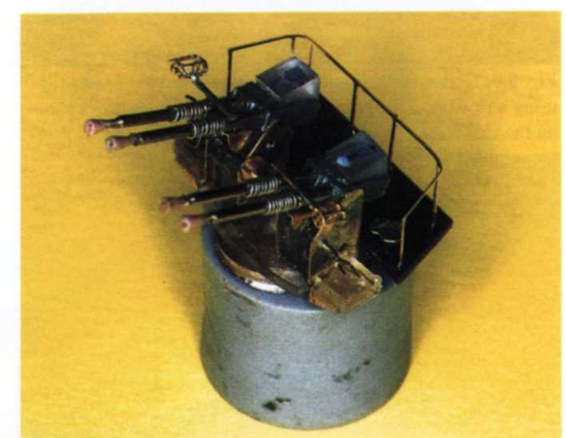


Fig. 7.27. View of Quad Bofors for Anson - scale 1 : 192

Fig. 7.29. Left, the final un-painted version of a 4.7in dual-purpose HA/LA gun for Glorious. Right, twice full-size mock up using the etching drawings as a pattern to check for accuracy. (The etching drawings are drawn twice final size). This is an example of a totally open gun position with no turret or shields.

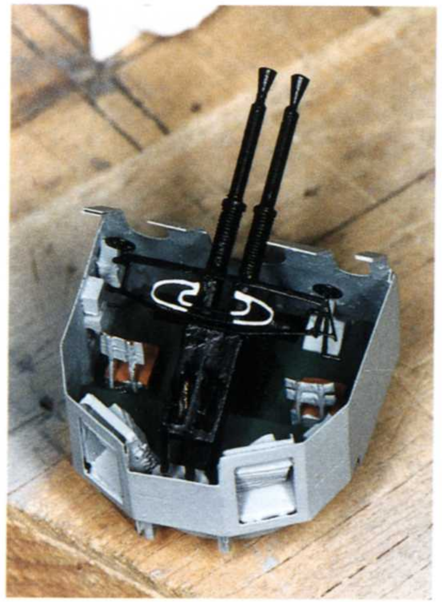


Fig. 7.30. Twin Bofors for Belfast 1 : 150 scale.

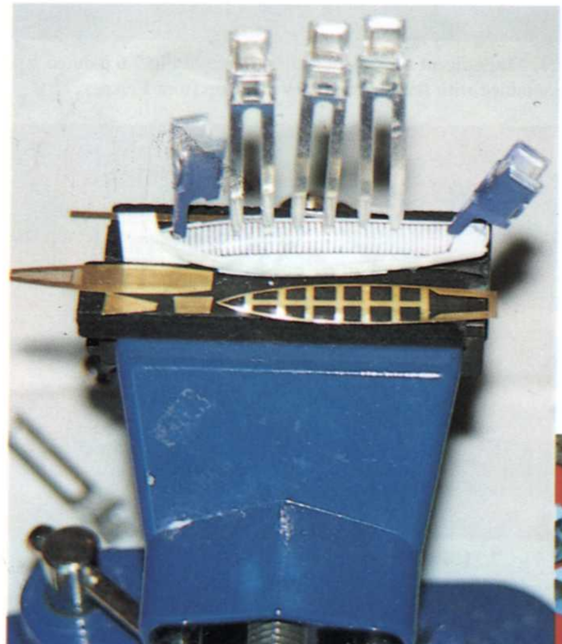


Fig. 8.9. Fitting etched timbers and inwale to boat moulding using hair clips. The remainder of the etched parts are sitting on the vice jaws.

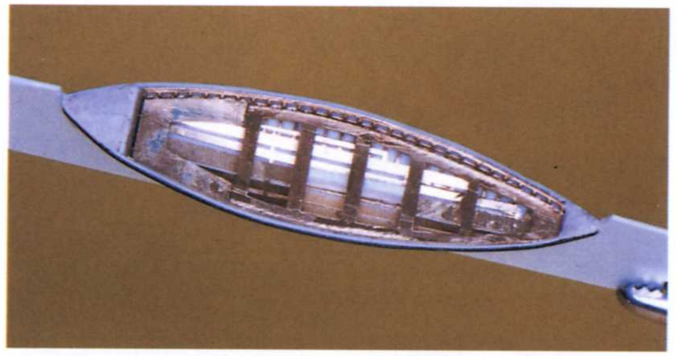


Fig. 8.10. Assembled 27ft whaler at 1 : 192 scale for Anson. The over-sized keel is held in a pair of Spenser Wells forceps.

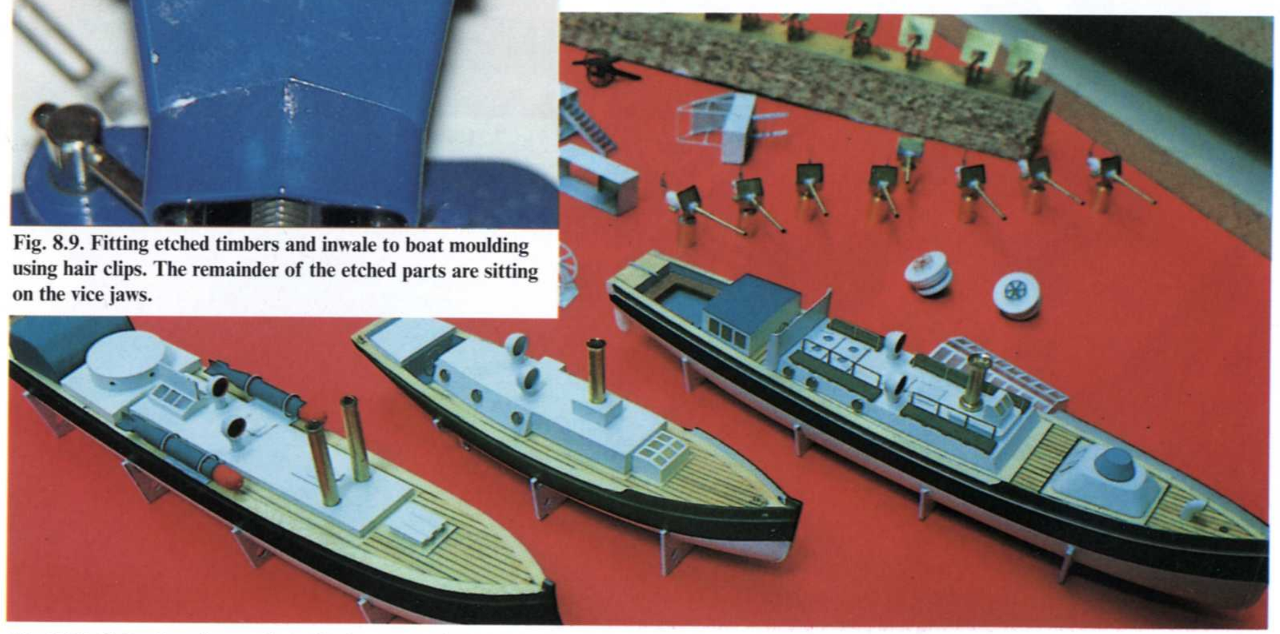


Fig. 8.13. Collection of carved wooden boats, etc. for Magnificent.

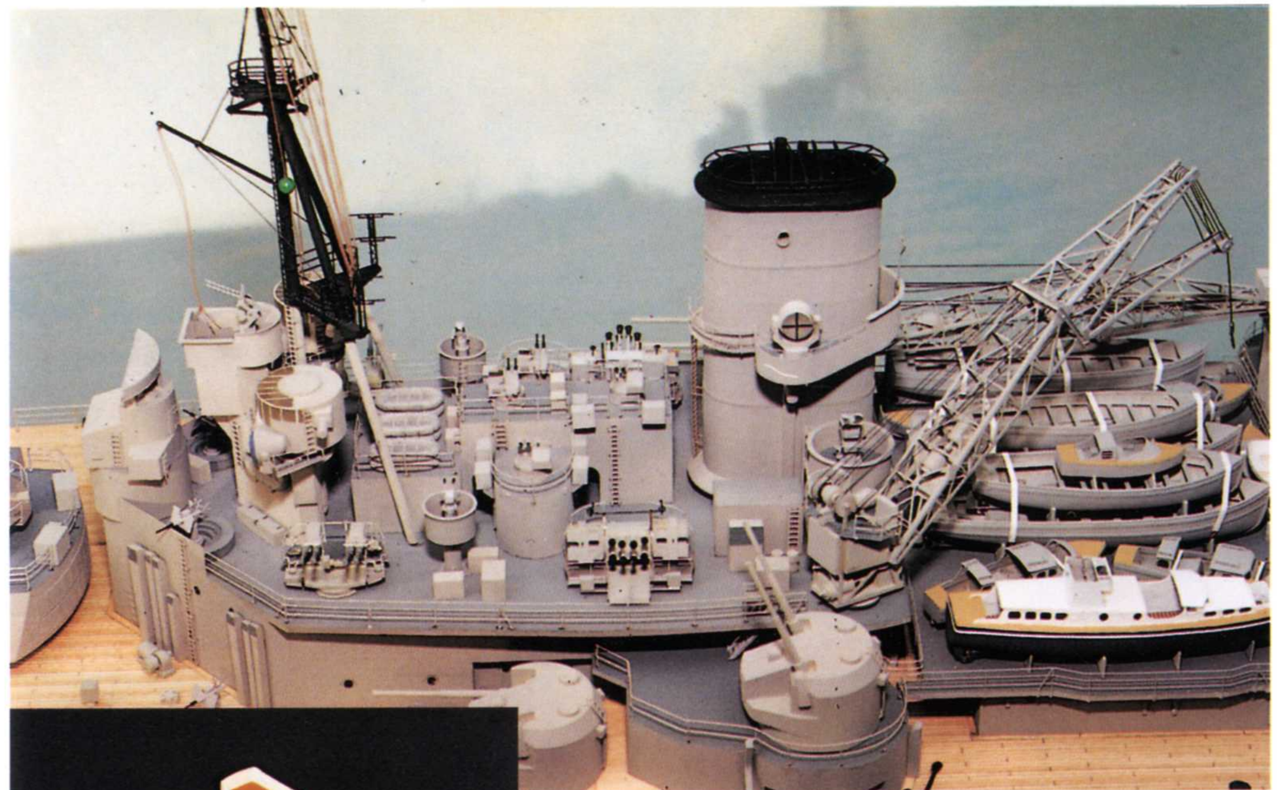


Fig. 8.18. Ship's boats on Anson sited over the old catapult position.

Fig. 8.14. Some of Belfast's ship's boats.

Fig. 8.26. Model of Fairey Seal at 1/192 scale (wingspan 71mm).

Fig. 9.2. Red anti-fouling sprayed by car aerosol.

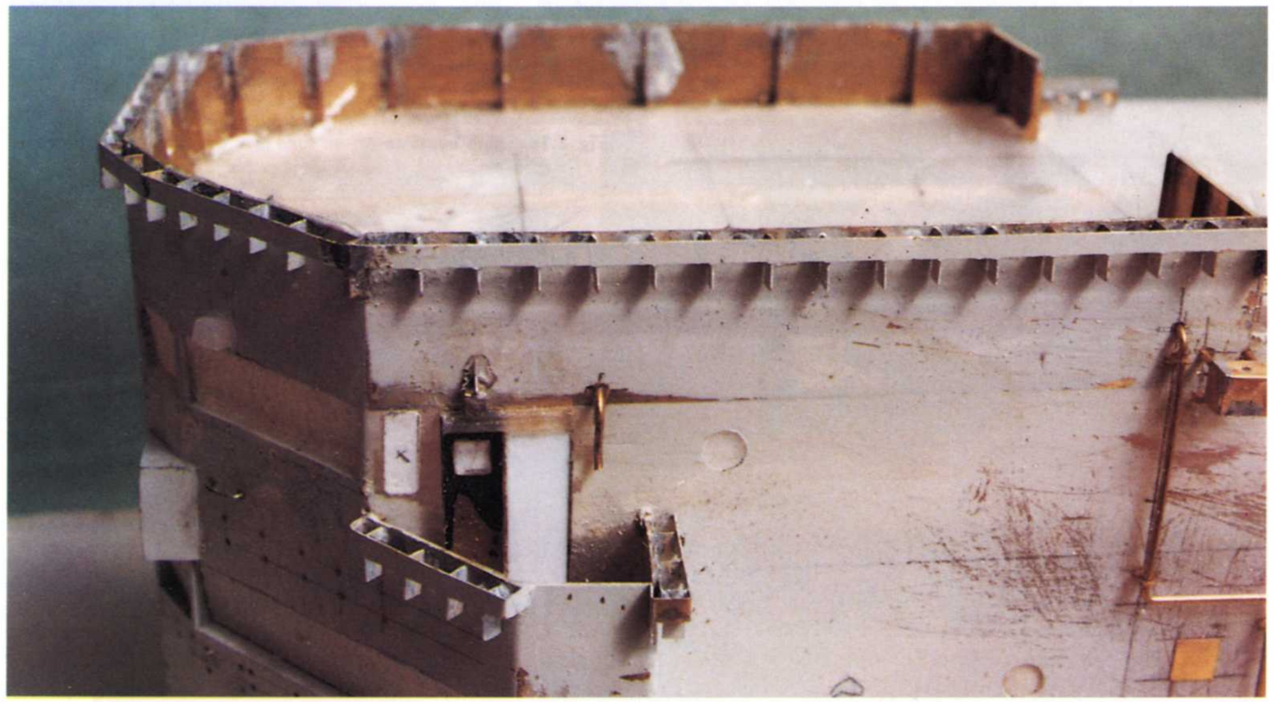


Fig. 9.3. Sacrificial coat applied to bridge.

Fig. 9.6. Hull of Anson sprayed with primer and plated with cartridge paper.

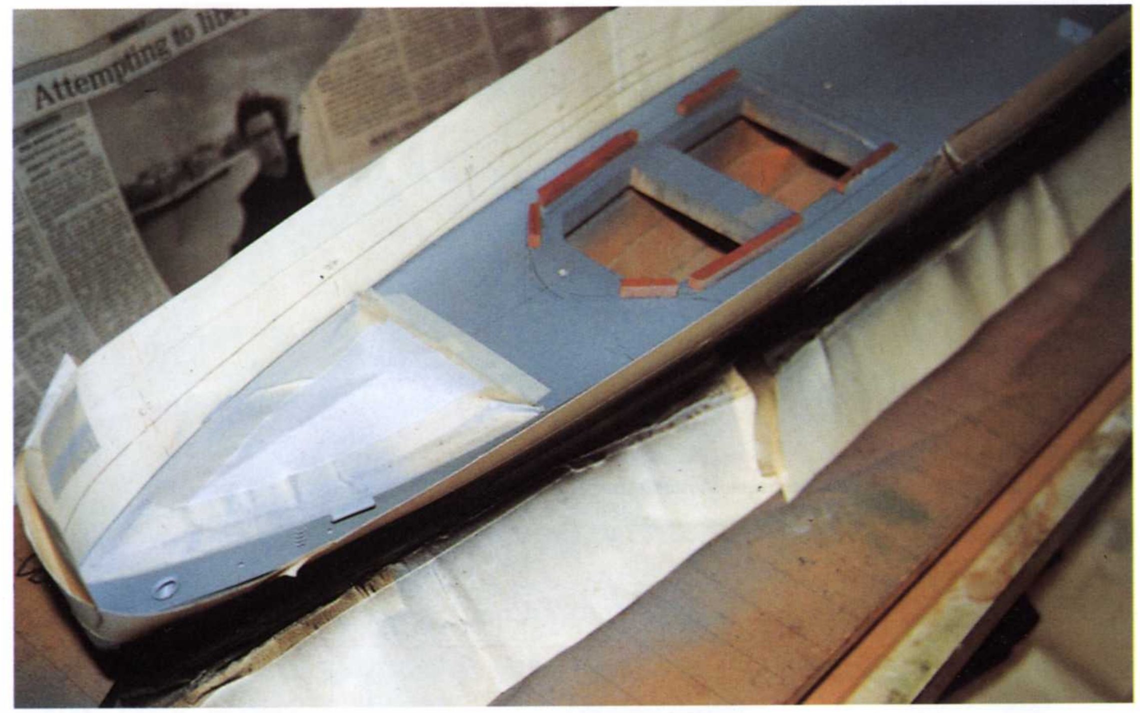


Fig. 9.7. Masking for black boot topping spraying. Note use of cartridge paper above and below defining tape.

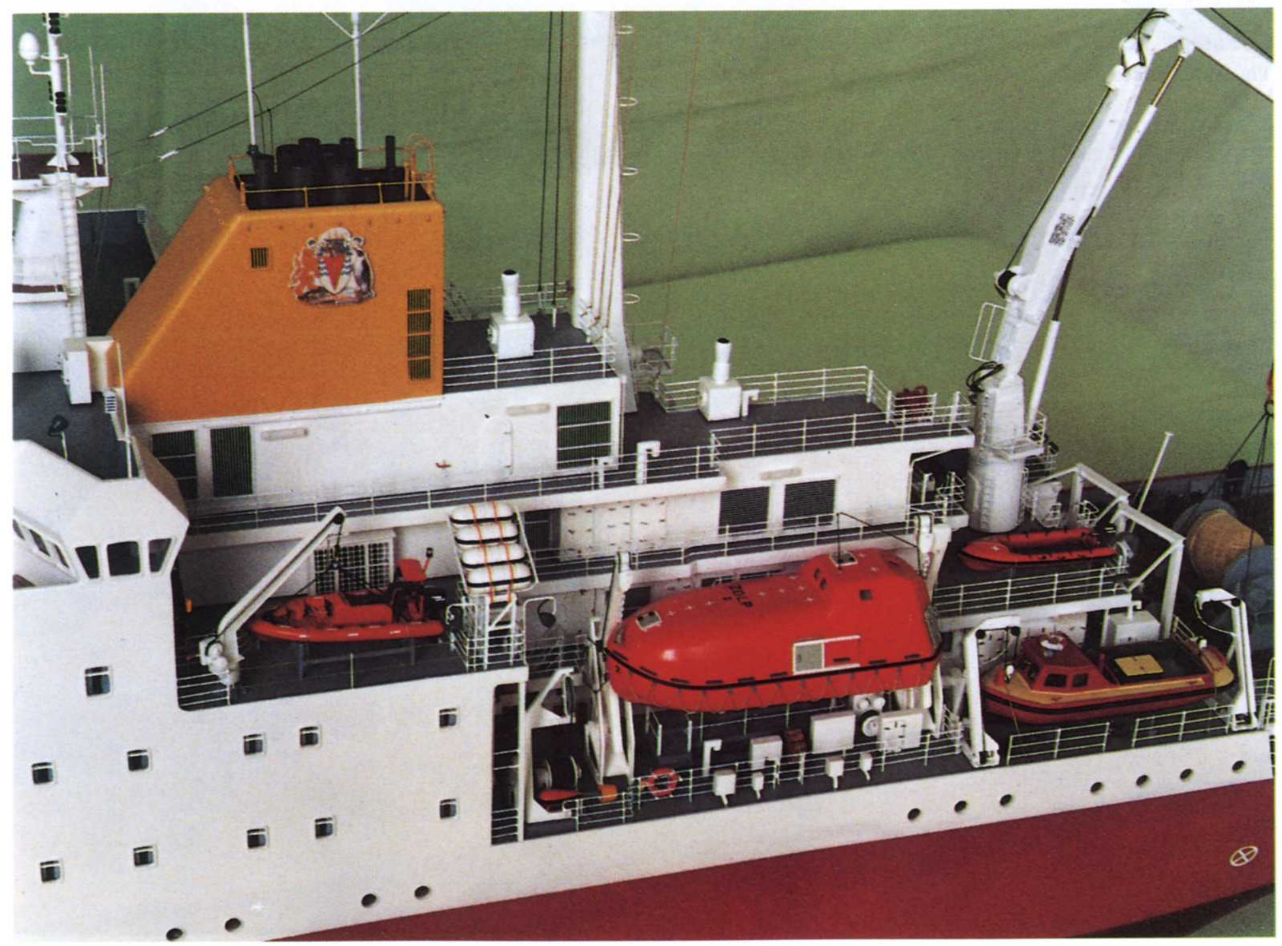


Fig. 9.9. RRS James Clark Ross by J Woods. (J Woods photo)

Fig. 9.13. Painted highlights and shading emphasis on Magnificent.

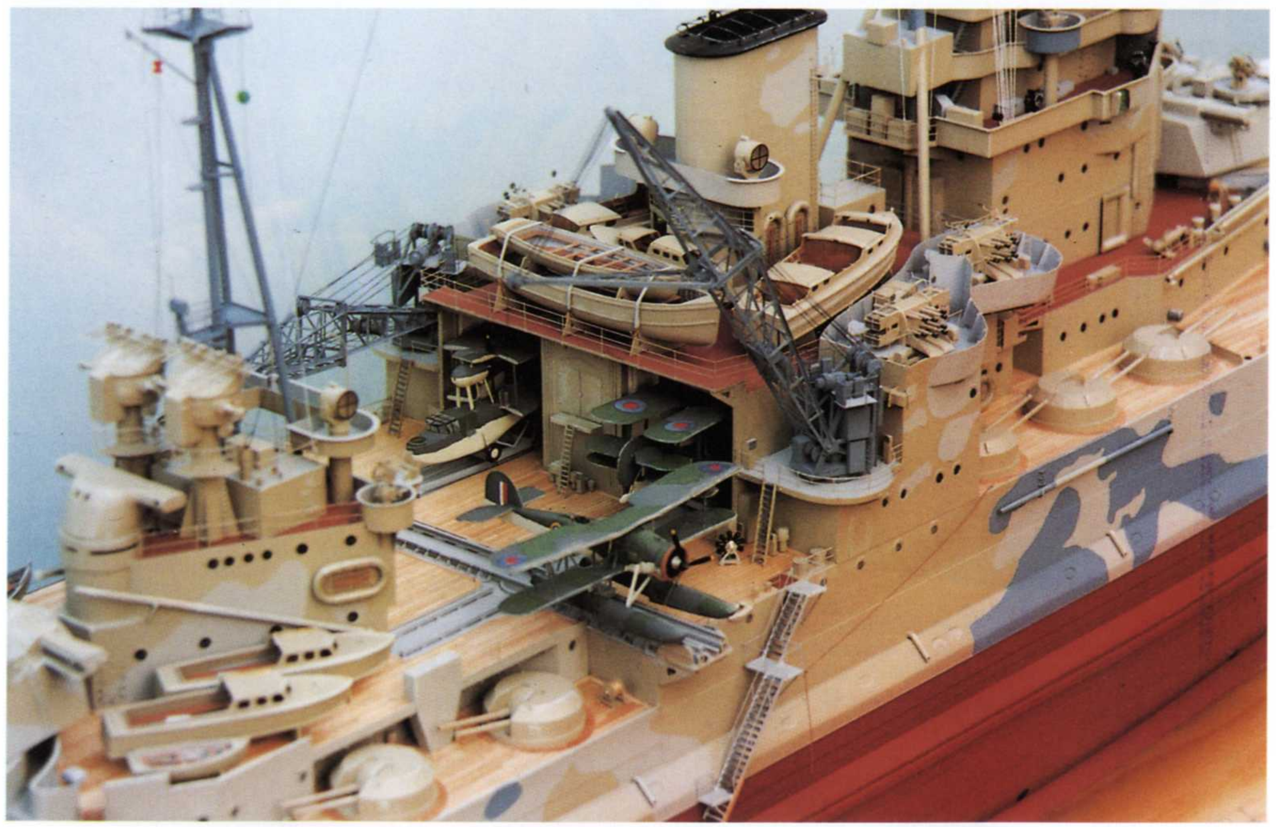


Fig. 9.20. An example of camoflage painting on Queen Elizabeth 1941.

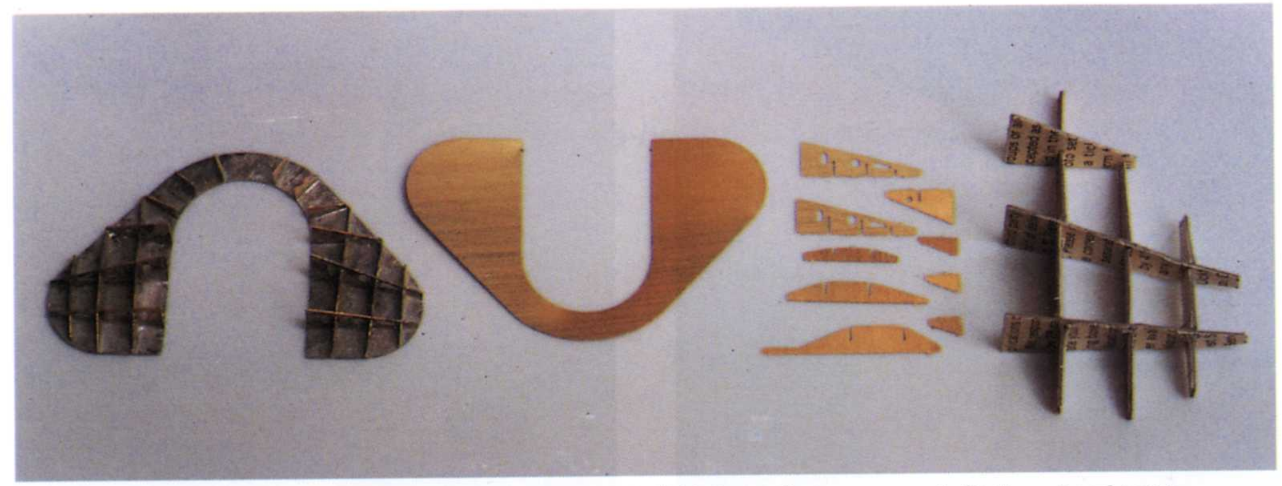


Fig. 11.9. Cardboard tryout plus completed part for funnel gantry. Left, finished part. Centre, components. Right, cardboard tryout.

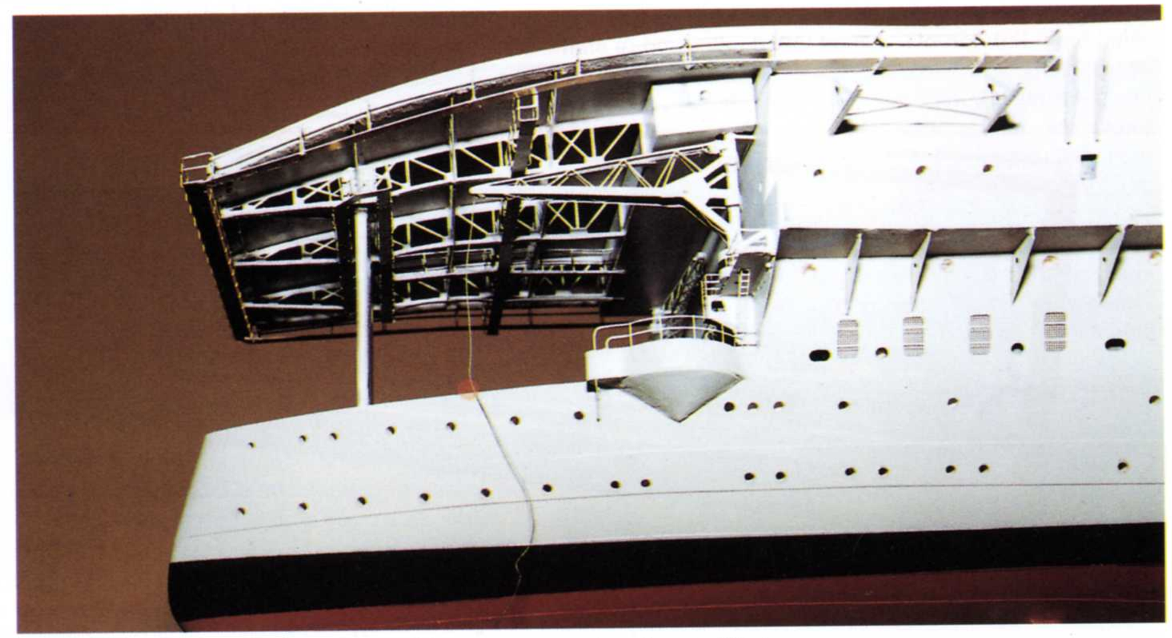


Fig. 11.12. Another view of the etched round down supports on aircraft carrier Glorious.

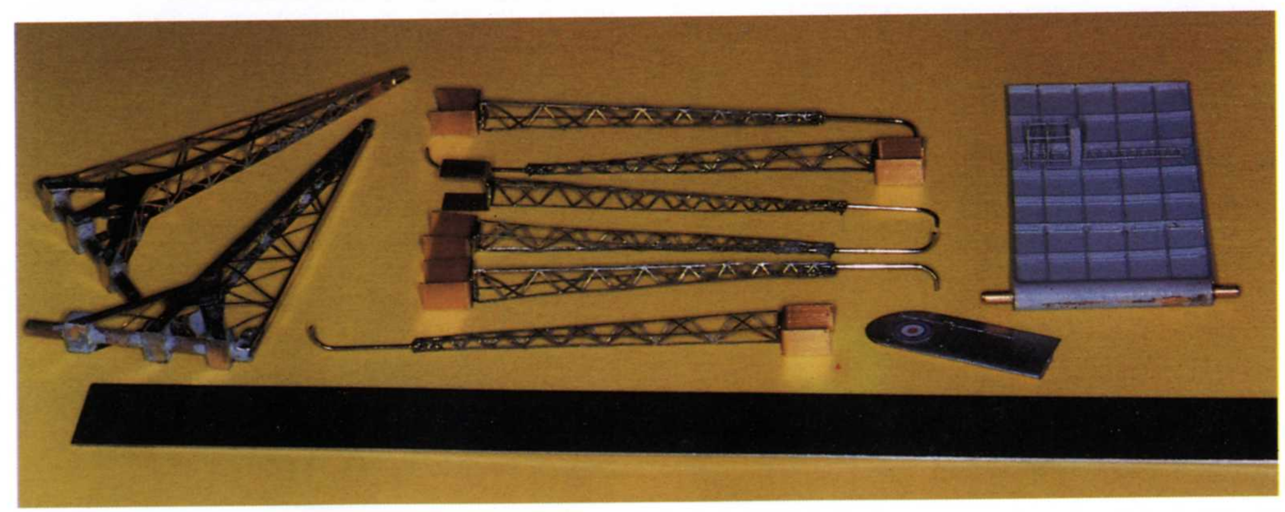


Fig. 11.13. Centre, wireless aerials with at left, cranes and at right, hangar door reinforcement.

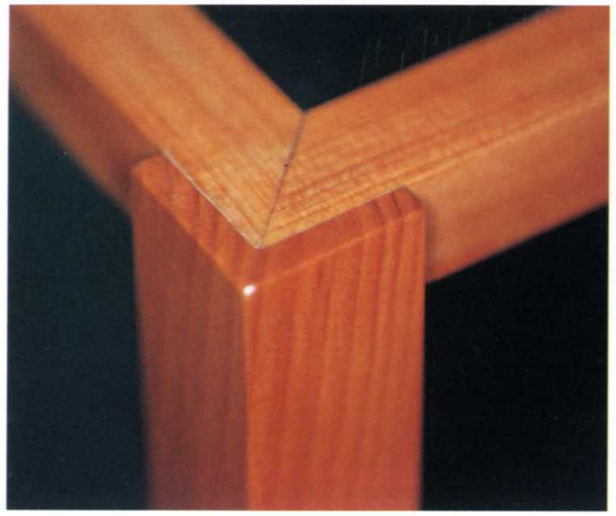


Fig. 12.12. Top corner of glass case made from Cedar.

Fig. 12.13. Bottom corner of Cedar case.

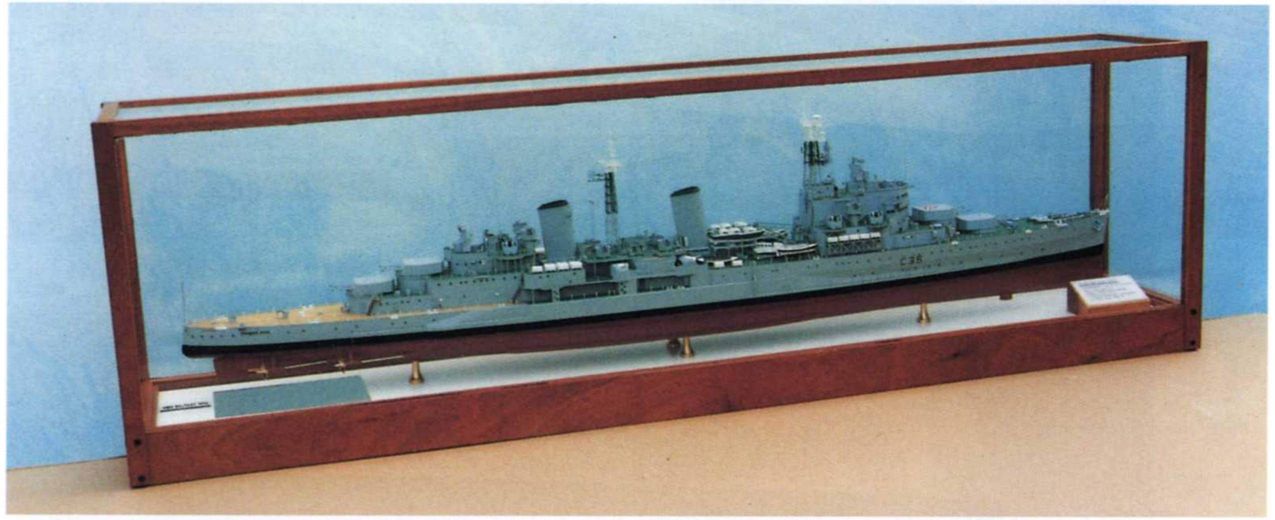


Fig. 12.10. Belfast in glass case of the author's design.
Wood used was Luan. The baseboard was plastic coated chipboard and the legend block Applewood.

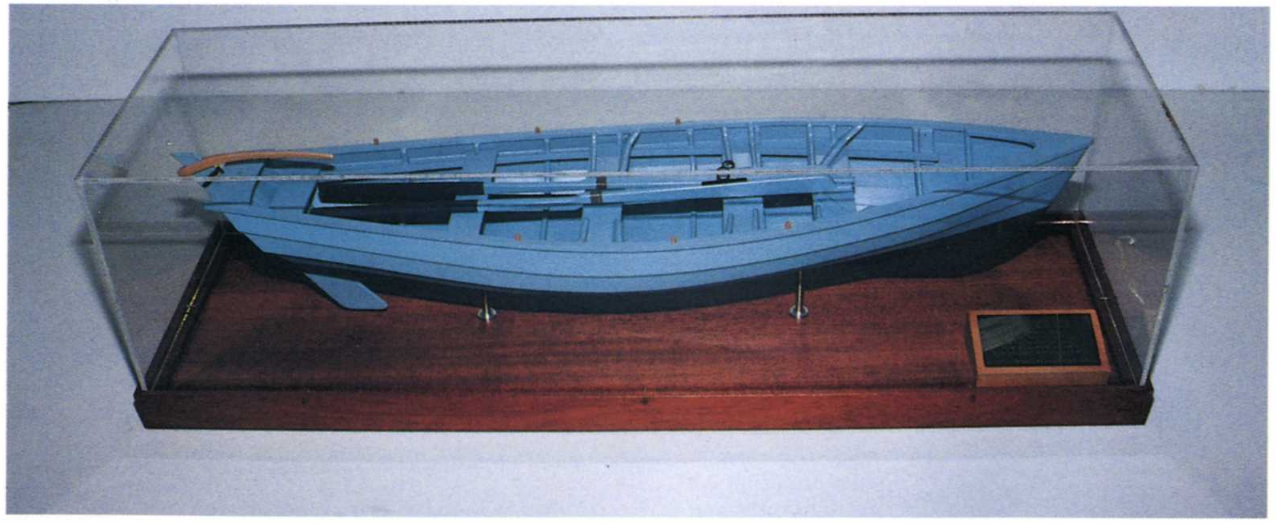


Fig. 12.2. Professionally made perspex case for Grace Darling's Coble.

Chapter Seven

Armament

No. 7 . Keep the de-bonder to hand when using cyanoacrylate

The quality of a warship model will largely depend on the excellence, or otherwise, of its armament. The reason for the warship in the first place is its armament and the eye is naturally drawn to it.

Main Armament (Battleships)

Unless you are building a Victorian battleship of the Royal Sovereign class the main armament will be housed in turrets. These vary in complexity from the fairly simple KG5 turrets to Dreadnought's complexity (see **Fig7.1 & 2**). When constructing turrets two options are available. Either to build up from several pieces of wood or plastic, as described in the last chapter on superstructure, or to carve or machine from the solid again wood or acrylic. Probably the best way, if material and machinery is available, is to machine from solid. This eliminates all joints and the machine guarantees accuracy. **Fig.7.3** (see colour plates) shows an unusual shape of turret on Barrosa whereas **Fig.7.4** shows a very simple Victorian turret on Victoria. **Fig.7.5** (see colour plates) shows a modern turret on Belfast.

As a comparison **Figs.7.6 - 8** (see colour plates)show a turret fitted to Magnificent (1894).

If the rear of the turret is curved with a radius centred on the axis of rotation, as many are, this curve can be put in in two ways. A rotary table can be used on a milling machine and an end mill, or slot drill, used to finish machining a roughly pre-sawn bandsaw shape. An easier way is to simply sand, instead of machining, on a disc sander. This is much quicker than setting up a rotary table even if you happen to possess one.

Some battleships have blow out panels on the back surface of the turret. These can be simulated by strips of self adhesive paper label. The divisions can be cut out with a scalpel. The trouble is working out the size of the panels and divisions to fit exactly into the curved space (see **Fig.7.1**).

On the Queen Elizabeth the turrets had a peculiar step on the top surface which was not machined in but a separate piece of sheet was glued on afterwards. Most main armament turrets have range finders and/or sight housings. These needed to be added to the main turret as extra pieces. The sighting hoods on the Queen Elizabeth were very complicated arcuate pieces sitting on the rear of the turret. As four were required they were best made as mouldings from a carefully made prototype. Final touches to turrets are the circular access plates on the end faces of the range finders and there is also usually a ladder for access to the roof, particularly if a weapon is on top. Gun positions usually also attract guardrails and ready-use ammunition boxes.

At some stage you will have to decide how the barrels will fit into the turret. This is usually done by drilling a hole to house the barrel breech. Do not drill these holes horizontal i.e. parallel with the base. For some reason horizontal barrels look all wrong. They need to set up about 3° to give the right aggressive appearance. Older turrets have a canvas blast bag connecting the face of the turret and the barrel together. These can be simulated with Milliput (epoxy putty) or Isopon (polyester) before being painted. **Fig.7.9**.

A completely different approach is to make the whole turret up from etched brass sheets. This not only allows shaping the component parts as part of the etching

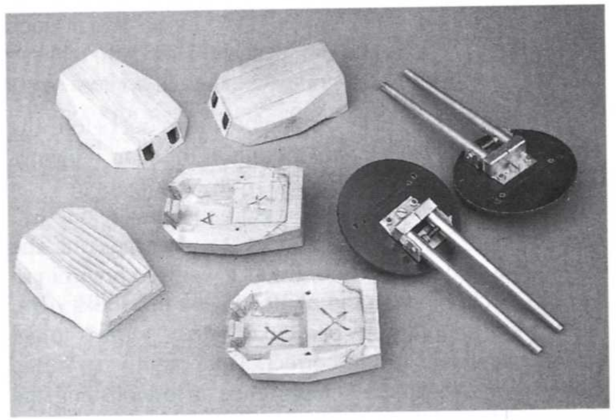


Fig. 7.2. Dreadnought turrets

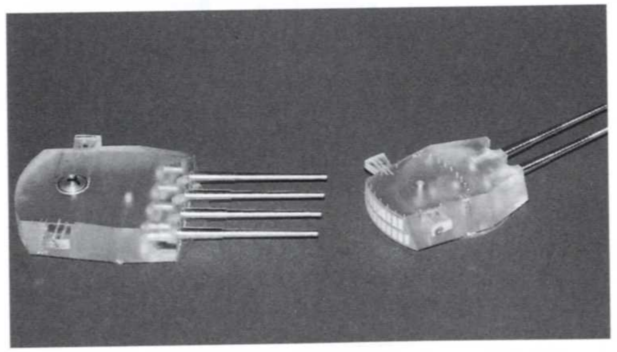


Fig. 7.1. Anson turrets

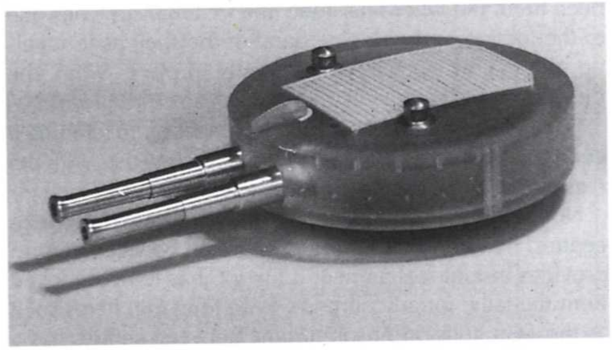


Fig. 7.4. A simple turret on Victoria, turned from Perspex

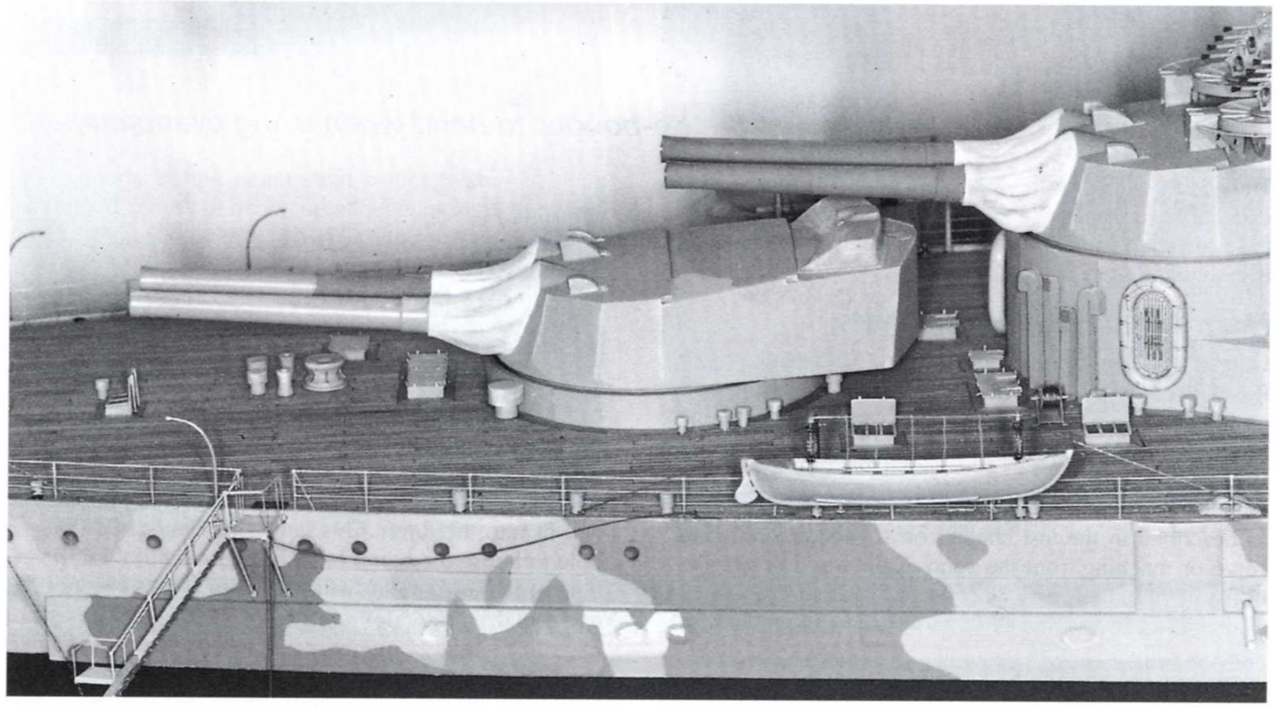


Fig. 7.9 Blast bags on Queen Elizabeth

process but also allows inclusion of surface etching at the same time. This technique is used by the advanced master modelmaker Friedrich Prasky on his Austro-Hungarian light cruisers and Danube gunboats. However, this sort of superb modelmaking requires a big rethink for workers used to wood and polycard.

Gun Barrels

Large gun barrels really need to be drawn out before any attempt is made to machine them. On the plan drawings several barrels will be drawn (ten on King George V). If you carefully and accurately measure them every one will be different. The only thing is to average out the dimensions and shape and draw, as it were, a compromise barrel. Check this with the photos to see if it looks right, this is most important. A particularly fussy point is to get the muzzle swell, if any correct. This, often very subtle shape, is of the greatest importance in establishing the characteristics of the warship.

Another point often missed, is that after the gun has been fired, the inner liner tube (the 'A' tube) stretches due to the friction of the driving band of the shell as it travels up the barrel and it consequently projects from the muzzle face slightly.

For those interested, an operation sheet for machining a gun barrel for Anson (KG5 class) is given together with the reasons for using the methods adopted. **Fig.7.10**.

Normally such items as gun barrels are turned between centres, headstock and tailstock. Turning between centres provides instant realignment if the job has to be removed from the lathe for any purpose. With long thin items such as the 14in guns on Anson turning between centres has a big disadvantage. If turning a thin parallel cylinder is

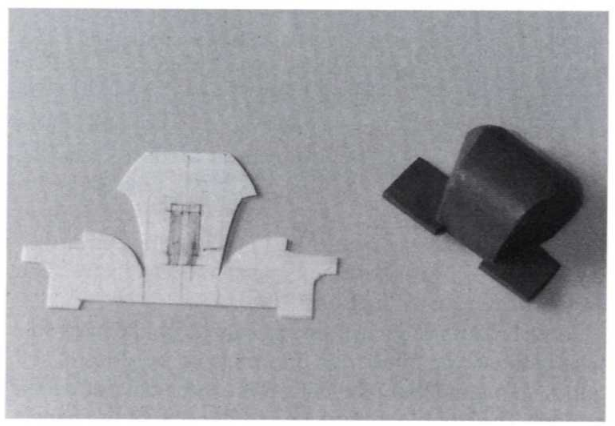


Fig. 7.11 Belfast turret shaping block and development

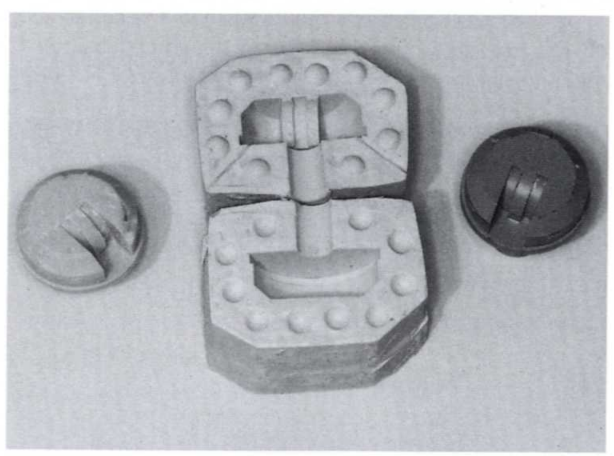


Fig. 7.12 QE - construction of twin 4.5in HA/LA Mk3 BD turret

attempted a beer barrel shape will result. This is because, whilst the ends are constrained by the lathe centres the centre of the work is not and this tends to move away from the pressure of the tool producing a larger diameter in the centre than at the ends - a barrel shape. The standard method of combating this is to fit either a fixed steady or a travelling steady (which moves with the tool) which supports the work against the forces produced by the tool i.e. the tendency for the work to move away from the tool and to climb up onto the top face of the tool. However, fixed steadies get in the way and travelling steadies only work when turning a constant diameter.

Holding the work in a chuck produces a much more rigid set-up. If the protruding end is also supported by the tailstock (T/S) centre maximum rigidity is obtained. Again if the protrusion from the chuck (the overhang) is kept to a minimum machining conditions are optimum. The following operation sheet follows this creed. Successful production of ten identical barrels requires great care. Every barrel must be machined in exactly the same way. Do not, for instance, expect success if you use coarse cuts on one item and fine cuts on the next. Success will only be achieved by the greatest attention to detail: tools stoned sharp, set at the correct centre height, all unused motions locked up, etc. I will explain the last remark. The tapers on these barrels were machined by using the topslide set over to the correct angle. The carriage was therefore locked to the bed. The carriage was used for parallel turning on auto-feed, unlocked of course. By locking up unused motions one source of 'play' is eliminated. Likewise, do not run the lead-screw if it is not being used. Anything moving unnecessarily is a danger. A student in my Technical College caught his dreadlocks in the lead-screw and scalped himself - a situation best avoided.

If the diameter/length ratio on these barrels had been less, turning between centres would have been the optimum method but with such thin barrels this was not possible.

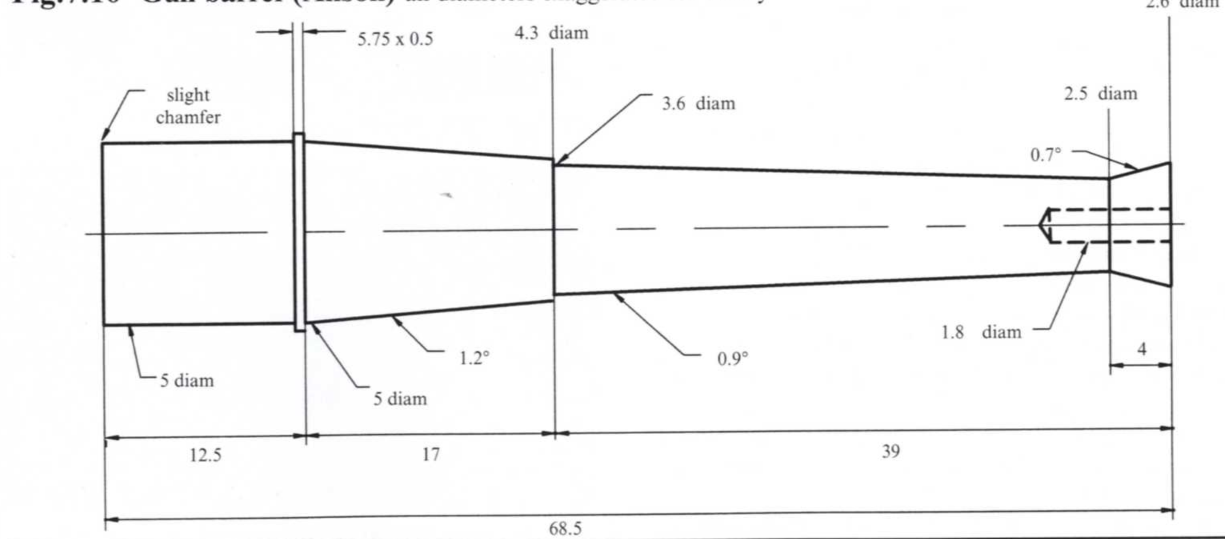
Operations

(**Fig.7.10**).Note each operation is done on ALL ten pieces before proceeding to the next step.

1. Part off all 10 pieces to length. Use a piece of rod in T/S as a length stop.
2. With 9mm projecting from the chuck-face, bore, centre and drill 1.8mm diameter. About 6mm deep. Turn outside diameter. (O/D) to 2.6mm diameter for 4mm length - use round nose tool.
3. Taper turn 4mm length 0.7deg using top slide.
4. Extend projection to 41mm, mark 39mm length and turn parallel 3.6mm. diameter. Measure at breech end. Support muzzle with lubricated drill shank in T/S chuck.
5. Taper turn the 35mm length 0.9deg using top slide.
6. Re-chuck to 58mm projection and turn parallel 5mm diameter. for 17mm long.
7. Reverse and hold on 5mm diameter. Turn 5.75mm (ring) and 5mm diameter. for 12.5mm long.
8. Reverse and hold on 12.5mm x 5mm diameter. and taper turn 17mm length 1.2deg.
9. Remove burrs with a fine file after every operation.

It is always best to do as many operations as possible at every single setting. You will note that a lot of re-chucking occurs on the above operation sheet. For example, all the tapered sections are first turned parallel and then taper turned later, after re-chucking. This is because setting up tapers is not easy (it is not an exact science) and it was essential that all guns had the same tapers. Using the above method each taper setting could be established, by trial and error if necessary, and machined on all ten pieces without altering the setting. Otherwise, the taper setting would have to be set up for each individual piece with consequent errors and expenditure of a lot of time.

Fig.7.10 Gun barrel (Anson) all diameters exaggerated for clarity



As each piece was machined the position of No.1 chuck jaw was marked on it, with a felt tipped pen, to enable the piece to be re-chucked in the same position to ensure, as far as possible, true running and concentricity.

The reason for reversing the component in operation 7. was to enable it to be held on the 17mm long parallel diameter. If this had been taper turned first the breech end, and the tiny bead, could not have been easily machined. The method used for any operation was to turn the diameters to size using the usual technique of taking a cut and using a micrometer to measure the size, re-setting the tool and repeating the exercise until the diameter was correct. At this point the index dial reading on the cross slide was noted and the remaining nine pieces machined to this setting thus speeding up the work considerably. In the case of tapers the maximum size was machined parallel using the autofeed before hand feeding the taper using the top slide. The tool was simply fed in until the whole length of the parallel diameter was tapered. The top slide was first angled to the calculated figure (see operation sheet) but this sometimes required slight adjustment to produce the correct diameters at each end of the taper. If the machine were equipped with DRO then this would be used rather than using the index dial readings. (Chapter Three).

Open Turrets

Destroyer primary armament and big ship secondary armament

These weapons often involve open turrets showing the gun breeches, fuse setters, etc. which means much more work of a highly detailed nature. The actual turret shape is often complicated and difficult to determine. Even if a three-view drawing is available you really need extra information in the form of photographs and drawings and an imagination to envisage the 3D shape. If possible, an actual visit is even better. One way to tackle the problem is to make up a hardwood block of the interior shape. Put some sort of extension onto it so that it can be held in a vice. When you have got the shape right try cutting paper patterns to establish where you will have to put the joints and folds and what the developed shape will be. Next produce a lithoplate copy of the paper pattern and 'tinbash' this around the hardwood block. The paper pattern will not stay put around the block but the aluminium pattern will. You will probably need to make several attempts to get this right. **Fig.7.11**.

When it is as correct as possible copy the shape onto thin brass sheet, bend up and solder. The brass will almost certainly need annealing. Annealing will produce a much more obedient material as the natural "spring" of the brass will be eliminated and it will stay closely round the wood block. Various slots for gun barrels and sights will be needed on the front face which are best cut out before you bend up. If you leave the base floor of the turret as a separate piece to be fixed in last, releasing the wood block is usually no problem.

Looking at gun drawings always leaves one with the impression of great complication. The only way is to split the mounting up into various pieces, the main three being the barrel itself, the cradle and the framework supporting it. If the shape of these can be determined and made accurately the rest of the pieces can be hung on. The other necessity is repeatability - all guns of one type need to look the same. The other problem is making sure the pieces can be fitted together, perhaps tabs need to be added to say, the shield to enable it to be fitted to the mounting?

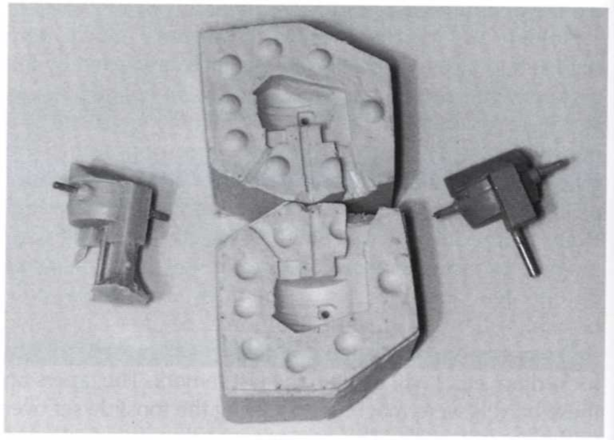


Fig. 7.13 QE - Mk1V director

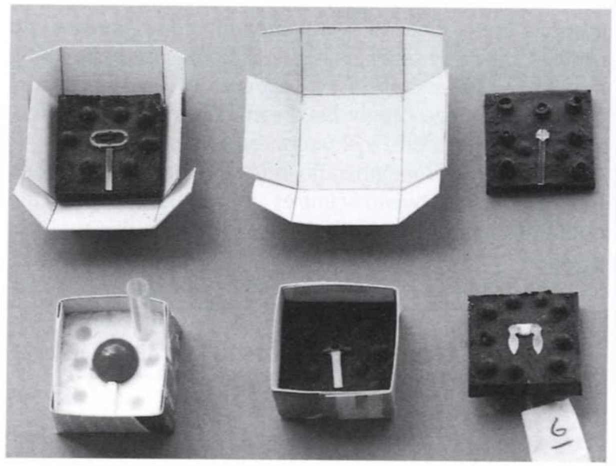


Fig. 7.14 Making moulds

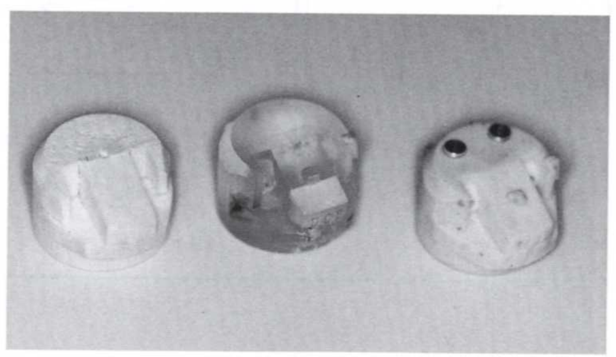


Fig. 7.15 Anson secondary armament turret

BD (between decks) Mountings

This kind of secondary armament is usually easier to make as the mechanism is completely enclosed, as described, between decks. All that does show are the gun barrels housed in a low turret. For shapes that can be easily turned this is almost certainly the best way. If, however, the shape is largely cylindrical but with some awkwardly angled faces and deep barrel slots turning is not really an option, particularly if eight or ten identical turrets are required.

Moulding

Instead of machining them all separately an option is available and that is moulding.

This will require a master pattern, as correct and complete as possible, from which to make the master mould. **Fig.7.12** shows the steps taken to produce ten twin 4.5in HA/LA Mark 3 BD turrets for my model of Queen Elizabeth. The first step was to obtain as many close-up pictures of the gun mounting as possible. The plan view of the ship contained ten plan views of the turrets drawn in an adequate manner for the drawing's purpose but not really accurate enough for modelling. The gun barrel problem over again. Model makers usually have no detailed drawings to work from and so are forced to look to general arrangement drawings which were not drawn for the purpose for which we are using them.

From all this information a brass pattern was turned and machined up with the extra parts, such as vents and doors added. In other words the turret was made as complete as it could be.

A split silicon rubber mould was then made and the castings/mouldings produced in polyurethane. Using silicon rubber as a moulding material has the advantage that any small under cuts can be tolerated owing to its flexibility. Rigid moulds must have a degree of 'draw' built in to allow extraction of the casting otherwise it will be locked in the mould. Another example of a moulded part is shown in **Fig.7.13** which is a MkIV director for Queen Elizabeth. Note the cast-in pivot and range finder.

Mould Making using Silicon Rubber

Obtaining silicon rubber, which is very expensive, in reasonably small amounts you need to go to a model house - I use 'Hobby's' of Knight's Hill Square, SE27 0HH, who also do mail order. Silicon rubber manufacturers will only sell you quantities requiring a bank loan.

Making a mould requires some care and some know-how. The method is as follows: obtain a box big enough to encompass the object to be moulded, allowing for enough space around the object to house the necessary locators - more on this later. Some people use Lego but making up a simple box from cereal box cardboard sealed with Selotape is easier. The point is the box must be leak proof.

Next a later of PlayDoh or Plasticene is put into the box deep enough to immerse half the pattern. Immerse this to the level required and work up the PlayDoh closely to the surface of the pattern to form a clean separation line. This is the reason for using the PlayDoh, to provide a clean separation surface. If you try to pour the silicon rubber half way up the pattern, because of the viscous nature of the material you get a large meniscus which prevents a clean parting edge. It is possible to obtain a solution to mix with the silicon rubber to make it less viscous but this sacrifices some of its strength. **Fig.7.14**.

Before pouring in the silicon rubber location dimples must be pressed into the surface of the PlayDoh. These are required to correctly locate the two halves of the mould otherwise the two halves of the finished casting will be misaligned. Also a separating agent is required, this can be Vaseline or diluted washing-up liquid painted on and allowed to dry.

After the moulding compound cures the PlayDoh has to be removed to expose the separation surface. This surface

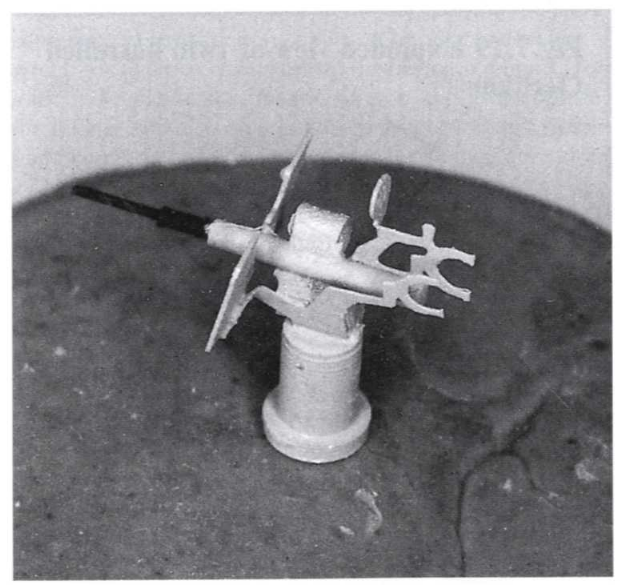
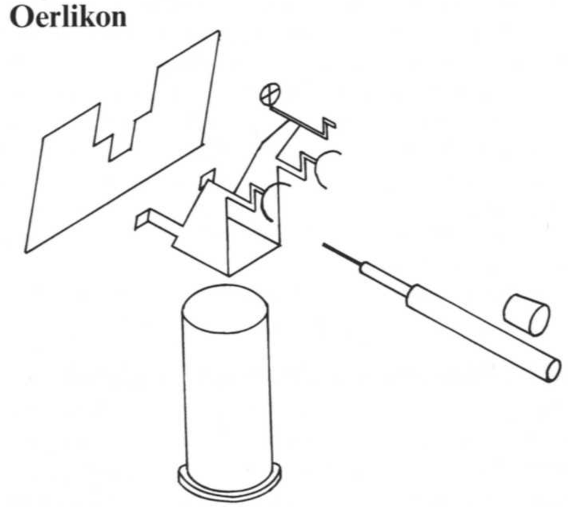


Fig. 7.17 Single barrelled Oerlikon

Fig.7.16 Exploded view of single barrelled Oerlikon



is again painted with dilute washing-up liquid and allowed to dry. The second layer can then be poured. You may need to build up the cardboard sides to contain the extra thickness of silicon rubber.

With every component the question must be addressed as to where to pour and how to vent the air in the mould. If the trapped air cannot vent easily the casting will be marred with air bubbles or be incomplete. Every shape needs to be treated individually.

Casting with polyurethane resin

The trouble with urethane is its fast setting time, which is used as a selling point, but it has a big disadvantage. Mixing resin and hardener invariably stirs some air into the mix but you cannot leave to stand to enable bubbles to escape, as it immediately starts to set. So the five-minute standing time to allow the bubbles to escape which is used when using slower setting resins cannot be adopted. If the component is cast upside down any air bubbles will be mainly in the base where they may be less visible.

Do not attempt to use clear polyester casting resin in silicon rubber moulds, as silicon rubber will inhibit the curing of the surface layer of the resin. This does not occur with urethane.

Mouldings are a good way are of producing identical parts but for quality work they need to be carefully made otherwise they will have a "sucked sweet" appearance which will ruin the model. It is much more difficult to produce sharp corners on a casting/moulding than on a machining but at least you do get identical parts. Two further points are.

1. Make sure adequate locating depressions are put in to ensure the two halves of the mould properly align otherwise the casting will be 'stepped'.
2. Adequate cleaning up of the parting lines must be carried out.

Twin 5.25in HA/LA Mk 1 turrets

Fig.7.15 shows a more complicated turret, that for Anson (KG5 class) in this case a twin 5.25in HA/LA Mk1. This is not a between decks turret and therefore is taller than that for the Queen Elizabeth. The photograph shows at left the original wood mock up made to get the feel of a turret that could not be turned because of the protruding shelf at the front. A Perspex pattern was then made carrying all doors, vents, and the fume extractor. It was hoped this would mould satisfactorily which it did. On the right is a finished, but unpainted, urethane turret with the locating pin (pivot) at its base. The top two hatches and the etched ladder were final additions. In the former case this was done to ensure sharpness of detail, but in the case of the ladder it was because of the impossibility of casting that in place!

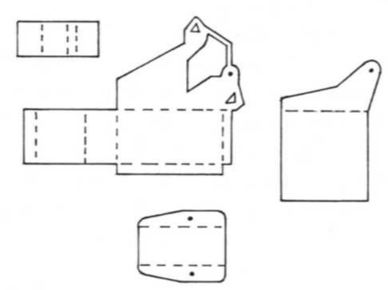
Light Weapons (40mm and below).

In this category we include 40mm Bofors and 20mm Oerlikons. An enormous amount of work can go into these smaller weapons. Again plenty of pictures as well as drawings - unfortunately the number of marks of Bofors seems legion so you will be lucky if you get the ones you want. Particularly with Bofors the number of mountings also seems legion but the housings themselves should not cause trouble.

Single Oerlikons

Fig.7.17 shows a single barrel Oerlikon without the used cartridge bag at 1:192 scale. The drawing **Fig.7.16** shows the breakdown of the weapon into pieces and **Fig.7.18** shows the pieces in the flat (for etching purposes). The pedestal is a turning. The barrel is an assembly of two pieces of tube with the thinner nesting inside the larger with an entomology pin for the barrel proper. Two further pieces make up the rest, both etched. The flat shield is supported by the two arms of the frame which also encompasses the shoulder supports and the sights. The main problem is getting the two right-angled bends in the frame correct. This can then be soft soldered to the pedestal. The shield is best glued to the frame arms with epoxy. If you try to solder you will end up with three separate pieces again! A little fixture of wood is needed to hold it at the correct height and slope whilst the glue is setting. The barrel is also epoxy glued between the vertical arms of the frame. Again, it will need supporting at the muzzle end. Which all reminds me of a friend, who serving on a minesweeper during the war, cleaned his Oerlikon barrels and forgot to replace the locking pins. He tells me they made a fine splash as they went over the side on firing.

Fig.7.18 Etched parts for twin barrelled Oerlikon



Etched parts for single barrelled Oerlikon

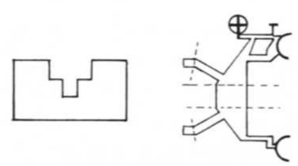
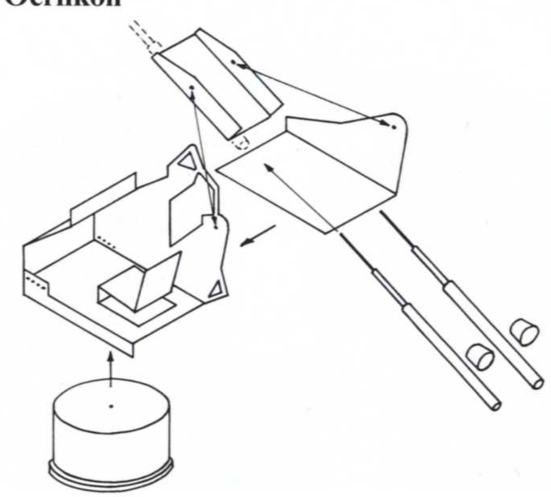


Fig.7.19 Exploded view of twin barrelled Oerlikon



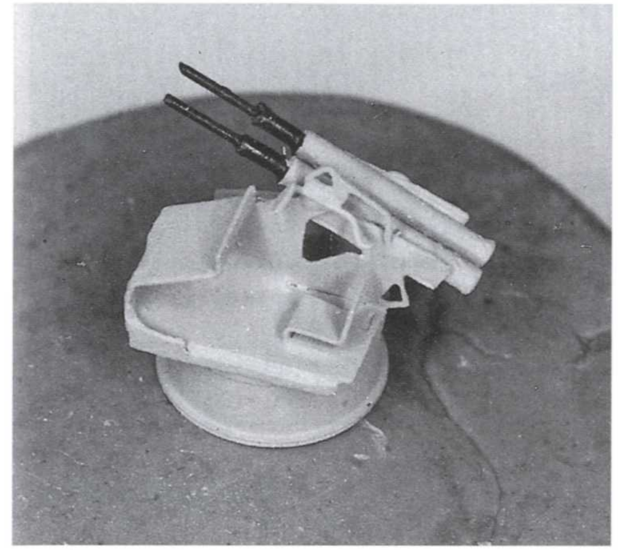


Fig. 7.20 Twin barrelled Oerlikon

Twin Barrelled Oerlikons

Fig.7.20 shows a completed twin barrelled Oerlikon. Apart from the barrels which are identical to the single the same type of construction applies. A turned base on top of which sits two pieces making up the trunnion mounts. The left-hand piece also forms the support and protection for the gunner and also incorporates the sights. A very simple rectangular piece folds up for the seat. The two guns sit in a U-shaped cradle supported by the trunnions.

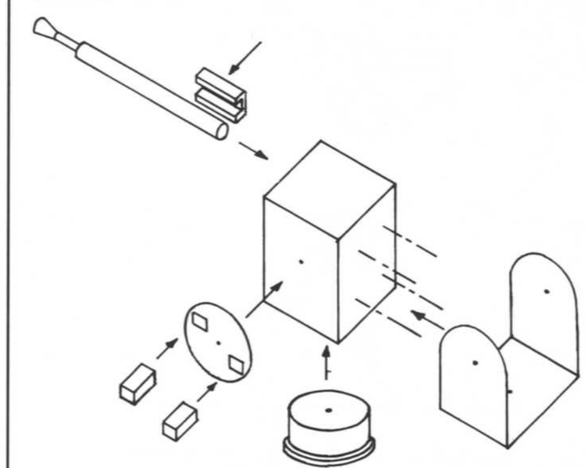
Fig.7.19 shows a perspective drawing and the breakdown of the parts (as shown in **Fig.7.18**).

Four Barrelled pom-pom (Fig.7.21 – see colour plates)

The main part of the weapon is a Perspex block supporting the four barrels. This is enclosed in a U-shaped trunnion mount about which the barrel block elevates up and down. Outboard of the supports two discs support two each of the four magazines. The whole unit sits on the base of the emplacement which in turn sits on a base allowing the gun to rotate. The magazines are U-shaped filled with a block of Perspex or wood representing the shell belts. The barrels are 0.5mm diameter sheathed in a larger tube with the breeches squared off with a U-section metal or plastic shroud. This is stuck on with epoxy which is also used to fill up the gaps to make a clean rectangular breech.

The sights (**Fig.7.25**), not shown on the exploded view in **Fig.7.22**, were etched flat and bent to shape. To make these any other way you would need to be a miniaturist which is a whole new ball game.

Fig.7.22 Exploded view of four barrelled pom-pom



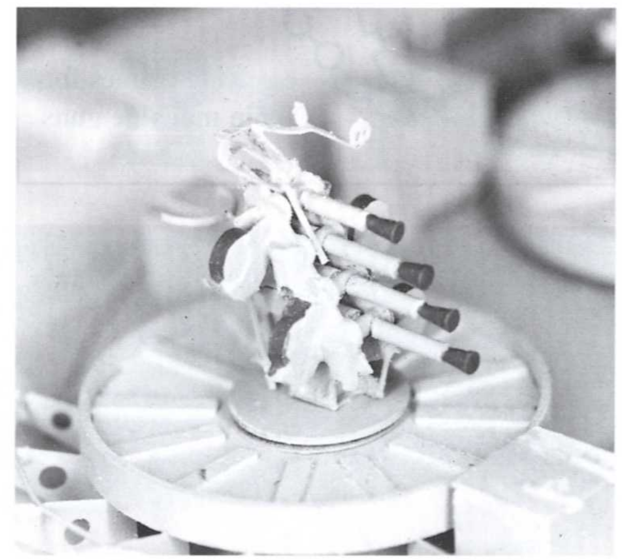


Fig. 7.23 Vickers quadruple 0.5in machine gun

Vickers Mk3 Quad 0.5in mounting

This weapon which proved useless against WW2 aircraft survived until the middle of the war and so may need to be made for some models. My model of Queen Elizabeth had four, two on B turret and two on X turret. These were built to 1:150 scale and are shown in **Fig.7.23**. Later on two more were required at 1:192 scale for my model of

Fig.7.24

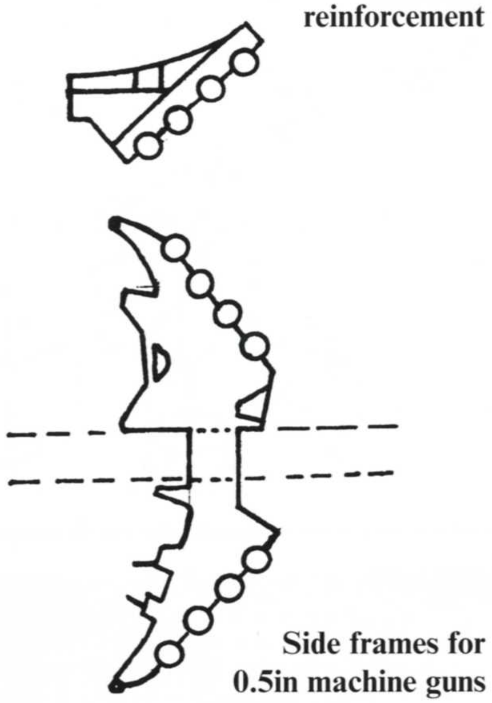
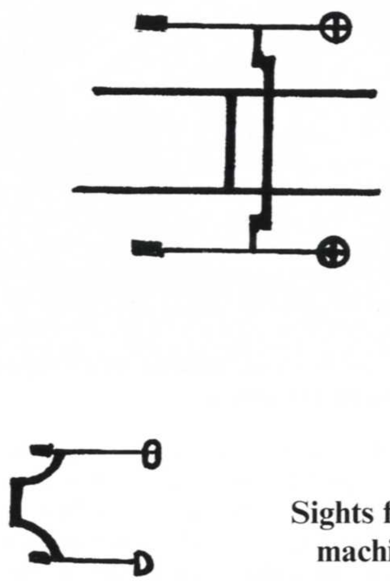


Fig.7.25



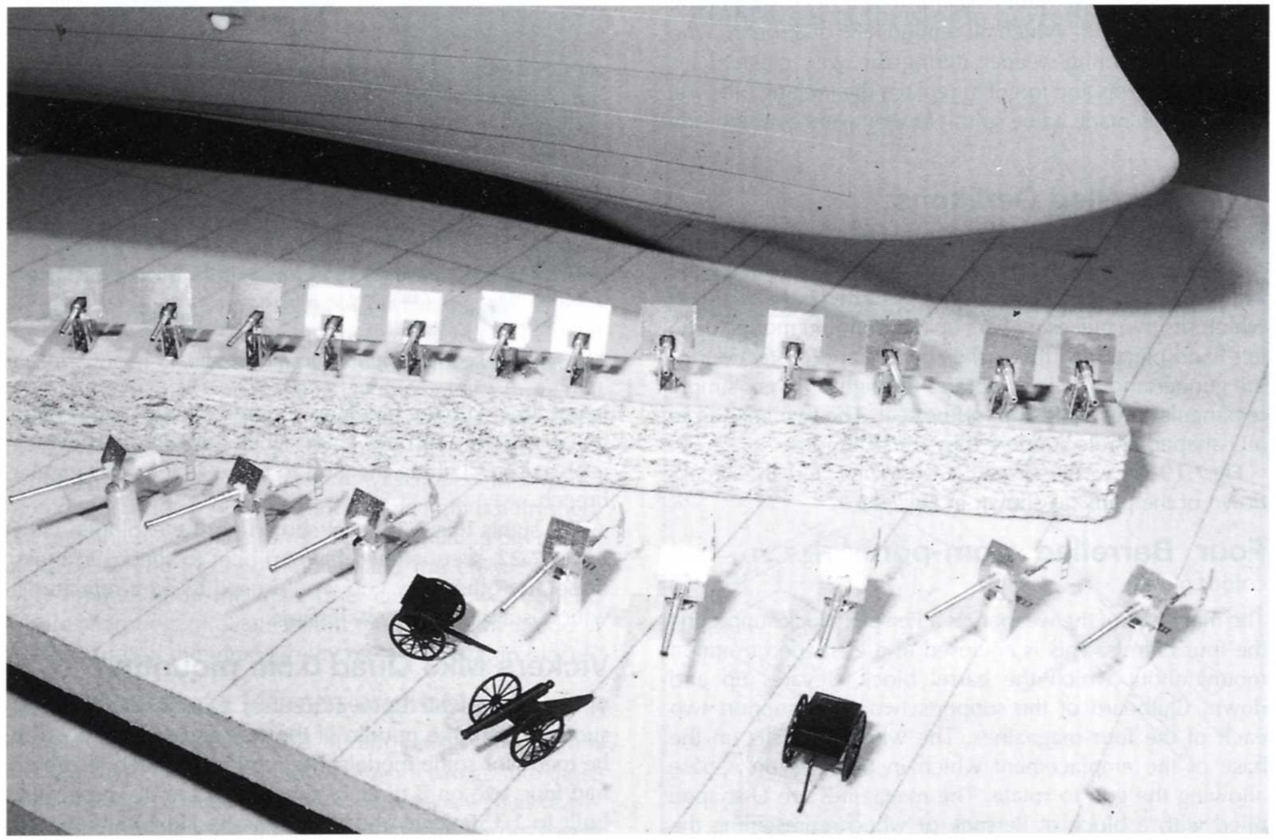


Fig. 7.26 Collection of quick-firers, etc

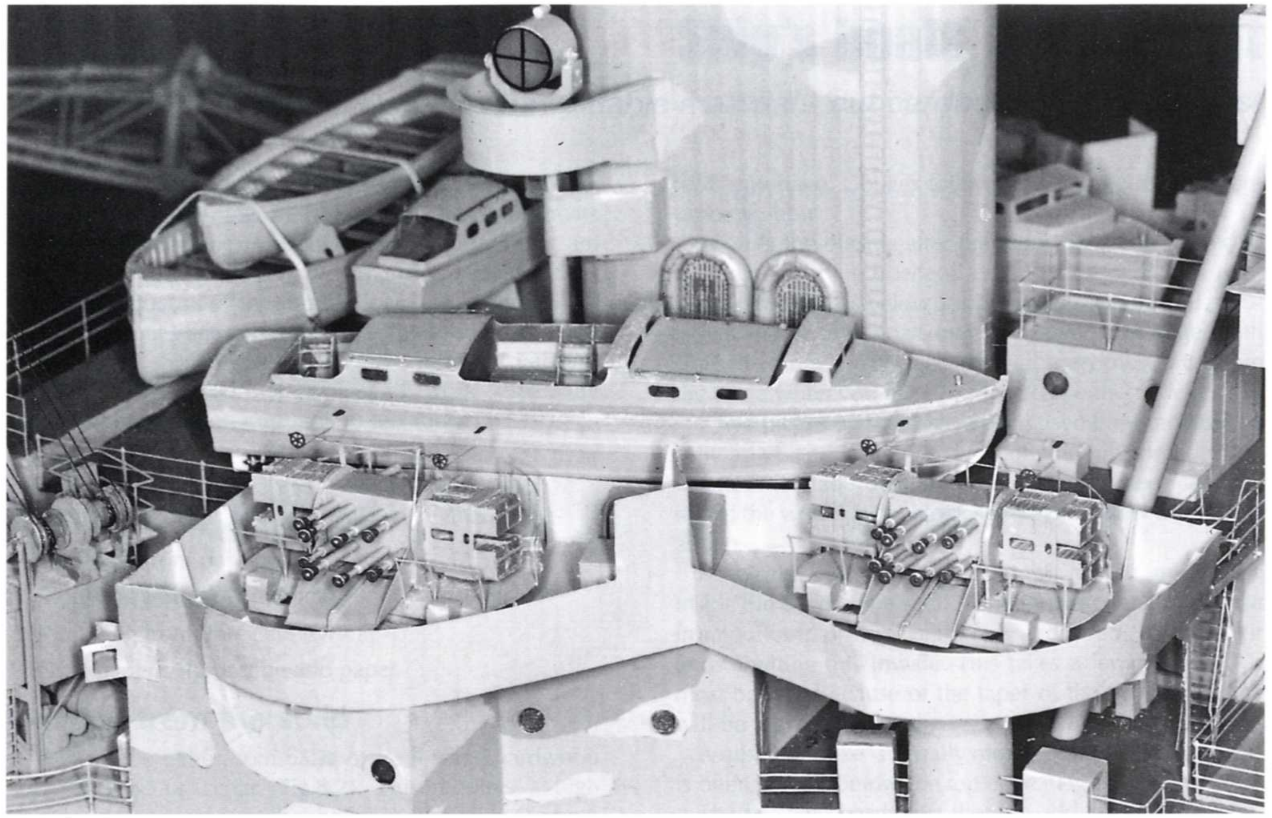


Fig. 7.28 Eight barrelled Pompoms - QE

the aircraft carrier Glorious. The etched framework and the applied reinforcing are shown in **Fig.7.24**. Both scales were built in the same way although some of the finer detail was left off the 1:192 scale.

Fig.7.25 shows the etching drawings for the sights for the Quad machine gun and for a four-barrelled pom-pom.

Chapter Eight

Ship's boats and aircraft

No. 8. Don't waste valuable material - cut cardboard templates first

Looking at some models the thought that the ship's boats were an unwelcome afterthought strikes one. Ship's boats are very eye-catching, particularly if a large number are carried, and the standard of workmanship should not let the overall quality of the model down. The secret is, of course, to treat their construction as models in their own right. The same goes for any aircraft carried. Unfortunately this sort of small-scale work, especially with aircraft, requires a re-think in technique.

Fortunately several well-tried methods exist for their production:

1. Carving from the solid
2. Moulding from polysheet
3. Moulding from polyurethane
4. Moulding from fibreglass (GRP)
5. Gum paper strip or glue and paper

Carving from the solid

This can be either from balsa or from some hardwood such as lime or cedar (**Fig.8.2**). This requires a high degree of expertise to get the shell thin enough not to look out of scale. It can be carved from a single piece of wood or two pieces temporarily glued together along the keel line. It is best to start hollowing out first, as the block form is easier to hold. How you do this is up to you and what tools you have. Gouges followed by a spherical burr are probably best.

Carving the outside after the block has been shaped to plan can be done freehand or it can be carved to template. If the boat is below 1-1/2in long freehand will probably suffice; larger boats may need templates to get both sides the same and correct. You will soon know if they are the same when you have to make/carve the crutches!

If two pieces of wood have been used they can now be split apart and a central keel of thin ply or polycard inserted. If made of one piece either the keel can surround the wood or the block split and the keel inserted as above.

Fitting out can start by putting an inwale around the inside top edge of the shell. Timbers (ribs) can then be cut from polystrip or strips of thin ply and sprung in with their ends abutting this inwale. This takes a long time and is most boring. Because of the taper of the boat every one will be a different length.

A rubbing strake is usually required on the outside. This is often set just below the top edge. (**Fig.8.3**)

The bottom boards can then be added either as separate strips or a piece of ply scored to represent separate boards. Some areas of the bottom of the boat may have gratings - often the stern sheets and head sheets are so fitted. Filter gauze, etched brass sheets or even paper or

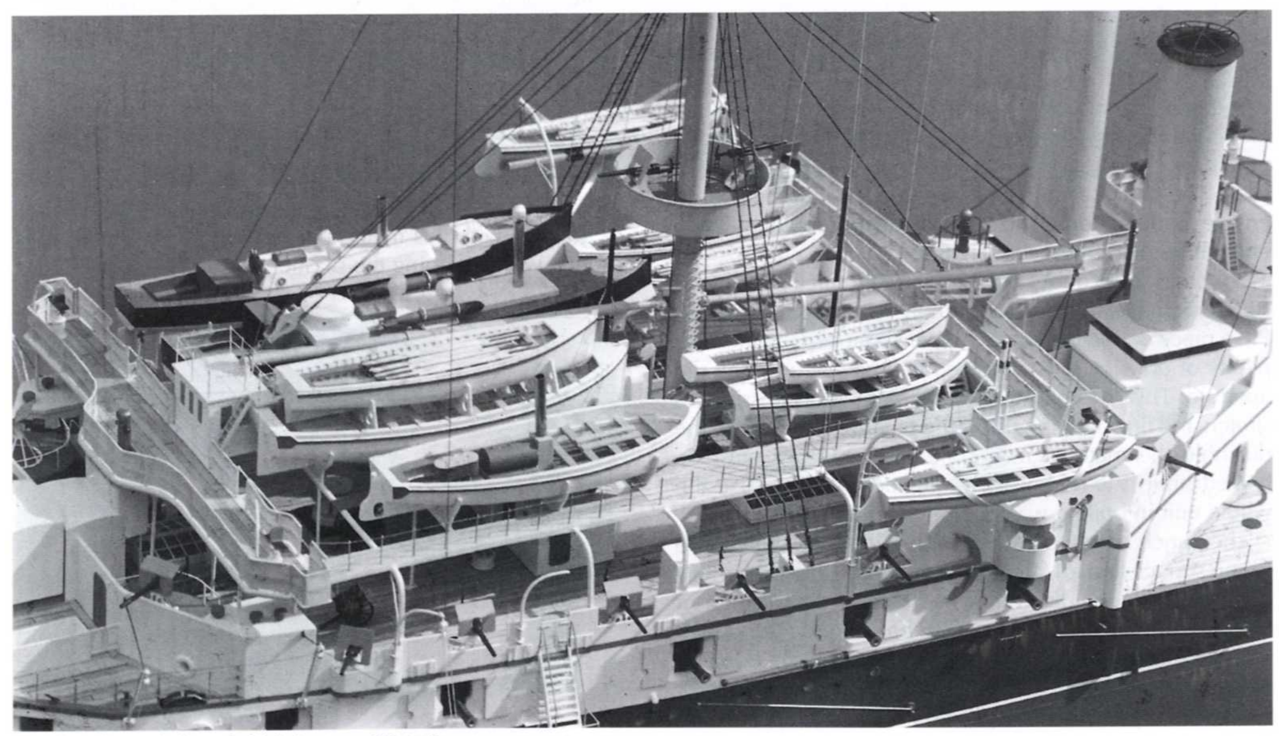


Fig. 8.1 General view of ship's boats on Victoria

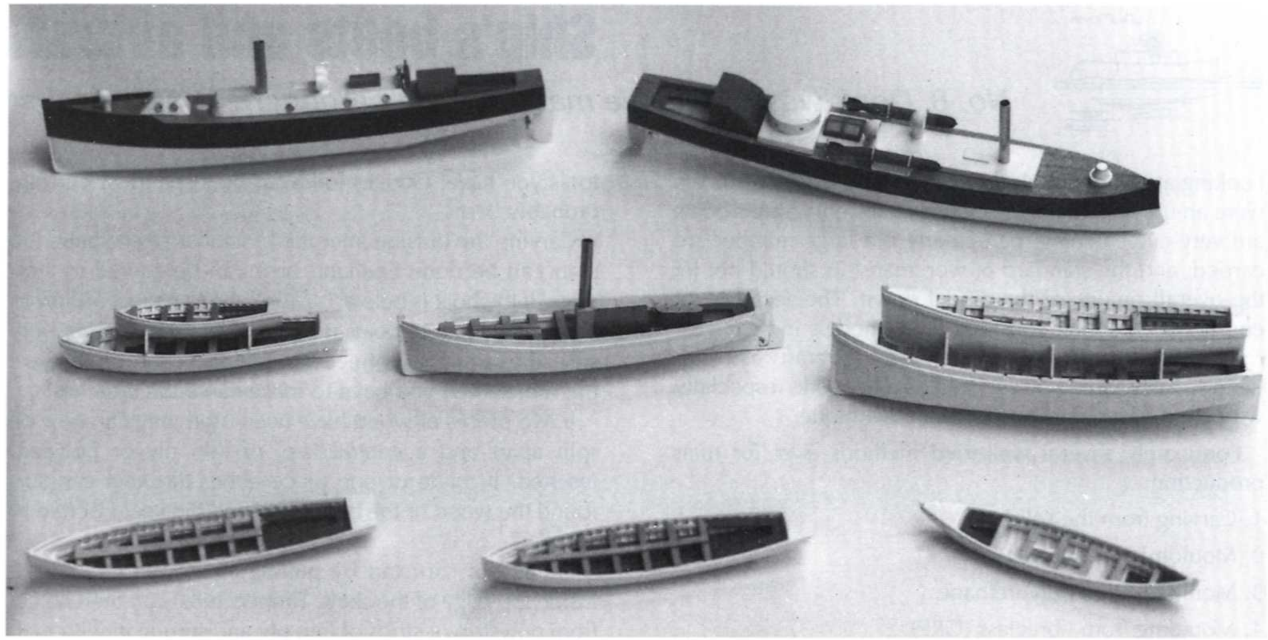


Fig. 8.2 Carved wooden boats for Victoria

card with inked grid can be used. With these secured the shelf can be inserted which forms a support for the thwarts. How much further detail is added is up to the modeller. Double knees sitting each end of the thwarts, pillars supporting the thwarts, etc. may be added. Usually the rudder is kept unshipped and lies on the stern sheets. Some boats used for sailing will also need a plate case if a centreboard is carried.

The main problem with carved boats is getting the shell down to scale size so that they do not look clumsy.

Moulding from polysheet

This method is so well known it hardly needs repeating. It requires a male shape of the inside of the boat (the punch) and a female die, which must be as large as the punch plus at least two thicknesses of the polycard to be used. The punch should be made deeper than the boat to ensure enough 'draw' to give a clean moulding deep enough to clear the sheer. (**Fig.8.4**)

For boats up to about 2in long 0.020in thick polycard is sufficient, boats larger than 2in may require thicker sheet. Pin a piece of polycard to the upper surface of the die. Use plenty of drawing pins and keep them away from the die aperture. This is to allow as much material as possible to stretch and flow into the die. If the pins are too close to the die hole the material may split. The polycard must be heated until it is rubbery. My method is to immerse the whole unit in boiling water.

The punch needs to have a 1/4in blind hole drilled into its top surface and a 1/4in brass rod about 12in long inserted. This is the handle which will control the position of the punch and enable pressure to be exerted. The punch and die must be made waterproof which can be done by spraying several coats of cellulose grey primer (**Fig.8.5**). With a fibre pen mark the position of the die aperture on the top surface of the polycard. This can be done by holding the assembly up to the light.

Next protect your hands very well (I use my old horse hide motor cycle gauntlets). Put the die into the water and hold it down with the punch - take the water off the boil to do this otherwise you cannot see. When the punch is correctly positioned, using the fibre pen marks, put pressure on the punch and you will feel it push the softened polycard into the die. Keep a steady pressure until the draw is deep enough. You can then withdraw the whole unit; it will be impaled on the punch, and cool in cold water.

One fault is if there is not enough clearance between punch and die you will get scratch marks on the moulding - increase the clearance. The other point is making sure the thickness of the die is great enough to allow sufficient draw.

Another method of heating the plastic is to put it under a grill but with this method of heating the temperature is falling whilst shaping the plastic whereas the heat is constant using the water technique and you cannot overheat the plastic (water boils at only 100deg C).

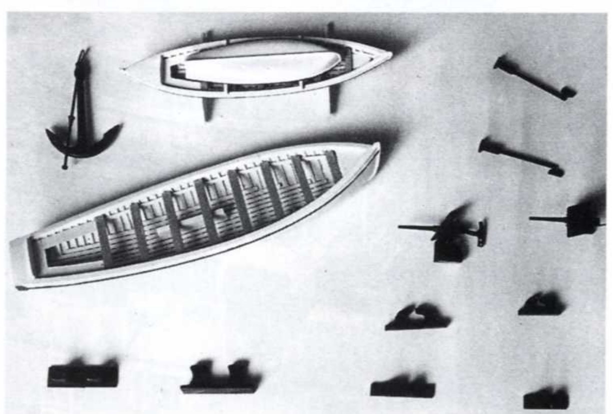


Fig. 8.3 Carved wooden boats and fittings for Victorian battleship

Two problems occur when moulding in polycard. One is the area of the forefoot can become rather thin owing to the severe stretching of the plastic. This can be overcome by using thicker sheet, which will mean clearances will have to be increased. Alternatively, if the material has not broken the forefoot it can be packed with Milliput (epoxy two part filler) rather than polyester which does not stick well to polycard. The second problem is that you cannot satisfactorily produce flat transom boats this way because you cannot get tight corners. The solution here is to extend the rear of the boat (and plug) about 1/8in and, after moulding, put in a false sheet transom in the correct position. The 'sucked sweet' bit can then be cut off. If you do not tell anyone no one will know!

Make sure you make enough mouldings to cover your needs and a couple of spares. To stiffen up the shell add a combined keel, stem and stern post again probably from 0.020in material. Gluing this to the centre line and keeping it vertical is an exacting task. You can try Plasticene, BlueTac or adhesive tape to hold it temporarily in position whilst gluing. (**Fig.8.6**)

To cut down the mouldings to the sheer line, first cut off the distorted flange. Next take your plug and cut it down to the correct sheer line. With the moulding held in a vice, using its extended keel, the plug can be dropped in and the sides of the moulding trimmed down to its top surface. Experience has shown this is a better way than trying to mark out each shell individually but the plug is ruined for any more mouldings hence the above exhortation. (**Fig.8.7**)

At this stage fitting out can continue as for a wooden shell. Having used wood, polycard, etc. I now use brass etchings for all the internal bits except for any external rubbing strakes for which I use polystrip. **Fig.8.8** shows etched parts of ship's boats. Combined inwales and timbers are drawn and these would need to be annealed to get them soft enough to 'dress' into the inside of the polyshells. This saves the time-consuming job of springing in the timbers as has been previously described. A certain amount of snipping of the bottom member would also be necessary when fitting to take out excess material. **Fig.8.9** (see colour plates) shows the fitting of a combined inwale and timbers using cyano.

Thwarts combined with the shelf are also shown in

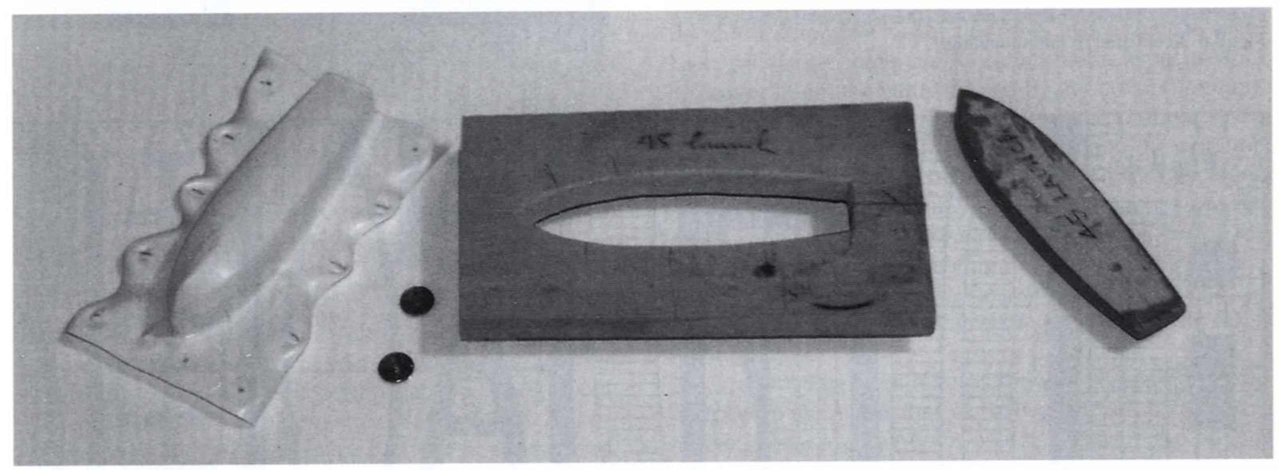


Fig. 8.4 Polystyrene moulding of boat hull

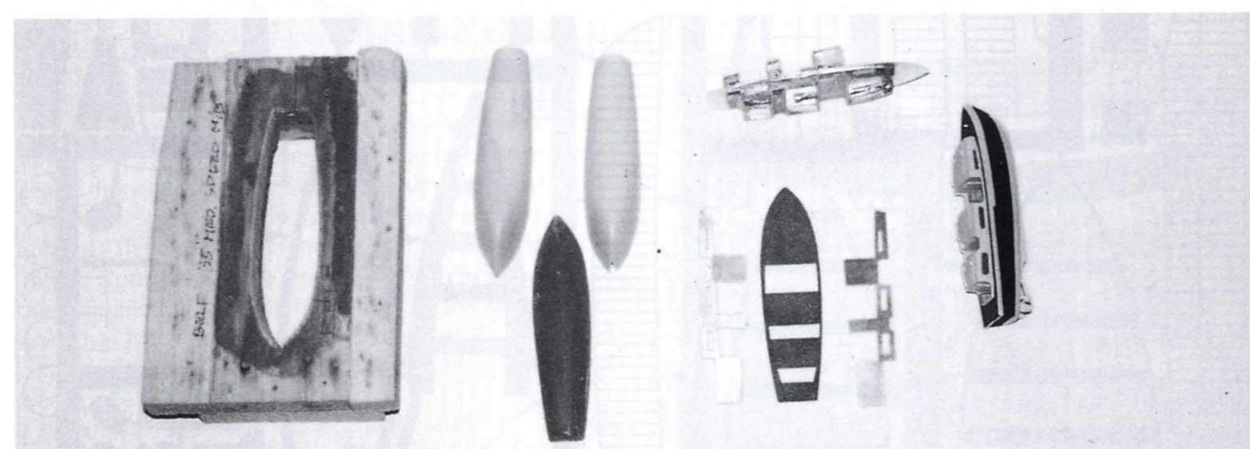


Fig. 8.5 Contstruction of 35' motor boat for Belfast

Fig.8.8. Thwarts normally sit on the shelf but at this scale who's arguing? Rudders of several kinds are also shown as well as, at top right, a piece of etched grating. The foot-boards can similarly be etched as one. Any cabin parts, etc. can also be etched but bear in mind they may need tabs, or what have you, to secure them.

This method of working is much faster than the old traditional methods and produces a very clean-cut model boat. (**Fig.8.10** – see colour plates), and **Fig.8.11.**

You cannot anneal very thin etchings by applying direct heat - they just get oxidised and distort beyond any recovery. The way to do it is to fold up a piece of metal with a tight fold. The components can then be dropped into the fold so they are totally supported and completely covered. If the whole unit is then heated up to about 600deg C, quenched and the fold prised open, out will fall an unoxidised, undistorted etching. I think the word is Eureka!

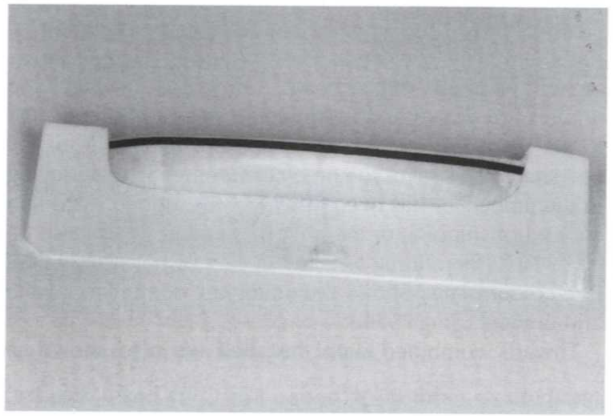


Fig. 8.6 Keel fitted to hull moulding

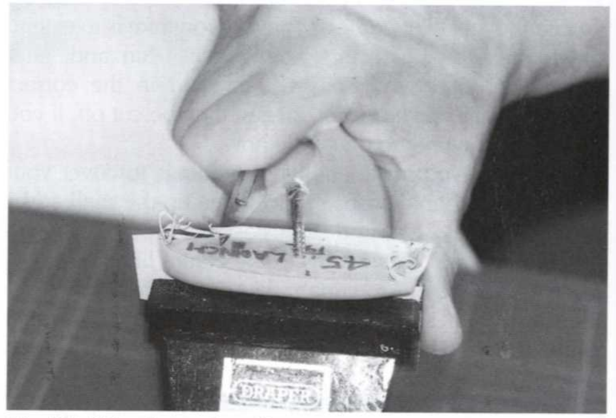


Fig. 8.7 Trimming to sheer line

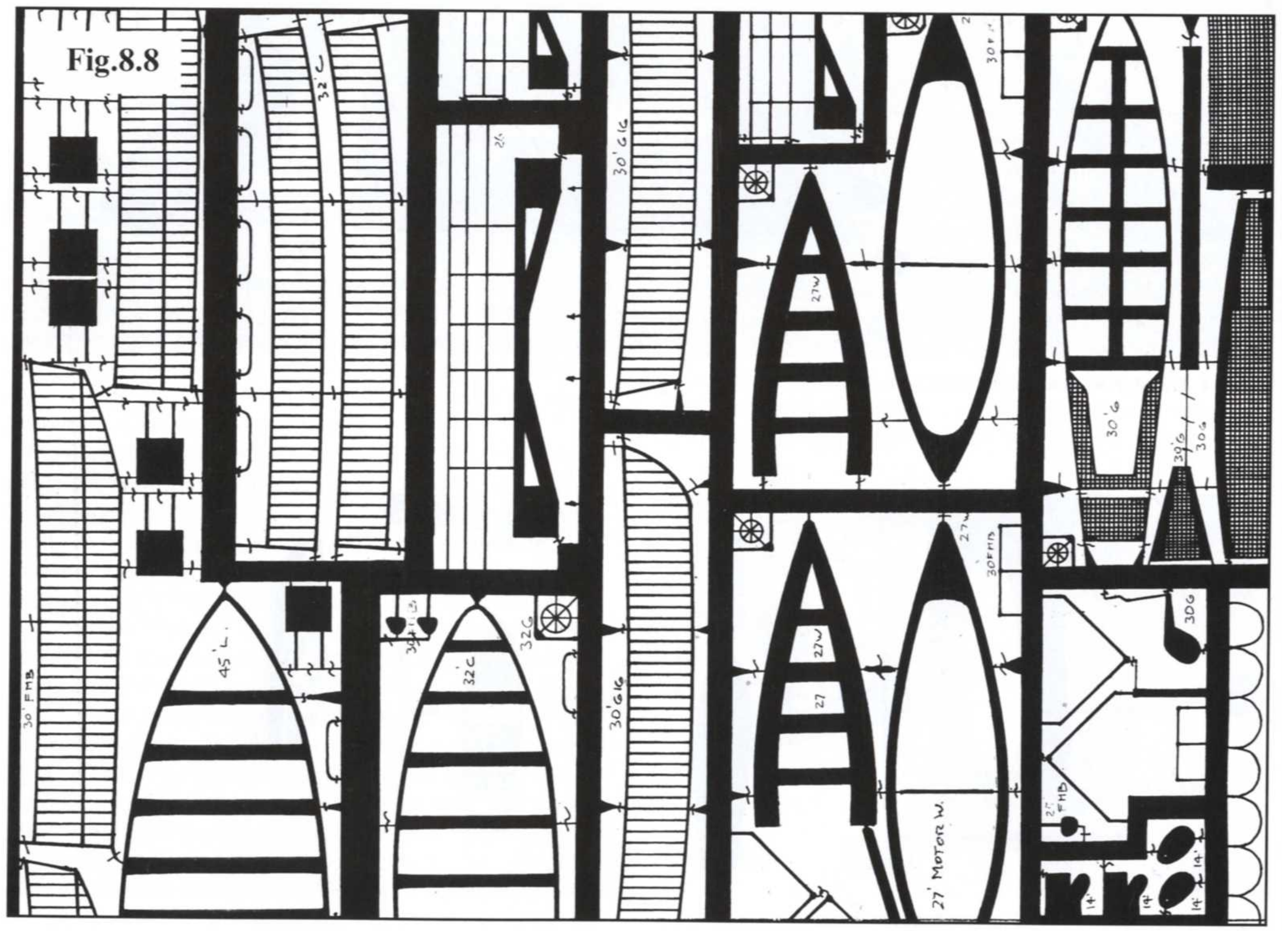


Fig.8.8

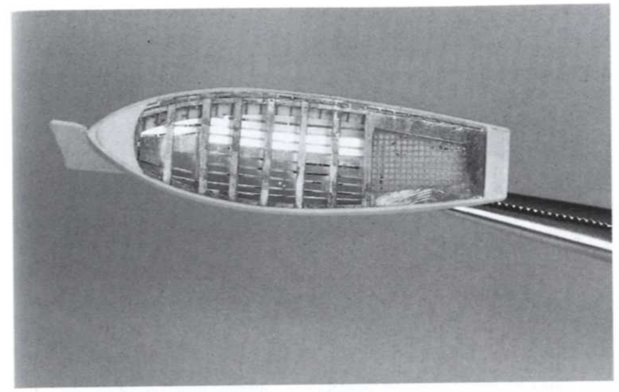


Fig. 8.11 Assembled cutter for Anson

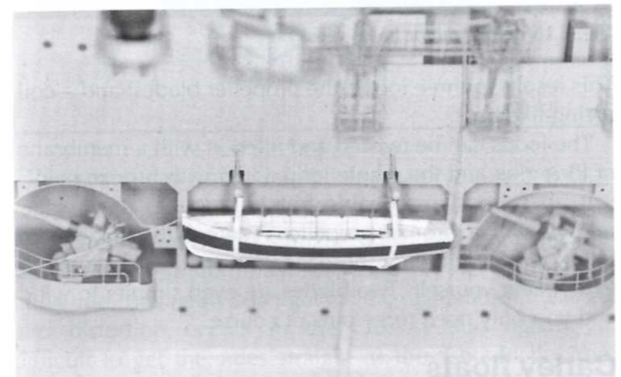


Fig. 8.12 Sea boat on sponsons (Glorious)

Further work may be necessary such as cutting slots for oars, fitting bilge keels, etc. (**Fig.8.12**)

Moulding using polyurethane

Most of the above is for open boats, whalers, cutters, gigs, etc. Some bigger boats, 45ft steam picket boats and the like, (**Fig.8.13** – see colour plates) can be carved from solid or moulded from polyurethane using a silicon rubber mould. This will involve making a male master and producing a female mould. Silicon rubber is an expensive material and, in the quantities wanted by private makers, best bought from model shops. It has the great advantage that it does not stick to many things and its flexibility allows you to cast shapes that would otherwise 'lock in' to a rigid mould.

Commercial mouldings of ship's boats are available but suffer from oversize thicknesses and too much over-heavy detail. It is possible to fine these down but at some expense of time. The other problem with urethane is air bubbles. The two parts on mixing start to solidify in about 3mins. Normal standing time to de-bubble is out of the question and bubbles are the result. I do not consider the urethanes that I have used are easy materials to use and certainly not for the newcomer. (**Fig.8.14** – see colour plates)

For details of silicon rubber mould work see Chapter Seven on Armament and for moulding from fibreglass, see Chapter Ten.

Gummed paper strip

As has been explained in Chapter Six, when discussing cowl ventilators, gummed paper strip or its alternative, thin paper and PVA, can be used. In the same manner a plug is required and the process of wrapping and gluing layers on continued until sufficient thickness has been built up. Owing to the shape, separation from the plug should be easier than with cowl vents. I have used this method and, with care, unlikely as it may seem, it is quite successful.

Crutches

Unless the boat is hung on davits (acting as a sea boat) crutches will be needed. These can be wood, polycard or metal. The life of polystyrene is open to question so, from the point of longevity, use one of the other two. It is, however, very useful in this role as it can be whittled with a sharp knife or scalpel so easily and fitting crutches to a little boat requires this sort of careful manipulation. Small boats usually sit on two crutches, larger ones up to four. (**Figs.15 & 16**)

The first stage is to mark on the model the position of the crutches which will, in all probability, be shown on the 'as fitted' drawing. Having decided on the thickness of material cut a strip a bit wider than the crutch will be high. Next cut a paper template, or rather half a template (fold the paper about the vertical in half), and cut and try until a reasonable fit on the hull exists at the point you are going to fit the crutch. Transfer this shape to the strip and either fret saw it out (probably best) or cut it with a scalpel. Use a sharp scalpel to finally shave the shape to size. The centre crutches, fitting the more or less parallel part of the boat, will not need to have any tapering on the contact surface but the fore and aft ones will need to be cut at an angle to suit the run of the boat. (**Fig.8.17 & 18** – see colour plates)

You are now faced with the problem of do you attach the crutches to the model first, or to the deck? Probably to the model is best as this allows you to sight line the bottom edges of all the crutches which should be in line. Do not forget that they may be sitting on a cambered part of the deck and need to be shaped so the centre line of the boat

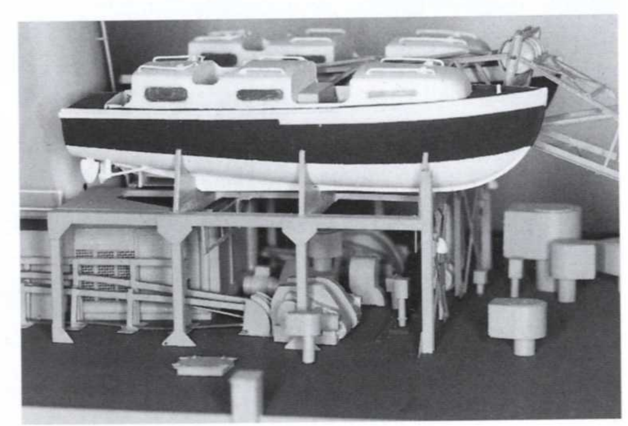


Fig. 8.15 Motor boats on crutches (Belfast)

is vertical. This is why the strip you originally cut needs to be wider than the crutch is high to enable the trimming to take place.

One further point about crutches is that when the boat cannot be lifted very much, as on aircraft carriers where the boats are stowed in apertures in the side of the hull, the outside part of the crutch is hinged at deck level so it can be laid flat to allow the boat to pass over it.

Etched propellers

Although elsewhere in this book (Chapter Three) propellers for the main model have been discussed the question of the tiny ones required for ship's boats present a different kind of problem. As these are only up to, say 4mm in diameter, they require a different approach.

Probably the simplest way is to etch them complete, as a two or three bladed flat shape, including the shaft hole. The blades can then be given a twist and the propeller secured with a spot of epoxy.

Wire propellers

If etching is not used another method can be adopted which gives good results. They can be made from thin 0.007in fuse wire. For a three blade propeller put four pins into a wood block as shown in **Fig.8.19 & 8.20**.

Start the wire by taking a turn around the centre pin as in 1. (this makes the boss). Proceed to loop it round the outer three pins in turn as shown in 2.

Finally take another turn round the centre pin as in 3.

Fig. 8.16 Belfast motor boats with crane

This results in three loops (the propeller blades) and a coil spring-like boss.

The loops can be twisted and filled in with a membrane of PVA glue and the whole lot painted with bronze paint.

It all sounds improbable but it produces a very fair rendition of a bronze propeller. There is no 'written in stone' way of winding these small propellers so you can experiment yourself. Two blades are even simpler to wind and you only need three pins of course.

Carley floats

The ways of making these can be likened unto the grains of sand in the desert **Fig.8.21**.

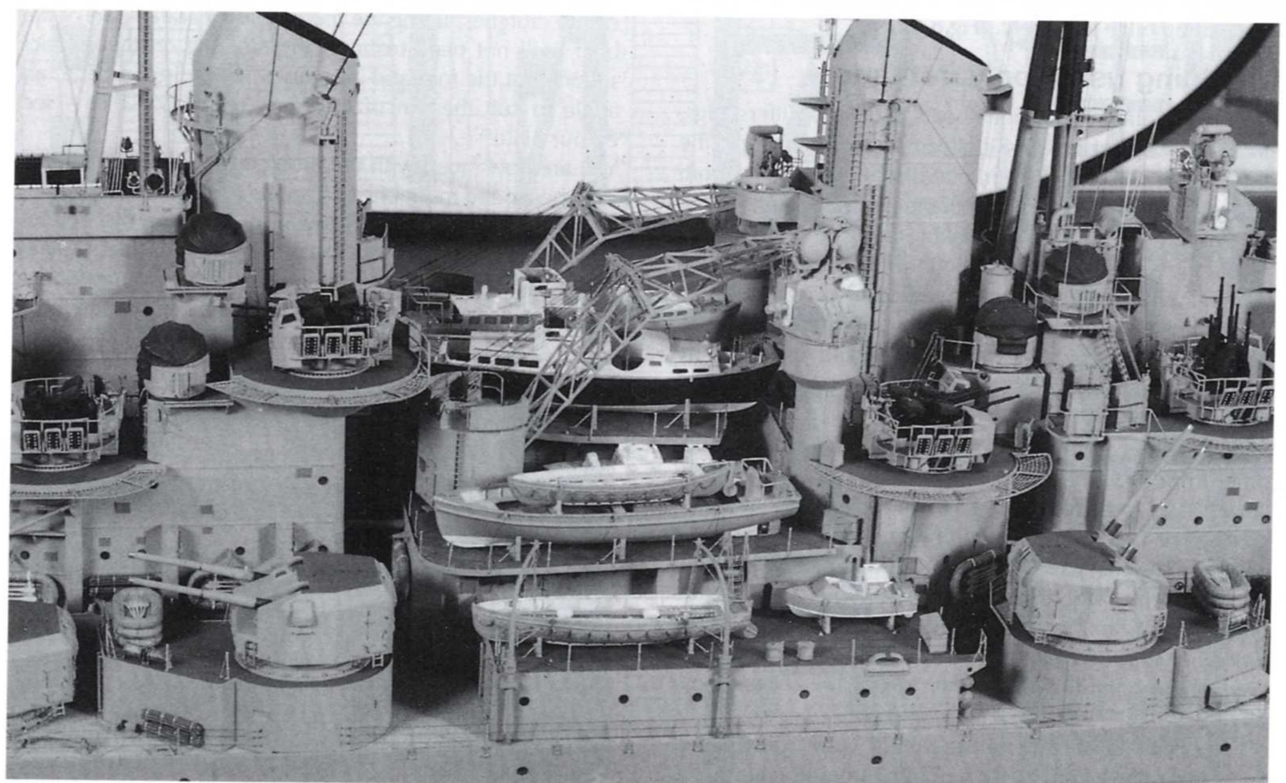
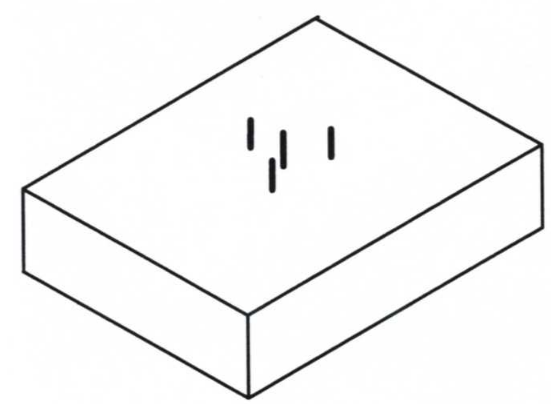


Fig. 8.17 Alex MacFadyen's Vanguard

Fig.8.19 Wire propeller jig



The obvious choice is wire for the float part which was originally made from copper tube. The English type had semi-circular ends and straight sides. Avoid getting the sides curved - a fault often seen. The problem is that the curve radius is really too tight for the diameter of the wire and distortion occurs in the cross-section making it difficult to get the sides straight as they should be. You tend to end up with a modified oval which is not the correct shape at all. American 'Carley' floats are even worse as they are rectangular with very tight corners.

One way out is to mould the float part either using urethane or Isopon. Make a master pattern in Perspex and from this make a two-part silicon rubber mould. From experience you can cast in urethane or by filling both halves of the mould with Isopon and closing the mould.

The gratings can be etched or made up by using a more orthodox method with strips of wood. Also do not forget the paddles.

The sizes, for those interested were: for carrying

6 persons	6ft x 3.5ft
20 persons	9ft x 6ft
39 persons	12ft x 8ft

Because, when stowed, it appears as if the grating is fixed directly to the float it is often forgotten that the grating actually hangs below the float when in the water. The two, float and grating, are connected by a circumferential net. After painting they need to have their ropes added. If the scale means very small floats these are probably best simulated by pencil lines.

SHIP'S AIRCRAFT

As well as for aircraft carriers fixed wing aircraft need to be made for large warships, at least up to the middle of WW2 when they were removed. Like ship's boats they are models in themselves and need to be treated as such. The most difficult are biplanes (pre WW2) and biplanes with their wings folded are even more difficult.

Having made some thirty aircraft a satisfactory method of construction has been worked out.

The fuselages can be carved from a suitable timber: lime, cedar or a fruit wood. You need a close grain wood that does not need grain filling. The main problem, at least with pre-war aircraft is the large number of holes required in the fuselage to house struts of all kinds, cabane, under carriage, skids, torpedo crutches and possibly tail plane supports. Trying to drill these accurately on a pre-carved hull is impossible as the drill wanders over the surface.

The secret is to use a drill jig and get all these holes as well as cockpits drilled out before any carving is carried out. Start by preparing a rectangular block of the overall size of the fuselage: width, height and length. This is the

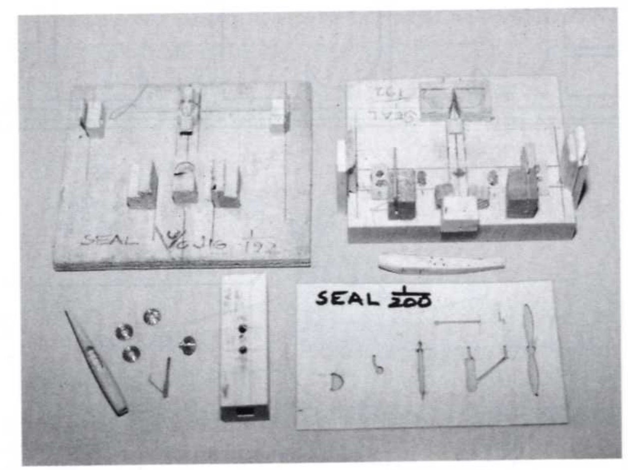
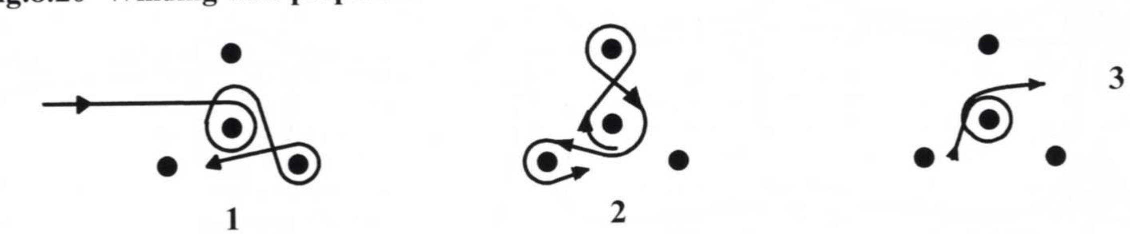


Fig. 8.23 Two assembly fixtures, fuselage drilling jig, etc.

Fig.8.20 Winding wire propellers



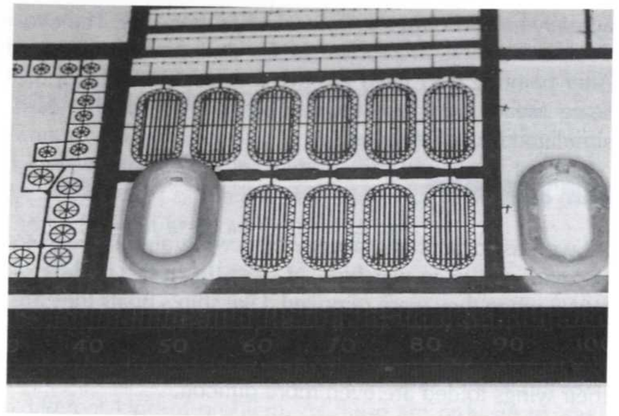


Fig. 8.21 Carley float mouldings and etchings

fuselage blank. Make up a box jig that fits this blank snuggly. Wood is good enough if only a small number of aircraft are to be built. Mark all the holes required on the outside of the jig and drill them out to the correct size. Push in the fuselage block and drill it. **Fig.8.22** shows the jig and a carved fuselage. Using a jig of this type all the holes can be drilled at right angles. If any struts need to be set at an angle this can be done by bending after assembly.

Following drilling, the fuselage blanks can be carved to shape.

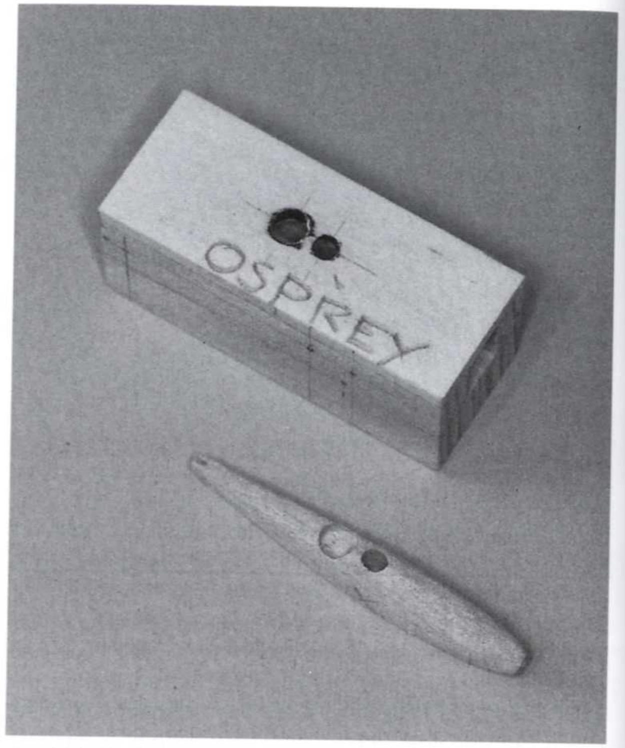


Fig. 8.22 Jig for drilling fuselage holes

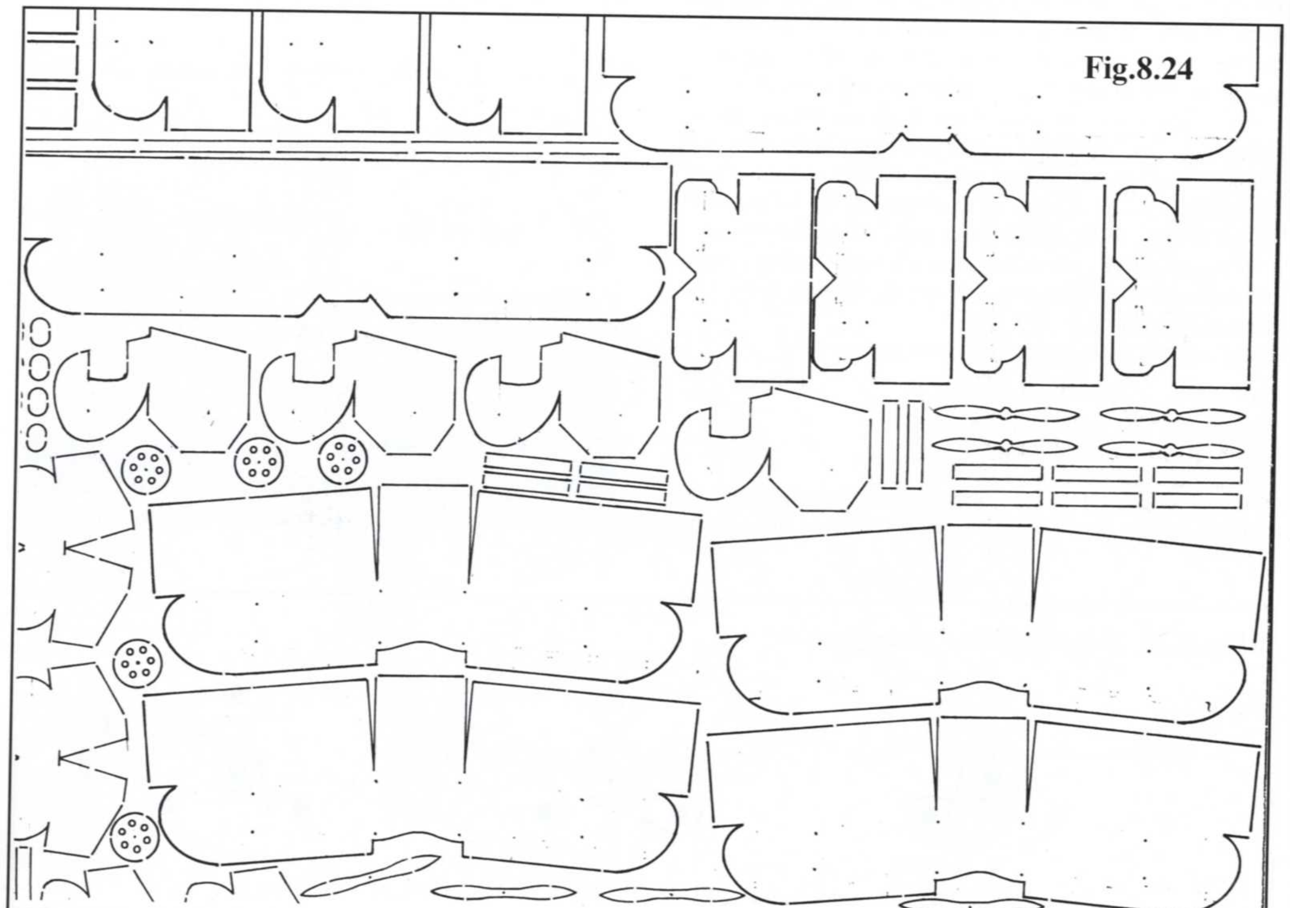


Fig. 8.27 Strike of aircraft on Glorious

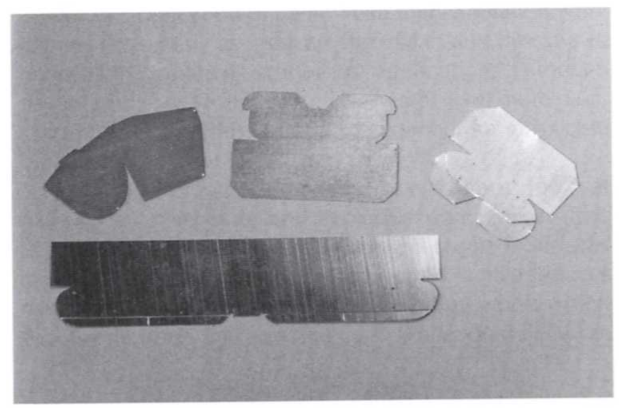


Fig. 8.24A Etched wing

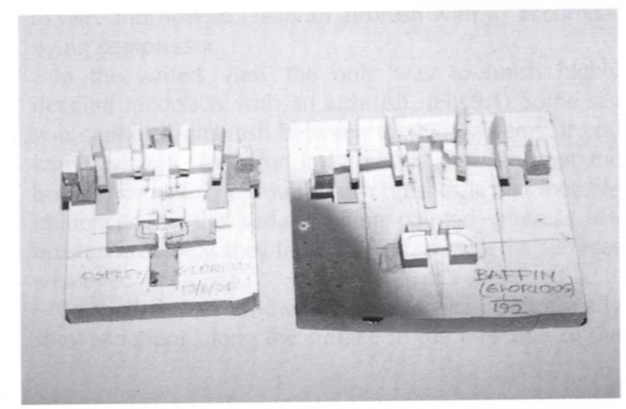


Fig. 8.25 Assembly fixture for Baffin

The planes, wings, tail, rudder and fin are best made from brass shim. This can be etched as can most of the other metal parts: struts, propeller, etc. The wheels and engine parts need to be turned. **Fig .8.23**.

Fig.8.24 shows the wing etching drawing. The top surface is etched completely to shape and the strut holes are also included but the under-surface is etched as a blank to be finally trimmed to size after folding and soldering up. The leading edge is a lazy fold over a shaped card or balsa former but the trailing edge and wing ends are closed down tightly and soldered before being finally trimmed to size. This technique should give you a nice aerofoil section. The strut holes need to be drilled through. To add greater realism the wing ribs can also be indicated. If, before folding up, parallel lines are scribed, fore and aft, on the inside face of the wings slight bumps will be raised on the outside thus simulating the ribs beneath the fabric. **Fig.8.24A** shows etched blanks for wings, tailplane and rudder.

To assemble the main parts a fixture is required to hold everything in the correct relationship whilst gluing (see **Fig.8.25**). After the lower wings are fitted the fixture may need to be extended to locate the top wing. Assembling the top wing can be tricky as there are so many struts to locate, wing struts of which there may be eight as well as four cabane struts (struts between wing and fuselage). If these are etched much longer than their final length it will be found easier to assemble. The wheels and engines for these aircraft, which were largely of the air-cooled type, are best turned. The cylinders are best formed by putting slots into the engine disc using a rotary table and a vertical mill.

Fig.8.26 (see colour plates) shows a model of a Fairey Seal at 1/192 scale for my model of the pre WW2 aircraft carrier Glorious.

Fig.8.27 shows a strike of aircraft on Glorious (Seal, Baffin, Osprey, Nimrod). Note the folded wing aircraft.

Chapter Nine

Finishing and Painting

No. 9. Always de-dust parts before painting and rectify after the first coat

These subjects require at least a chapter, and probably a book, to explore their part in modelling. They can turn a good model into a superb one or ruin it.

When I was first interested in modelling we used to read of models finished with 24, 34, etc. coats (you choose!) of gloss paint hand applied, each one rubbed down by hand. This was always spoken of in hushed tones as if the bloke concerned should have a medal. Perhaps he thought of himself as a latter day Hercules cleaning out the Augean stables. What all that paint did to the detail can only be imagined, all interior corners filled up with paint and all the external corners, with all that rubbing down, looking like sucked sweets.

I hope by now we have left all that type of folly behind. Perhaps before looking at ways and means a bit of basic thought should be indulged in?

'Finishing' can really be looked at as two separate problems:

1. The base surface on which paint, or whatever, is applied, and
2. The actual painting

Looking at 2. Firstly the paint should be there only to protect and colour the model and to give it the correct degree of sheen. The aim should be to achieve this with minimum application of paint. With highly detailed work paint is the enemy as it covers fine detail and destroys it, hence this minimal school of application. Although having said that, working models usually need more paint for protection but this is not a requirement for glass case models.

Looking at 1. Unfortunately one cannot look at painting as a separate and exclusive operation as it is dependent on the surface to which it is applied. Surfaces can be divided into active and passive. The active surfaces react to the paint finish, an example being wood which sticks up its fibres and ruins the finish. Paper does likewise. Inevitably this requires rubbing down which takes up time and needs to be done very carefully indeed, to avoid ruining what has been done before.

Passive surfaces such as metal and plastic do not react in this way and are therefore to be preferred. For those still determined to use wood, the surface can now be rendered fit to paint with a surface akin to that of metal and plastic by the use of two part epoxy finishes such as SP113 epoxy resin made by SP Systems and supplied by Ripmax. Often one coat will suffice to give wood a glass like finish which may need flatting with abrasive before painting. This resin accepts most paint systems. These relatively new materials are far more effective than sanding sealers which seemed to need rubbing down and recoating "n" times to get a really perfect surface.

The point of all this is to emphasise that the finish must be there before any paint is applied. The 34 coat brigade relied on the paint itself to provide the finish. Unfortunately the paints used are not the best material from which to build up a surface.

Brush or spray?

Before continuing it is perhaps opportune to discuss painting methods. Whether to use a brush or to buy, learn to use, and how to clean an airbrush with its accompanying compressor.

In the writers view the only way to finish highly detailed models is with an airbrush. (**Fig.9.1**) Some say you cannot distinguish between the two systems. If you know what to look for it is usually easy to spot the brushed model. The trouble with brushes is that they are influenced by the surface being painted whereas airbrushes are not as they have no contact with the surfaces whatever.

Brushed surfaces show two phenomena. They usually show striations along the surface in the direction of the

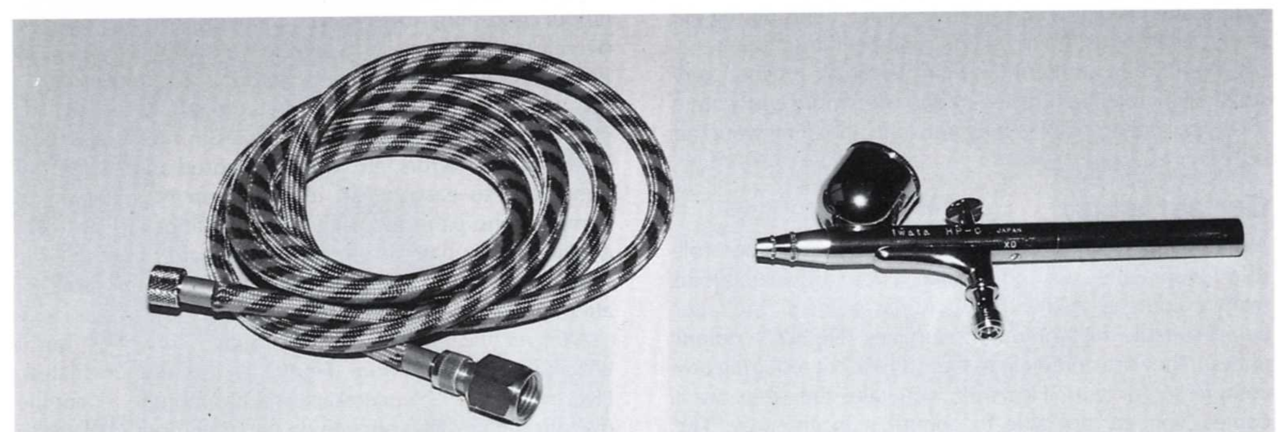


Fig. 9.1 Iwata airbrush and hose

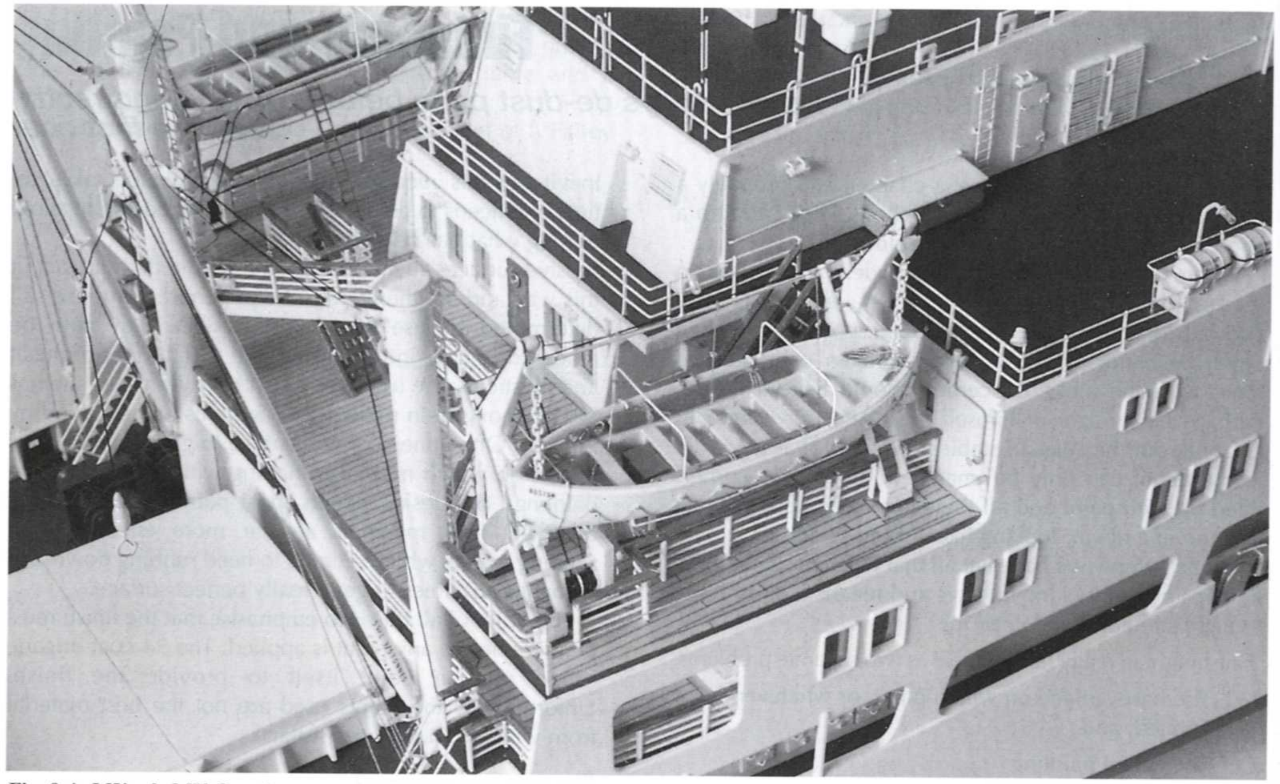


Fig. 9.4 J Woods MV Geestbay

laying off brush stroke and, more telling, the paint will fillet the internal corners. If any holes exist, such as ports in a hull, they will often show, perhaps minor, drips (sags) falling from them where the hole has bled paint from the brush. These problems are avoided by using airbrushes but these have the disadvantage of usually requiring more extensive masking to control where the paint is applied. There are experts, who probably possess a Paasche AB Turbo (must be the Rolls Royce of airbrushes), who can use air brushes in a precise way to put paint only where required. For instance, airbrush artists who use them for what they were invented in the last century, retouching photos and the production of air brushed pictures. Those of you, like me, into the sear and yellow, will remember Vargas and his highly imaginative young ladies during the WW2. Most of us, not so skilful, will need to mask.

Even if the majority of the paint job is air brushed very small detail may be brushed as it is often more convenient to do so rather than getting out and cleaning your air brush.

Car aerosols

A third method of finishing exists in the use of the aerosols sold for spraying cars and the like. These are available in many colours as well as grey and red primers. The latter being suitable for antifouling surfaces (**Fig.9.2** – colour plates). They are complete in themselves not requiring any compressor or gun. However, you take the spray as it comes, you are not able to control it in any way. The aerosol either sprays or not. Experience teaches that the larger cans spray better than the small cans and also give you plenty of paint which prevents you stopping before the job is finished. This is also why it pays to buy a compressor for your airbrush. If you use pressure cans they will always run out at the most inconvenient time. It's known as Murphy's law. When using paint aerosols always invert the can and allow a shot of propellant to clean the nozzle after spraying. Otherwise the next time you try to use it you will find the nozzle is blocked.

Rectification coat

This is probably the most important operation in model making but from observation sadly often neglected. Before the painting operation proper, put on an overall coat. The colour does not matter. Its function is to provide an overall uniform surface to expose surface problems. With different colours and different materials it is impossible to see where some rectification is required. Items such as glue exudate, gaps in joints, mistakes in finishing, rough areas, contour errors, etc. will be exposed and can be put right. It is so easy to fall into the trap of going on to complete the paint job without rectification. It is always exciting to get paint onto the job but care in completing rectification will be well rewarded. It's this sort of attention to detail that wins gold medals.

After rectification this first coat may hardly exist but it will have done its job (**Fig.9.3** – see colour plates). However, it may be necessary and desirable to repeat the operation more than once to do the job properly, that is to produce the perfect surface for painting.

The dust problem

Most modellers spend a lot of time rubbing down. This wastes time and is, unless carried out very carefully, destructive to the model. The essence of high-class model making is the production of a clean-cut job - no excessively rounded corners and the detail kept clean and sharp. If "passive" base surfaces are used (as has been discussed) any rubbing down needed is almost certainly because of dust problems, or paint that has been contaminated by dust, or the result of paint skin getting mixed into the paint (in which case the paint needs to be strained through old tights material).

The secret is to recognise the problem is caused by that almost invisible dust that exists everywhere. Just as surgeons have developed a technique that requires all germs to be eliminated from the operation site modellers should develop methods to eliminate dust at ALL stages of finishing. Do not take for granted that it is clear of dust merely because it looks clean - it will not be. Paint cups for airbrushes may look clean and they probably were when you last cleaned them but they will have collected dust since then. Plastic surfaces get electro-statically charged and attract dust like wasps to a honey pot! If you spray without cleaning, that dust will get incorporated into the paint film and hence require the hated rubbing down. Eliminate the dust and the need for rubbing down also disappears. You will say 'but I do clean off work', but do you? Would your standard of cleanliness pass in an operating theatre? You must develop a real anti-dust philosophy if you want to stop the time wasting chore of rubbing down. Not only will you save time but also your finishing will improve beyond measure.

With my last model I doubt, apart from the hull the surface of which was an active surface of wood and paper, the total time that was spent on rubbing down exceeded five minutes.

Keep everything under cover. For instance, store brushes where they will not pick up air borne dust. Store just painted parts in as dust free a position as possible. The use of fast drying finishes, such as acrylics, helps of course.

Rubbing down

Having described methods of eliminating this operation there will be times, of course, when rubbing down is necessary so, perhaps, an examination of the process is called for. If the base surface is water-resistant (plastic or metal) fine wet and dry paper is best used wet. A touch of washing up detergent or toilet soap will aid the operation. Particularly if small parts are being rubbed down use a piece of wet and dry paper that has been well soaked in water. This will render the paper soft and it will then do what you want. Stiff paper goes off and does its own thing and you will find scratches where you did not want them. Make sure any soap/detergent has been washed off and the surface is dry before re-painting.

A close examination of the intermediate results of trying to rub off an upstanding spot will show you that the spot has been reduced in size but also an annulus (ring) of paint surrounding the spot has, in all probability, been removed as well. This is not what is wanted at all. A method that removes 'yon spot' is required that does just that and leaves the rest of the surface as was, intact.

Another method exists and that is 'rubbing down' by scalpel which is much quicker, more efficient, and removes spots but leaves the paint surface intact. If a sharp, number 25 scalpel blade is held at a shallow angle to the surface and pushed along this will remove the offending defects without taking off any other paint (see **Fig.9.5**). The angle needs to be shallow, less than the angle of a plane blade, to avoid any digging in. This technique is quicker and more efficient than rubbing down and requires little practice to get it right. One snag exists - make sure you get rid of the "dust" produced by this operation otherwise you are back to square one.

Rubbing down paint applied to surfaces such as wood or paper requires a dry technique. If the above methods are used the water will raise the grain given half a chance and again you are back to square one. However, you can use the scalpel method which requires no water.

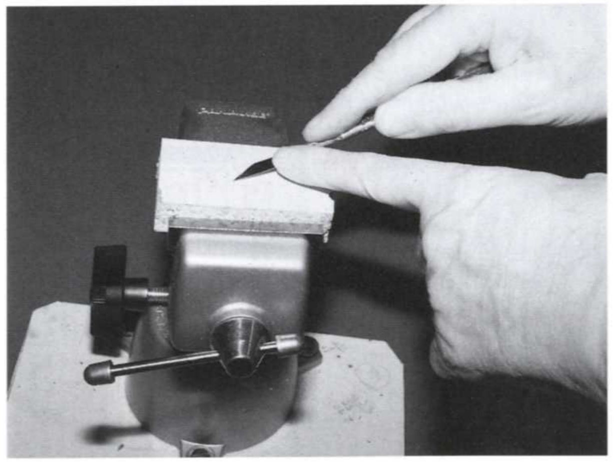


Fig. 9.5 Scalpel rubbing down

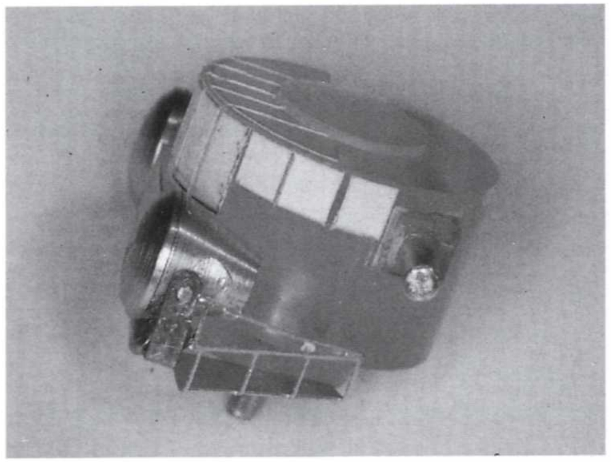


Fig. 9.8 Masking of director windows

Hull Plating

I have never tackled this job properly, that is plotting the plating detail from a plating expansion drawing. This would require a very accurately built hull otherwise the plating would need 'adjusting' to suit any errors.

The plating arrangement above the waterline can usually be deduced from photographs, the underwater detail is a different matter. Unless pictures of the vessel in dry dock are available this must be guesswork. It is usually impossible to do a proper job as the information is not available so plating can be simulated rather than leaving the hull plain (**Fig.9.6** – see colour plates). I plate with ordinary cartridge drawing paper glued on with white PVA glue. I mark out using pencil lines as a guide but laying to a pencil line is not easy and wetted cartridge paper, being very delicate, cannot be handled too much. I therefore put down masking tape on the wrong side of the line. This can be handled any number of times until a fair curve is achieved. The paper can then be laid up against the tape edge first time whereupon the masking tape can be removed.

One of the problems is to get just the right amount of glue onto the paper - too little means the edges will lift, too much will give glue exudate thus destroying the sharp edge you are trying to achieve. In the past I have left the paper without any further treatment and carried on spraying colour. However, this means the first coat raises the fibre of the paper, as has already been discussed, which then requires rubbing down. On the last model this problem was avoided by painting the paper strips with PVA glue diluted with water. The water was added to help smooth application and to aid penetration. The aim was to stabilise both the surface and the thickness to prevent delamination when pulling off any subsequent masking tape. Again attention to the edges of the plates was necessary to preserve their sharpness. Make sure both sides are identical. It is alarming to squint along the hull from either bow or stern only to find the plating lies in a smooth line but is lower one side than the other.

Pre-painting

Needless to say, the surface should be dust free and clean. With woods the main problem will probably be dust which can be quite difficult to get rid of completely. Plastic surfaces may be contaminated with releasing agents, dust and finger grease. Washing with soap and water may be the best answer followed by slight flatting of the surface if necessary. This operation will produce the old enemy, dust, of course but we have been through that before.

Metal surfaces may be oily and contaminated with finger grease. These can be removed with soap and water (non-ferrous materials only because of rusting problems) or with white spirit or methylated spirit. Any contaminants from previous soldering or brazing operations also need removing. The surface may also need abrading slightly to increase paint adhesion. Remember the dust problem! Do not expect very good adhesion on aluminium or aluminium alloys. Paint tends not to adhere very well for some reason. If fibre pens have been used for marking out this coating can be removed with methylated spirit.

All the above will, if left, contribute to poor adhesion of the paint film. Good adhesion is essential for obvious operating reasons on working models but all paint films need to be able to withstand the impact of masking tape. The one thing that raises the ire of the most patient modeller is the sight of masking tape pulling off its underlying paint film, but more of this later.

The received knowledge of the professional sprayers is that the first coat should be very thin, the underlying surface should still be visible and that this coat should be left for twenty four hours before adding further coats. Try and adhere to this. It is very tempting, as with the rectifying coat, to press on and put a nice thick opaque coat on so that you can gloat. This is not the way to get good adhesion and later disaster may occur if you ignore these rules.

Masking

The object of masking is to protect an already sprayed surface and to produce a clean separation line between two colours (**Fig.9.7** – see colour plates). The tape must be applied firmly to avoid 'bleed' of the new coat under the masking edge but it must not remove the paint on which it is sitting when it is removed. These last two factors are, unfortunately, somewhat at odds. The harder the edge of the tape is rubbed down to avoid "bleed" the more likely it is to pull off the paint.

For normal paintwork, only use tape that is made expressly for the purpose. Masking tape has a relatively low tack adhesive to prevent 'rip off'. If you use, say Sellotape, for masking purposes the adhesive is so strong that rip off is almost assured. However, there are cases where such tape can be used.

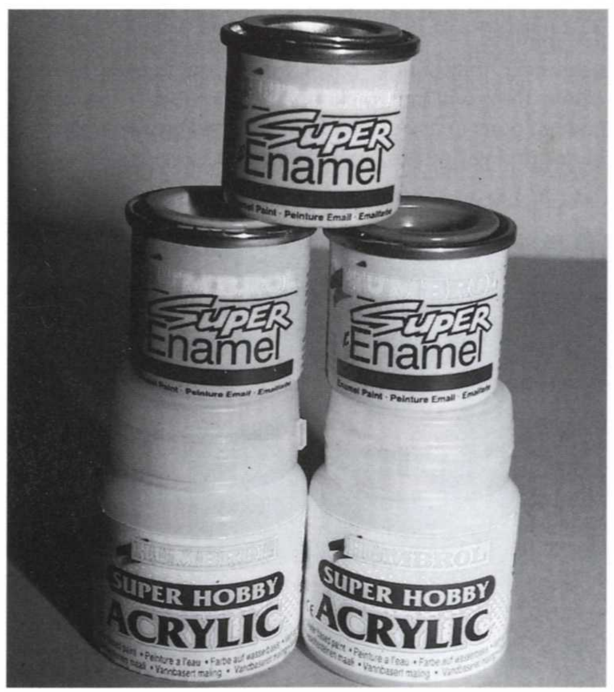


Fig. 9.10 Enamel paints

Fig. 9.11 Acrylics

If clear Perspex is used for a component, such as the housing of a MKV1 HA/LA director, the windows can be masked out and the component sprayed. Removing the masking tape will produce 'built in' windows (see **Fig.9.8**). In this case and where it differs from ordinary masking methods is that, the Perspex is not pre-painted and there is nothing for the tape to rip off. Using tape with strong adhesive has the advantage of curing bleed but it may have a disadvantage in that you may have to clean off any residue adhesive.

Proper masking tapes are usually pretty clean in that respect. If any adhesive is left behind it can usually be dabbed off with another piece of tape. Residue adhesive problems usually stem from over indulgent application of paint so that the excess solvent attacks the adhesive film. Always spray "dry" especially with first coats and near the edge of a mask. This is to avoid the above and to seal the tape edge. Some modellers first spray the original colour so, if bleed does occur, it will not show. The writer deprecates this; if the correct procedure is followed it is unnecessary.

Other products can be used as a mask. Frisk film is one, mainly used by graphic artists and the like and there are liquid masks applied with a brush that set like a skin and can be pulled off afterwards. For holes and difficult nooks where the use of tape is not possible Play Doh or Plasticene can be used simply pushed in.

Applying masking tape

First make sure the surface is really dry and clean. The aim is to secure a firm seal which cannot occur if dust is present. Again the old enemy! For the best work do not rely on the tape edges as it comes off the roll. It is never as perfect as a freshly cut edge. Pull off a sufficient length and lightly stick it to a clean surface. Scalpel off a thin strip to produce a new clean edge. If curves are present, and where on a boat are they not, thin strips rather than full width tape are usually better to first define the edge. With this defined, backing strips can be added, which may also be used to fix cartridge paper or the like to protect larger areas. Do not use newspaper as if the print does come off it can ruin the job.

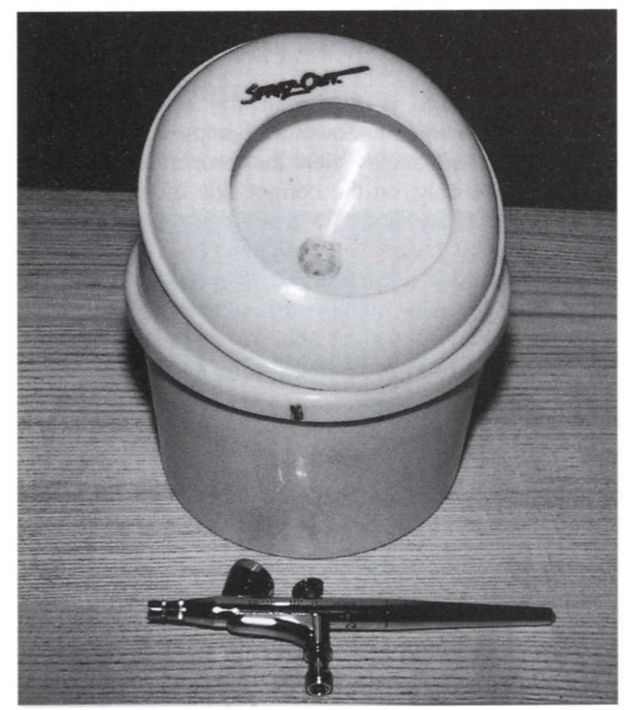


Fig. 9.12 Airbrush paint discard container

The defining edge of the tape must be rubbed down firmly. A piece of Balsa is a good tool for this used end grain on. If you use fingers watch your nails as these can seriously damage previously painted surfaces but fingers are not really recommended for this job. Do not rub down the tape except for the defining edge as it serves no purpose and may lead to rip off. Just make sure it is attached and will not fall off, beyond that no rubbing down is required.

One of the great problems with masking is getting a fair curve with no lumps or bumps on such things as water-lines. It is a problem as can be seen at any model show.

The problem is, having marked the line with some sort of height gauge off a flat surface, masking to this line. If you are reading this book I presume you know how to mark off. First check that both sides are the same. It saves a lot of time if you make sure the marked lines are correct in every way. A tip here is to slightly lift both ends of the line even if the plans show a perfectly level waterline. This is to avoid the waterline appearing hogged even when it is not. Sweep the first and the last six inches up slightly say 1/8" and this will prevent any such illusion. Also make sure the datum you measure from, when defining the waterline, is flat. On one occasion the writer did not check his datum and the amount of work involved in correcting this error was most depressing.

With the line defined and double-checked the tape can be applied and this is where the trouble starts. Most modellers apply the tape to the correct side of the line ready for spraying. The trouble is that applying the tape in a clean curve is very difficult and a game of sticking on and pulling off ensues. The secret is to apply a tape on the wrong side of the line i.e. the side on which the paint is finally to be applied. This tape can be pulled off and re-applied any number of times without wondering if the adhesive is still viable i.e. will it seal and keep the paint out?

When this tape is finally in the correct position following the marked line with no bumps or lumps when viewed from *all* angles then the proper tape can be applied, once only, on the correct side of the line. It is much easier to lay tape to a tape edge rather than to a pencil line. It is actually very difficult to lay to a pencil line to any degree of accuracy and smoothness. With this latter final tape in the correct position the first tape can be pulled off and destroyed, its adhesive is usually ruined by this time! Before spraying make sure no adhesive has been left behind.

This double tape technique is often useful in all kinds of situations.

The normal slightly crinkly masking tape supplied by large DIY suppliers is satisfactory for most jobs but a plain brown paper tape made in China is better. This is sold in various widths and has been found superior.

Whichever tape is used try and remove it as soon as possible. The longer it is stuck to a surface the greater the risk of rip off. Also do not expose any masked up model to sunlight as this hardens the adhesive and makes tape removal more difficult. To remove masking tape first take

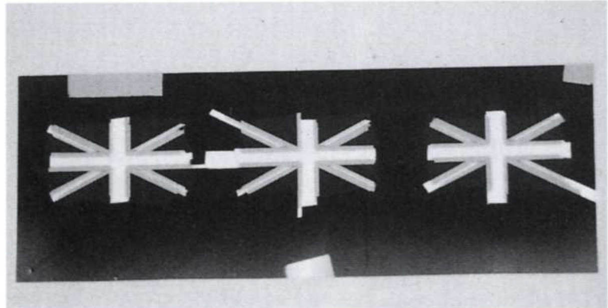


Fig. 9.14 Airbrushed flags

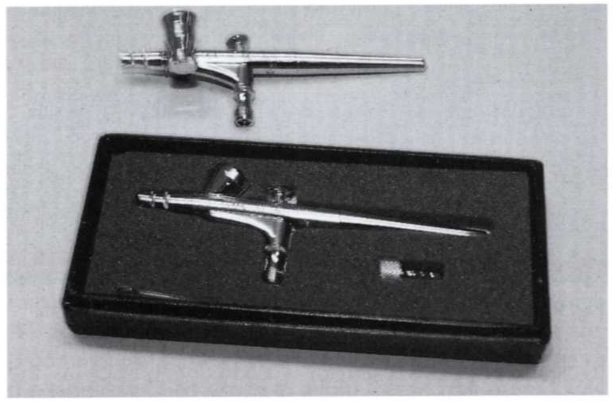


Fig. 9.15 Iwata airbrushes

off the outer masking leaving the primary defining tape in position. Carefully and slowly pull off the tape back along the line of adhered tape. This allows the defining edge to cut the overlapping paint film. Do not pull the tape away from the surface at right angles as this is courting disaster! One last point about masking and that is to emphasise that the initial coat must be 'dry' and directed, if possible, across the tape edge and not against the edge. 'Dry' means that not enough paint is sprayed to start to glisten (shine). If a heavy coat is put on it may well penetrate under the edge and bleeding will result. Spraying across and not against the edge will also help. Once this initial coat has dried the tape edge should be sealed and further coats can be safely added.

Paints

The three main methods of paint application have already been discussed i.e. brushing, airbrushing and aerosol packs (largely car finish orientated).

Enamels. For years the standard oil based paints and enamels have been used. Now we have the Super Enamels, manufactured by Humbrol, which are a modified alkyd resin solvent paint. (**Fig.9.10**) These can be brushed and sprayed satisfactorily as many tens of thousands can testify. Their pigment particle size is now down to fifteen microns (a micron is one thousandth of a millimetre). The smaller the better for spraying as the clearances in spray guns are very small and large particle paint cannot be sprayed satisfactorily as some of us have found in the past.

A great range of colours, orientated towards the model-maker i.e. aircraft, army, navy and railway requirements are available and also in degrees of sheen: matt, satin and gloss. It is nearly always possible to obtain what you want. The one disadvantage with the Humbrol range is that their basic size tinlet is too small for most ship modelling.

Humbrol also make metallic colours, which can be dry polished to achieve a realistic metal-like sheen, and clear transparent colours for use on glass and clear plastic parts. They also supply a loose-leaf book on their unique Humbrol colour system, which contains proper paint chips of their ranges, and much information on mixed colours. There is a charge for this unfortunately. Other paints are made by Testor, Revell, Tamiya and Gunze Sangyo.

Acrylics. These are a relatively new type of paint which is generally described as being water-based. Like most products acrylics have been refined over the years and whereas once they had such large pigment particles that they could not be sprayed satisfactorily; they are now the preferred medium for many modellers because of their superb finish, permanence and the ease with which brushes and airbrushes can be cleaned after use. They adhere well to most surfaces and are available in all finishes - gloss, matt, satin, metallic, translucent, dayglo etc. There are even varieties designed for 'difficult' plastics such as Lexan. (**Fig.9.11**)

Some acrylics, although spraying well and this is the preferred method of application, are not easy to apply with a brush. If brushed the material should be 'flowed' on to the surface using minimum brushing otherwise the paint tends to dry before the job is covered and bits of semi-dried paint get incorporated into the coat.

Acrylics come in many varieties and modellers seeking a particular colour or effect could well look to ranges of artists colours, for example Liquitex, if what they want is not readily available in the ranges of the usual 'model' paint manufacturers.

The many varieties of acrylics include many consistencies. Liquitex, for example, comes in tubes (of the consistency of toothpaste and for brushing only) and jars (of the consistency of cream). This company does, however, sell an excellent product called 'Airbrush Medium' which can be used to thin the paint to the required degree for spraying. Other ranges, for example Badger Air Opaque, are ready to spray from the container and yet more, (Tamiya and Humbrol) require varying amounts of dilution with special thinners for airbrushing.

Having said that these paints are water-based the implication is that they can be cleaned up with and thinned with it too. This might be so when nothing better is available but you will notice that the thinners supplied by some manufacturers for their acrylics has a distinctly chemical or alcohol smell. One of the purposes served by thus making the thinners more volatile than plain water is to accelerate the drying time. This is a particularly useful feature in that quicker drying reduces the possibility of dust damage, minimises bleed under masking tape and permits tape to be removed sooner, before the adhesive becomes too tacky with age.

As for cleaning a little mild soap (or even better, artists brush-cleaning soap) and water will remove undried paint but dry acrylics are often unaffected by their own thinners. Badger, however, make an excellent and cheap cleaner for their Air Opaque range which works on all acrylics. In the absence of this product the technical pen cleaner supplied by such manufacturers as Rotring, Faber-Castell or Staedtler can be used, although it will be more expensive. With many former drawing office supplies shops now closing because of the introduction of computer-aided design a visit to a specialist supplier of materials for graphic artists and designers will often yield the more uncommon items, including miniature spray-booths and extraction systems and containers for catching the spray of cleaner from an airbrush that is being serviced after use. (see **Fig.9.12**)

Post Painting

It is always a good idea, however absorbed you are in your particular branch of handiwork, to look at whatever

Fig. 9.16 Diaphragm air compressor

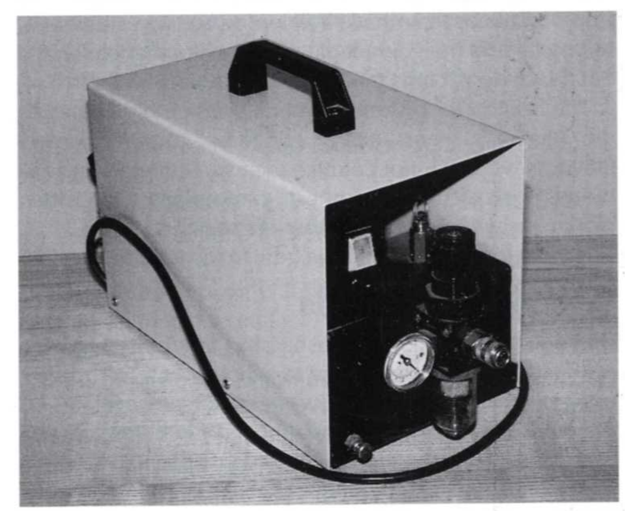


Fig. 9.17 Enclosed air compressor

related branches are up to. Usually some ideas come across that you have not thought about. Some years ago there was a burst of activity in the painting of military models and various magazines sprang into publication dealing with the subject. On reading these I was struck by the use of painted highlights and shadows. Seemingly the natural high and low lights were not considered enough and were therefore emphasised.

It seemed to me that the technique could possibly be applied to ship models, particularly naval models where the universality of grey does tend to produce a drab looking job. I found the process worked well and was not difficult to carry out. It worked particularly well on the matt black hulls of late Victorian battleships. The hull faces of these ships were strewn with hatches, fittings, gun emplacements, anti-torpedo net gear, etc. but, because of the matt black surface, these were largely invisible; they simply merged into the background. Highlighting top edges, hinges and any points that would normally catch the light improved the appearance by quantum leaps. The secret was in understatement.

The technique was to use pale to medium grey paint, not white which was too overbearing, and apply this with as dry a brush as possible in as sparing a manner as possible. The paint usually needed thinning first. A cloth was kept handy to wipe off any exuberant excess of paint. On first glance the technique appeared to do nothing until it was compared with an untreated area when the improvement was most marked.

Grey turrets and fittings also benefit from such treatment but the highlight paint needs to be paler, nearer to white than when applied to matt black surfaces. It must be again emphasised that subtlety is the secret.

The appearance of canvas work, dodgers and awnings, can similarly be improved by adding highlights and shadows to them. Dodgers show the imprint of the supporting guard rails if a wind blows them back against their structure (**Fig.9.13** – see colour plates). Draping in the corners where the rope attachments pull up tight can also be simulated. Similar effects can be seen on the 'pram covers' on open type directors and the canvas covers on ship's boats. You can have a field day but step cautiously, too much and the gold medal goes to the other bloke and the 'black dog' roams the house for days afterwards!

The fashion for distressing models which blossomed in the seventies seems, thank goodness, to have largely faded. Naviga will not countenance such models and the writer feels it was a good camouflage for rotten workmanship in a large number of cases.

Having discussed technique now to the tools for the job.

Selection of Brushes

Without a doubt the best brushes and the most expensive are made of sable. However, a whole range of brushes using synthetic fibres are now made some especially for the modeller. They vary in quality and price. Perhaps the best guide is price. So buy the best if you aspire to perfection. It is also a good idea to buy some cheap ones for the more mundane jobs in modelmaking such as applying glue, etc. Having acquired your brushes take care of them. Clean them properly and store them away from strong light and that old implacable enemy - dust.

AIR BRUSHES

The selection of an airbrush is more complicated than the choice of brushes. You need to get it right as the total price with a compressor will probably be in excess of £200.

The first point to consider is what you want it for and what you expect it to achieve. For instance, some light guns will not spray heavy enamels. Make sure your choice will do the type of work you contemplate.

Types of airbrushes

Two basic types of airbrush exist: single action and double action. In the first type the trigger acts as a simple on/off air valve - a single action. In the second type the trigger controls the air supply by downward pressure, as with single action guns, and also the paint supply by backward pressure on the trigger. This gives total control of the whole process. There are further sub-divisions: internal mixing, external mixing, fixed double action and independent action, the latter being the acme of the airbrush genre.

The choice of which gun can only be determined by finding which manufacturers specification fits your needs and budget. I would suggest you buy the best you can afford if you are serious and determined to master the art. If you are not so sure buy one of those cheaper guns made especially for the modeller.

One last point is that airbrushes can be temperamental and do require looking after. However, in the writer's opinion, they are a must for advanced model making. The names of some airbrush manufacturers are: Badger, Humbrol, Conopois, Paasche, De Vilbiss, Iwata, Thayer and Chandler. (**Fig.9.15**)

DRIVING THE AIRBRUSH

Airbrushes need compressed air to drive them at about 30-40lbs/sq.in. (2-3bar). Several methods of supply exist:

1. Compressors (and reservoirs)
2. Foot pump and storage tank
3. Spare tyre
4. Propellant air can

Compressors and receivers (reservoirs)

Of these alternatives number one is the best and most convenient source of supply. Compressors can be of many types but most of those for home use are of the almost silent diaphragm type with or without a receiver. (**Fig.9.16 & 17**) If no receiver is fitted the air must be able to bleed away when the compressor is running but the gun is not being operated. This is to avoid the motor overheating. The bleed is provided by an air bleed-off valve. With receiver type units a pressure switch is fitted which monitors the receiver's pressure and switches the compressor on and off accordingly. This gives a constant air supply pressure to the gun, the ideal condition for maximum gun performance. The system also needs a moisture trap, to remove water and oil from the air, a pressure gauge and a pressure regulator to set the spraying pressure to suit the gun in use. A suitable air hose to connect gun and compressor will also be required.

Unless you are knowledgeable about these matters expert advice needs to be taken to ensure the whole set-up is compatible and suitable for its predicted use.

Foot pump and storage tank

This comprises of a vessel which is pumped up using a foot pump. It needs hard work and only provides a limited compressed air supply with the pressure falling when the gun is being used.

Spare tyre

A pumped up spare tyre, mounted on a wheel of course, can be used as a compressed air supply either inflated to about 40lbs./sq.in. at a local garage or with a foot pump. Again you have a falling pressure to work with and probably a damp, contaminated air supply to boot. You will need a control valve to connect tyre to gun hose.

Propellant air can

A cheap form of air supply. These are supplied in 120gm. or 200gm. cans. They are best used with a metered valve which tells you how much air is left in the can. Before attempting a job make sure you have a spare can(s) available to avoid being left high and dry.

Cleaning airbrushes

These precision instruments will not work if they are dirty. They must be kept clean and undamaged. If water based media are being used (inks and acrylics) use technical pen cleaner or water plus a drop of detergent to flush out the bowl and gun. The use of a paintbrush to release the paint is recommended using copious amounts of water. Cotton buds, obtainable at chemist shops, can also be used to clean out the paint bowl. Back flushing is also an effective way. First retract or remove the needle to avoid puncturing your digit, or cloth held with said digit, and apply a small amount of air pressure. This will force the fluid back into the cup thus blowing out the inside of the gun.

If other media are being used the appropriate thinner must be used instead of water.

A small amount of lubricant (Vaseline) on the back of the needle will reduce friction and wear and tear.

Sooner or later you will need to disassemble the gun to clean it more thoroughly. Taking it apart is usually straightforward and most manufacturers show an exploded view to label the part numbers. The needle requires special care. It must not be bent and the pointed tip which, on some guns is very thin, must not be bent or damaged if the spray pattern is to remain as designed. The nozzle, the part that sits on the pointed end of the needle is also vulnerable. Do not force the needle into it too hard as if it splits the spray pattern will be permanently ruined. The

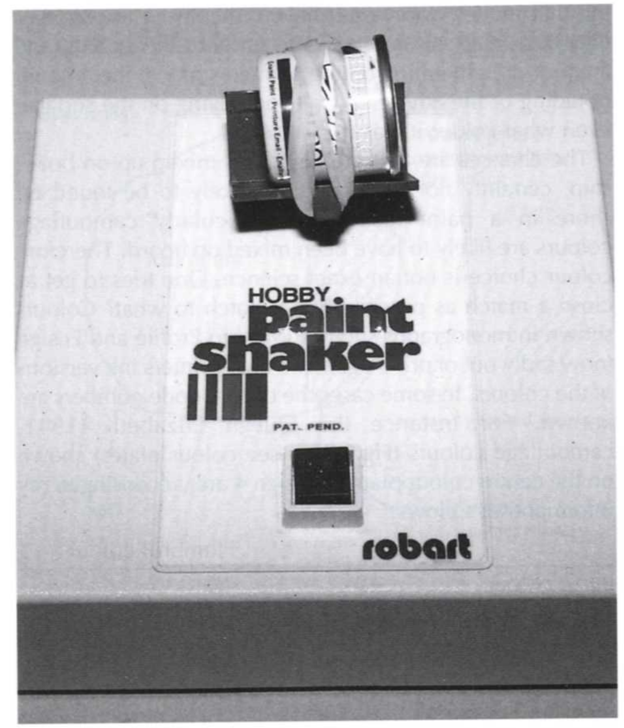


Fig. 9.18 Paint shaker

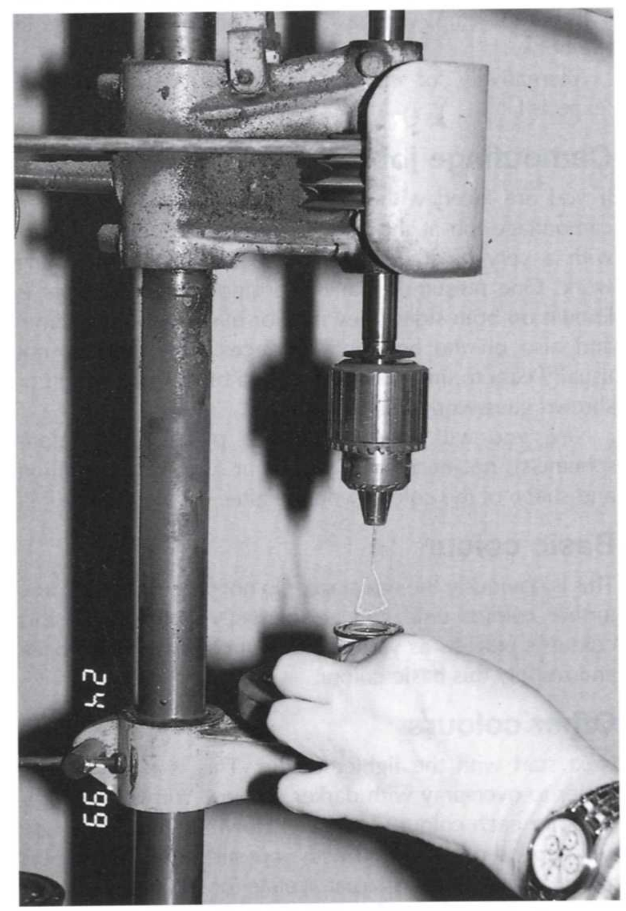


Fig. 9.19 Drill and paint stirrer

only cure for this is a new nozzle. Some manufacturers supply a reamer (the same shape as the needle but provided with a flat on the point to produce a cutting edge) for cleaning out paint from the nozzle. Needless to say use it with care.

Safety. One last point about compressed air is that it is dangerous. Any gas under pressure has explosive properties and if its container explodes the results can be very serious indeed. Any receiver that exhibits signs of damage or is rusty should be discarded.

Gloss or Matt?

When considering the paintwork for a model the scale effect must be taken into account. Just because the prototype has a glossy finish some modellers apply the same to their models. The only vessels likely to have a high gloss finish are lifeboats and luxury yachts, and when they are seen at a distance the shininess is suppressed. Models are really vessels seen at a distance and, therefore, the gloss needs to be toned down. The maximum degree of shine you should allow yourself is satin (semi-gloss or semi-matt) and that only on certain models. Matt is probably the best thing for warships although a slight degree of shine is permissible especially on working models. Dead matt can show finger marks to an astonishing degree. If there is a problem matt varnish can be applied which should cure the problem.

The sheen on a model can be controlled to some extent by the airbrush. If a full coat is given it will tend to be more glossy than if a mean coat is applied. This can be achieved by moving the gun faster or putting on a 'dry' coat. It is a good idea to practice this technique. Being able to control the kind of finish you produce is a valuable technique.

Mixing Paint

Before use all kinds of paints need to be thoroughly mixed. Some types also need occasional agitation during use to prevent separation of the pigments. Complete mixing of the contents is important to ensure proper consistency and colour. This is particularly important when colours are to be mixed to get repeatability of the results. **Fig.9.18** shows a battery operated paint shaker and **Fig.9.19** shows the use of a power drill, on a slow speed setting, equipped with a wire stirrer doing the same job. Or, if you have the time and energy, you could stir it by hand!

Getting it right colourwise

So far nothing has been said about the vexed question of colour. If you build warships or lifeboats you will never get the right colour - according to some people that is. We have 'experts' in the model boat world who will argue until the Second Coming that the shade you have adopted is the wrong one. When encountering one of these types I often wonder if there is an equivalent to sound perfect pitch in the colour world - you know without reference to a standard you can tell to an Angstrom whether a colour is right or wrong. It is almost certain that they have never seen the original colour anyway!

I had about 300 colour pictures of Belfast when building that model. You would have difficulty in finding two the same. Colours depend on so much: the quality and amount of light falling on the painted surface, the amount of fading or the amount of salt spray lying on the surface, even what colour it was to start with.

The chances are that the paint was mixed up on board ship, certainly not the conditions likely to be found on shore in a paint laboratory. Particularly camouflage colours are likely to have been mixed on board. Therefore colour choice is not an exact science. One tries to get as close a match as possible but a match to what? Colours shown in monographs such as Warship Profile and Ensign (now sadly out of print) again are only printers ink versions of the colours. In some cases the official code numbers are known. For instance the Queen Elizabeth (1941) camouflage colours (**Fig.9.20** – see colour plates) shown on the centre colour plate in Ensign 4 are, according to my informant, as follows:

		Humbrol colour
Basic colour	507C	168
Green	MS3	162
Blue	B5	144
Dark grey	MS1	106

Unless you have colour chips of these colours again you are largely in the dark. Appended are the nearest Humbrol colours that were used on my model of Queen Elizabeth. Without the chips you have to rely on the colour plate in the book.

Alternatively, of course, you could ask one of the 'experts'!

Camouflage jobs

If you are faced with building a warship which had a camouflage job at the time of the model, you are faced with a very great deal of careful and time consuming work. One presumes that the position of the colours is known on both sides (they may or may not be the same) and also on the horizontal surfaces. This latter is not usually easy to find, in which case a bit of imagination or shrewd guesswork will be required.

Next you will need a full size plan of the colour scheme(s), not necessarily in colour as it is the position and shape of the colours you are after.

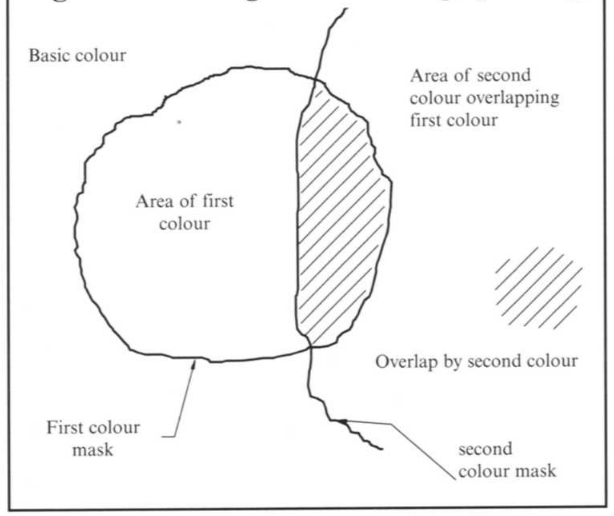
Basic colour

This is obviously the first stage. Do not proceed to add any further colours until you are perfectly satisfied that this colour is perfect, as you do not want to have to go back and respray this basic colour.

Other colours

Next start with the lighter colour. This is because it is easier to overspray with darker colours. You will need to mask for each colour separately. How big your masks are will depend on your skill with your airbrush. One way is to put a sheet of transparent acetate (or similar) over your full size camouflage plan to protect it from your scalpel

Fig.9.21 Masking for camouflage painting



and put both of these over a light box. You can then lightly stick masking tape onto the acetate sheet, in the area you are working on, and scalpel out your mask. Remove the mask and stick it onto the model. You may need to add extra tape to increase the masked area. To prevent any stray over-spray drape cloths over the model.

The secret is to spray very dry to avoid bleed. This will dry very quickly and further dry coats can be added until colour saturation occurs. Cut your masks so that where two colours meet you get an overlap otherwise the second mask for the next colour will have to join exactly with the first - difficult and best avoided. (see **Fig.9.21**).

Before masking over a pre-sprayed colour you will need to allow drying time of course. If you paint with a brush, instead of spraying, the use of masks to mark and outline the areas is still probably going to be a must. In this case the masks probably need not be of tape but can be of card, if these will drape over the superstructure, that is.

Chapter Ten

Glass Reinforced Plastic Work

No. 10 . Always use proper masking tape

'Plastics' are a group of organic chemicals characterised by having long chain-like molecules. More specifically they are man-made resins called polymers and they come in two versions.

Thermoplastics

The first of this type was invented by Alexander Parkes in the mid 19th century. He plasticised nitro-cellulose with camphor to produce celluloid still used to produce table tennis balls. Its main disadvantage is its extreme flammability. Later on other more modern plastics were made including Nylon, Polythene, PVC and ABS, all of which can be re-softened by the application of heat and, provided they are not heated enough to char or burn, will return to their original state on cooling. ABS is usually the preferred choice for hulls made by the vacuum-forming process which uses this property.

Thermosetting Plastics

The first of these was 'Bakelite', a compound of phenol and formaldehyde, invented by Dr. Baekeland at the turn of the 20th century. Unfortunately Bakelite can only be made in dark colours owing to the colour of phenol (brown). Urea formaldehyde complements phenol formaldehyde as it can be made in light colours. It is the plastic used in the Beetle range of resins/products. Both these resins are also used to produce laminates of paper and cloth marketed under the names of Tufnol and Paxolin. These types of plastics have limited use in model boat work.

The main characteristic of this type of plastic is that, once heated to their curing temperature, they cannot be re-softened by reheating. Their main use now appears to be for switches and plug sockets in the electricity industry.

Glass reinforced plastic (GRP)

A relatively late development was the invention of cold curing thermosetting plastics - the polyesters which is where GRP comes in. Having a resin that could be cured by merely adding a hardener (no external heat) and which wetted out glass fibre mat, really set GRP up. Glass fibre has a high tensile strength but lacks rigidity and form. Combining it with resin, which is in itself a brittle material, produces a strong laminate. It is comparable with reinforced concrete which adds the tensile strength of steel to the very high compressive strength of concrete, which makes a perfect material for beams and columns.

Basic GRP Technique

In the writer's opinion commercial hulls are usually too thin and could do with an extra layer of material to stiffen them up. There is no real problem in producing GRP work at home except for the really rather pungent smell! To make any component in this material requires a mould. For model boat work, usually a female one. To produce this you will need a 'plug' that is a shape identical to the shape of the hull to be moulded. A master female mould is then made from this as shown in **Fig.10.1**. If a mould is then taken from this you get back to square one - the hull shape. For a one-off this is a lot of work and only you can decide on whether it is worth while.

The nature of the process, involving as it does, the gel coat resin being painted onto the master mould surface, ends up with both of them in intimate contact. To allow their separation, releasing agents have to be used on the mould surface before any attempt is made to start the process. Several kinds of release agents are available from wax finishes to PVA's which produce a skin between mould and job. This is one part of the process that must be done most conscientiously otherwise it may be impossible to separate mould and job or, if it is possible to get them apart, damage to the mould may result. In any case, often considerable force is required to part them.

Following correct preparation of the mould surfaces the lay-up can begin. The first stage is to paint on the gel coat and this is followed by layers of glass fibre mat, or whatever, wetted out with lay-up resin until sufficient thickness has been built up. In a book of this type, the whole technique cannot be gone into especially as an excellent book is available on the whole process: The Glassfibre Book by R.H. Warring (published by Nexus Special Interests Books/ISBN-85242-820-0). This details all stages of the process and, having read it, you ought to be able to build a hull in GRP.

When I first decided to build a model lifeboat, a 48ft 6in Oakley, the question of how to build the hull arose. The problem was the screw tunnels which resulted in a very complicated set of curves at the stern. Plank on frame seemed to present too many difficulties so I decided to try GRP. The snag was that I had no experience whatever of the materials or technique. The above book was

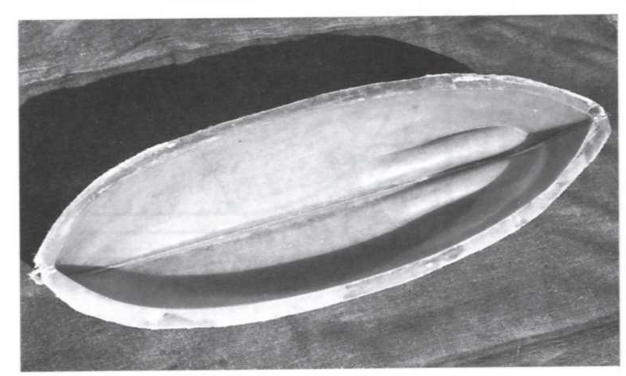


Fig. 10.1 Master mould for 48'6" Oakley

read, a plug was carved and the hull was produced with no real trouble. Experience taught that if everything was done by the book and no short cuts attempted, success was assured.

GRP Design

In the history of technology every major advance starts by using the technology of the previous method. Archaeology shows that when clay pots started to supersede leather vessels the stitch marks on the leather vessels were repeated on the clay pots! When plastic dust pans were first made the design closely copied the former metal ones which produced useless articles - the dust collecting edge was too weak to stay 'glued' to the floor when the dust was swept into the pan. In brief, plastic being less rigid than even thin steel, following the design of the steel pan was useless. The point is, designing in another material requires that the characteristics of that material must be taken into account and the design altered accordingly.

The weakness of GRP is its inability to maintain sharp corners. The technique of using a brushed gel coat followed by a lay-up of fibreglass can result in air bubbles appearing between gel coat and lay-up. **Fig.10.2** explains this and why rounded corners are a must in GRP design.

In use the unsupported corner of 'A' will rapidly break down due to the presence of the air bubble. Because the reinforcing mat sits tightly against the gel coat, 'B' will be much stronger. Good GRP design then requires no sharp corners.

Unfortunately in model ship work sharp corners cannot always be avoided so a modification of straightforward GRP practice is required. Having to mould many lifeboat hulls the writer had to find an answer. This was found by eliminating the void which allows air bubbles to form by filling the corner with polyester putty (Isopon P38) as shown in **Fig.10.3**.

As can be seen this allows the lay-up to flow round the corner.

Hulls often have slight excrescence's such as the frames round freeing ports on lifeboats (see **Fig.10.4**). With these filled the lay-up mat will not leave any voids for air bubbles to form.

The frame recess is filled and the shape altered to avoid any air bubbles between the gel coat and lay-up glass fibre. It is essential to remedy any design features likely to cause air bubble trouble.

Another feature with model GRP is the ratio between resin and glass. For maximum strength the resin content needs to be a minimum as the resin is weaker than the glass. This leads to the pundits talking disparagingly about resin rich lay-ups. If you are talking about glider fuselages and other highly stressed items this makes sense. For model boat hulls a resin rich moulding is usually nicer to

Fig.10.3 Use of filler in corners

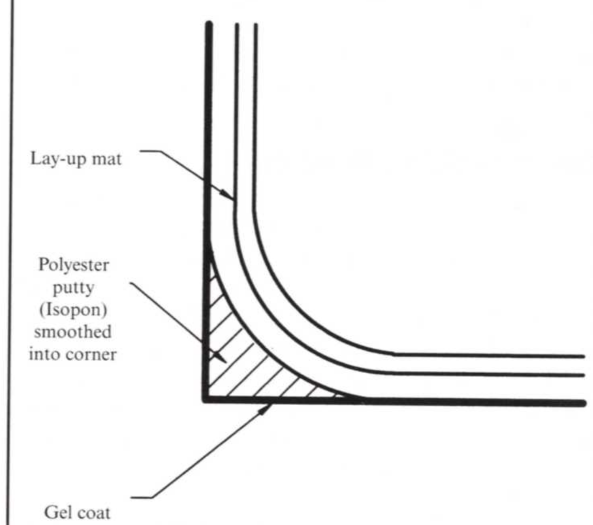
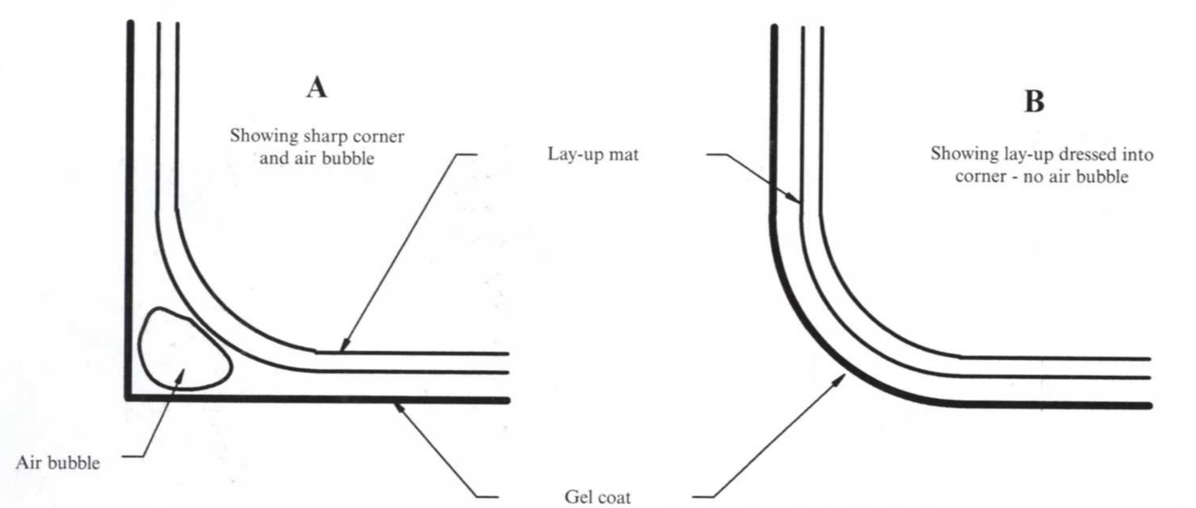


Fig.10.2 Lay-up on square and round corners



handle than the optimum lay-up and strengthwise it is still more than adequate.

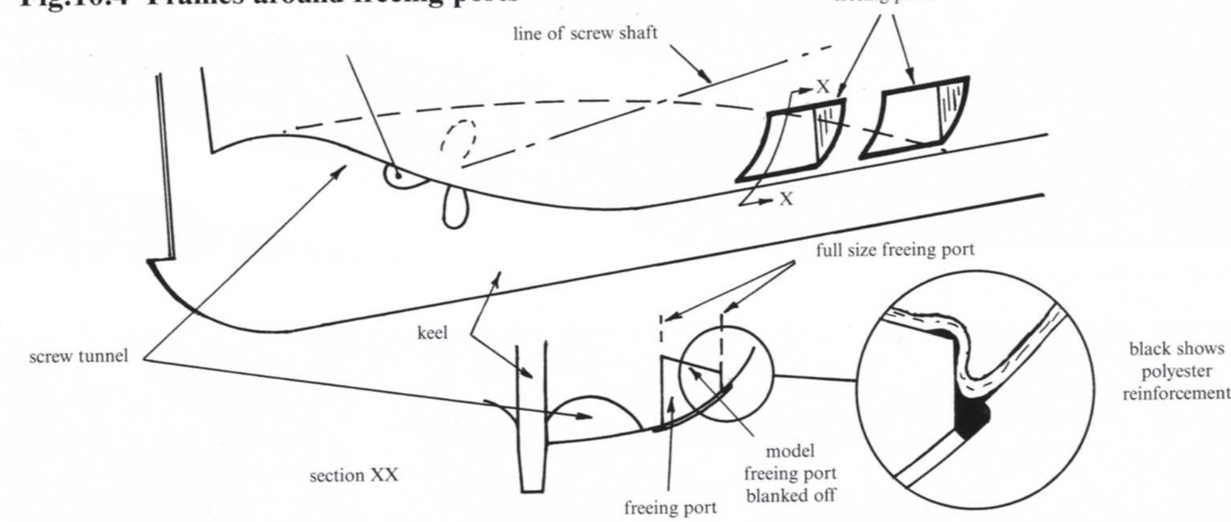
Fig.10.5 shows a model of an Arun lifeboat with recesses for fire pump, etc. - another problem which can only be solved by using a loose piece in the original mould (see **Fig.10.6**).

In this case a square recessed housing for a fire hydrant is required in the side of the forrard cabin of a lifeboat. The loose piece, which will form the recess, is first screwed to the female mould. The moulding is then laid up in the normal way. After the moulding has cured the screw(s) are removed and the moulding released from the main mould. The loose piece will come out with the moulding and can be removed afterwards.

Fig.10.7 shows in the centre the wooden plug

Fig. 10.5 Fire pump housing in cabin side

Fig.10.4 Frames around freeing ports



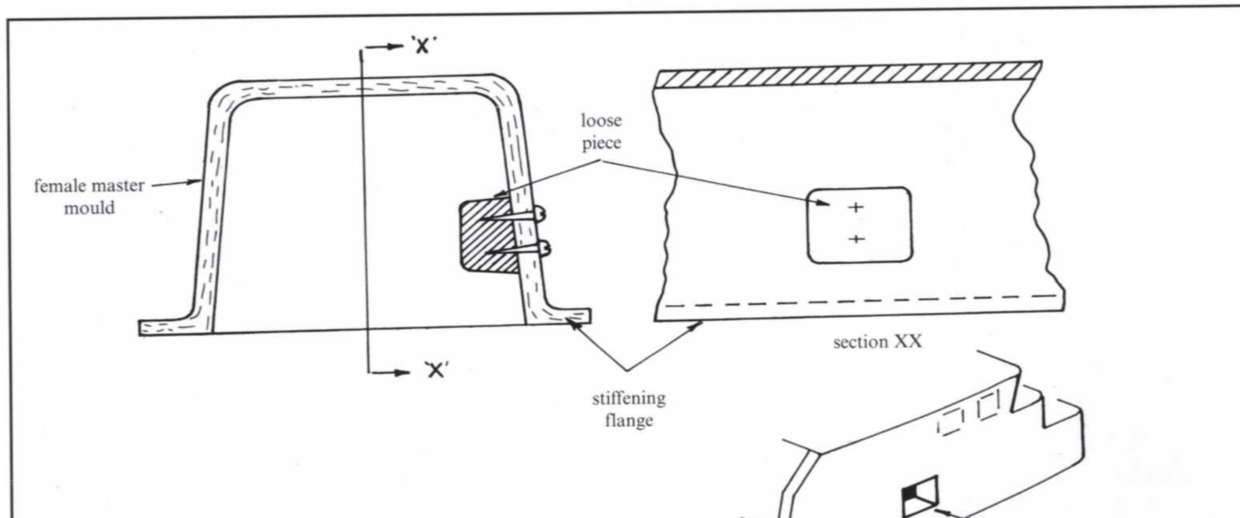


Fig.10.6 Use of loose piece in moulding

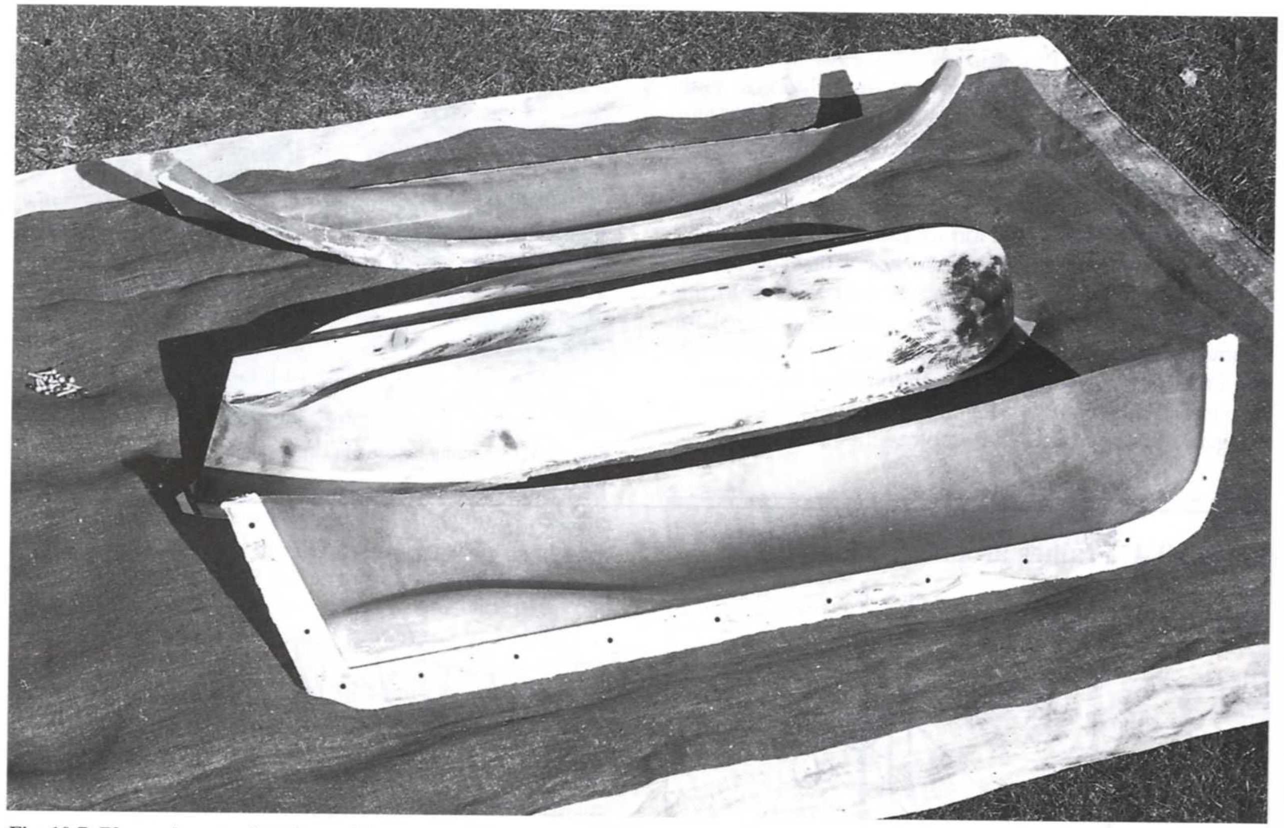


Fig. 10.7 Plug and master female moulds

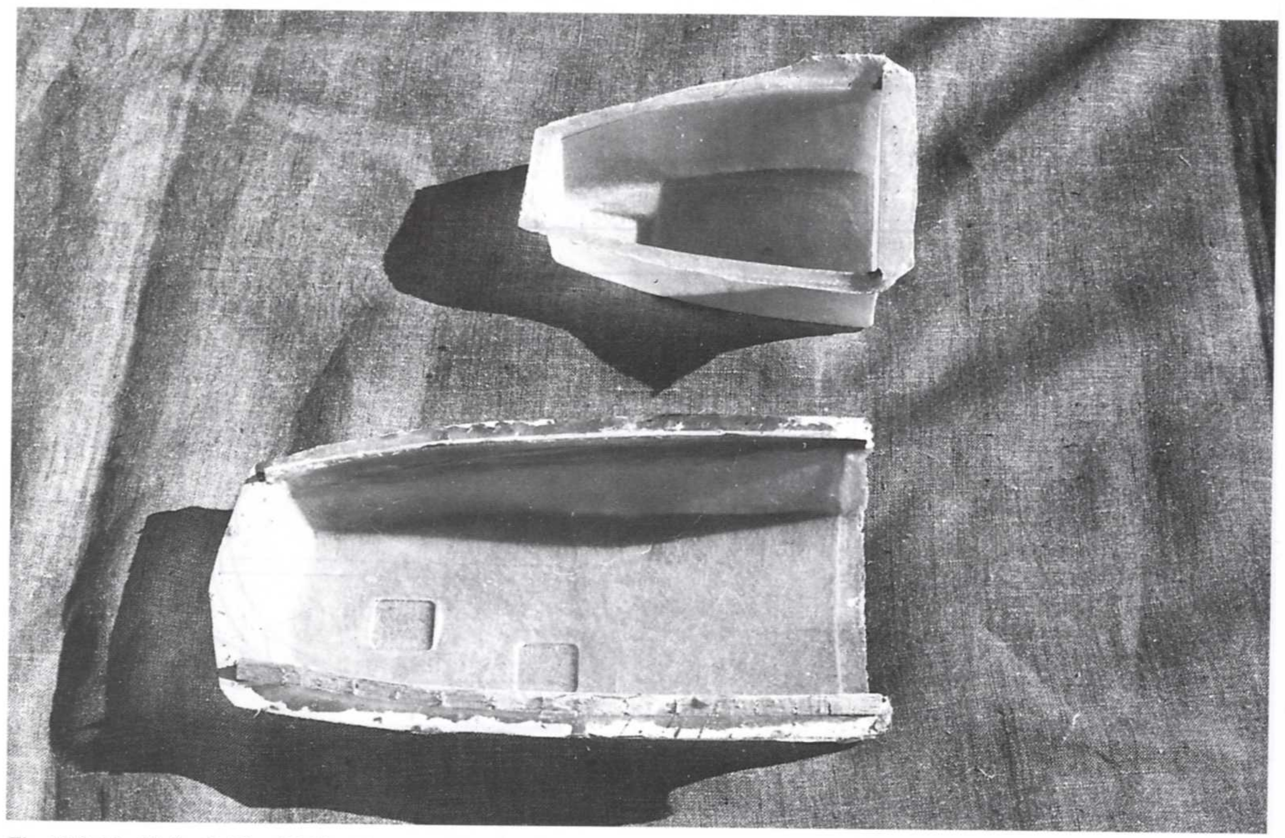


Fig. 10.8 Moulds for Oakley 18' 6" cabins

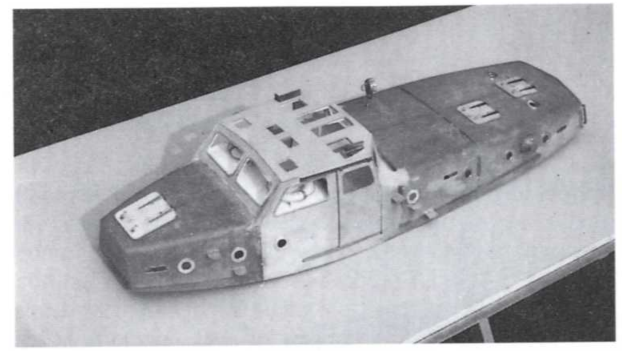


Fig. 10.9 Completed cabin assembly

Fig. 10.10 Cabin and hull

Fig. 10.11 Oakley class lifeboat radio controlled working model

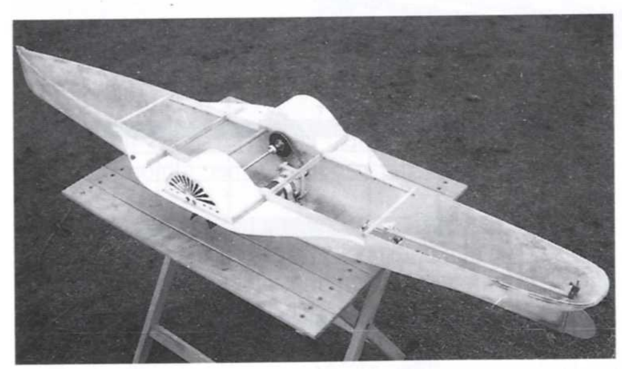


Fig. 10.12 Albion paddle steamer

Fig. 10.13 Trial assembley of Rother lifeboat

Fig. 10.14 Finished model of Rother

Fig. 10.15 Three identical static models of the Rother class lifeboat Silver Jubilee

surrounded by the two halves of the master female mould. Note the 2BA screws for assembling the mould.

Fig.10.8. These are two female moulds for the fore cabin and aft cabin for a 48ft 6in Oakley lifeboat. The completed cabin is shown in **Fig.10.9** where the fore and aft GRP mouldings are wedded to the central control cabin which is made of 2mm ply. **Fig.10.10** shows this assembly on the GRP hull and **Fig.10.11** shows the completed model.

Paddle steamer models have a nasty habit of floating too deep owing to their limited displacements. This is where the lightness of GRP helps. **Fig.10.12** shows the writer's working model of the paddle steamer Albion ready for water trials.

Fig.10.13 depicts a trial assembly of a Rother class lifeboat. The hull, fore deck and cabin, and aft deck are all in GRP but the cabin is in 2mm ply. **Fig.10.14** shows the completed non-working model. Hull building in GRP is about three hours work once the master mould is made. **Fig.10.15** shows three identical models. Building them is no real problem but you still have three paint jobs to do!

Chapter Eleven

Etching

No. 11 . Keep trying new techniques

Photo etching of metal parts puts a most powerful tool in the hands of any modeller, particularly those doing complicated and intricate work. Normally, shaping and cutting by any orthodox cutting method, involves stressing the material being cut, to above its ultimate shear strength. This, particularly when cutting sheet material, causes considerable distortion which is undesirable. Etching (it is also known as chemical milling) being a chemical process, involves no distortion and the pieces come out absolutely flat and pristine. Also because physical strength in the piece to withstand cutting stresses is not required, very delicate parts can be produced. The problem with very 'delicate parts' is handling them subsequently, but more of that later.

Figs.11.1 & 2 show what can be achieved by the process. Briefly for those not familiar with the etching process: in essence the cutting action on the sheet is provided by a chemical (usually an acid) which dissolves parts of the sheet but leaves the wanted areas untouched as these are protected by a photographic film. The process is closely analogous to the manufacture of printed circuit boards (PCB's) although these have a plastic backing of course.

Fig.11.2 shows parts of the etched sheet for Anson. The left-hand side of the sheet is mainly guardrails numbered for identification (this is essential!). The bottom line shows a row of single barrelled Oerlikon main body parts including sights and shoulder guides. The four arcuate

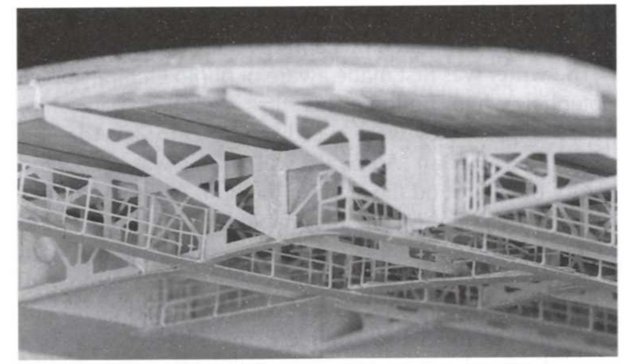


Fig. 11.1 Carrier round supports

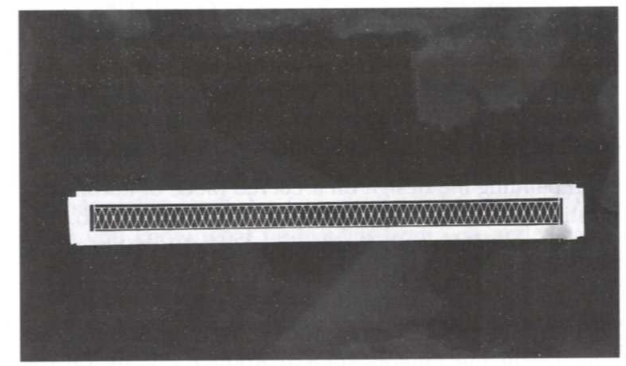


Fig. 11.3A Etching negative of Admiral's Walk guardrails

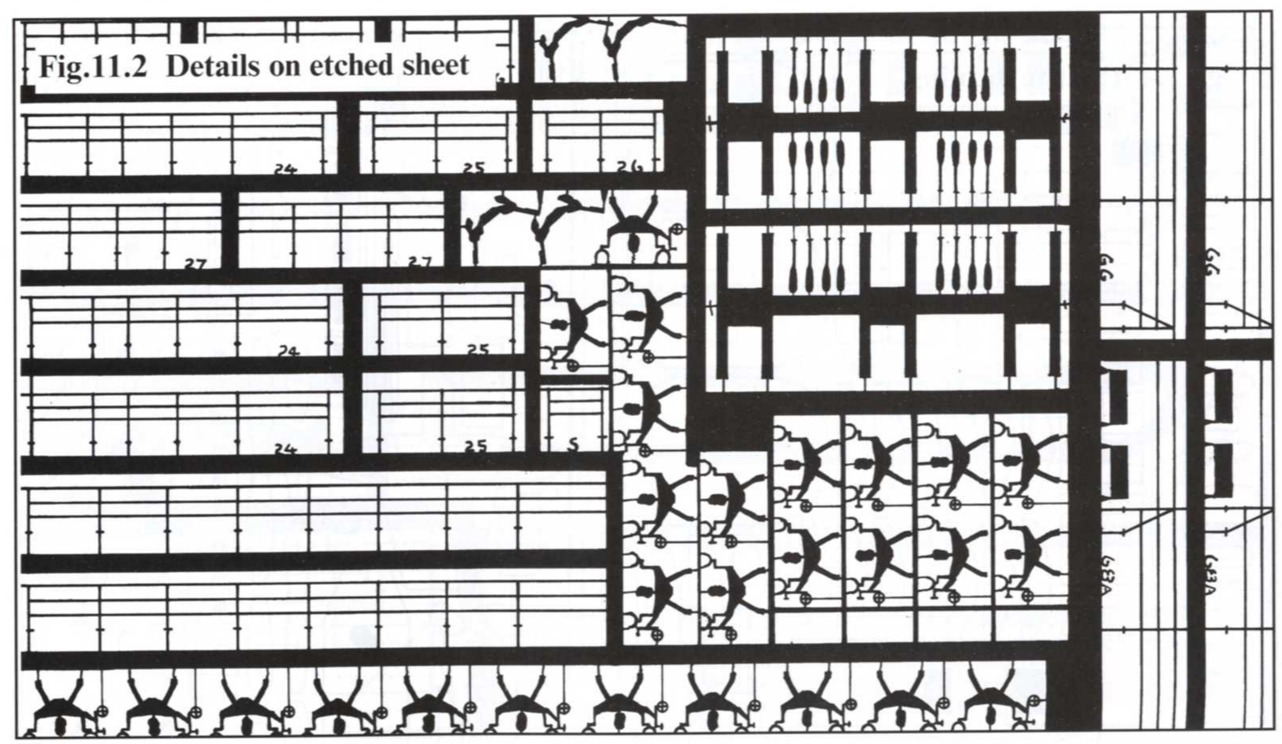


Fig.11.2 Details on etched sheet

pieces in the centre are the main bodies for the quadruple Bofors directors. The H like etchings in the centre right are the developed parts for the Carley float stack supports on Y turret. Note the use of 'spare' area for Carley float paddles. Also the four rectangular Anson nameplates with the name only half-etched (drawn in red). This is an example of a positive drawing showing the use of connectors to attach piece parts to the grid matrix.

The writer was first made aware of photo etching and its potential when building his first Victorian battleship. These ships, if they were ever likely to carry an Admiral, were fitted with an 'Admiral's walk'. This was a covered gantry fitted around the stern of the hull. As the Admiral's quarters were in the stern this enabled him to stroll around in the open air contemplating the works of Chairman Mao, sight unseen by the rest of the hoi polloi. (Ship's company).

The actual gantry was no real problem but its guardrails were most definitely very difficult. These were always of a multi-diamond pattern with a motif of a star, or similar, at the cross-junctions. Because of the pattern, it could not be cut but had to be of an exact length to fit round the gantry deck exactly. In real life these were probably castings of cast iron (the Victorians were masters of cast iron work). However, cast iron was out of the question on the model so - how to simulate them?

Several methods including bent wire were considered, even painting the design on a curved piece of transparent plastic, but none were going to do a good job. My neighbour, who was a professional model maker at the time, suggested photo-etching as a possible solution which he could get done if I did the drawing (artwork); the necessary first stage in the process. **Fig.11.3.A** shows the negative of the artwork for the Admiral's Walk on the Empress of India.

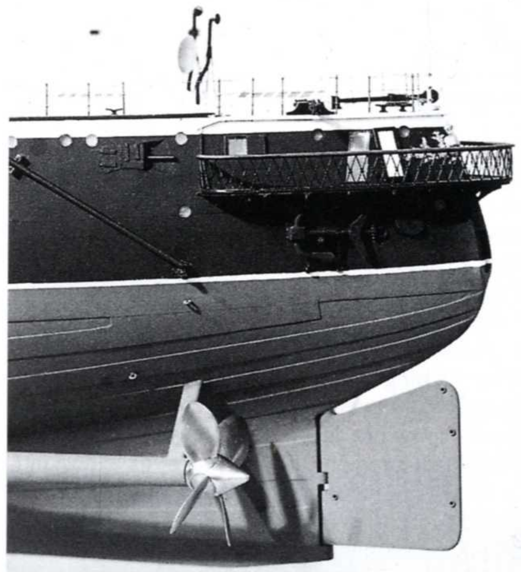


Fig. 11.3 Admiral's walk guardrails

The result was perfection (see **Fig.11.3**) and, more importantly, I had found a very promising technique to add to my armoury. Each successive model has incorporated ever-increasing amounts of photo-etched work.

It is to be noticed that certainly the best kit manufacturers are now including etched material in their kits. It is necessary to go into the process a little further to examine the requirements. The process can be split into two parts:

1. The production of the artwork (usually drawings). This involves the design of the parts and producing a layout for photography. As will be seen later, the drawings can be either positive or negative. Even parts in 3D can be etched if a flat development is possible.
2. The actual etching. Although the whole process can be done at home using the materials sold for PCB work it is probably best to rely on a professional etcher to do the photographic reduction required, and the actual etching process, as they use jet machines which attack both sides of the sheet and can produce better results than a static bath which is about all you can do in a kitchen sink. You also need a commercial camera and a controlled source of ultra violet (UV) light. Etching at home may incur the wrath of the distaff side of the family if you manage to stain HER sink. Beware!

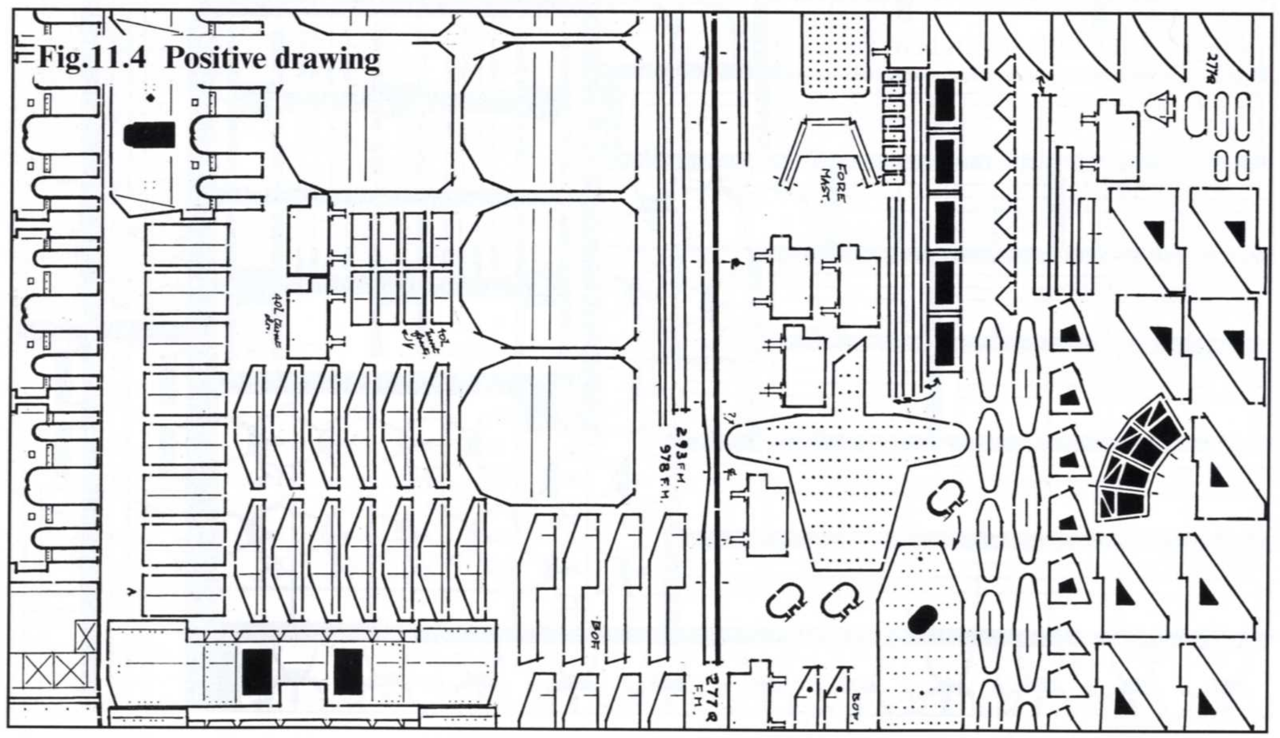


Fig.11.4 Positive drawing

However, the first part of the production of the artwork is more than possible for most model makers and probably necessary, as your etcher won't know what you want otherwise! What he needs is a drawing(s) or image from which he can prepare his etching tools. These are transparent sheets with the wanted design photographed onto them at the actual size using a commercial camera.

It is usual to draw the artwork larger than the actual size - say x2, x4, etc. this is because a) it is easier and more accurate to draw at a larger scale. The etching process really exploits the ease and accuracy at the drawing stage; it being easier to mark out on the drawing board than on a tiny piece of metal, and b) the photographic reduction sharpens and cleans up the image and reduces any drawing errors. If the work is to be done at home without a camera the artwork must be final size of course.

These processed acetate sheets are placed either side of s previously been coated with a light sensitive emulsion. All three components are carefully registered by a series of punched holes or whatever. The whole assembly is then exposed to UV light. Where the light can penetrate the clear areas of the acetate sheets the emulsion will be changed and can be washed off exposing the whole sheet. These unprotected areas will be attacked by the etching medium thus producing the parts required which will have been protected by the emulsion.

Because professional etchers etch from both sides, thus speeding up the process, the two masks required can be different. The black cutting lines, which will eventually isolate the part, will be on both masks and will enable the etchant to cut through the work sheet. However, fold lines can be incorporated which will only be on ONE mask. These will only etch half way through the work. These allow tight folds, difficult to produce on full thickness sheet and also accurately position the folds. With very small parts accurately positioning folds can be very difficult. It is much easier to pre-locate folds at the drawing level.

These fold lines are usually incorporated on the artwork by using lines drawn in coloured ink. One professional etcher uses red lines for fold lines on the front of the work and blue or green lines on the reverse. Colour sensitive film is used to register the fold lines on the appropriate mask. If you intend to produce artwork make sure your etcher and yourself sing from the same hymn sheet! Make sure you know what he expects from you and what his parameters are first, before you launch into the preparation of the artwork. Such things as the size capacity of his camera, how large an area he can etch, etc. this may determine the drawing magnification you adopt.

It seems logical to mark fold lines the complete length

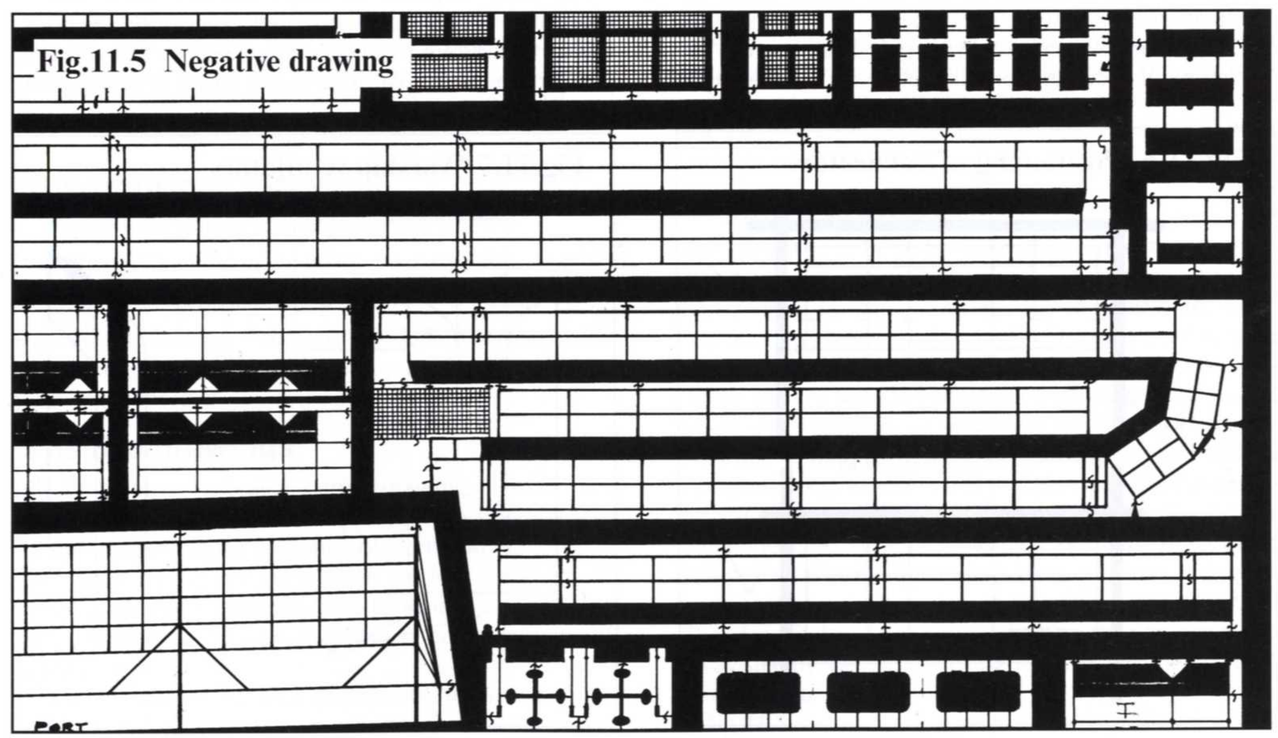


Fig.11.5 Negative drawing

of the wanted fold from cutting line to cutting line. In practice, because the acid can attack the sheet from all sides, this produces a weakness at the end of the fold. It is better to stop the fold line just short of the cutting line, which gives a short length of full thickness sheet. This short section produces no problem when folding but stops 'tearing' at the ends of folds. Who said, 'experience is an excellent but expensive teacher'?

Do not forget that labels, ship's names, etc. can be etched using the half depth etch principle.

Most etchers would probably plump for artwork presented as a black on white image i.e. black lines on a white card or paper. For the modeller this may not be convenient. From experience the ability to be able to trace drawings from your original plans is most useful but cannot be done if card or paper is used. The writer's technique is to first layout the artwork on tracing paper in pencil. This allows changes, re arrangement, etc. before finally tracing this drawing in ink on drawing film. Normally ink work is produced using tubular drawing pens of the Rotring type. They give a constant width line without any adjustment, unlike the original draughtman's pens of the two blade type which needed constant adjustments. Ink lines on film can be removed, if required, by scraping with a sharp scalpel.

Geometric shapes i.e. squares, rectangles and circles are easily drawn with straight edges, compasses and profile templates. It is even possible to obtain the latter for ellipses, and these can be very useful for the odd shape.

Very complicated shapes, usually developments of components such as gun cradles etc. are best drawn from custom made templates. These can be made as male or female. It is usually easier to run your pen around a female shape (hole) rather than around a male profile where the pen tends to run away from the edge.

Cut your template from 0.010in polysheet. You can use thicker but it becomes more difficult to cut out the profile the thicker you go. You will need to cut larger to accommodate the pen width. Make sure the result is correct. Time spent getting the shape absolutely right is well spent. The only other thing needed is to put masking tape on the underside of the template, set back from the working edge. This is to ensure this edge is isolated from the surface of the drawing. If this is not done ink can bleed from the pen under the template. This occurrence has been known to cause bad language.

However, computer owners may prefer to prepare drawings on their computers instead of on a drawing board. This is easier in some ways as the line width and density cannot vary. Also rubber-stamping makes multiple copies easy. You must make sure you produce even dense lines of constant width otherwise you may end up with unwanted gaps in your etchings because they will not photograph properly.

The thing to remember is that you are charged per sheet of etching i.e. by area, so it pays to stuff as much detail onto a sheet as possible. The other objective is to make sure enough parts are etched, plus some extra. For small numbers of parts, say up to six, draw six parts. If you then order two etched sheets from each drawing you will have six extra parts. This is necessary as some parts, particularly complicated ones, may not etch perfectly and you will undoubtedly damage some on folding up, assembly, etc. A redundancy is necessary, if appearing, on first thought, wasteful. It also enables you to build up a scrap box of parts which, as experience shows, can be most useful. It is surprising how often the odd part can be made from an etching made for something else. Also do not throw away the bits left over after cutting out the wanted parts. These too can be of great use.

For parts required in large number etch only a proportion and use parts from both sheets. An example: say thirty parts are required - draw twenty - this will give you forty parts in total leaving ten spare. It is suggested that you do not draw the whole thirty (which will give you thirty redundant parts) because they will take too much valuable sheet area.

For very large numbers of identical parts, only one need be drawn. By using a stepping camera your etcher can reproduce these easily. A close friend and superb miniature model maker had three hundred shroud dead eye sets made up in this way.

You may end up with some spare space(s) on your etching drawing. Do not waste this space which you will have to pay for anyway. Fill these areas with strips say 1mm, 2mm wide etc. or any component of which you may need large numbers. You can always find a use for such parts particularly strips which seem to be required on complicated models. Another use for spare space is for drawing grids (negative drawings only). You can try drawing finer and finer grids, as this will be useful in finding the limits of the drawing/etching system. Sooner or later a grid will fill in which will be the limits which you can work to next time.

Fig.11.6 Positioning of connectors

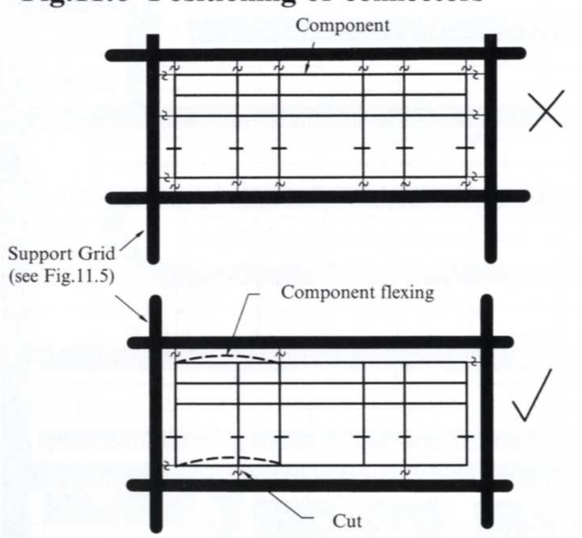


Fig.11.7 Warship ventilators

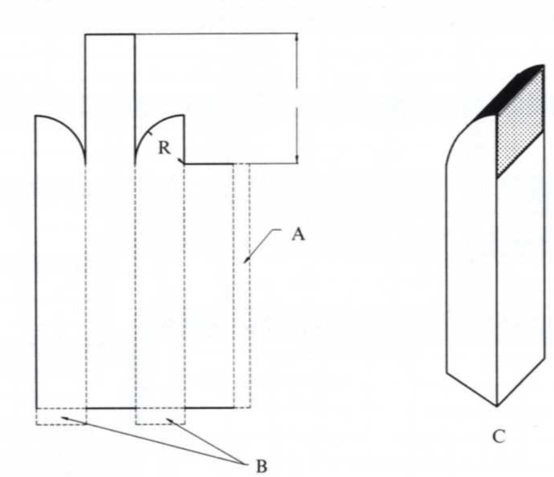
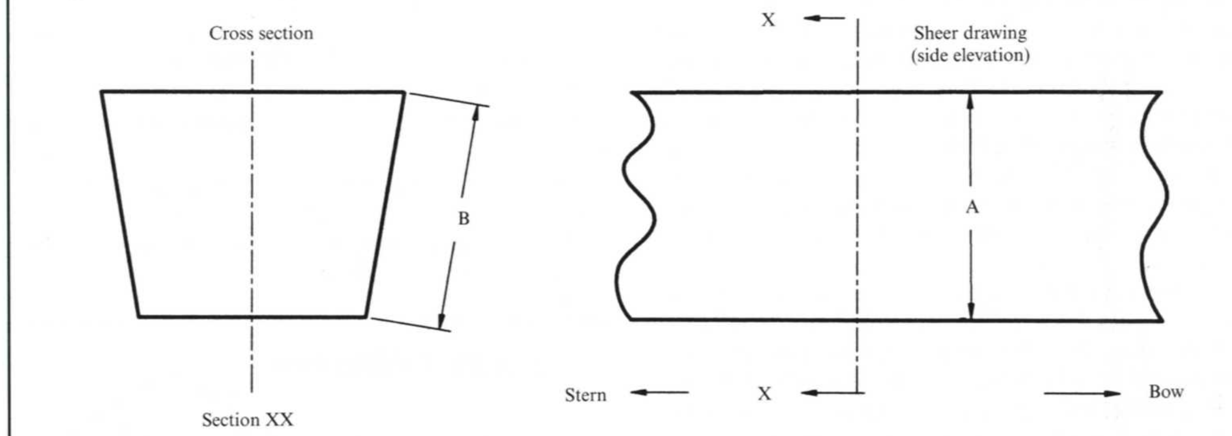


Fig.11.8 True length of line



The Drawings (Artwork)

Etched work can be divided into two types:

1. Pieces largely dominated by areas e.g. discs, washers
2. Pieces largely dominated by lines e.g. guard rails

A different drawing technique is adopted for each. You can mix the two but this will provide difficulties in drawing technique.

Positive drawings

Fig.11.4 shows a typical 'area' drawing, known as a positive, for parts for Belfast. The faint lines stopping short of the exterior cutting lines are coloured fold lines, red on the front, blue on the back. Note the four piece arcuate development of the stand for the Stevenson's screen. This is a standard item which contains the meteorological instruments.

You will notice that the components are surrounded by a black cutting line. A moments thought will show that, left at that, all the parts will drop out as the cutting lines meet from both faces of the sheet. To avoid this the cutting lines are 'nicked' (i.e. a small section, say 0.5mm, is removed by scraping with a scalpel) at intervals on the drawing to provide tiny 'bridges' holding the components into the matrix of the sheet. Using a scalpel to nick the ink lines on the drawing is quicker than trying to draw in the "nicks" by interrupting the lines. For the same reason any holes on this type of drawing are filled in, thus ensuring they etch away rather than dropping out into the etching machine and causing problems. Large pieces can be saved by linking them rather than destroying them by filling in.

After etching, parts can be removed from the sheet by cutting with scissors, craft knife or a scalpel. These little nicks will probably need to be cleaned up. One important point is to make sure any nicks are not put into positions where cleaning up is difficult, on concave edges for instance. The number of nicks needed on any one component comes with experience. Try to make sure it is adequately supported without too many, as they all need cleaning up afterwards.

Negative drawings

This format is best suited to thin components, such as guardrails, as the width of the component can be represented by the width of a pen-ruled line. Such components drawn in the positive mode would require two lines drawn accurately parallel and close together - not an inviting task! In effect the component is drawn as a black area. Nicking, as previously used, is not possible with this technique. Instead, components are surrounded by rectangles to form a matrix to which they are connected by thin 'connectors'. These are necessary to support the component. As with nicking, their positions need to be selected with care. These connectors are severed using a craft knife or scalpel, which causes some distortion. Therefore, if they are positioned where the part can move away slightly, permanent work distortion can be avoided. (see **Fig.11.6**)

Fig.11.5 shows the use of this mode of drawing. The girder parts are for the structure supporting the round-down (aft end of the carrier flight deck). See **Fig.11.1**. Also shown are grids and locker lids, etc. The two crosses are night lifebuoy frames. The little curly crosses on some lines are to show these are connectors and are not part of the component. It should be noted that the position of some connectors would not now be considered ideal as previously discussed. (**Fig.11.6**).

Most models will require both types of drawing. At some point two lists of components can be drawn up when you decide which format to use for each component.

It is very important that each part is identified on the sheet. This may be surprising as it ought to be obvious what the part is but, after several months, (time between drawing and actually fitting the part) it is often far from easy to identify what the part is. Therefore number all the parts on the sheet and keep a list of numbers and descriptions. This is most important as is only removing parts from the sheet when they are required. Loose parts get mislaid or unidentified!

Using photoetching instead of normal model building technique really requires a rethink. It is a much more cerebral process than normal bench working. The parts have to be visualised in the mind before being drawn: 3D objects have to be transposed into flat etchable shapes, extra holes, tabs, etc. need to be incorporated for assembly purposes. Remember parts have to be anchored down on assembly. Perhaps an extra hole(s) or tab(s) should be incorporated for this purpose as well? This has to be thought out first at the drawing stage. Do not hesitate to add bits, which can be removed later if not required. Etched pieces can always be cut down if, on second thoughts, they are not required. However, bits cannot be added.

Likewise do not hesitate to draw the same part in both drawing modes if you are not sure which method is best. Experience will usually tell you but that takes time to acquire.

Also remember the final etched part can never be better than the original drawing. What you send your etcher determines the quality of the final result: lousy drawing = lousy etching.

Development of shapes

Many objects, which end up as 3D items, can be etched if their shape can be developed into a flat shape. It is often necessary to calculate the length of a curved shape. A typical example is a warship ventilator as shown in **Fig.11.7** where:

- L. is the developed length of the curved top of the ventilator
- A. is a tab added to aid assembly, if required
- B. are fixing tabs, added if needed
- C. shows the finished component folded up.

The developed length of the curved top (shown as L) will need to be calculated. This is easily done using the general formula:

Developed part =

$$\frac{\text{Angle of curved part}}{360} \times \text{Total circumference}$$

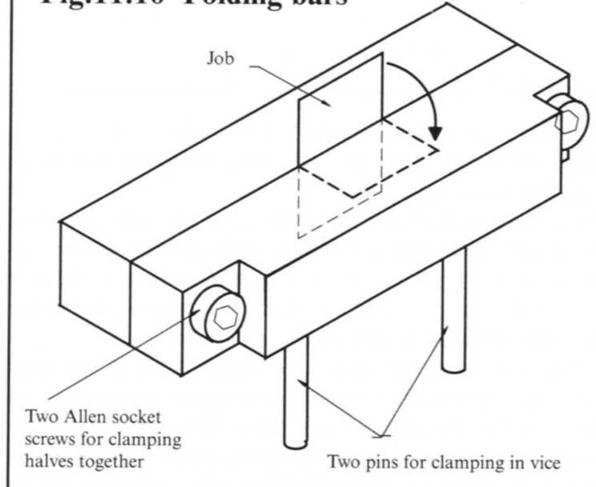
Total circumference = $2\pi R$ or πD where $\pi = 3.142$

In this case the angle of the curved part is 90°

$$\text{Developed length} = \frac{90^\circ \times 2\pi R}{360^\circ} \qquad \text{Where } 2R=D$$

In this case the length is obviously 1/4 of the total circumference of a circle of radius (R).

Fig.11.10 Folding bars



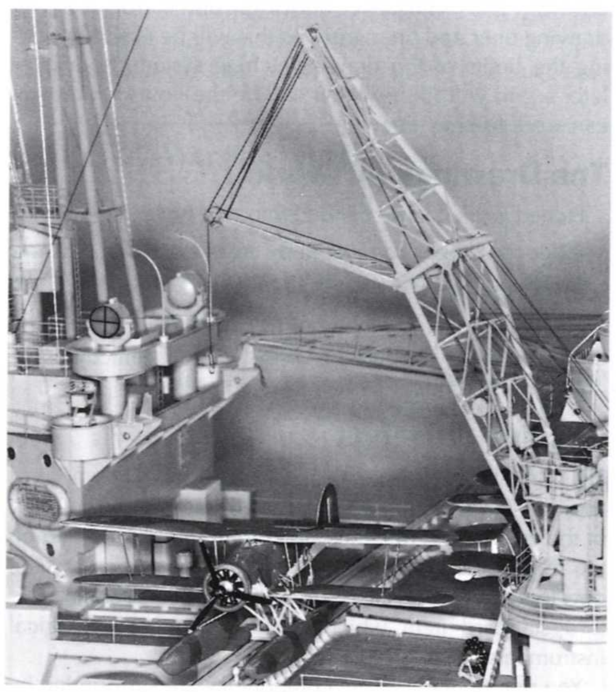


Fig. 11.11 Aircraft crane

But the formula is correct for any angle. After that heavy Maths it is best, in practice, to make this length slightly longer and trim off any excess. As has been said before etchings can be reduced but not added to.

Most developed lengths are usually a combination of straight lines and parts of true circles. For lengths which are neither, a piece of thin wire carefully bent around the drawn profile must be substituted and can be used, instead of calculations, for the unmathematical anyway.

One other aspect of etching drawing should be examined, particularly for those who have no engineering training, and that is the determination of the true length of a line. Looking at ships drawings it is essential to know whether the lengths you are looking at are true lengths or not. An example : consider **Fig.11.8** which is the representation of a section of an aircraft carrier and a short section of the sheer drawing either side of that section.

Dimension 'A' on the sheer drawing is not the true dimension of the side of the ship, only the height of the hull. The correct length is shown drawn on the section drawing xx at 'B'. If you only looked at the sheer drawing a mistake could easily be made. You may say that is obvious. It is when you have the actual hull in front of you. It is not so obvious when nothing solid exists - only the drawings!

The same problem exists in the horizontal plane. The length of hull measured off the sheer drawing is not the length of the side owing to the curvature of the hull. Only in the central area where the face of the hull is parallel to the keel are length dimensions anywhere correct.

With the artwork completed, because you have no physical parts to play with some doubt may exist, as to whether all these nice parts you have drawn will in fact go together. Take a copy of your drawing, Zerox or off the computer, and paste them to a sheet of cereal box cardboard. In this way they can be cut out and fitted together and any errors corrected before sending the drawings off for etching. Components made this way will be drawing and not etched size but this will be an advantage. A stock of cereal box cardboard should be held in any modeller's workshop for cutting tryouts, etc. thus saving raw material and time. (**Fig.11.9** – see colour plates)

Surface etching

Mention has been made of producing, by etching, surface detail, in this case fold lines. The same process can be used to etch away larger areas to expose a line of rivets for example or other details. Often flat surfaces on the shields around various details on warships are reinforced by ribs. These can be etched in quite easily but it may be necessary to use thicker sheet for this type of work. Normally brass is used as the metal for etching. The writer uses 0.004in and 0.008in thicknesses, normally ordering two sheets of each thickness from each drawing. This enables a choice of thickness. Large pieces are often best in 0.008in whereas this thickness may prove to be too clumsy for fine details. The choice is yours. Likewise you can have your pieces etched in stainless steel. This probably puts up the price per sheet but produces much more rigid pieces which can be an advantage. However, stainless steel has a snag, it makes cutting out parts from the sheet much more difficult.

Handling etched parts

Handling parts which are fairly strong poses no more of a problem than any other small detail. What becomes difficult is parts that have fine detail attached to a more solid piece. Trying to fold these usually results in the component folding where it wants, i.e. at the weakest part, rather than where it should. Trapping the part under a steel rule and using a scalpel blade to fold up the exposed part is one way. A pair of custom made folding bars is another. **Fig.11.10** shows a pair made by the writer. Other ways will present themselves as experience is gained.

Limitations of the system

Like all processes there are limitations. As has been mentioned the etcher will be limited in what size of etched sheet he can produce. Likewise he will be limited to what size drawing his camera can handle.

Long etching times will produce undercutting, that is the etch will tend to get behind the protective film. This will reduce slightly the size of the component and may ruin fine detail. It is obvious, therefore, that the thicker the sheet the less sharpness will be achieved. What can be achieved depends on your drawing and how much detail you want. Too finer detail may not reproduce - you have camera and etching process limitations to contend with.

There is no doubt that photo-etching is the way ahead for modellers seeking perfection in detail. It is expensive but if a model takes several years to build the cost amortised over that period is of no great amount. The main cost is in the photographic part of the system. The actual cost of an etched sheet is quite small.

Fig.11.11 shows an example of etched work in this case the aircraft crane on Queen Elizabeth. **Fig.11.12** – see colour plates shows another view of the etched round down supports on the aircraft carrier Glorious.

Fig.11.13 – see colour plates shows etched wireless, aerials, cranes, door reinforcement and aircraft wing.

Chapter Twelve

Glass Cases

No. 12 . Make sure the glass is clean on the inside surfaces

All exhibition models deteriorate rapidly if not cased. Most children (and a few adults) see with their fingers and rigging lines break and parts get knocked off and disappear. Perhaps the main trouble, however, is our old enemy - dust - particularly if you live in an area where the dust is oily i.e. living next to a motorway. Also dust is produced in the workshop and during the final fitting out stages.

Once dusty it is almost impossible to clean it satisfactorily. That marvellous model maker, of happy and beloved memory, Harold A. Underhill is alleged to have left his models out in the rain to clean them. A rather drastic solution not likely to be followed by many of us.

The problem of keeping a model dust free during the last stages of construction can also be a problem and some sort of protection is required. Vertical hardboard ends can be erected each end of the building board and parallel strings connected to the corners. This enables a piece of thin polythene sheet to be thrown over the set up at the end of the work period (see **Fig.12.1**).

However, to a more permanent and elegant protection. Perhaps the simplest case consists of five pieces of Perspex (acrylic sheet) glued together and fitted in some manner to a wooden base perhaps fitting into a groove cut into the base. (**Fig.12.2** – see colour plates). The advantage of such a case is its easy removal. Proper glass cases are usually fixed together permanently. The main problem with Perspex cases is keeping the adhesive off the surfaces. There are special solvent adhesives made for Perspex but cyano will do a good job and does not attack the surface. For smaller cases professional case makers use a special electrically heated folder to put tight right-angled folds into the sheet. In this case the two long sides and top can be made in one U-shaped piece only leaving the ends to be fitted in.

Perspex cases can also be made using L sectioned wood or metal pieces to frame around the Perspex.

When I first decided to make a wood and glass exhibition case for one of my masterpieces (?) I asked the editor of the magazine, for which I was writing, "How do you make glass cases?" His reply was "I don't know, find out and write me an article". I never did find out. I decided instead to design my own and have since made about ten to the same basic design but with modified details to make construction easier.

Figs.12.3 - 9 show the basic method. It consists of two rectangular frames each mitred together. The top, which is quite delicate, and a much heavier base. Four vertical corner pieces envelope and connect the two frames together. When making these, the top 'nest,' in which the top frame sits, should be made slightly deeper than the frame to allow for cleaning off. The bottom nest should be 1/8in shorter than the depth of the bottom frame to keep the edges of the corner piece off the ground as these, otherwise, will be very vulnerable to damage. The top four corners are permanently glued together. The bottom four are attached by sixteen Allen countersunk machine screws which allows fitting of the four vertical glass pieces (and dismantling if required).

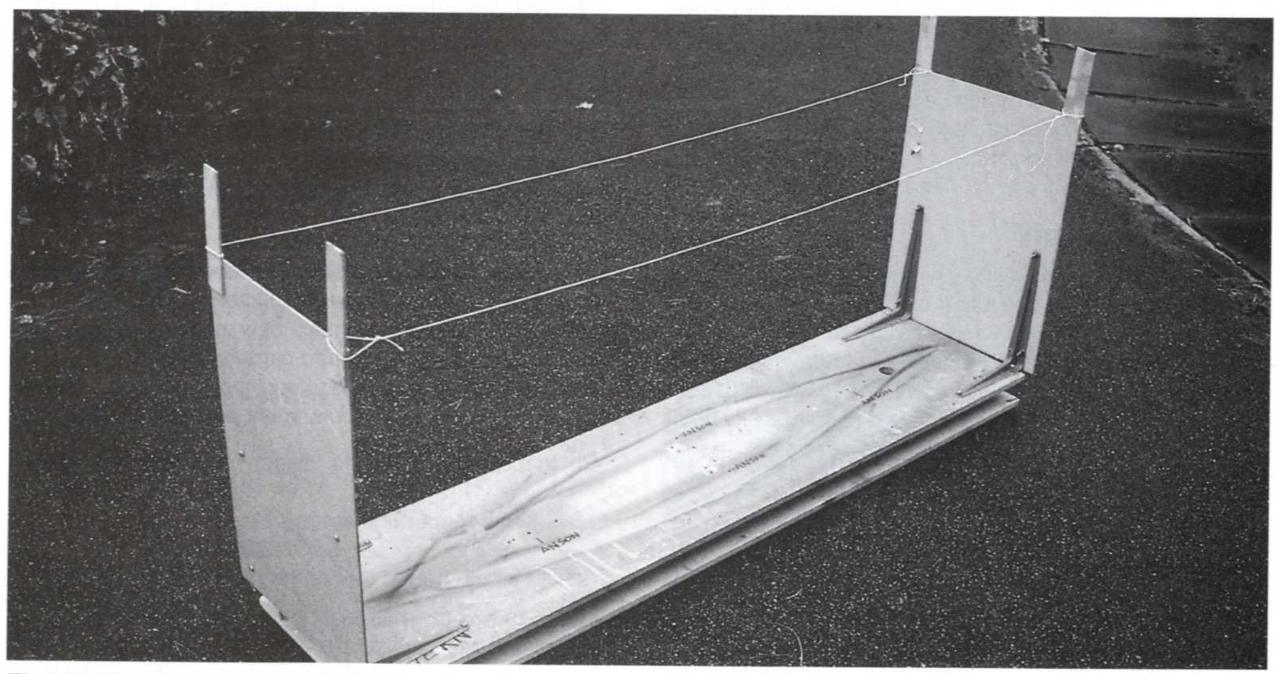


Fig. 12.1 Temporary dust cover on building board

The machine screws, as can be seen, screw into tapped holes in the brass or aluminium slugs glued into the corners of the base. These not only attach the corner pieces but also lock up the base joints making a very strong case. Unfortunately countersunk Allen cap screws cost a fortune (second mortgage variety) but ordinary countersunk or cheese-headed machine screws can be substituted instead. Alternatively the slugs can be dispensed with and ordinary wood screws used instead but this will produce a weaker job. If slugs are used brass is easier to tap than aluminium which tends to cling to the tap.

The baseboard on which the model sits is inserted up from the base; or rather the completed case is dropped over the model fitted to its baseboard. The baseboard is pushed up inside the base until it abuts a 1/4in square bead attached near the top of the inside of the base rectangle. Three or four 'bridges' are then screwed into the sides of the base rectangle to support the baseboard and the model and to hold the sides together.

The strain of putting the model into the case induced the nightmare of dropping the case onto the model which caused my late, much missed, wife extreme stress and, if it had to come out for any reason, talk of divorce was in the air for days. Even I had to lie down in a darkened room and take the tablets afterwards. Ain't life hell?

The drawings are mainly self-explanatory. It is best to draw out the case to scale first. Do not case the model too closely as it will look crowded. On the other hand, do not make the case too big as it causes transport problems - it will not go into the car! (**Fig.12.10** – see colour plates)

Having decided on the sizes you can start by preparing a cutting list for the wood parts:

	No.	Thickness x Width	Length	Timber
Top frame	3	18 x 18	1400	Amboyna
Bottom frame	3	25 x 64	1400	Amboyna
Vertical	5	25 x 25	450	Amboyna
Beading	3	6 x 6	1400	Amboyna

All dimensions in millimetres. Finished sizes given. PAR (means planed all round)

This list was for my last case for Anson and is only given as an example.

You will notice that three pieces equivalent to the length (the greatest measurement) are ordered for both top and bottom frames. This is so the best two pieces can be selected for the sides and the shorter ends cut from the third piece. Likewise five vertical pieces so that the best four can be used and you have a spare. Always add 75mm (3in) to actual wanted lengths as you cannot rely on the condition of the ends of timbers.

Remember you are dealing with a natural material, wood, and you cannot expect perfection. You will note the wood is ordered PAR so make sure the sawmill knows the sizes given are finished sizes.

When you have the timber, examine it and decide which surface you want outside. Try and arrange things so that any defect or roughness comes inside or is cut out. You cannot treat wood like metal where you expect perfection. If the long members are slightly bent make sure they lie with the curve inwards. The top glass and the baseboard will then straighten them. If the curve is outward, i.e. wider in the middle than the ends, inserting glass and baseboard will not help the situation.

The glass grooves can be put in with a hand plough (a special plane with narrow blades and a fence) but it is easier to use a circular wood cutting saw. You will need to make two cuts for each groove. The kerf made by the saw blade will not normally be wide enough to fit 3mm glass. Experience has shown that 3mm glass is perfectly satisfactory although one glass merchant made me sign the bill to confirm it was 3mm glass that I ordered! Actually that case was trailed to and from East Berlin for a Naviga championship without any trouble whatsoever. If the thought of breakage does disturb your evening slumbers Perspex could be substituted but it will probably be thicker than 3mm. For very large sheets it may be better to use thicker glass. Do not make the grooves too tight a fit. Testing groove width with an odd 4in length of 3mm glass may be fine but fitting a large sheet needs a bit more play.

The top glass fits into a rebate, not a groove, and is held in with wood strips brass pinned or screwed in. The wood strips can normally be salvaged from the material cut out when machining the rebate. If not remember to add them to your cutting list. Do not order the glass until the wood part is completed. Allow clearance, say 1/16in, each end and tell the glasscutter to treat your sizes as maximum. If he then cuts smaller the glass should still fit in the grooves.

Cutting the mitres can be done in a number of ways. I mark out the mitres making sure I get them the right way round on each piece and in correct relationship to the glass grooves. Check this at least twice before cutting, it is so easy to get them wrong and if they are cut wrongly the piece is scrap. I then cut the mitres free hand and finally sand to size and angle on the 8in disc sander. (**Fig.12.11**) This gives a glue friendly surface. Use white PVA glue for

Fig.12.3 General view of glass case

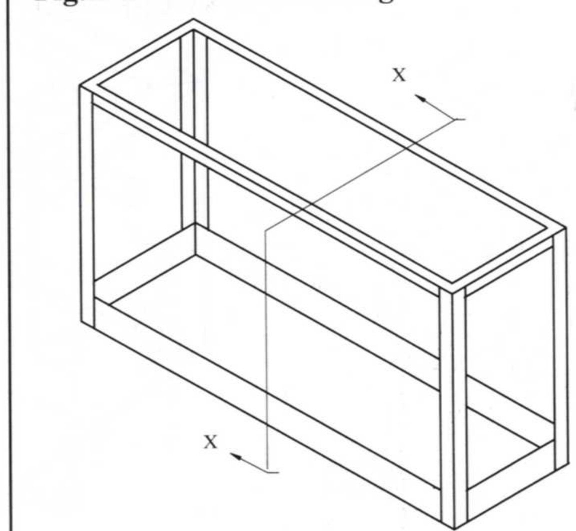


Fig.12.4 Corner assembly

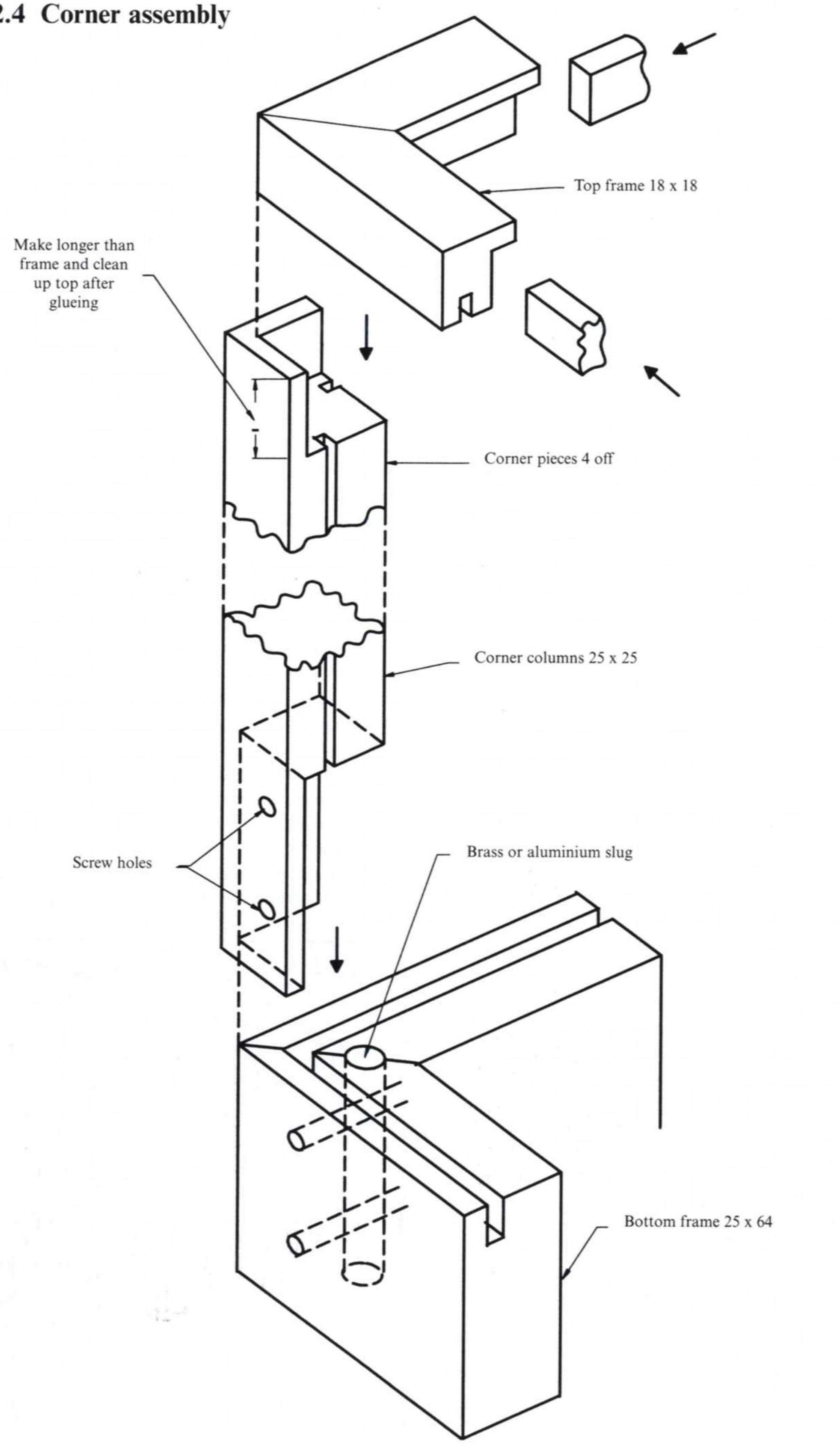


Fig.12.5 Corner assembly (Section XX)

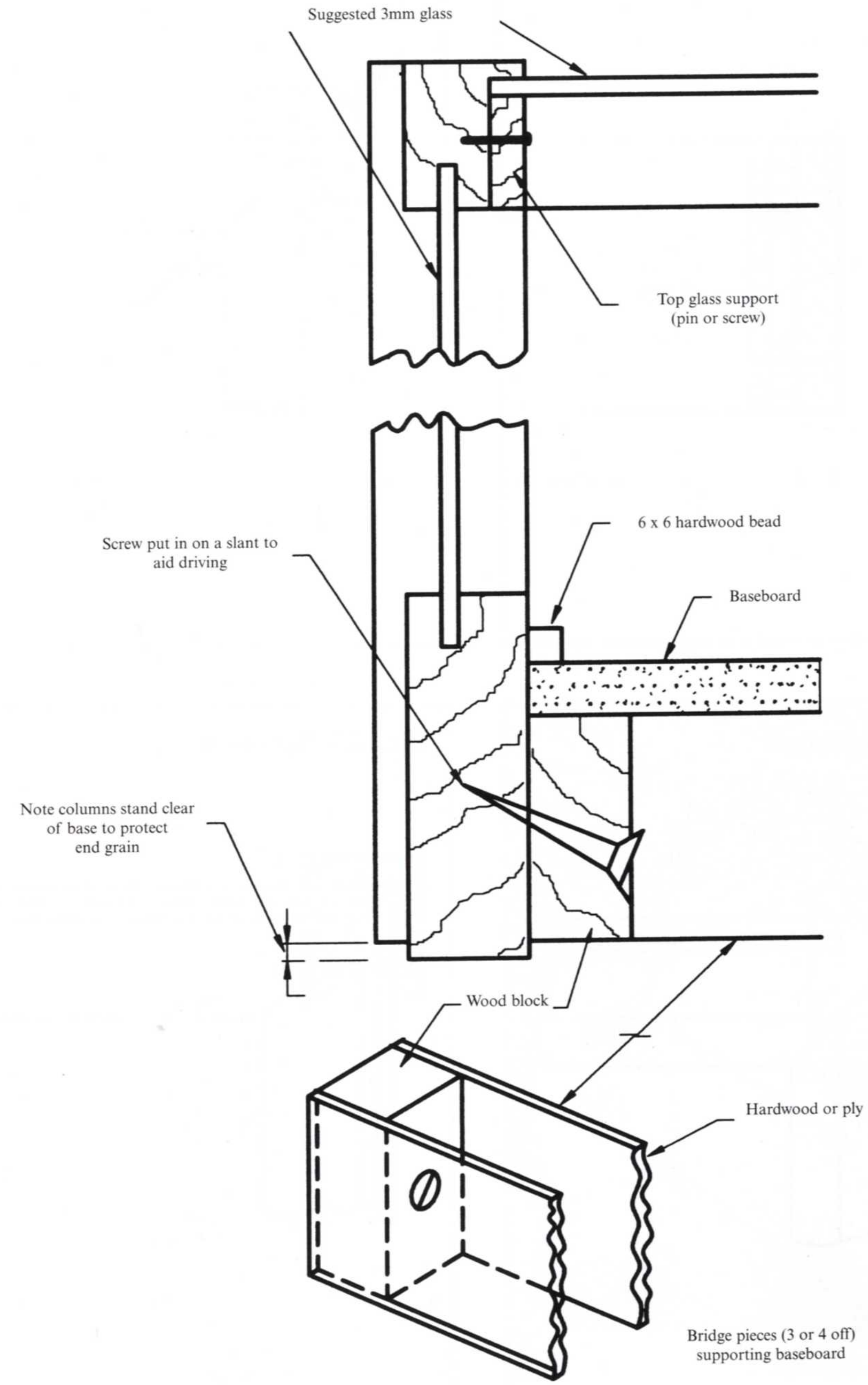


Fig.12.6 Arrangement of fixing screws

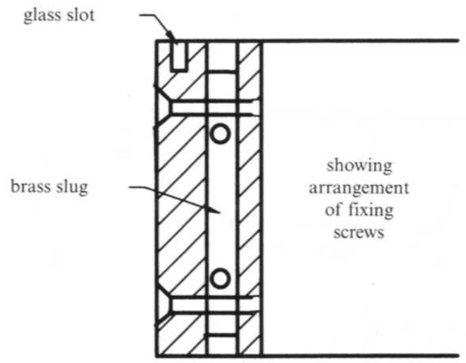


Fig.12.7 Glueing top corner

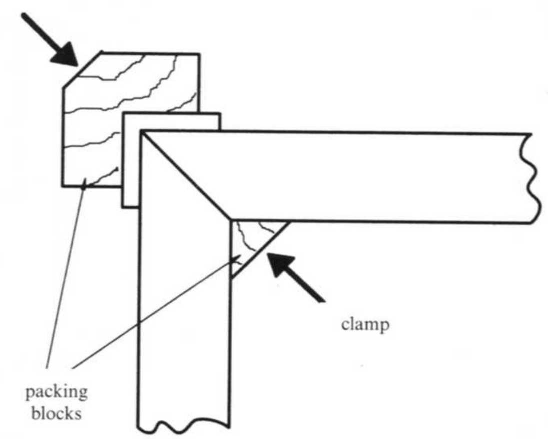


Fig.12.8 Top corner

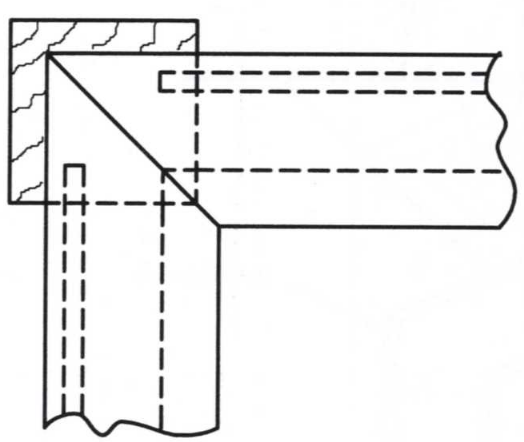
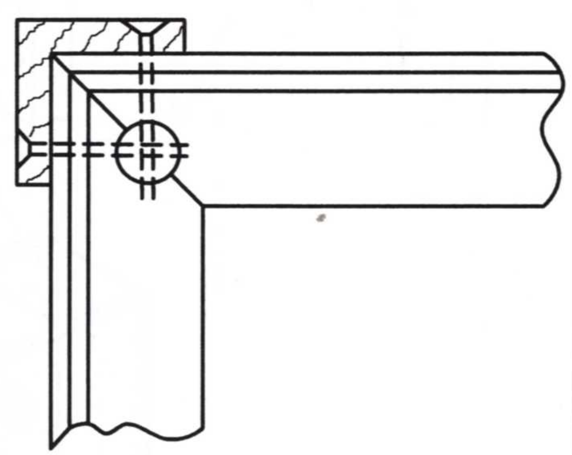


Fig.12.3 Bottom corner



the joints as it is more flexible than urea type glues. Alternatively a mitre block can be used to cut the mitres.

Cutting out the ends of the vertical pieces can be done with saws and chisels by hand. It is easier to mill them out on a milling machine or on a lathe if an auxiliary vertical slide is available. Use about a 5 or 6mm slot drill. You will need to clean out the radius with a chisel.

When fitting the four screws holding the case together at each corner make sure they are at different heights and thus miss each other in the brass or aluminium slug. I normally put the end screws in between the side screws. When drilling the holes make sure the corner piece is pushed up tight in the correct position against the bottom frame. Use the tapping drill for whatever screw thread is being used and drill into and through the slug. Take off the top of the case and drill out the holes in this piece only and, if screws are being used, countersink the holes. The bottom frame holes should be left tapping drill size and tapped in the normal way. (**Fig.12.12 & 13** – see colour plates)

Finishing the case, which should be done before fitting the glass, is a matter of choice. I prefer to leave the wood its natural colour and put on an eggshell clear finish. If you use full gloss it looks a bit treacly. There are now quick drying (twenty minutes touch dry) low odour varnishes available which are perfect for this job (Ronseal make one).

Two coats should suffice with a quick rub down after the first coat. One added advantage of these varnishes is that the brushes can be cleaned out with water.

Two further points. When varnishing wipe out the grooves otherwise drips will interfere with the glass fitting. When finally fitting the glass put some white PVA glue into the grooves. This stops the glass making frightening noises every time you move or transport the case and it tends to make it dust proof. Unfortunately you will get it all over the glass surfaces which will require very careful cleaning up.

As to the timbers to be used. I have made cases from Teak (expensive), Brazilian Mahogany (probably difficult to obtain owing to the embargo), Lauan, Cedar, and Amboyna. You will need to find a supplier of exotic timber as your local yard will almost certainly be useless. Expect to pay about as much for the preparation as for the timber itself. For addresses of suitable wood yards looking through the pages of wood working magazines is probably best.

If machines are not available this design of case can be made by hand and provides a good exercise in wood-craftsmanship. If machines e.g. circular saw, lathe and milling machine are available it just speeds up the process.

What has been described is just one way of making a glass case. I have found the design eminently satisfactory and it looks good. There are many other ways, of course, but do not fall into the trap of making it too elaborate. You want people to look at the model not the case. This might, however, be a good idea if the model is only second class!

To finish off the case a suitable plaque is required. (**Fig.12.14**). The classic way is to use a polished brass engraving. These are both expensive and difficult to read in certain lights. Another way is to use Letraset, or similar rub down lettering, on a piece of 1/8in white Perspex or thick polycard mounted on a suitable block of exotic wood. It can be decorated with coloured Letraline tape. It needs to be protected by a sprayed clear lacquer.

For further embellishment the name of the model and possibly the modelmaker can also be marked on the glass using Letraset. On the plaque the lettering will need to be black or some dark colour but on the glass white can be used with effect. Again Letraline can be used to underline the words before clear lacquer is applied. You will need to mask the area around the words, of course, to do this.

Now you can sit back and admire your work.

Well that is it, all 52,000 words (my computer tells me). I hope you have enjoyed reading it. I have tried to put down what I have learnt over the last sixty-five years of dedication to the finest job in the world - building models of ships. It has always been my endeavour to put life into my models, to recall something of their prototype's being, for the delectation of anyone sufficiently interested to look at them. If, at times, this book has seemed a bit highfalutin it is meant to be about advanced modelling but even the greenest greenhorn ought to be able to extract the odd nugget here and there. If it succeeds in pointing the way ahead, it will have done its job, and mine. As I said in my

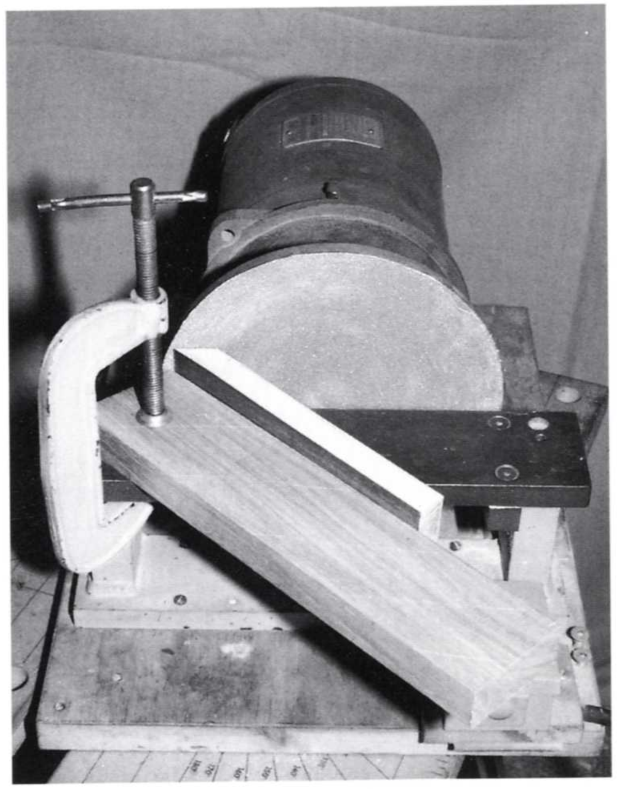


Fig.12.11 Sanding mitre on disc sander

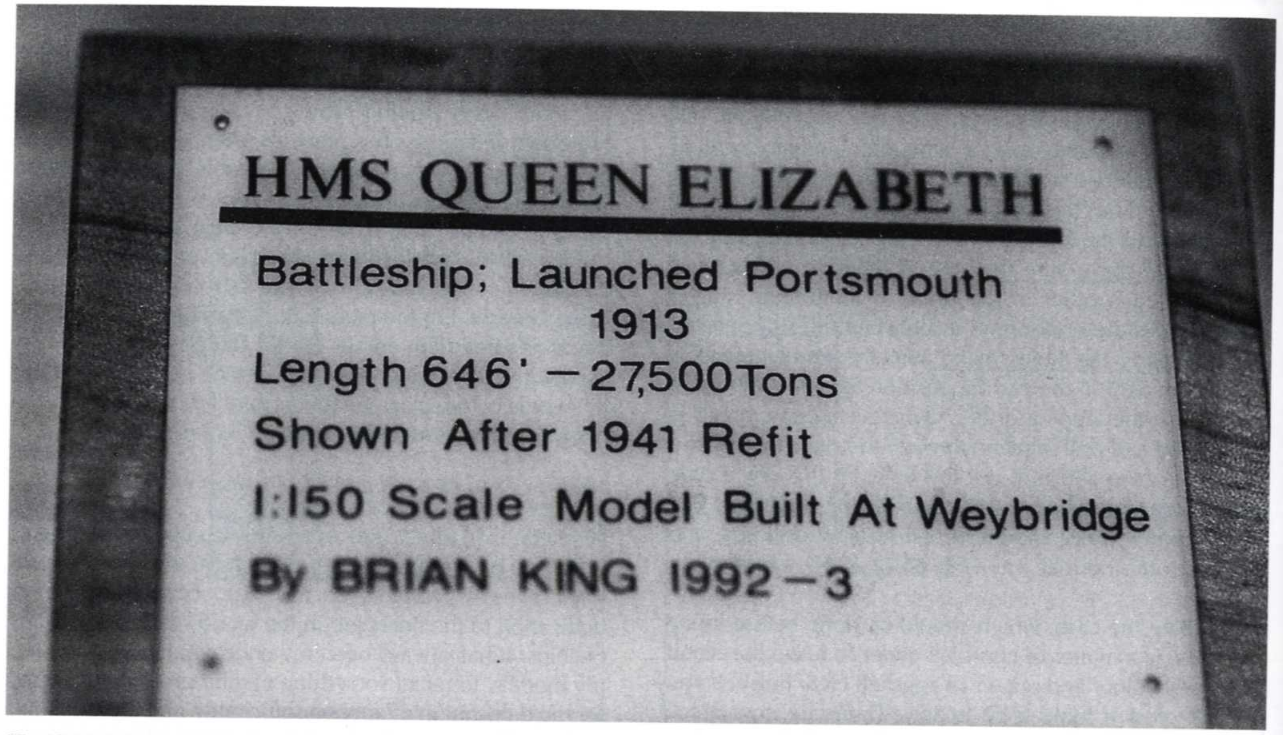


Fig.12.14 Legend block

opening words: "never think you can't achieve something". Too many people give up too soon.
Keep looking at the stars and eventually you will get there.

It is to those who do, this book is dedicated. Good modelling!

B.K. 1999

Brian King has spent his life thinking of and/or building model boats. He has also tried his hand at a full size Solo dinghy. This became a test of his woodworking skills as he found sailing her too much of a cold and wet experience.

Following on from a technical college education, Brian served a 5 year indentured apprenticeship in light engineering and went on to work in the engineering industry for the next twenty-five years. The latter part of his working life was spent in higher education. During this time he built mainly working models including lifeboats.

He was an early member of the Lifeboat Enthusiasts Society when he became interested in the RNLI and their boats. Several models were built for the Institution including a model of Grace Darling's coble used in her brave rescue bid off the North East coast.

One of his great interests is in writing about model boats of course! He has supplied many articles for the British and North American model press, but this is his first book.

Since retirement he has spent most of his time building very complicated complete hull static scale models of warships: firstly Victorian ships of the latter part of the 19th century starting with Devastation (1873) and finishing with Magnificent (1894). His later models have been of ships of the 20th century. These have included Belfast, Queen Elizabeth, the pre-war aircraft carrier Glorious and the King George V class battleship Anson.

This book is devoted to not only trying to put down any knowledge he has acquired along the way but also to his philosophy on model making.

To Brian King model ship building is not a hobby but a way of life!

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