SMALL WOODEN PATTERNS FOR MODEL ENGINEERING

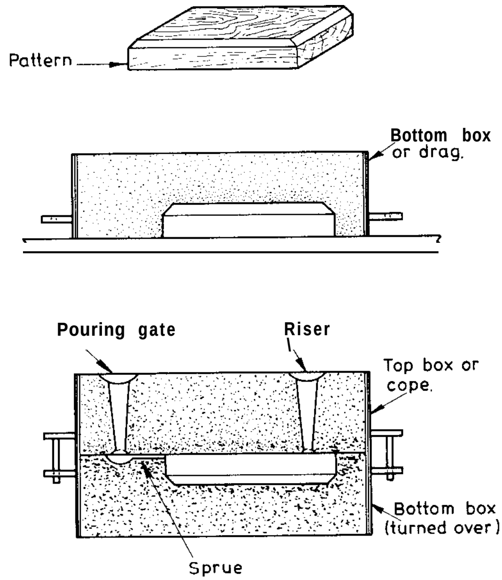
by Syd Pipe (Australia)

Part 1

Introduction

The budding model maker will quickly find that, for any but the simplest projects, he will need castings. Of course he can always buy these from commercial outlets for specific models, assuming he has access to commercial outlets and he is happy to accept what is available. For those who cannot or do not wish to buy castings and still want to make their models, making their own patterns for the castings is the answer.

For the castings themselves one can set up one's own backyard foundry, or maybe find a friendly foundryman. In each case the approach to pattern making will differ. If you are your own foundryman and therefore able to control the chain of events, you can take liberties with the design and robustness of the patterns. On the other hand, the foundryman has to be communicated with and understand what you want. Your pattern will probably pass from him to the moulder with some verbal instructions. The moulder will treat it just like any other job, in other words your pattern will stand or fall on its merits. The resultant casting will depend largely on how well you made your pattern. The cost of the casting will reflect how much the design of your pattern simplified the moulder's work. A good moulder boasts that anything is mouldable, but it is at a price. This series of articles will attempt to help the reader to make small wooden patterns, specifically for models and for model maker's equipment. The subject will be approached in general terms along the lines accepted in commercial practice for producing castings in sand moulds.



© SMALL MOULDING BOX. FIG. 1

Casting in Green Sand Moulds

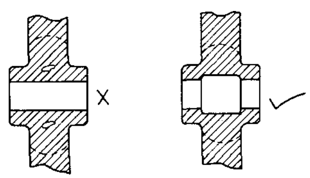
As with all trades the growth of founding has produced its own technical jargon. The following terms appear to be common in the English speaking area, but some terminology is interchanged and there are variations. To talk to your favourite foundryman in his own language, some of these terms will help.

Metal is melted in "crucibles" or various "furnaces" or "cupola". For pouring it is usually transferred to a "ladle", for small castings it is then poured into "moulds" formed from a special sandy mixture contained in suitable boxes or "flasks". Fig. 1 shows a simple mould ready for pouring. Metal from the ladle enters the "pouring gate", passes along the "sprue" into the mould cavity, and up the "riser". The air in the mould is swept ahead of the molten metal and out through the riser; metal sighted at the top of the riser indicates that the mould is full. The sand is porous and hot gases generated by the molten metal pass out through the sand, assisted by vent holes formed by passing a wire through the sand mass a number of times. As the metal cools it "shrinks". The heads of molten metal in the gate and riser act as reservoirs to feed the casting, thus compensating for this shrinkage. Once the metal solidifies it continues to "contract" until it reaches ambient temperature. A definite distinction is made in foundry terminology for the reduction in volume before and after the metal freezes. This is important from the pattern maker's point of view as the "contraction" must be compensated for when the pattern is being made, but more about this later.

From Fig. 1, it is seen that the pattern is positioned in the bottom half of the box, the "drag", simply by placing it on a plane surface. The half box which is open top and bottom is positioned around it. Sand is then packed around the pattern and rammed tight, then "screeded" off level with the top of the box. The sand mixture is sufficiently damp to be plastic. Thus once rammed up the whole can be lifted and turned over. The top half of the box or "cope" is placed in position with its locating pins engaged in the holes in the lugs on the drag. "Parting dust" is sprinkled over the joint face to prevent the sand surfaces sticking, and tapered pins are placed in position to form the pouring gate and the riser. Sand is introduced and rammed up, the surplus being screeded off. The tapered pins are withdrawn and the cope lifted off. The top and bottom ends of the pouring gate and the riser are bell-mouthed. The pattern is removed from the drag and one or more sprues cut in. The mould cavity is dressed to give the casting a good finish. The cope is then replaced in its original position and the mould is ready for pouring.

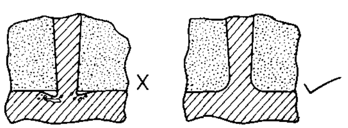
The pattern in Fig. 1 is a simple rectangular block with its top edges chamfered. The sides would be slightly tapered from the unchamfered edges, to facilitate its withdrawal from the sand. All surfaces should be sealed for waterproofing and finished smooth. To remove the pattern the moulder would insert a spike into the exposed surface and strike the spike in several directions. This is called "rapping" and breaks the joint between pattern and sand, and increases the size of the mould relative to the pattern. If the surfaces of the pattern are rough or insufficient taper or "draft" has been allowed, severe rapping may be required to free the pattern,

The following sketches show some of the common defects in castings and methods of preventing them.



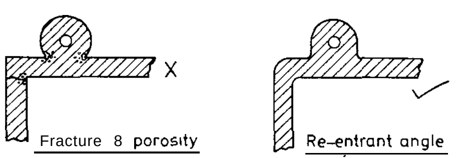
Probable blowholes

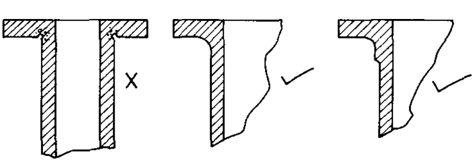
BOSS OF FLYWHEEL



Shrinkage, cavities & porosity

JUNCTION OF RISER





© PIPE FLANGE UNEQUAL SECTION

with consequent oversized casting being the result. Draft of 1/8 in. per foot or a little over 1/2 deg. of taper is considered adequate for hand lifted patterns. When machine lifting is used the draft can be less; however, as much draft as practicable should be applied on all vertical surfaces. Often the pattern can be designed so that surfaces to be machined later can be moulded vertically, thus incorporating plenty of draft as extra metal on these faces. Likewise the positions of sprues and risers should be considered at the pattern design stage to allow their location on machined surfaces or where their finished appearance is unobtrusive. Of course this is not always practicable, but if appearance is very important these aspects could be discussed with the foundry prior to designing the pattern, and the best-locations arrived at.

The behaviour of the metal as it cools from the molten state to solid and thence down to ambient temperature is important in both pattern and casting design. This is a very wide subject and cannot be treated in depth here. Fortunately these behavourial characteristics become a lesser problem as the size of castings decreases; some however remain intransigent and these will be discussed now. Metal does not solidify uniformly-thin sections cool first, and solidifying also proceeds from the surface inwards. This causes undesirable effects such as depressions formed in the upper surfaces of the castings, porous and hollow places at the junctions of small and large sections, cavities or blow holes in thick sections, warping, twisting or even fracture of castings. In order to minimise these problems the thickness of castings should be kept as uniform as possible, and where variations in thickness cannot be avoided sectional changes should be gradual. The sharp corner of re-entrant angle is a cause of serious weakness because of internal stress, notching and porosity. This can be controlled by including a tillet of as generous a size as practicable. Good moulding practice calls for bellmouthing of sprues and risers at their junctions with the casting to obviate re-entrant angles. Risers should be as large in section as practicable to prevent premature solidifying at their junction with the casting, which would result in insufficient "feeding" causing surface hollow or porosity.

Contraction of the casting after solidifying is not uniform, due to shrinkage stresses and variation in size, shape and section. Once again size is on our side. On very small castings reduction in size due to contraction can often be ignored. Where contraction allowance is to be applied to following allowances are acceptable up to 24 inches.

Cast Iron	—	⅛ in. per foot or	1.04	per cent
Cast Steel	—	¼ in. ,, ,, ,,	2.08	,, ,,
Aluminium	—	5/32 in. ,, ,, ,,	1.29	,, ,,
Brass	—	3/16 in. ,, ,, ,,	1.56	,, ,,
Bronze	—	⅛–¼ in. ,, ,, ,,	1.04-2.08	,, ,,

Continued