FOR THE SCHOOLS Elements of patternmaking

When WOOD is not used

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By Edgar T. Westbury

EVEN THE BEST timber has its disadvantages for some kinds of pattern work. Its durability is not all that might be desired for patterns which may have to go many times to the foundry and be exposed to rather rough handling. The finish of surfaces may deteriorate and delicate detail work be damaged.

A common practice in foundries is to make metal castings from the original wood patterns, and to clean them up to be used as patterns for repetition work. Besides being more durable, the metal patterns can be duplicated, multiplied or joined up in a group or spray to increase the rate of production. The original master patterns are generally made with double shrinkage allowance, so that the final product, cast from the metal patterns, will be of correct dimensions. To some extent the need for this can be avoided if a metal of low expansion coefficient is used. The removal of a certain amount of metal would be allowed for in cleaning up and smoothing the metal patterns. Low-grade zinc, or spelter, is often used, as it can readily be cast at a moderate temperature, takes a good finish, and is durable and resistant to corrosion.

Metal patterns of this kind may be of little interest to those who do not require long-term quantity production of castings, but it is sometimes worth while to fabricate or machine metal patterns even when only one or two castings are likely to be needed. This applies particularly to very small work with intricate and fragile details. It is often just as easy, and sometimes even easier, to make a small pattern in metal as in wood. The complete absence of grain enables the structural parts to be disposed in any direction, without loss of strength or difficulty in smoothing away roughness. Fabrication by all normal metalworking processes can easily be carried out, and soft solder can be used to form natural fillets in corners, or even to build up surfaces. No painting or other surface finishing applications are normally required, though colouring to denote core prints and so forth may be useful.

The difficulty of making really accurate and well-finished wood patterns, and maintaining them in proper conditions, has often caused me to use metal in preference to wood. Examples of simple patterns which I made for parts of the Kiwi *Mark II* prototype are shown here. The timing cover, seen on the left, is built up from a turned disc, with holes drilled to take stems turned on the four bosses. These were secured by light flush riveting and by sweating, with just sufficient excess solder to flow into a fillet in all comers.

A pair of balance weights can be cast in one piece, and machined on essential surfaces, before separation, from the pattern seen in the centre. This was made from the solid, and the groove across the centre was machined with slightly tapered sides for draught. The connecting rod on the right called for rather more detail work in fabrication, as it consisted of seven pieces soft soldered together. Here too the solder is used to form fillets. The big end has a well tapered bore to produce its own core, but the little end has only deep conical depressions to locate the position of the hole. Unwanted metal is thus eliminated as much as possible without skimping of the machining allowance. A hole drilled and tapped in the centre of the shank provides for lifting the pattern from the mould, but it is not produced in the casting.

In the production of the pattern for the *Kiwi* cylinder head, the methods employed ensured accurate contours of all parts by quite straightforward machining. The main part was first machined as a solid disc without any attempt to produce the fins at this stage. The lower circumferential fins cannot be directly cast from the pattern. They would call for a corebox to form the fins in casting; but as they can easily be machined at the same setting as the underside operations on the casting, this is not necessary.

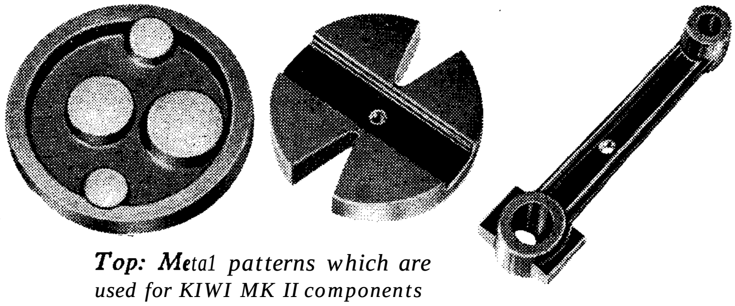
The positions for the horizontal inlet and exhaust passages, the inclined sparking plug boss, and the four bosses for holding-down bolts, were then marked out and holes were drilled in the solid disc, in appropriate positions. Pieces to form the two passages, complete with their outer flanges, were turned, together with a plug to form the sparking plug boss, and four suitably tapered stems to provide draught for the bolting bosses, the holes for which were tapered from the underside with a Standard taper pin reamer. Similar bosses for the valve guides and rocker column were also provided.

Having ensured that these parts fitted neatly together, I dismantled the assembly and set up the head on the cross-slide of the lathe for machining the fins. These were first gashed by a slotting cutter (composed of three thin saws ganged together, in the lack of a solid cutter of the right thickness). A tapered fly-cutter, with a rounded nose to produce a fillet at the root, was mounted in a boring bar and used to finish the fins. The lathe was run at high speed, and the work was fed from the rear end of the slide at a slow rate.

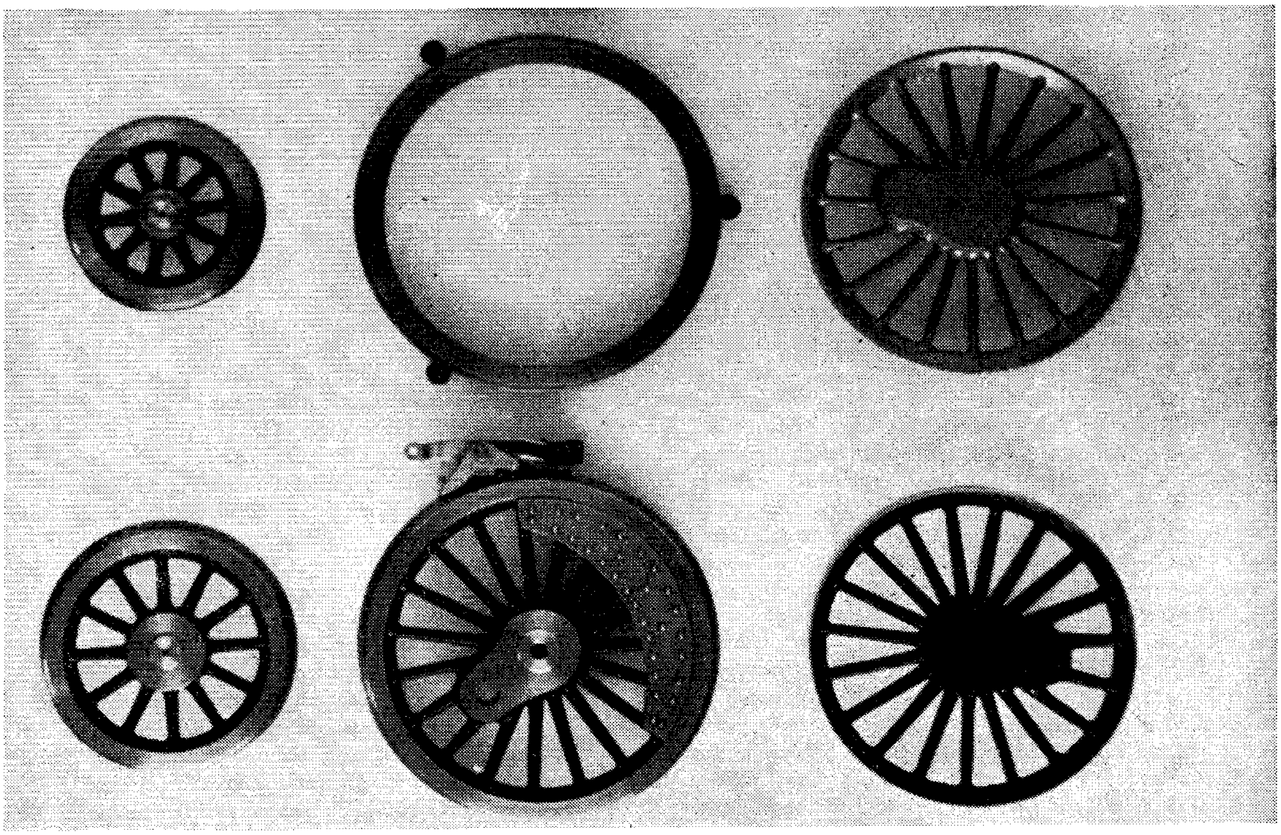
After removing burrs, I fitted the parts of the pattern together and cemented them with Araldite. I had to fill in the undercuts, where they occurred, with Holt's plastic metal, and I used the same material to build up fillets where they were needed. There are several kinds of plastic metal, based generally on polyester or epoxy resins, which adhere firmly to metal, and are to all intents equally hard and durable when they have properly set. The photograph of the cylinder head pattern was taken after it had been to the foundry several times and had lost much of its original brightness. It would have been more difficult to make such a pattern in wood, and still more difficult to ensure that it would stand up to foundry treatment.

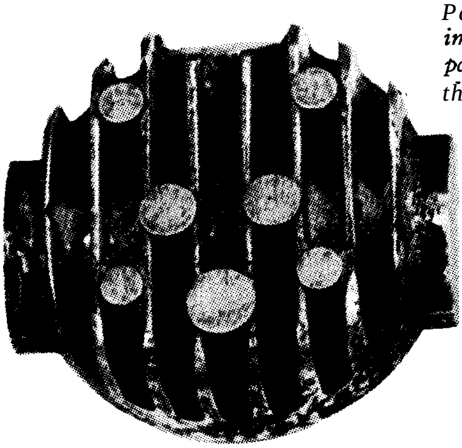
Among many other patterns which I have made in metal I may mention those for carburettors and ignition gear, pistons with internal coring, and propellers of various sizes and pitches, some of which were machined from the solid to produce true pitch and blade section. I have also produced crankshaft patterns in metal for casting in alloy steel, but it is difficult to find firms willing to undertake this work on a small scale. My many metal moulds for gravity diecastings, do not come within the legitimate scope of patternmaking.

I have often heard it said " Why go to the trouble of making a metal pattern for one or two castings when you

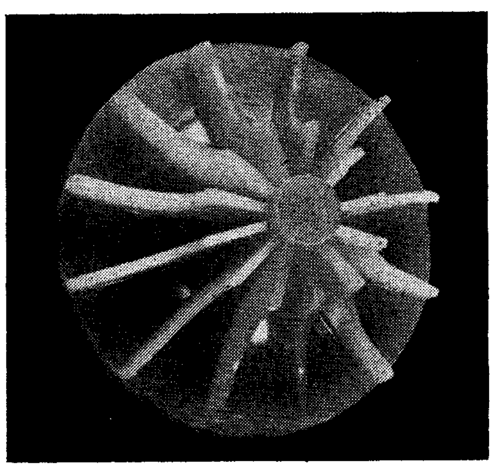


Top: Metal patterns which are used for KIWI MK II components
Below: H. A. Taylor produced these patterns and castings for the wheels of a locomotive





Pattern for small turbine impeller, in dental wax and pattern in metal (left) for the Kiwi Mk II cylinder head



might just as well make the finished article right away, with little more effort ? " The answer is that the pattern may often be fabricated from easily worked metals, in relatively simple shapes, and joined together without special regard for mechanical strength. To make the actual article may call for complicated or tedious operations, in relatively intractable materials, which have to be repeated in detail for every component.

Another photograph shows an excellent example of the use of metal patterns for locomotive wheels. The patterns are for the bogie and driving wheels of a 3-1/2 in. gauge LMS Class 5 engine being built by Mr H. A. Taylor of Bletchley in Buckinghamshire. They are shown on the left and right at the top, with the steel tyre which is eventually to be shrunk on to the driving wheel in the centre. In the bottom row, the rough casting of the driving wheel is seen on the right, together with a finished bogie wheel on the left, and a driving wheel with attached balance weight in the centre. The careful work which Mr Taylor has put into the fabrication of the patterns has been well repaid in the quality of the castings.

In my own experimental work, I often make use of crudely fabricated or machined parts, so long as they will serve the purpose of tentative construction; but when a design is more or less finished, it is my general policy to tidy up all the detail components and produce patterns, so that castings of good quality can be offered to readers.

Plastic materials of various kinds can also be used for making patterns, and may sometimes have advantages over both wood and metal. Casting resins, which are widely used for sheet metal forming dies, are equally suitable for the production of patterns from existing wood patterns, as the impressions or matrices can be made in plaster or cement. The resin, mixed with its hardener or catalyst, is poured into the matrix in a liquid state and cured either by heat or at normal temperature, according to the time allowable. Some acrylic plastics in the raw state, including those for dental work, can also be cast in this way.

To test some samples of metal alloys a laboratory needed in a hurry short cast rods of these materials. Wood or metal patterns could, of course, have been made quite easily, but the quickest way to make patterns in the circumstances was to pour liquid resin into a number of test tubes, cure them in a steam oven, and break away the glass of the tubes when they had set. The possibility of making more complex shapes, from vessels which may be used as moulds, is fairly obvious.

Paper or fabric-based phenolic plastics such as Bakelite, Tufnol or Paxolin are very useful for the fabrication of patterns, as they can be machined and drilled by metal working tools, and joined by adhesives or screws. But laminated materials have a definite grain, and paper-based plastics are liable to break out or rag at the edges, so that the homogenous plastics (those without fillers of any kind) can generally be dealt with more easily. The acrylic plastics, including Perspex, are very easy on tools, and can be almost welded together by adhesives which have a solvent action. This applies also to polythene and polystyrene; but in my experience, p.v.c. and nylon, which are much less susceptible to the action of solvents, do not make such tenacious joints. Nearly all plastics can be cemented together more or less effectively by rubber latex adhesives such as Pliobond, Britfix or Evastick, or cellulose cements such as Durofix or Opaline.

Fillets can be applied to plastic patterns in much the same way as for wood or metal, and with the same materials. For Perspex patterns, shavings or powder of the same material dissolved in chloroform will serve either as an adhesive or, in the consistency of treacle, as a semi-liquid fillet. Bostik glazing strip can also be used for fillets, but does not harden as quickly as we might wish. Mouldable plastic pastes and compositions generally tend to cling to the fillet tool or palette knife more tenaciously than to the pattern, and are therefore more difficult to smooth off than is wax or putty.

Patterns in metal or plastics, being heavier than wood, are sometimes more difficult to draw from the mould, and the moulder cannot drive a spike into them for this purpose. It is usual to provide a small tapped hole in the pattern, and to insert a screwed rod or eyebolt in the hole for lifting. But I have found that the lifter invariably gets lost. A better method, where circumstances permit, is to drill a larger hole in the back or parting face of the pattern and cement in a small plug of wood, fibre or rubber, with a centre hole to take the usual spike. The rubber sheathing of an electric cable serves quite well.

Wax patterns may be made in any convenient way, and are mostly associated with investment moulding, though they could be used in sand moulds equally well. In the industrial manufacture of precision castings, elaborate metal moulds are often made for producing the wax patterns. This may seem like putting the cart before the horse, but direct production of the casting from the metal moulds is usually impracticable because of high melting point or otherwise unsuitable nature of the metal for diecasting. Complete turbine rotors with numerous integral blades can now be cast in steels of the highest strength and resistance to heat and so precise in shape and dimensions that they require no more than mere polishing of the blades. Dynamic balancing may, however, involve further local machining or some other means of removing small amounts of metal.

I have made several dies to produce wax patterns for various experimental turbine wheels and impellers, but so far I have not been able to get castings made in the alloy steels necessary for this duty.

A recent article in ***Machinery*** refers to the use of expanded polystyrene foam in making patterns for casting by similar methods to those used with wax. The material which is extremely light for its bulk, and is extensively used for protective packing and for the thermal and sound insulation of buildings, can be sawn, routed, machined, sanded, cut with a hot wire and joined by adhesives; it can be fabricated as desired, and moulded in sand or investment moulds. Removal of the pattern from the mould is unnecessary, as the material almost completely evaporates on contact with the molten metal, and the small residue of solid matter escapes through normal vents. Used in this way, the material is suitable only for one-off castings, but the ability to cope with undercuts and other complicated shapes not easy to cast from removable patterns, together with the complete elimination of joint lines, may make it worth while to sacrifice the pattern, as in the " lost wax " process.

* *To be concluded*