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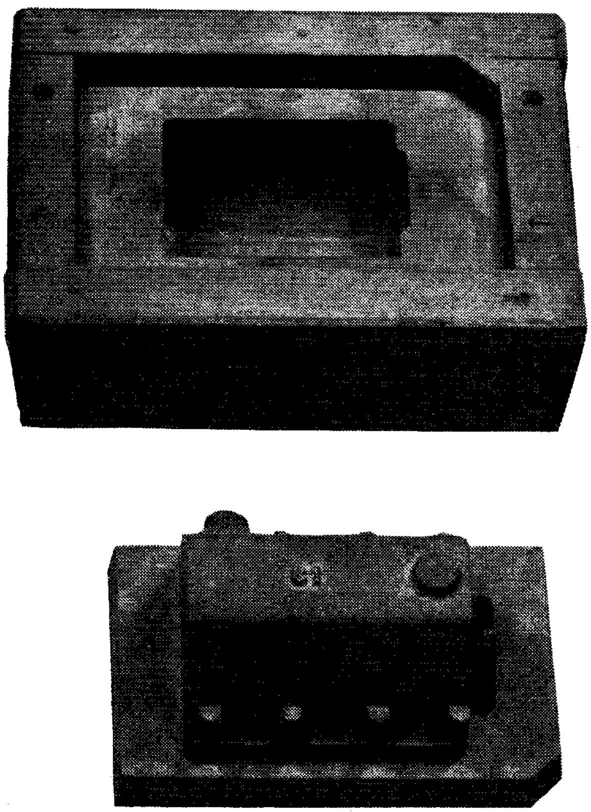
New challenges all the time

While the transfer passage conforms more or less to the curve of the main bore, the exhaust passage has sides as near parallel as possible, with allowance only for draught. The main bores of the casting, shown in Fig. 24, both have machining allowance, but the two passages should require little or no finishing after they have been cast. The width of the exhaust passage is actually greater than that of the main bore as cast, and so it must run right into the centre of the corebox, though not so far as to invite the risk of an imperfect seal between the two passages after the machining.

Castings vary so widely in their external and internal shapes that patternmaking is always full of variety and can never become monotonous. Nearly every new job presents its own problems, and not infrequently they are a challenge to the ingenuity of the patternmaker. In small patterns, the need to avoid unnecessary complexity in moulds and cores is not always fully understood by the designer or draughtsman, and as a result the pattern-maker and moulder may be caused a good deal of trouble.

In modelling, the external shape must be as accurate as is reasonably possible, though some details may be simplified. Internal shapes may prove extremely difficult, and anything which makes the work easier is always welcomed and is sometimes essential.

A good example of a " conventional " casting which might well be modified is the water-cooled engine cylinder in Fig. 25. This kind of cylinder has often been



Pattern and corebox for WALLABY sump
(Woking Precision Models)

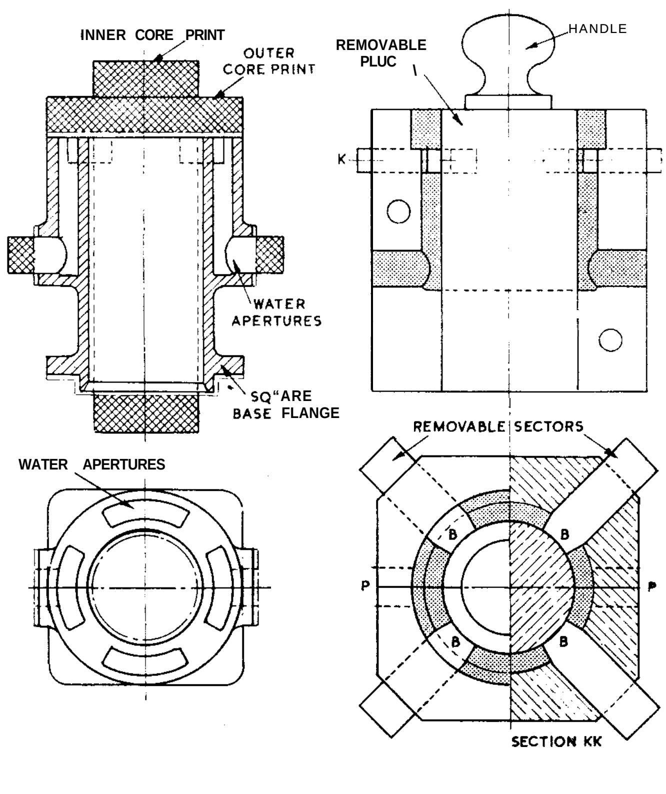


Fig. 25: Patern and corebox for a cylinder with annular water jacket

employed in stationary and marine engines and was used in early motorcars. Besides the main bore, it has an annular space around this to form the water jacket. To produce such a casting we need two cores. The inner core is plain and calls for nothing more than prints on the two ends. But the annular core requires a special corebox, and the problem is how best to support and locate the core in relation to the outside of the casting and the inner core.

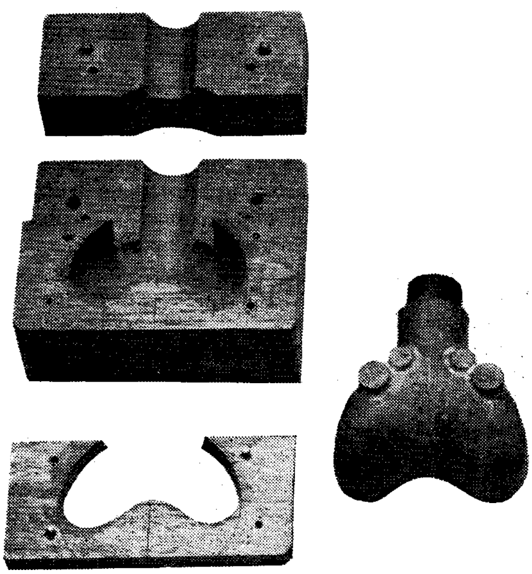
It is usual in this kind of cylinder to provide segmental water apertures in the top joint face, with bridge pieces between them which position the cylinder wall centrally and also form an anchorage for the cylinder head studs. The part of the annular core which locates it in the mould corresponds to the large diameter print on the top of the pattern, but provision must be made in the corebox for forming the bridge pieces. There are several ways in which this can be done. One of the simplest is that shown in the right-hand part of the drawing.

The corebox is split on the centre line and fitted with two or more dowels. It has a removable cylindrical plug to form the inner wall of the annular jacket. The plug may be slightly tapered, and may have a handle so that it can be pulled out from the top. To form the bridge pieces, sectors ***BBBB*** are fitted to slots in the four corners of the box. The box is simple to make if it is built up, so that grooves, rather than deep mortices, will fit the sectors. The grooves are pushed in to make contact with the centre plug while the box is rammed up, and are then removed, together with the plug, for the box to be, split and the core to be taken out.

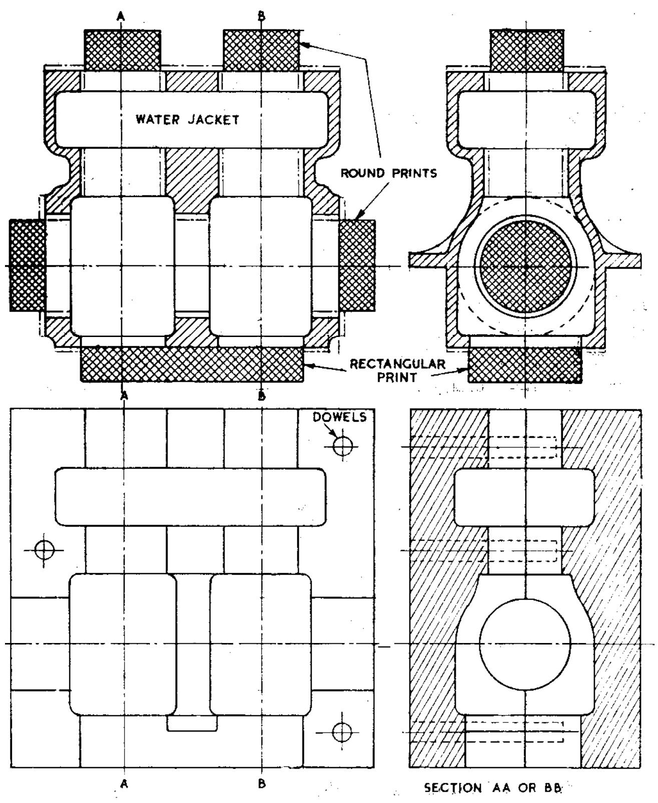
Another point about this casting is that the lower part of the core will need support to prevent sagging. In a large casting, " chaplets " might be used. These are small studs or bent pieces of the same metal as is used for the casting itself, and placed in the mould to support overhung parts of the core. When the casting is poured, they fuse into the molten metal and become an integral part of it. But for positive location it is often better to provide holes in the casting, so that core projections can be extended from the pattern. The holes are sometimes added specially to the design; but use is made here of the inlet port needed at the bottom of the jacket for the water circulation system. While a single support on the bottom of the core might suffice, two core prints as shown on the drawings, horizontally disposed on the parting line, give better support and also alternative water inlet positions.

Sometimes cylinders of this kind are made with a blind end, and water spaces have to be formed over the head as well as round the barrel. Apart from the casting difficulty, this is not a very desirable form in small sixes, because it is less easy to machine or gauge accurately than is a cylinder open at both ends. Again, a cylinder with ports or passages, such as for transfer and exhaust in a two-stroke engine, may call for further complication and more separate cores.

The complications involved in a small casting of this kind justify investigation of possible alternative forms of castings to eliminate the need for a double core, without any great alteration to external form. An obvious way is to fit a separate cylinder liner, and as a matter of fact this is now common practice not only in models, but also in many full-size engines as well. It calls only for some



For the uptake of Trident Mark II
(Woking Precision Models)



Right, Fig. 26: Monobloc pattern and corebox for a water-cooled engine

thickening of the lower wall of the casting, to provide sufficient tensile strength after enlarging the bore to fit the liner. Not only does it simplify moulding, but also enables special hard-wearing metal to be used for the liner, and light alloy for the water jacket.

In some of the engines which I have designed, the use of cylinder liners has enabled "monobloc" construction (an integral one-piece casting forming the entire major structure) to be employed not only for single, but also for multi-cylinder units. The ***Seal, Sealion*** and ***Wallaby*** engines are examples of this structural design, and many can also be found in full-size practice. Monobloc construction does not always eliminate complexity in coring, but very often a single core will fulfil the essential requirements.

Simplified core prints

The monobloc engine design shown in Fig. 26 exemplifies the use of a fairly simple core; it does not represent any particular engine and could be adapted to two-stroke, four-stroke, or even single-acting steam units. While neither the design nor the construction of the corebox is difficult, the multiplicity of prints on the core makes it essential that they are located to correspond exactly in the pattern and the box. It is possible to simplify and reduce the number of core prints.

If the cores are supported at the top and bottom as shown, it is permissible to omit the end prints of the crankcase tunnel; flashes left at these points would be machined away in the normal course. Many patternmakers, instead of providing separate core prints for the two cylinder bores, as shown at the top of the drawing, would combine them in a single elongated or rectangular print, as at the bottom. Engines of this type would nearly all have an open bottom to the crankcase (ultimately to be closed by a recessed cover plate or sump) to give access to the big-end bolts; with the others, end prints would be required. A centre main bearing, essential in a two-stroke, and desirable in any event, can be fitted in the bored tunnel to avoid a further complication of coring.

Most small steam engine cylinders have ports and passages milled and drilled from solid metal. Perfectionists would like them to be formed in the casting as at full-size, but serious moulding difficulties are involved, at least in engines of less than about 1-1/2 in. cylinder bore. Apart from the problem of making the long and narrow cores for the passages, it is still more difficult to ensure that their location at the port face is accurate enough for the admission and exhaust events to be properly controlled by the slide valve.

The passage cores in Fig. 27 are integral with those of the main bore and port face (which may or may not be recessed). This is pretty well the only way to be certain of really positive location in small cylinders. But it results in an extremely fragile core, even though the passages are stiffened by wires or metal strips, and it is difficult to pack and ram these parts properly unless a more complicated form of box is used. Sometimes removable pieces are made to form the passage cores, so as to avoid the risk that they will be destroyed when the complete core is lifted. More often, the passage cores

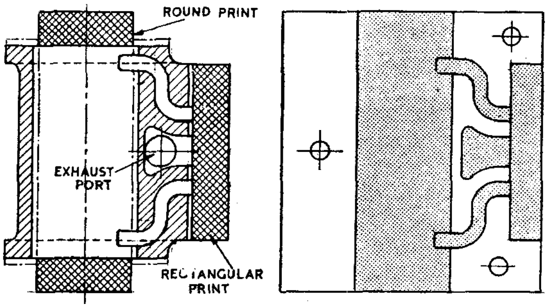


Fig. 27: For a steam-engine cylinder with cored passages

are made separately, as in Fig. 28, to be positioned by notches in the main core and separate prints on the port face. The exhaust cavity is sometimes omitted: its location is much less critical than that of the end passages, and it is easier to drill from the solid.

Piston valve cylinders have shorter steam passages than those for flat slide valves, and the location problems may be simplified by the fitting of liners with machined ports. But coring is still a problem, and generally is best avoided in ***all*** kinds of small cylinders, if this can be done without loss of working efficiency. Most steam engine modellers would agree that there is little evidence of superior performance in an engine made with the most meticulous fidelity to full-size practice.

My experience in recent years is that moulders are reluctant to attempt small and delicate cores, not only because of the extra work, but also the greater risk of failure. Misplacement of cores, or their collapse while pouring the mould, account for a high percentage of scrapped castings, for which the foundry has to bear responsibility.

But this does not mean that cores should be avoided. As already explained, excessively thick ***or*** uneven thickness of sections is not conducive to perfect castings, and a core in the appropriate place may improve the grain flow of the metal, and thereby its ultimate strength.

If one is lucky enough to find a moulder who is interested in the special problems inherent in small castings, and is prepared to take the trouble to deal with them, it is well worth while to accept the increased cost. It is very poor economy to haggle over expense on raw material, and castings in particular; in model engineering only the best is good enough, and cost should be a secondary consideration.

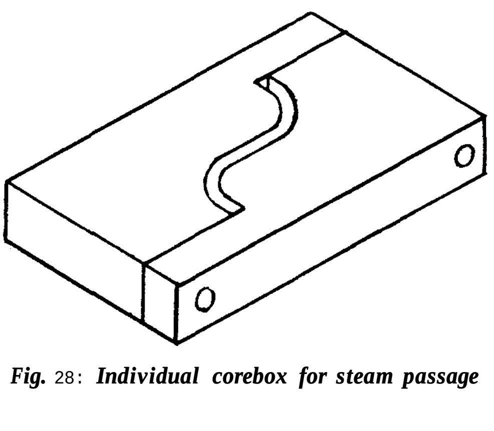


Fig.* 28: *Individual corebox for steam passage

** To be continued*