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The Manufacture Technology of Sand Castings

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ABSRACT: This article examines the technology of casting in sand-clay molds and the requirements for obtaining quality castings. In addition, the advantages and disadvantages of sand-clay castings are discussed. The manufacture of a sand casting can be considered in three main stages, namely the production of the mould, melting and casting, and finishing operations: these will be the subjects of separate sections of the chapter.

KEY WORDS: manufacture, sand, casting, mould, production, steel, cast iron, aluminum, brass, pattern, equipment

I. INTRODUCTION

Although many process variations are used in metal founding, the production of castings from solid patterns in rammed refractory moulds still accounts for the greater part of the industry's output. The present article, a review of the essential stages in founding, is based largely on this process, although much of the subject matter is applicable to a wider range of casting processes [1].

Sand castings, a term used loosely to include other castings made in refractory moulds, range in weight from a few grams to several hundred tons, thus covering almost the entire size range for cast parts; virtually all types of casting alloy are produced.

II. RELATED WORK

The reason for the dominant position of the process lies mainly in its great flexibility in relation both to design and to production facilities. In these respects it epitomizes the qualities attributed to casting processes as a whole and discussed. Almost unlimited freedom of shaping is combined with low capital and operating costs, whilst the process is suitable for any quantity of components. Thus, although other casting processes may excel in individual respects, sand casting is uniquely versatile in relation to weight, composition, shape and quantity. Specific design characteristics of sand castings are examined in article..

III. LITERATURE SURVEY

Mould Production

The first major stage in founding is the production of the mould, with its impression of the casting and its planned provision for metal flow and feeding. For this purpose a pattern is required, together with foundry equipment ranging from moulding and coremaking machines to moulding boxes, tackle and hand tools. Following a survey of this equipment the basic techniques of moulding and core production will be reviewed.

It should be emphasised that the moulding procedure for a particular casting is largely determined by the means chosen at the outset for pattern removal and embodied in the construction of the pattern. For this reason, decisions as to the entire manufacturing technique should be taken at the earliest stage, including consideration of the orientation of the casting for gating and feeding as well as for pattern withdrawal. A rational choice can then be made of the system of parting lines, cores and other features to achieve overall economy in manufacture [2,3].

A further decision which greatly influences production costs concerns the size of mould unit to be adopted and the arrangement of patterns in relation to mould dimensions. The object should be to employ the largest size of mould that can be conveniently handled by the plant, and to achieve intensive use of mould space through a high packing density of castings.

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IV. METHODOLOGY

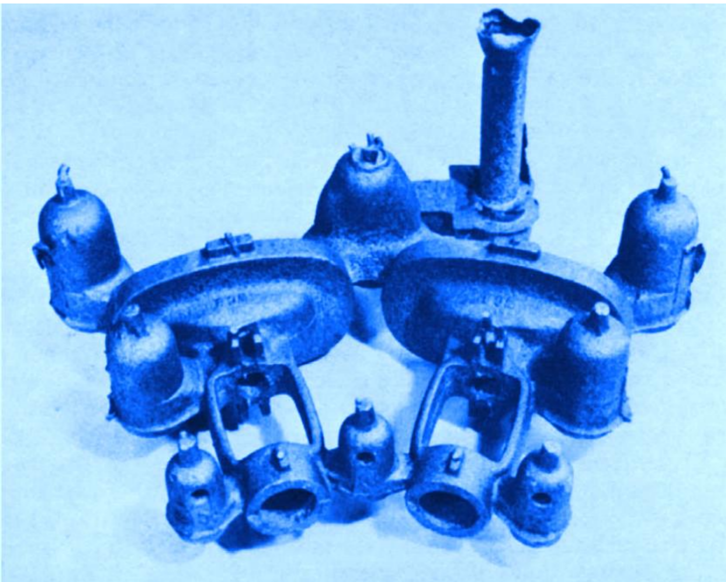
This reduces the number of moulding operations and minimizes sand consumption. These objectives are achieved by the use, whenever possible, of multiple-casting moulds in which two or more patterns are grouped round a common sprue or feeding system, or in which mould parts are stacked to produce superimposed layers of castings. These techniques are illustrated in Figure 1. In the case of stack moulding it is sometimes possible for the back of one mould part to form the face of the next as shown in Figure 1c, virtually halving the number of mould parts required. Where such parts carry impressions on both faces they may be produced by machine squeezing between two pattern plates, a principle employed in some of the automatic box less block moulding systems. A further advantage of such systems is the possibility of improved casting yields through the sharing of feeder heads and gating systems.
It can also be advantageous in certain cases to combine components into larger units for casting purposes. A black casting may thus be designed for the production of a number of machined parts. Single rings may be parted from a cast cylindrical bush, or a half round component may be tied to a similar component to provide more symmetrical cooling and avoid distortion; all such measures need to be determined before the pattern is constructed.
The nature of the moulding practice is closely related to the moulding material employed. Various classes of binder were examined, as were the characteristics of green and drysand practice and various mould and core hardening reactions. These considerations influence the choice between moulding box and block moulding, for example, and thus affect the pattern requirements from the outset.

V. EXPERIMENTAL RESULTS

Equipment for moulding

A. Pattern equipmentThe nature of the pattern equipment depends in the first instance uponquantity requirements and the intended method of production. Patterns can range from simple wooden equipment, requiring skilled handling and intended only for short life, to elaborate metal plate assemblies, complete with gating and feeding systems, suitable for mass production by machine moulding; similar considerations apply to core boxes. The governing factor is the permissible first cost in relation to the output envisaged.

a)



b)

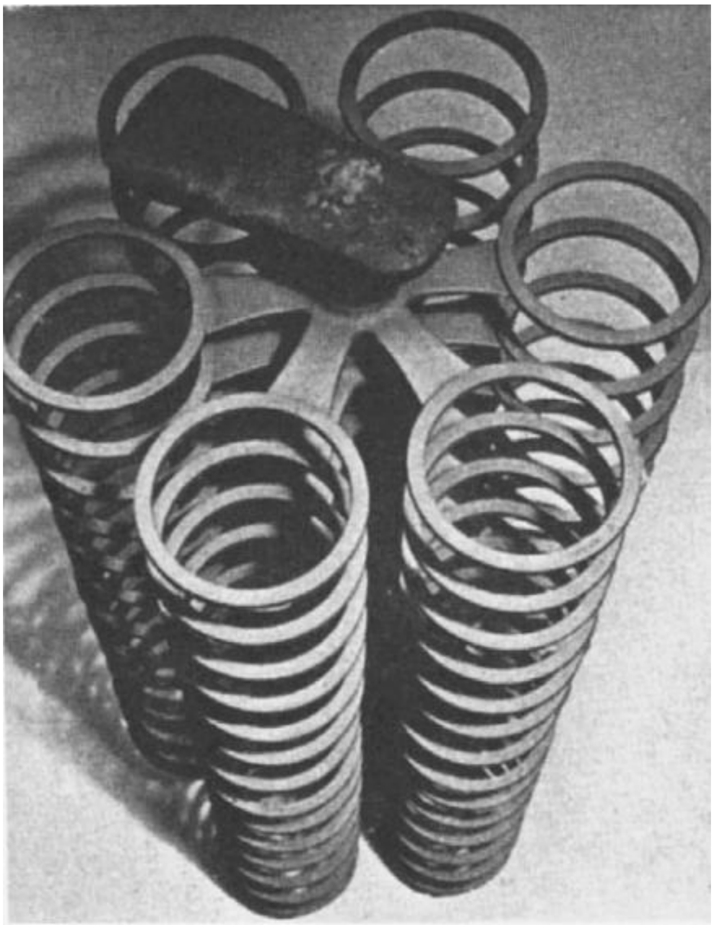


Figure 1. Grouping of castings for production: (a) Steel valve cover castings produced two-in-a-box using a common sprue: (b) stack moulded cast iron piston (c) (overleaf) arrangement of stacked moulds to employ both faces of mould parts

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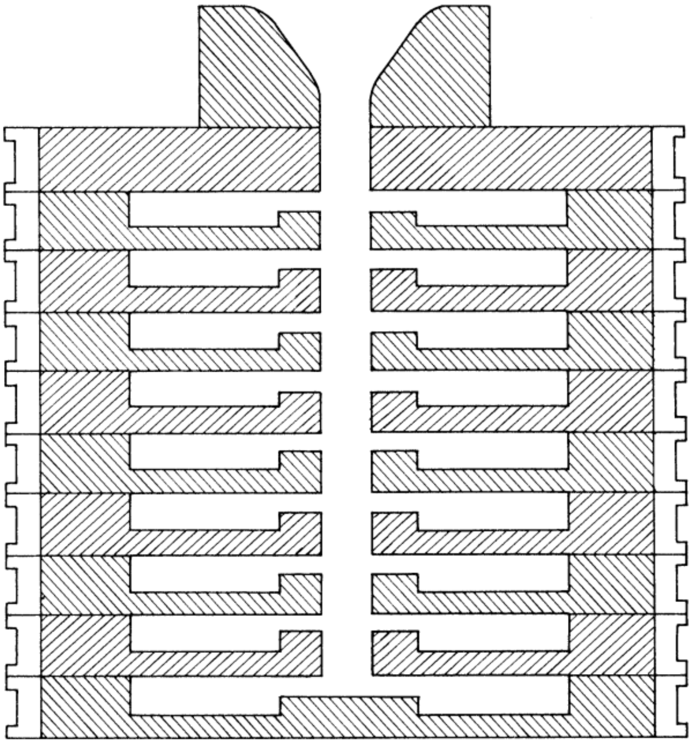

c)

Although it is generally recognized that pattern equipment should be designed to suit the founder's own method of production, castings are frequently ordered from previously existing equipment. This can place a restriction on moulding and casting methods; a further disadvantage is the occasional survival of an insufficiently durable pattern, originally intended for the production of a few castings, into bulk production. In such cases the cost of pattern modification or replacement represents a valuable investment in terms of casting quality [4].
The basic types of pattern will be considered at a later stage in relation to moulding technique. There has been a major shift towards more refined equipment, accompanying a widespread transition from manual skill to engineering technique as the principal element in moulding. Standardization and mass production, coupled with fewer available skilled craftsmen, requires that mould production be 'pre-engineered' at the patternmaking stage. Patterns are accordingly designed with less reliance on the sculpture of difficult stepped joints and use of loose pieces, but with correspondingly greater use of cores in conjunction with design measures for simplification of moulding. Moulding skill can then be deployed on heavier castings and on jobbing work required in small quantities.
A further feature of mounted patterns as used in machine production is the inclusion of integral gating and feeding systems, giving complete standardization of casting method and avoiding the loss of mould quality which accompanies manual cutting.
Manufacture of pattern equipment may be undertaken either by the foundry or by a specialist concern able to supply a comprehensive range of modern tool manufacturing techniques. Materials used include wood, plastics or resins, cast iron, brass, white metals and light alloys. Composite construction, with harder materials used as inserts at critical wearing points, can be used in some cases: the standard of materials and construction depends on the need for durability and dimensional stability.
Important features are the allowances made for contraction and draft. Examples of standard contraction allowances are given in Table 1, but it is the practice to vary these in the light of experience with particular types of dimension. The various factors influencing contraction behaviour, including mould constraints, have been examined in great detail by many researchers with a view to the production of calibration curves for the more accurate prediction of dimensional behaviour in individual circumstances. Draft taper, incorporated on faces normal to the intended parting plane, is usually in the range 1/2-3 degrees for sand castings, although it is preferable to design castings incorporating more generous natural taper.
Moulding operations are aided by a colour coding system indicating the functions of the patterns, for example coreprints and machined surfaces. Typical colours used for some of the principal features are as follows:

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As-cast surface–main body of pattern: Red/orange
Machined surface: Yellow
Coreprint: Black
Loose piece seating indication: Green

Table 1
Typical contraction allowances for castings

Alloy type	Allowance %	Equivalent ratio	Equivalent in per ft
Steel	1,6	1 in 64	$\frac{3}{16}$
Cast iron	0,8	1 in 120	$\frac{3}{32}$
Brass	1,4	1 in 70	$\frac{11}{64}$
Aluminum	1,3	1 in 77	$\frac{5}{32}$

In loose pattern moulding this system can be extended to include indications for the positioning of heads and chills, thus using the pattern as a vehicle for method instructions to the shop floor.
B. Moulding boxes. Moulding boxes and flasks are selected for minimum sand consumption and production time per unit weight of casting. This aim can often be realized by grouping and stacking castings as previously described.
The shapes and sizes of box parts selected to form a stock must depend on the type of product, but much is to be said for standardization on a few sizes, with a high degree of interchangeability of parts. This is particularly necessary for machine production, for which length and breadth can be fully standardized, leaving only depth to be varied according to need.
Boxes can be of cast or fabricated construction in steel, cast iron or light alloy. Robust construction is required to meet the rough handling to which they are often exposed. For small castings, units fabricated from rolled steel section find wide use, being both strong and light. Heavy construction is needed for large moulds to give rigidity in lifting; for the largest boxes sectional construction can be adopted, side and end elements being bolted together as required, reducing the number of parts which need be held in stock [5].
One of the most important features is the location system for accurate alignment of the mould parts. This is commonly based on steel pins riding in holes through projecting lugs. The holes should be jig drilled and the boxes thereafter carefully maintained with respect to the accuracy of the pincentres dimension. Many boxes are provided with wear resisting hardened steel bushes in the pinholes; the use of one round and one elongated hole enables accurate location to be maintained even with limited box distortion. This system can be combined with loose pins which can be renewed as soon as wear is detected: these must however always be left in position in closing to avoid movement when clamping.
Other features include fixed or detachable bars, often fitted to large boxes to reinforce the sand mass. Handles and crane lifting attachments, trunnions for turnover, clamping bars and sand retaining flanges are also fitted according to the size and purpose of the equipment.
Moulds may also be produced using the snap flask or similar systems in which the box is used only as a frame for ramming purposes. The flask is hinged at its corner, being opened after ramming to leave a block mould bound by steel bands placed in the flask beforehand. This method, suitable for the mass production of small moulds, dispenses with the need for a large box stock. In certain cases boxes are dispensed with altogether as in floor moulding, high pressure block moulding, and core assembly production; these techniques will be further referred to at a later stage.
Intensive box utilization is desirable in view of the appreciable capital value represented by the box stock: one object of production planning is to achieve rapid box turnround by minimizing delays between moulding, casting and knockout.
C. Ancillary equipment and tools. Apart from the moulding box, tackle is required for mould strengthening and core support [6]. Reinforcing grids for larger moulds are usually cast to the required shape and size in an open sand bed in the foundry, whilst general stocks of irons, nails and sprigs need to be maintained, with studs and chaplets for core support. Tools for hand moulding include the following:

Ramming:
Cutting and finishing:
Venting: peg and flat rammers; pneumatic
rammers for bench or floor work;
trowels, gate knives, cleaners;
vent wires of various diameters

Moulding and core making machines are vital items in modern foundries: these will be considered later in relation to the ramming of moulds and cores.

With increasing demand for precision in casting, patterns, core boxes, driers, moulding boxes and machines must be manufactured and maintained to the highest standards. This minimizes the need for hand finishing, patching and rubbing of moulds and cores or for subsequent sculpture in the fettling shop due to imperfect or worn equipment.

IV.CONCLUSION

In summary, obtaining quality castings is more important than obtaining sand-clay molds compared to other molds. Ease of making sand-clay molds, low cost, we can cast small and large volumes. Currently, 75-80% of castings are made in sand-clay molds. But it is recommended to clean the surface of the casting, which is poured in a sand-clay mold. The reason is that when the liquid metal is introduced into the sand-clay mold, fine sand grains stick to the surface of the casting due to the high temperature of the liquid metal. Therefore, the casting surface is cleaned in different ways and the surface quality of the casting is improved.

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