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THE PLACE AND IMPORTANCE OF CASTING PRODUCTION IN THE MECHANICAL ENGINEERING INDUSTRY

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Abstract: Technological processes such as the role and importance of casting production in the mechanical engineering industry, casting alloys, casting properties of alloys, sand casting, forming and core mixtures, casting systems, preparation of casting molds, machine forming, automatic forming flow, preparation of cores, cooling, ejection and cleaning of castings, special methods of obtaining castings, casting in multiple molds, preparation of castings from various alloys, and technological principles of casting design are widely covered.

Basic word: Casting, capacity, alloy, casting system, shape, core, sprue, temperature, cooling rate, sand clay molds, automatic forming flow, mold materials, casting in molds

Enter: Casting is one of the oldest and currently the most common method of obtaining products for all branches of industry. It is a relatively simple and inexpensive process and is used to obtain products of the required mass, size and complexity from almost all known metals and alloys. In many cases, casting is the only method for producing large-sized and complex-shaped products (cylinder blocks, pistons, gas turbine impellers and blades, machine tool housings), when other methods of obtaining it (forging, stamping, welding) are used.

The essence of foundry production is to obtain cast parts (ingots) by filling specially prepared casting molds, the internal cavity of which corresponds to the shape of the future casting, with molten metal. During the crystallization and cooling process, a casting is formed, which has certain mechanical and operational properties. Various casting methods are used in industry and can be divided into two groups: one-time forms that are destroyed when the casting is removed (sand molds, shell molds, melting models, gasified models, etc.) and multiple forms (in a mold, under pressure, centrifugal, continuous casting, etc.) [2]. The use of one or another casting method is determined by the volume of production, the size of the products, the type of metal used, the requirements for the geometric accuracy and surface roughness of the products, economic feasibility, etc.

The schematic diagram of one-time sand casting, which is used to obtain the bulk of castings in mechanical engineering, is shown in Figure 1.

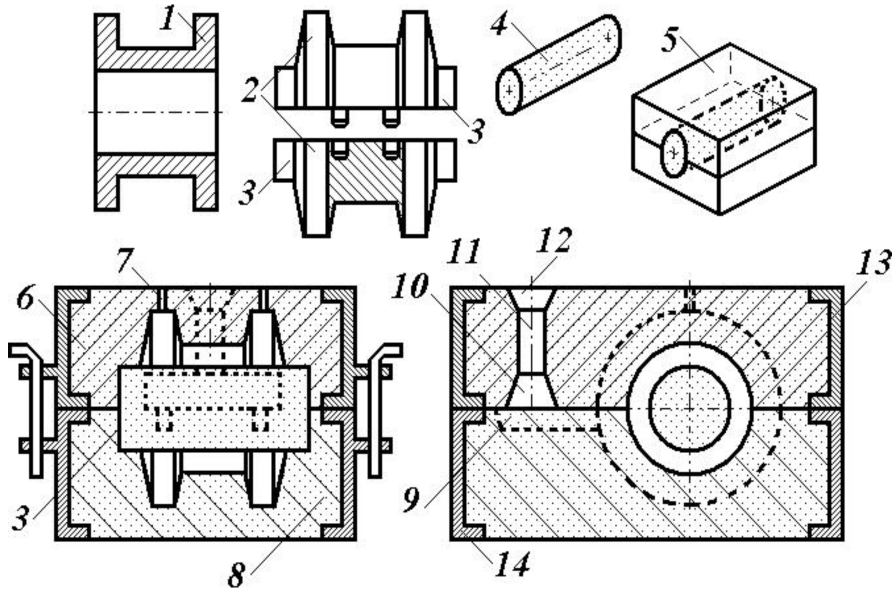

Fig. 1. Scheme of casting in a one-time sand mold:
1-cast part; 2-opening model; 3-distance mark; 4-rod; 5-core box; 6,8- upper and lower half-forms; 7-extruder; 9-sluice; 10-slag remover; 11-column; 12-pourer; 14-opaques;

The casting mold consists of the lower 8 and upper 6 half-forms, which are taken from the molding mixtures consisting mainly of quartz sand, soil and water in the 13 and 14 opacities. The opaque is a mold shell made of cast iron or cement, which serves to hold the molding mixture. The mold cavity is formed using the model 2. Cores 4 serve to form holes or other complex shapes, and they are made in distance boxes. The cores are solidified from the mold using the symbol 3. The molten metal is brought into the mold cavity, filled and fed into the casting system during solidification through channels 9-12. After the part has solidified and cooled, the mold and spacer are removed, the casting is separated, the mold is cleaned of the molding mixture and the casting is scraped [2-3].

Cast alloys: The most important and widely used alloys in modern large-scale production of alloys are cast iron, steel and non-ferrous metals. The most common cast metal is gray cast iron. Because it has good castability properties, it is not in short supply and has a low price. A significant part of the casts is made of high-strength, malleable and alloyed cast iron. Steel cast iron has higher mechanical properties than cast iron, which creates great difficulties due to the lack of castability. Among the cast alloys of non-ferrous metals, copper, aluminum, magnesium, zinc and titanium alloys are used, and various additives are added to them, which affect their mechanical and physical and chemical properties. However, regardless of this, all cast alloys must have castability properties, and without taking them into account, it is impossible to obtain the most perfect quality castings [5].

Castability properties of alloys: The main properties of castability are fluidity, the tendency to solidify gases during liquidation, the formation of cracks, etc. Liquid fluidity is the ability of metals and alloys to flow according to the rules of the liquid state, fill the voids and form a single type of casting. Liquid fluidity Liquid fluidity depends on the nature of the metal, its physical properties, chemical composition, and the properties of the metal casting form in the temperature range. All alloys that do not have a crystallization range in the case of pure metals in the form of eutectics have a greater fluidity than alloys of the same system that are cast in the temperature range. This law is explained by the flow conditions in the channel filled with molten metal. Dendrimers that branch from the alloys that are cast in the temperature range are formed and they significantly thicken the process of melting. If the pure metal or alloy is filled with a non-crystallization gap, the molten crystals have a relatively less branched and more compact shape. They reduce the melting rate and speed to a lesser extent than in the first case and are filled with a slightly larger length. In addition to the shape of the precipitated crystals, the crystallization temperature is also important. If the precipitated phase has a high crystallization heat, then it takes a long time to solidify and solidify the solution, as a result of which the alloy is longer than the liquid state and has time to enter the mold channel. Increasing the pouring temperature and the temperature of the casting mold and the alloy increase the fluidity of the alloy. Increasing the thermal conductivity of the mold material, as well as non-metallic additives in the metal, reduces J and makes it difficult to slide it in the mold [6].

The more carefully the mold and the sprue channels are processed, the faster and more completely the mold is filled with the solution. In foundry production, J is estimated using special spiral samples into which molten metal is poured. The length of the filled part of the spiral is the criterion for estimating J and is measured in millimeters. Shrinkage is the solidification of cast alloys and their decrease in volume and linear dimensions during cooling. Shrinkage processes occur in castings from the moment the molten metal is poured into the cast mold until the casting is completely cooled. The size of the shrinkage is primarily influenced by the nature of the metal, the chemical composition of the alloy, and the properties of the cast mold. Shrinkage increases with increasing temperature of the poured metal. Shrinkage is divided into volumetric and linear. Volumetric shrinkage is the volumetric decrease in the alloy during cooling in the cast mold. Volumetric shrinkage leads to the appearance of shrinkage voids and diffuse pores in the castings. Inlet voids are relatively large voids located in the casting and solidifying last. (Fig. 2). Inlet voids are a collection of voids in one place, which are formed as a result of the inflow of molten metal into certain parts of the casting (Fig. 2).

In the crystallization of pure metals, alloys and alloys with a narrow crystallization range, which are similar in eutectic composition, the solidification of the casting proceeds layer by layer, gradually moving from the walls of the mold and into the body of the casting [7-8].

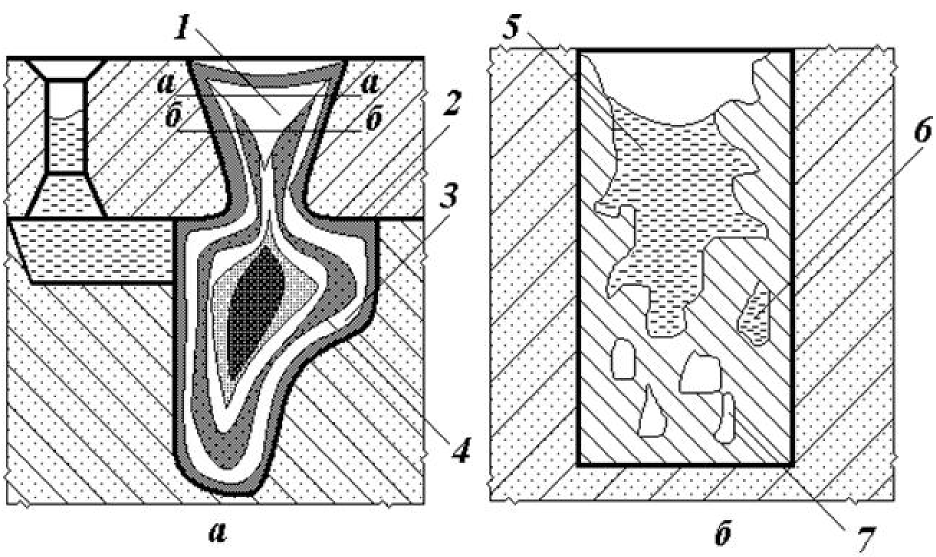

Fig. 2. Scheme of the formation of an inlet void and an inlet void:
a - formation of a penetration gap, b - formation of a penetration pore, 1 - accumulated penetration gap, 2,2,4 - successively formed layers, 5 - solution, 6 - isolated areas, 7 - porosity, a-a, b-b - solidified metal heights.

The penetration of the solidified part is filled at the expense of the not yet solidified part of the casting, in which the metal height gradually decreases (heights a-a, b-b) until the solidification process is completed, upon its completion a cumulative penetration gap 1 appears. If the casting has parts of different thicknesses, the thinnest part solidifies first. The penetration gap formed in it is filled with liquid metal from the part. It cools more slowly and a penetration gap is formed in it. To prevent the formation of a void, it is necessary to install a special filler in the casting mold, the dimensions and shape of which are selected so that it is the last to solidify, that is, it should be heavier than the thickest part of the casting. In alloys with a crystallization gap, a void 7 appears in the middle of the casting, located along the boundaries of the metal grains. To obtain a casting without voids and voids, it is necessary to ensure continuous supply of molten metal during the crystallization and cooling of the casting and to equalize the solidification rates of its different sections. Linear shrinkage is a decrease in the linear dimensions of the casting during its cooling from the casting temperature to the ambient temperature. The casting is always smaller in its linear dimensions than the mold cavity used to obtain it.

Relative linear shrinkage is the ratio of absolute linear shrinkage to the linear dimensions of the ingot after complete cooling. Linear regression is defined by the following ratio:

$$\varepsilon = \frac{l_{sh} - l_q}{l_a} 100\%$$

Here l_{sh}val_q 20 S temperature form gaps and casting dimensions.

Linear penetration in castings is practically never free, but rather difficult to one degree or another, and therefore ductility and plastic deformations occur in castings. The outer, relatively cooled layers of the casting make it difficult for the inner hot layers to penetrate, as a result, the inner layers are plastically stretched, and the outer ones are elastically compressed, which leads to the formation of internal stresses. If the magnitude of the stresses exceeds the yield point, the casting will collapse and warp. If the magnitude of the stresses exceeds the strength limit of the material, cracking will occur.

According to the period in which cracks appear, hot and cold cracks are distinguished. Hot cracks appear at temperatures close to the solidification temperature of alloys, when the alloys have very low strength. The crack surface is dark, acidified. Cold cracks appear when the alloy is completely solidified, within the framework of elastic deformations. Cold cracks occur when there is a large difference in thickness between thin and thick parts of the casting, that is, when it cools unevenly. The metal surface at the crack is not acidified, because it appeared in cold metal [10].

Liquation is a non-uniformity of the chemical composition of the alloy in different parts of the casting. The tendency of an alloy to liquify is affected by the chemical composition of the alloy, the acidification interval, the cooling rate of the casting, etc. There are two main types of liquification: dendritic and circular. Dendritic liquification is characterized by a lack of chemical uniformity within the boundaries of a single grain of the alloy, and becomes more noticeable with a high solidification rate of the alloy in the form. Circular liquification occurs when the structure and composition are not the same in different parts of the casting.

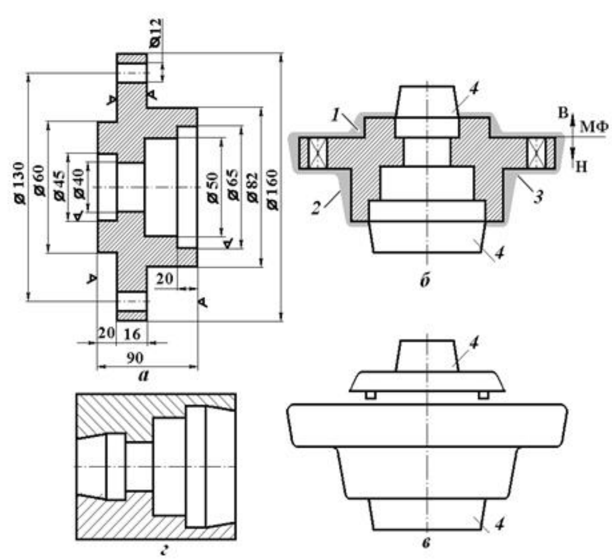

Figure 3. Development of a model drawing:

a - detail drawing; b - model drawing; v - sketch of a scattering model; g - sketch of a model box; 1 - machining surface; 2 - casting slope; 3 - casting radius; 4 - core mark; MSH - model and shape opening plane.

The casting for machining surfaces that must have the required surface quality relative to the model detail drawing should be increased by 1 size. The size of the casting depends on the size and material of the casting, its complexity, the condition of the given surface when casting, production classification and other factors and is selected by calculation or from the appropriate developed tables. The castings are marked with a thin solid line on all machined surfaces [9]. (In Figure 4, the castings are shown in black).

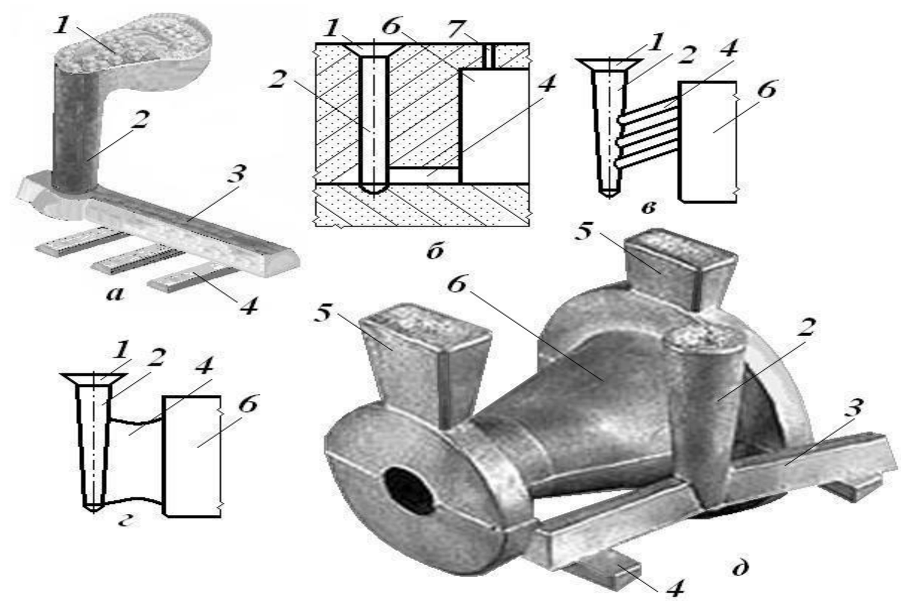

Figure-4. Types of pouring systems.

a – horizontal pouring system; b – siphon; c – tiered; d – vertical slot; d – with pouring pouring system; 1 – pouring bowl; 2 – column; 3 – slag collector; suppliers; 5 – inflows; 6 – pouring, 7 – discharges

Conclusion: Gutter systems (GTS) are a system of channels for the flow of molten metal into the mold cavity. They must ensure the correct filling of the mold with liquid metal, the solidification of the casting in the mold in a directed manner, the feeding of the casting during the crystallization and cooling of the metal, and the separation of slag and acids that accidentally fall out of it. The design of the QT should be simple, so that metal consumption is minimal, the molten metal moves evenly in the mold, there are no coils and no air, acid film and slag get into it. The location of the tundish system and the place of metal introduction into the mold should be such that the casting solidifies in the mold in a directed manner and the incoming metal is supplied with the hottest metal.

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