Transformation in alloys (metallic and nonmetallic) are illustrated graphically by phase diagrams, which make it possible to determine qualitatively and quantitatively the phase compositions of alloys and the type of the transformations occurring in them. The transformations in binary alloys have been investigated in great detail, although there has been no single classification of them up to now, and authors of textbooks and monographs classify "types of alloys" rather arbitrarily.

Binary alloys and their phase diagrams can be quite accurately classified according to the basic properties of the components forming the binary alloy. These alloys must be classified by the solubility of the components in the liquid and solid states, the heat of solution, and the presence or absence of allotropic transformations, intermediate phases, or chemical compounds of the components. In regard to the solubility of the components in the liquid state, alloys can be divided into three large groups or classes.

At a sufficiently high temperature the components of the alloy form in the vapor state intimate continuous and homogeneous mixtures of molecules or atoms of the components ("gaseous solution").

During condensation of the vapor, the components form homogeneous liquid solutions (Fig. 1a), or liquid solutions with limited solubility (Fig. 1b), or, finally, with complete insolubility of the components (Fig. 1c) they form two liquid layers of the pure components.

If a homogeneous liquid solution is formed in the alloy then it belongs to the first group of standard casting alloys; alloys with limited solubility in the liquid state belong to the second group of alloys; the third group consists of unalloyable compositions, from which articles can be made only by sintering of powders (powder metallurgy) or treatment by special processes such as alloy-suspension or alloy-emulsion.

CRYSTALLIZATION OF STANDARD CASTING ALLOYS

As is well known, the crystallization temperature of solutions does not correspond to the solidification temperature of the pure components of the solution. Molecular depression (lowering of the solidification temperature of the solvent on the addition of one mole of the second component) can be calculated
Fig. 3. Elementary phase diagrams of binary alloys. a) Eutectic type; b) peritectic type; c) megotectic type. Vertically the alloys are the same type with different solubilities of the components in the solid state: I) complete solubility; II) limited solubility; III) complete insolubility.

Fig. 4. Types of alloys similar to those in Fig. 3 crystallizing from liquid solutions with limited solubility (from a mixture of two liquid solutions).

by van't Hoff's law (or Raoult's law)

$$\Delta T = \frac{RT^2}{W},$$

where $W$ is the heat of solution.

Depending on the properties of the particular components, the heat of solution can be positive or negative, i.e., formation of solutions (or, on the contrary, crystallization of the solid phase from the solution) is accompanied by evolution or absorption of heat. If the formation of the solution is exothermic then, in accordance with Raoult's law, the crystallization temperature of the solution is lowered; in the endothermic process the crystallization temperature is raised.

If the formation of liquid solutions based on component A is exothermic the solidification temperature of the solution will be below the crystallization temperature of the pure components, and the higher the concentration of the dissolved component the lower it will be (Fig. 2a). Since in the given case it is not the pure component A which is crystallized (at temperature $T_1$) but a binary system, the solidification of the solution, in conformance with the phase rule, occurs over a range of temperatures. This is shown by the two descending curves in Fig. 2a: The temperature at the beginning of crystallization of the solution (or liquidus line) and the temperature at the end of solidification (or solidus line).

The same occurs during formation of liquid solutions based on the second component. If we assume that the formation of liquid solutions based on component B is also exothermic, then the crystallization temperature of the forming solution will be below the crystallization temperature of component B. Similar alloys, of which the temperatures of melting and solidification are below the solidification temperature of the respective pure components, are called alloys of the eutectic type (low-melting by comparison with the basic components).

There are alloys in which one of the components forms endothermic solutions while the second is exothermic (alloys of the peritectic type – Fig. 2b) and alloys in which both components form endothermic