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# INDUSTRIAL ELECTRON-BEAM EQUIPMENT ON BASE OF NOBLE AND NON-FERROUS METALS

**N.GRECHANYUK, P.KUCHERENKO, P.SHPAK,G.KROITORU**
Kiev National University of Building and Architectures
Kiev, Ukraine

## ABSTRACT

*Method of obtaining of metals and alloys by melting – is basic. By this way make in practice the majority of metals, alloys and ligatures. The essence of a method is, that in special melting device (furnace) to melt metal or basic component of an alloy and overheat it. After that, to liquid will add alloying elements in solid or liquid condition. Temperature of liquid lead up to necessary level, make metallurgical processing (refining, modifying), and then alloy spill to the foundry forms or crucible.*

KEYWORDS: electron-beam equipment, noble and non-ferrous metals.

Depending on purpose of metals and alloys necessary degree of cleanliness, economic reasons connected to reduction of losses of metal and the charge of fuel (electric power), character of initial materials and their physical-chemical properties them make by the following ways:

a) direct melting of pure metals and elements;

b) by joint restoration of components of alloy (ore-thermal melting);

c) by electrolyze of liquids or solutions;

d) by replacement of one element by another element (thermal-metallic);

e) by diffusion's way with use firm, liquid and vapor of substances;

f) by the combined way with application two-three above-stated.

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The essence of a method is, that in special melting device (furnace) to melt metal or basic component of an alloy and overheat it. After that, to liquid will add alloying elements in solid or liquid condition.

Temperature of liquid lead up to necessary level, make metallurgical processing (refining, modifying), and then alloy spill to the foundry forms or crucible.

In quality of scrap's materials for manufacture of metals and alloys by the melting's method use as pure metals, and re-scraps, secondary metals and alloys, ligatures. High efficiency and opportunity of reception of high pure alloys, impurity from metal- and non-metal inclusions (oxides, gases, slag) with the strictly certain chemical structure both necessary physical-chemical and mechanical properties - basic advantages of this method way.

Preparation of liquid carry out in melting's devices (furnaces) of various designs. The widest application now have open melting's furnaces working at atmospheric pressure and environment. Thus quality of metal liquid and its chemical composition depend on processes occurring in melting furnaces:

1) heating and melting of metals;

2) boiling and evaporation ;

3) interaction with oven gases;

4) interaction of metals with inner surface of furnace. Thus one of the named processes are necessary for reception of metals and alloys, others are extremely undesirable, as are accompanied by an intoxication of components, oxidation, pollution of liquid by not metal inclusions and gases. For translation of metal from solid state to liquid it is necessary to spend quantity of heat (energy) determined by melting point temperature, thermal-capacity and latent heat of melting.

Thus the various sources of heating and, accordingly, various melting furnace and equipment are used. Also more and more wide application find in practice use re-melting processes of special electric metallurgy, in particular vacuum. The comparative characteristic of methods of melting of metals and alloys are given in table 1.

***Table 1.*** *Comparative characteristics of different method of metal's melting*

| **Method's name:** | | **Furnace's environmental** | **Input materials:** | **Refining environmental** | **Method of ingot's obtaining** |
|---|---|---|---|---|---|
| **full** | **short** | | | | |
| open melting in burning furnace | OM | air, products of fuels burning | scrap, re-scrap, (pure metals and alloys), ligatures | slag | casting (foundry) to the form or crucible |
| open melting in electrical resistive furnace | OM | air | | slag | |
| open induction melting | OIM | air | | - | |
| open arc melting | OAM | air | | slag | |
| plasma melting in ceramic crucibles | PM | protective (Ar) | | slag | |
| vacuum-induction remelting | VIR | vacuum | | vacuum | |
| vacuum-arc remelting | VAR | vacuum | spending electrode | vacuum | solidification in crucible |
| electric-slag remelting | ESR | air | | slag | |
| electron-beam remelting | EBR | vacuum | spending electrode, scrap | vacuum | |
| plasma-arc remelting | PAR | protective (Ar) | | - | |

From analysis of the data, given in the table 1, follows, that for reception of high-quality metals and alloys of high purity (especially refractory) certain advantages and prospects there is use of the method electron-beam melting.

Also it is necessary to emphasize complete ecological safety of realization electron-beam melting, as all processes thus occur in vacuum without contact with environment.

The basic lacks of a method limiting its wide circulation, are: difficult of melting of metals with high elasticity pair; relative dearness of the equipment and its limited productivity.

Today Research-production enterprise "GEKONT" has a wide experience of development, introduction and application of technology electron-beam melting of metals and alloys, and also industrial equipment for realization of technological processes. In particular, the technologies electron-beam melting chromium and aluminum bras, alloys on nickel basis, and also platinum are developed.

The characteristics of industrial electron beam installation B 5 for melting of noble metals developed in "GEKONT" is given in table 2. The scheme and general view of this facility are showed on figure 1.

The equipment represents the vacuum technological chamber with connected to it by horizontal mechanisms of scrap's loading and withdrawal of ingot. The facility is equipped with three EB-heaters with independent control by each. It allows to carry out of melting under the circuit with use of intermediate capacity, that, in turn, allows effectively and separately to operate processes of scrap's melting, overheating and refining of liquid in vacuum, their solidification in copper vater-cooling crucible and formation of the ingot.

***Table 2.*** *Technical parameters of the EB-melting unit B 5*

| No. | Technical parameters: | |
|---|---|---|
| 1 | Total power, kW | 280 |
| 2 | Accelerating voltage, kV | 20 |
| 3 | Input voltage, 50 Hz (3 phases), V | 380 |
| 4 | Quantity and power of EB-heaters, n x kW | 3 x 100 |
| 5 | Level of vacuum, Pa | 1 x10$^{-2}$ |
| 6 | Discharge of cooling water (15°C), m$^{3}$ per hour | 8 |
| 7 | Pressure of cooling water, Pa | 3-4 x10$^{5}$ |
| 8 | Diameter of melting ingots, mm | 74 |
| 9 | Maximal length of melting ingots, mm | 500 |
| 10 | Velocity of ingots withdrawal, mm/min | 0.15-300 |
| 11 | Maximal size of re-melting billet, mm | 150x130x500 |
| 12 | Velocity of billet's feeding, mm/min | 0.15-300 |

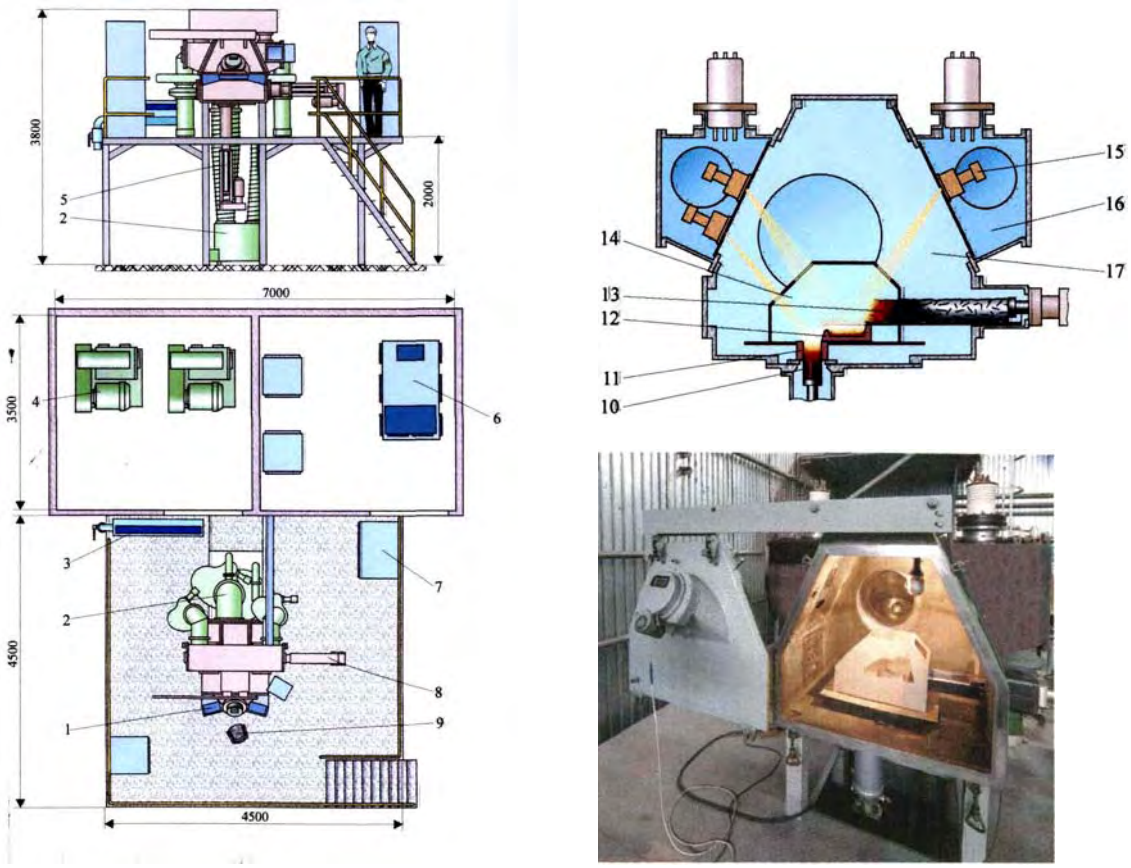


***Fig. 1.*** *The scheme and photo of EB-melting unit B 5. The EB-facility is equipped by automatic system of registration of technological parameters of melting.*

## References

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