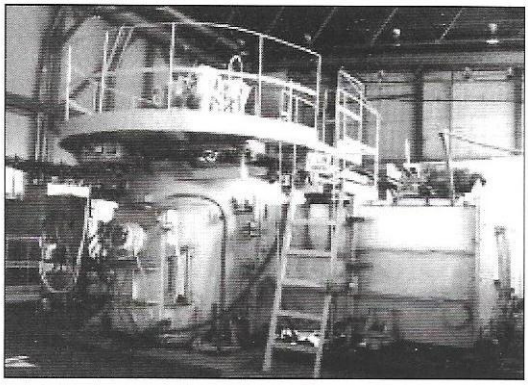
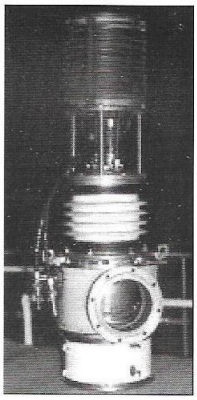
ELECTRON BEAM MELTING OF TITANIUM ALLOYS FROM UKRAINE

Fundamental research performed at a leading Institute of Ukraine, of the processes of alloy component evaporation from the melt in vacuum and ingot solidification at electron beam melting with an intermediate crucible (EBMIC) allows forecasting the composition and structure of the produced titanium alloy ingots and producing ingots of a guaranteed composition. Application of an intermediate crucible eliminates penetration of high- and low-density inclusions into the mould.

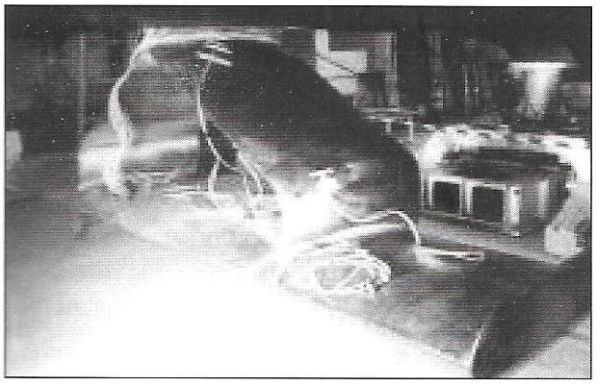
EBMIC mini-plant of 3000 tons / year capacity



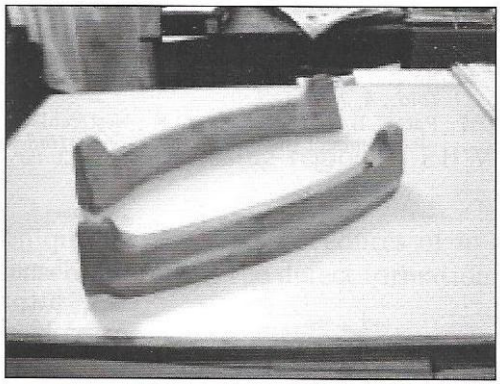
Appearance of electron beam unit



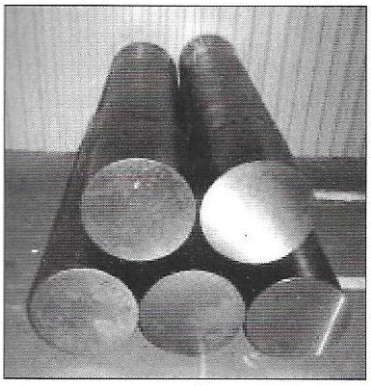
Axial gun



Underwater wing of a sea boat of titanium alloy PT-3V



Aircraft parts (VT22 alloy) made of EBMIC ingots



EBMIC ingots of VT6 titanium alloy of 400 mm diameter

The sequence of and special fixture for continuous feeding of alloying elements into the charge have been optimized. Technology of producing ingots of alloyed titanium alloys (VT6, PT-3V, VT22, etc.) in electron beam unit has been introduced, fitted with axial guns of the rated power of 300 kW with differential pumping, thus allowing the melting process to be conducted in a stable uninterrupted mode. The produced ingots fully meet the requirements of international standards both as to the content of alloying elements and impurities, and as to their distribution over the ingot cross-section.

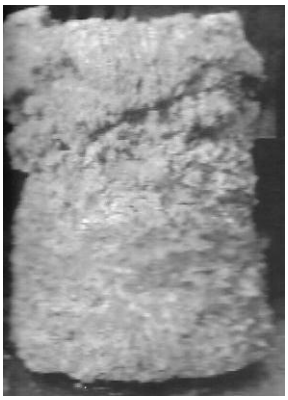
Application - The developed technology can be used for a guaranteed production of high-quality ingots of titanium alloys, not containing any low- or high-density inclusions.

ELECTRON BEAM MELTING OF TITANIUM SPONGE BLOCKS

In order to lower the cost of the initial materials, the Institute suggested performing re-melting of uncrushed titanium sponge blocks (Figure 1) in a specialized Electron Beam unit with an intermediate crucible (Figure 2). In this case, cleaning of the block surface to remove the films or contamination is performed directly in the Electron Beam unit of the pre-heating stage.

During melting, the bloom is continuously fed into the working space, where the block bulk and its preliminary degassing occur under the impact of the electron beams. The process runs in a stable and steady manner (Figure 3). Comparison of EBMIC metal yields shows that the titanium losses for evaporation are practically the same in melting of the bloom and lumpy wastes, and are by 30 to 40 % lower than in melting of crushed sponge of 12 - 70 mm fraction.

Distribution of impurity elements is uniform along the ingot length (Figure 4), and their content is in the range of standard requirements. Ultrasonic testing of the ingots and template studies showed that the metal structure is dense, uniform and without defects.



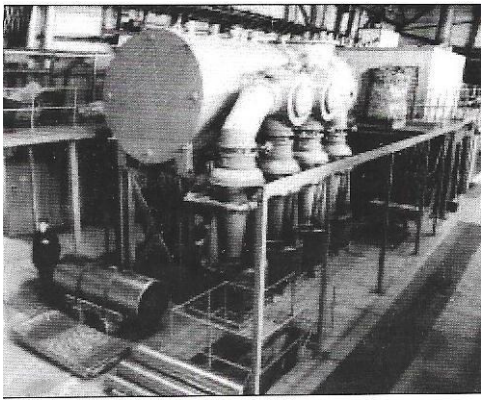


Figure 1. Titanium sponge block of 4 ton weight	Figure 2. Appearance of another electron beam unit

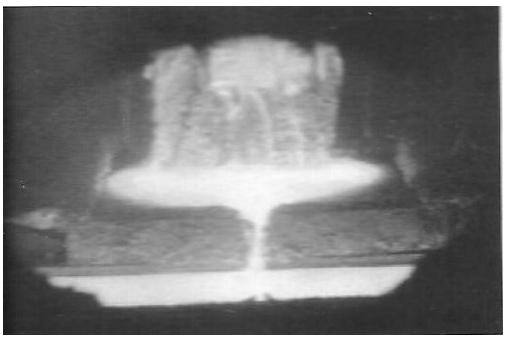
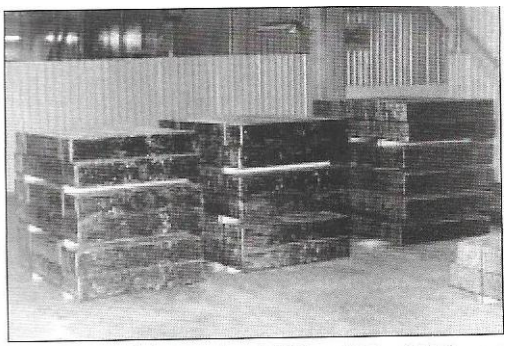

	

Figure 3. Process of melting a titanium sponge block	**Figure 4. Titanium slab ingots of 950 x 165 x 2000 mm dimensions**

Proposed technology of EBMIC of titanium sponge blocks provides 20 % improvement of the technical and economic characteristics, compared to EBMIC of sponge titanium of 12-70 mm particle size.

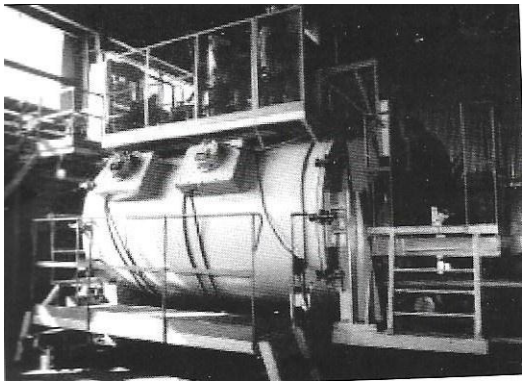
Application - The technology is applied to produce sound titanium ingots directly from uncrushed blocks of titanium sponge.

SURFACE MELTING OF INGOTS BY THE ELECTRON BEAM

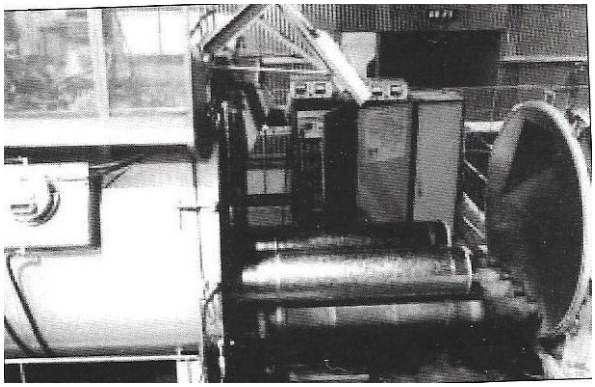
The ingots are traditionally subjected to machining at different stages of metal processing. The amount of wastes is usually equal to 5-15 % of the dressed ingot weight.

In order to reduce the metal losses, the Institute developed a technology to replace machining, namely melting of the side surface of the ingots of both the round and rectangular cross-sections by electron beams and respective equipment for its implementation. Surface melting of ingots of both the round and rectangular sections is performed through heating and melting of the ingot surface layer by the electron beams along its surface simultaneously over the entire length. The process of electron beam surface melting is characterized by a high density of the applied energy, as well as easy monitoring and control of process parameters.

Visual and ultrasonic testing of surface-melted round ingots and rectangular slabs showed that the ingot surface is smooth without any visible cracks or tears. No discontinuities were found in the surface-melted layer.

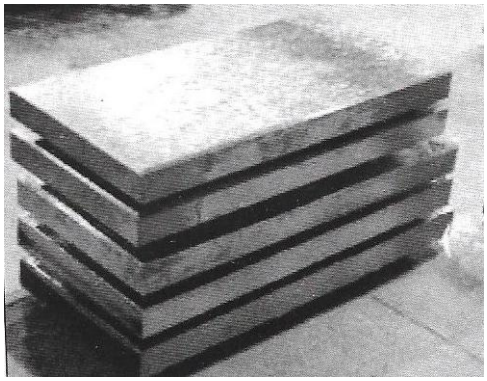


Appearance of electron beam unit for ingot surface melting



Technological fixtures for surface melting of round ingots

Titanium ingots of 110-600 mm diameter after surface melting



Titanium slabs of 165 x 950 x 2000 mm, after surface melting

The developed technology of electron beam surface melting of the ingot side surface allows eliminating surface defects without machining, thus increasing the metal yield up to 15 %, depending on the ingot weight.