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Welding in Space Conditions

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Electron Beam Welding is a method which uses a focussed stream of high energy electrons generated by a filament and directed to the joint requiring to be welded. The heating is very localised and the bulk of the assembly therefore remains cold and stable. This results in a very narrow weld with a minimal heat affected zone. There is no need to use filler metal as the parent metal of the assembly is melted. As this is a line of sight method it is not possible to weld around corners or re-entrant angles. Weld depths of up to 30mm can be produced and computer controls ensure minimal operator dependence, thus providing good reproducibility throughout a batch of components, even though this is a piece part process. Since the heat input is very localised it is possible to weld together previously heat treated components, which is a very economical method for producing composite gear shafts, with for example a case hardened gear on a hardened and tempered shaft.

The electron beam welding process (Figure 1).

The key benefits:

- Minimal Distortion - Welds finish machined parts
- Welds difficult and dissimilar materials
- Exceptional Quality and Repeatability
- High Weld Speeds
- Deep narrow welds of close to Parent Metal strength

Producing savings in:

- Cost
- Weight
- Lead time
- Size
- Inventory

EBW is a machine controlled welding process with welding carried out in a vacuum with no filler material resulting in exceptional weld quality and repeatability.

Weld spees are typically 1-2 metre/minute and result in deep, narrow welds requiring less than 5% of the heat input needed for a comparable depth TIG weld.

The remarkably low distortion resulting from Electro Beam welds means precision parts can be finished machined prior to welding, ever ground gears.

Industry who require the high quality weld that is produced by Electron Beam welding are Aerospace, Electronics, Scientific research, Nuclear and General manufacturing both industrial and commercial.

More benefits of Electro Beam Welding:

- Low heat input for the welded parts;
- Minimal distortion;
- Narrow melt zone (MZ) and narrow heat affected zone (HAZ);
- Deep weld penetration from 0.05 mm to 200 mm (0.002” to 8”) in single pass;
- High welding speed;
- Welding of all metals even with high thermal conductivity;
- Welding of metals with dissimilar melting points;
- Vacuum process yields in clean and reproducible environment;
- Natural welding process for oxygen greedy materials such as titanium, zirconium and niobium;
- Machine process guaranteed for reliability and reproducibility of the operating conditions;
- Cost-effective welding process for large production in automatic mode; and
- Parts can mostly be used in the as welded condition - no sub-machining required.

Application & Materials

- Aerospace
- Jet engine components
- Parts of structures
- Transmission parts
- Sensors
    - Power generation
    - Space
- Titanium tanks
- Sensors
    - Vacuum systems
    - Medical
    - Automotive
- Transmission parts
- Gears
- Parts of turbocharger
- Electrical/electronic industries
- Parts in copper material
- Nuclear
    - Fuel housing
    - Parts of structure
    - Valves
    - Instrumentations
- Research centres
    - Copper parts
    - Superconductivity material components
- Miscellaneous
- All metals even with high thermal conductivity
    - Steel and stainless steel
    - Aluminium and alloys
    - Copper and alloys
    - Nickel alloys and refractory metals
    - Titanium and alloys
    - Zr, Mo, Ta, Hf, W, Nb, etc
- Welding of metals with dissimilar melting points
    - Copper to steel
    - Copper to nickel alloys
    - Steel to nickel alloys
    - Tantalum to tungsten

References:
1. EBW is used widely in the Aerospace Industry. [Электронный ресурс] – URL: http://www.westermans.com/electronbeamwelding.aspx.
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Spacecraft Mars Odyssey

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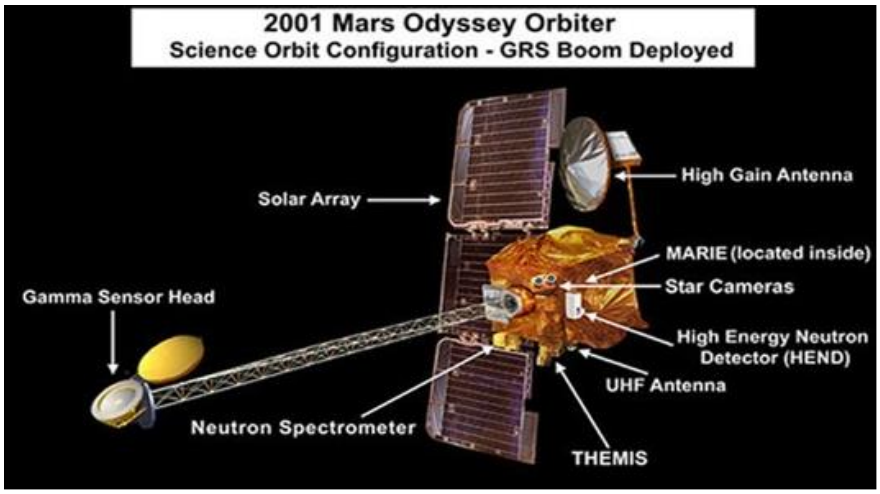
Studying Mars is one of the priority areas in the study of the planets of the solar system. The first attempts to launch spacecraft to Mars were taken by S.P. Korolev in 1960 - unfortunately failed. It took more than 10 years of hard work and 11 starts to finally, December 2, 1971 the Soviet spacecraft "Mars-3" reached the goal and made the first soft landing on the Red planet in the vicinity of the crater Ptolemy. February 12, 1974 the Soviet interplanetary spacecraft "Mars 5" was released on the Mars orbit and shoot the surface. The Earth got relief maps, which well distinguished dry streambed. That allowed the scientists to suggest that Mars, which currently has a cold and dry surface, in the past was warm and humid [1].

The project was developed by NASA. Its mission is to use spectrometers and imagers to detect evidence of past or present water and ice, as well as to study the geology and the radiation situation on the planet. NASA hoped that Odyssey will help to answer the question of whether there was ever life on Mars and create an assessment of radiation risk for future astronauts on Mars. It also acts as a repeater for communication between the rover Mars Science Laboratory, and the Phoenix lander on Earth. The mission was named in honor of Arthur C. Clarke, causing the name of 2001: A Space Odyssey.

The device launched on April 7, the first day of the 21-day launch window. Mars Odyssey was launched into interplanetary trajectory Delta II launch vehicle from the site A, Launch Complex 17. The unit arrived to Mars 20 October 2001 and entered the initial elliptical orbit. It eventually will go to working solar-synchronous polar orbit at an altitude of 400 km [2].



Picture 1 - Device Mars Odyssey

The launch weight of the spacecraft Mars Odyssey - 725.0 kg, dry weight - 331.8 kg, 44.5 kg of which falls on the scientific equipment. In the starting position the device has dimensions