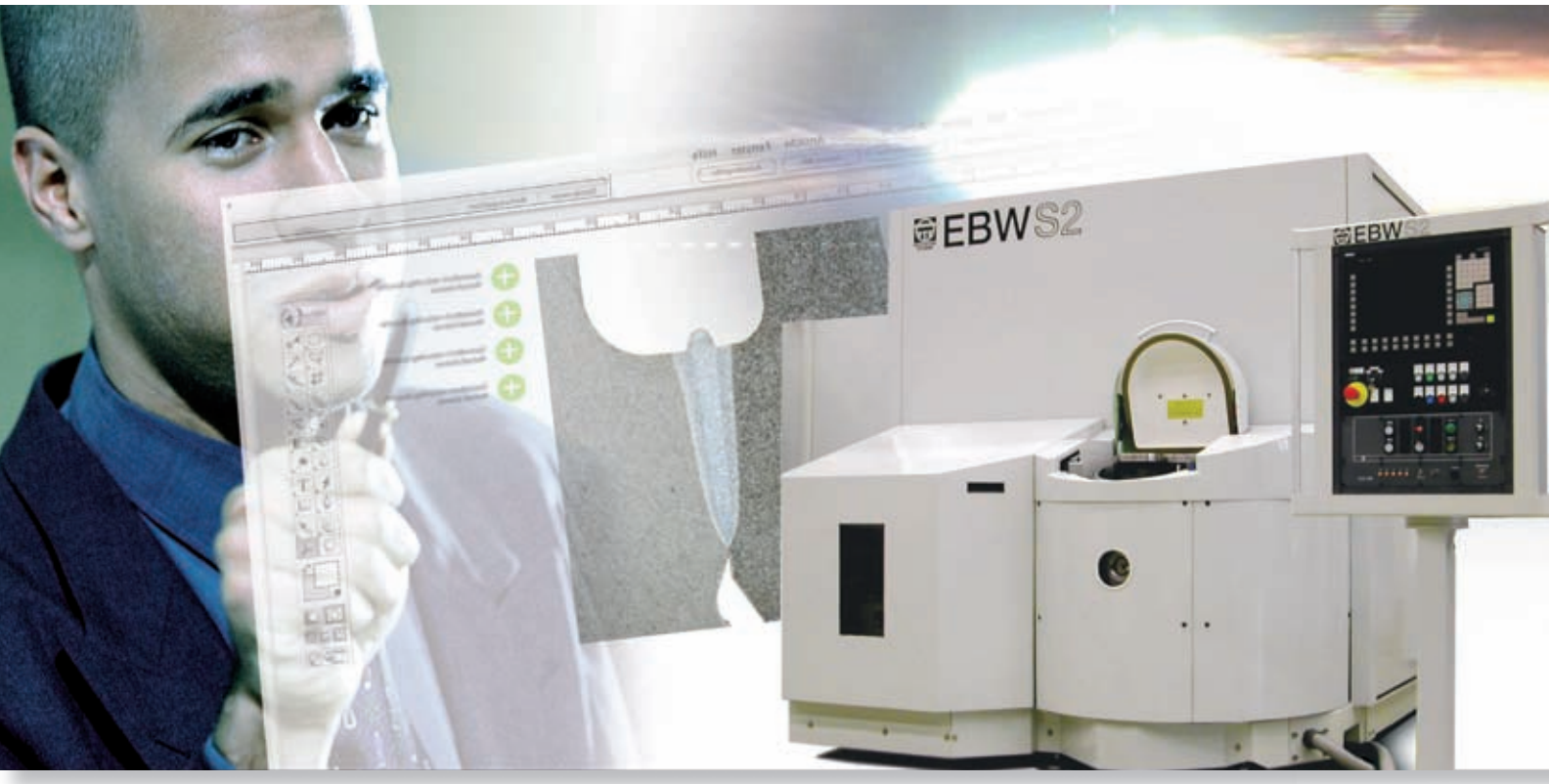
THE ADVANTAGES OF THE ELECTRON BEAM IN THE AUTOMOBILE INDUSTRY

PTR
PRÄZISIONSTECHNIK GMBH



An AWT group company

ALL WELDING
TECHNOLOGIES GROUP

THE INVENTOR OF ELECTRON BEAM TECHNOLOGY

Dr. Karl-Heinz Steigerwald developed the first electron beam processing machine in 1952. Since then, the Electron Beam technologies have been continuously developed by Steigerwald Strahltechnik GmbH and PTR Präzisionstechnik GmbH. The modern high performance EB machines from PTR and SST now represent the best in terms of productivity, precision and investment. The EB process is continually expanding into new fields of application across all sectors; is not only an alternative to lasers but is in many instances is more suitable and may prove more economical.

All operational processes and procedures are continually certified in order to maintain the highest level of quality and functionality.

This, above all others, means:

- **Effective management systems and targeted operational processes tailored to the customers requirements**
- **Continuous optimisation of processes**
- **Regular, independent checks by recognised technical experts**
- **Proof of guarantee for the highest standards of quality**

Checking, testing, verification and certification – the SGS group is a global leading company in this area.

A powerful group – we weld together!

ALL WELDING TECHNOLOGIES GROUP

As a globally active medium sized company, PTR have for decades been one of the leading developers of electron beam machines for welding and drilling. As an integral part of All Welding Technologies we supply world renowned customers across diverse sectors from automotive to aerospace.

The electron beam specialists from the PTR group, together with its sister company Steigerwald Strahltechnik, represent the leading force in delivering high value, safe and highly durable welded connections.

Companies from all over the world profit from the know-how, reliable technology and experience collected over decades by our electron beam specialists. Over 1200 delivered systems for welding and drilling speak for themselves.

PTR PRÄZISIONSTECHNIK GMBH

PTR PRECISION TECHNOLOGIES, INC.

SST STEIGERWALD STRAHLTECHNIK GMBH

We take care of your connections – globally.

The strong EB specialists

Innovations are developed jointly inside the AWT group – although each company has its own product and services portfolio targeted towards certain sectors and special technical applications and features.

PTR Präzisionstechnik GmbH, Maintal:

- Mass production (welding, hardening) with customer-specific indexing machines
- Fully automated production cells and transfer lines
- Non-vacuum electron beam applications
- EB job shops; customer contract production from individual component right through to mass production

Steigerwald Strahltechnik GmbH, Maisach:

- Individual production machines (welding, drilling) with specific or universal designs

PTR Precision Technologies Inc., Enfield USA:

- Indexing machines and universal machines; for American companies all over the world
- Non-vacuum electron beam applications

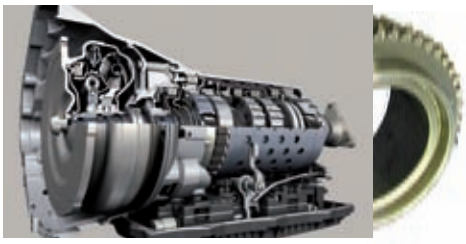
The PTR sales and distribution network: with numerous agencies all over the world

THE ADVANTAGES OF THE EB PROCESS

EB welding requires the lowest energy input for creating a specific seam, compared to all the other fusion welding processes. Because of this fact the welding distortion is a minimum and therefore for most part finished production parts can welded – a huge advantage for industrial production processes.

High power density

The extremely high power density of the electron beam allows the so-called deep weld effect, so that materials with large cross-sections can be bonded together in a single pass – usually without additional fillers. Micro-welds can also be made with the electron beam without any problems.



Economical and space saving

High efficiency, high working speed and the non-contact working procedure justify the excellent economic benefits of beam technology.

- **Extended selection of materials**
- **Avoiding corrective or rework processes (minimum distortion)**
- **Inclusion into production lines**
- **Eliminating need for filler welding material and inert gas**
- **New ways of design and production planning bring improvements to the existing parts whilst at the same time realising completely new products**

The right seam for each component

Electron beam welding is used to fuse metallic materials within normally accepted welding depths. The very narrow weld seam with its small heat affected zones drastically minimises the input of energy and distortion within the whole component. This process can be used to bond individual or component groups that are sensitive to distortion, the parts are usually welded without any filler material.

The EB technology can join all weldable materials and a large number of their combinations. This means that the designer can use a technically and/or economically optimum material anywhere on a component. The process offers optimum protection for highly reactive materials.

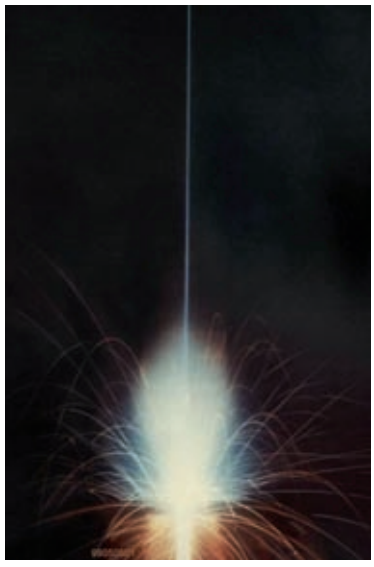
The fully automated sequence of EB welding according to tried and tested programs guarantees reproducibility independent of the operator – day after day. Other tasks use other programs.

An unbelievably flexible technology

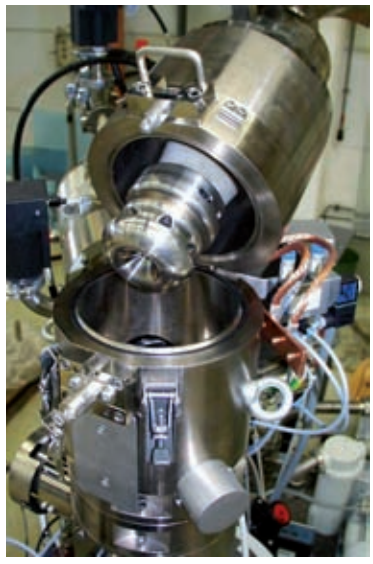
The electron beam is generated within the high vacuum of the generator, it is accelerated by a high voltage potential (60 to 175 kV) and shaped using magnetic fields so that the miniscule particles (electronic mass 9.1 x 10^{-28} g) impact on the part to be welded at up to two thirds the speed of light. Convergent energies of up to 30 kW or even 60 kW transform into heat – focussed with power densities above ten megawatts per square centimetre (10^7 W/cm^2).

The welding procedure can be observed on the TV monitor of the EB machine.

All beam parameters are controlled electrically, so that the optimum selection can be made for each job, e.g. welding, hardening and drilling etc. The automated movement control deals with all types of contours; whether radial or axial rotational or, linear or curved seams.



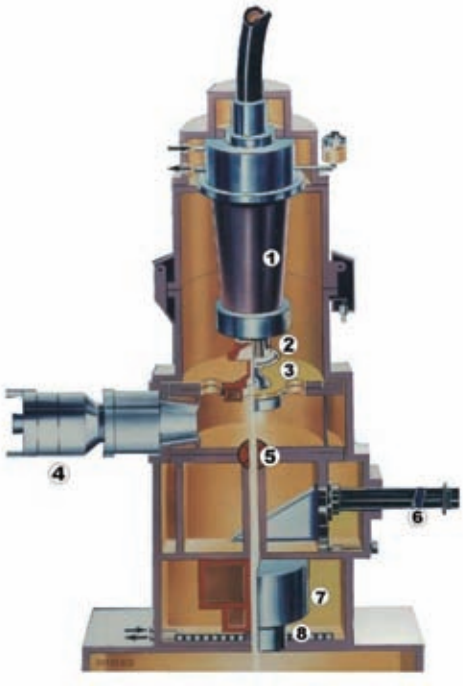
Focussed electron beam in vacuum



Open generator for cathode exchange

The Electron generator

1. **Water-cooled high voltage insulator with optimised vapour protection**
   Operationally safe, even at 100% duty cycle when aluminium and magnesium alloys are being welded
2. **Computer optimised design of modular beam-generator® (triode)**
   A high degree of operational safety due to the minimum electrical field
   Tungsten ribbon cathode emitter
   High emission density with increased working life of the cathode. Simple cathode exchange
   Wehnelt cylinder (equivalent to a negative control grid)
   Power-free, highly dynamic control of the beam energy
   Acceleration potential anode
   Optimised beam-generator geometry®
3. **Focus stabilisation®**
   Constant beam focus in high vacuum are of 10^{-3} to 10^{-5} mbar
4. **Turbo-molecular pumping station**
   Hydrocarbon-free vacuum for extended working cathode life
5. **Column valve**
   Vacuum isolation of the beam generator when the working chamber is vented
6. **Visual observation system (also with TV colour camera)**
   Observation coaxially to the EB beam, before, during and after processing
7. **Electromagnetic focussing lens**
   Ultra precise focussing of the electron beam, also at various working distances
8. **Electromagnetic deflection system**
   Universal beam deflection both static and dynamically with frequencies up to 100 kHz

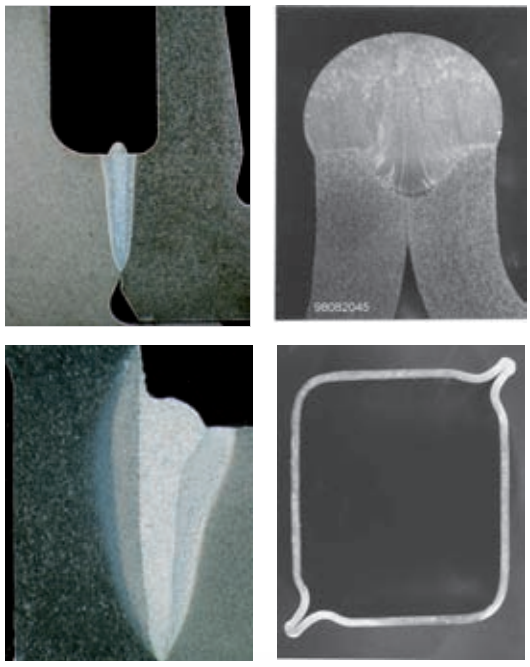


The electron beam generator is the heart of each EB machine.

The multi-talented electro beam in vacuum ...

The required selected weld-seam profile can be influenced modulating the molten pool with small, low-frequency beam deflections, this also serves to reduces unwanted irregularities. The electron beam can possess this multi-talent because of the innovative technology of ”ultra-fast beam deflection“ and can perform several functions at the same time, for example:

- **preheating, deep welding and cosmetic smoothing on the top bead in one single pass**
- **welding or hardening at several different points simultaneously**
- **automatic joint detection for parts with variable tolerances**
- **and many other applications**

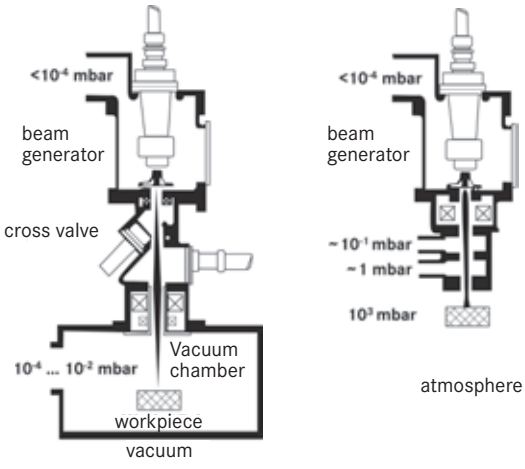


Typical EB welded seams: in a vacuum and in atmosphere

... and in free atmosphere

Deep welding effects of up to 20 mm are possible without an evacuation chamber where

- **tolerances can be easily taken care of,**
- **high welding speeds are possible,**
- **minimum heat input and component distortion**
- **usually no protection gas is necessary.**



Electron beam and laser beam

The laser has far less of a power spectrum compared to modern EB technology, even when the laser beam and the electron beam are considered for similar application.

The laser in comparison is limited because of its different, physical beam structure. It requires the light to be formed and guided by physical lenses, mirrors, prisms and other elements – all these elements suffer from performance influences such as mass inertia, heat sensitivity and absorption loss and also the energy absorption coupling that takes place at the workpiece itself, which is very different from the electron beam.

EFFECTIVE SERIES PRODUCTION
AUTOMATED PRODUCTION LINES

The EB technology is extremely well orientated for mass production parts and is used in the widest range of industrial sectors. Constant quality, good reproducibility and high productivity with full automation of the plant produce the economy benefit which is significant in terms of competitive advantage. Global based production companies working together with PTR are increasingly able to utilise our technology to realise new opportunities at the same time lowering costs and increasing turnover.

Demagnetising

Washing

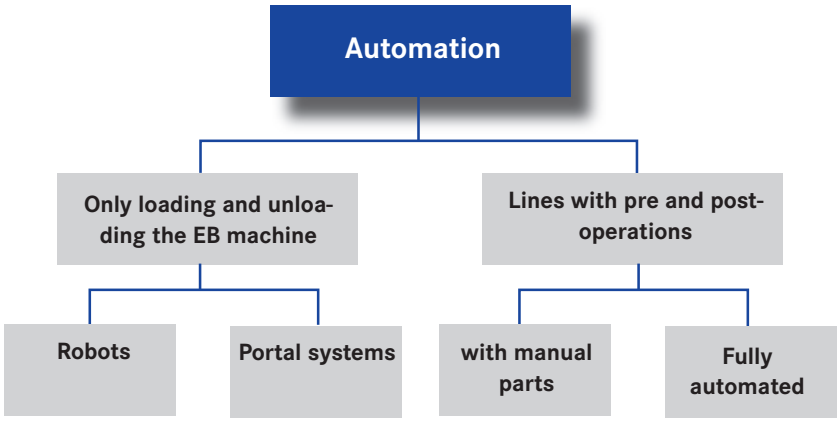
Heating

Assembly

Holding buffer

Welding

Mechanical processing



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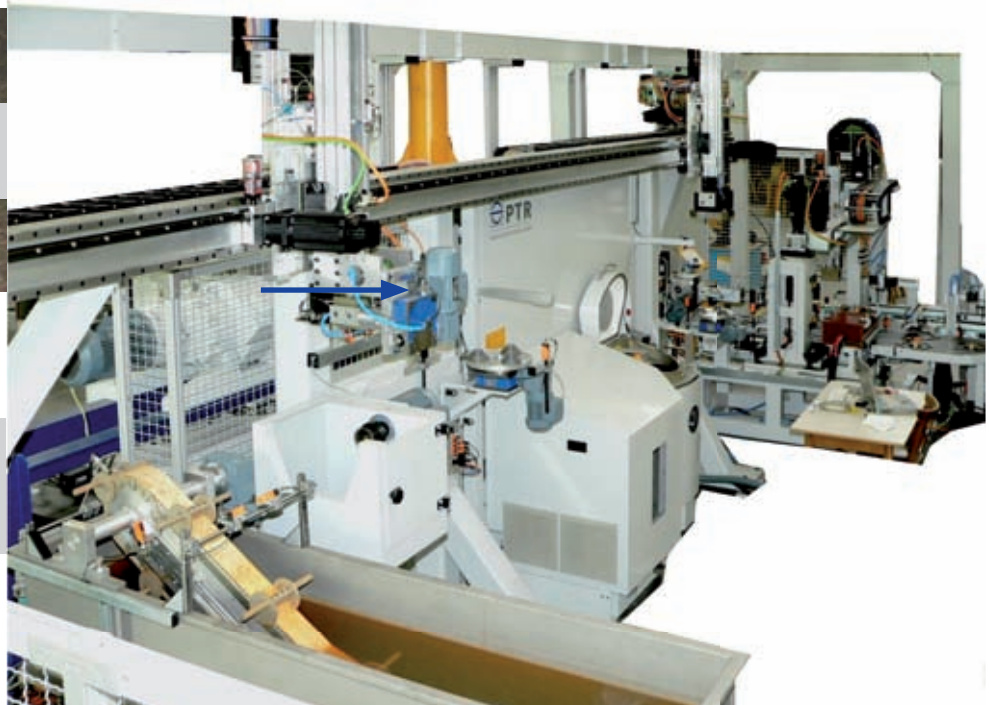

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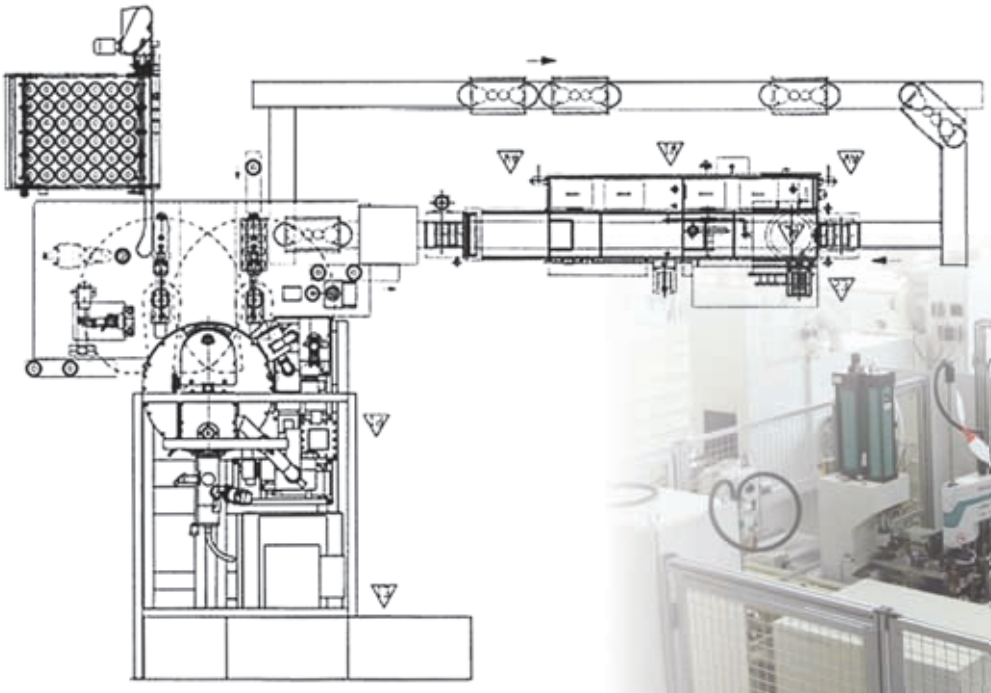
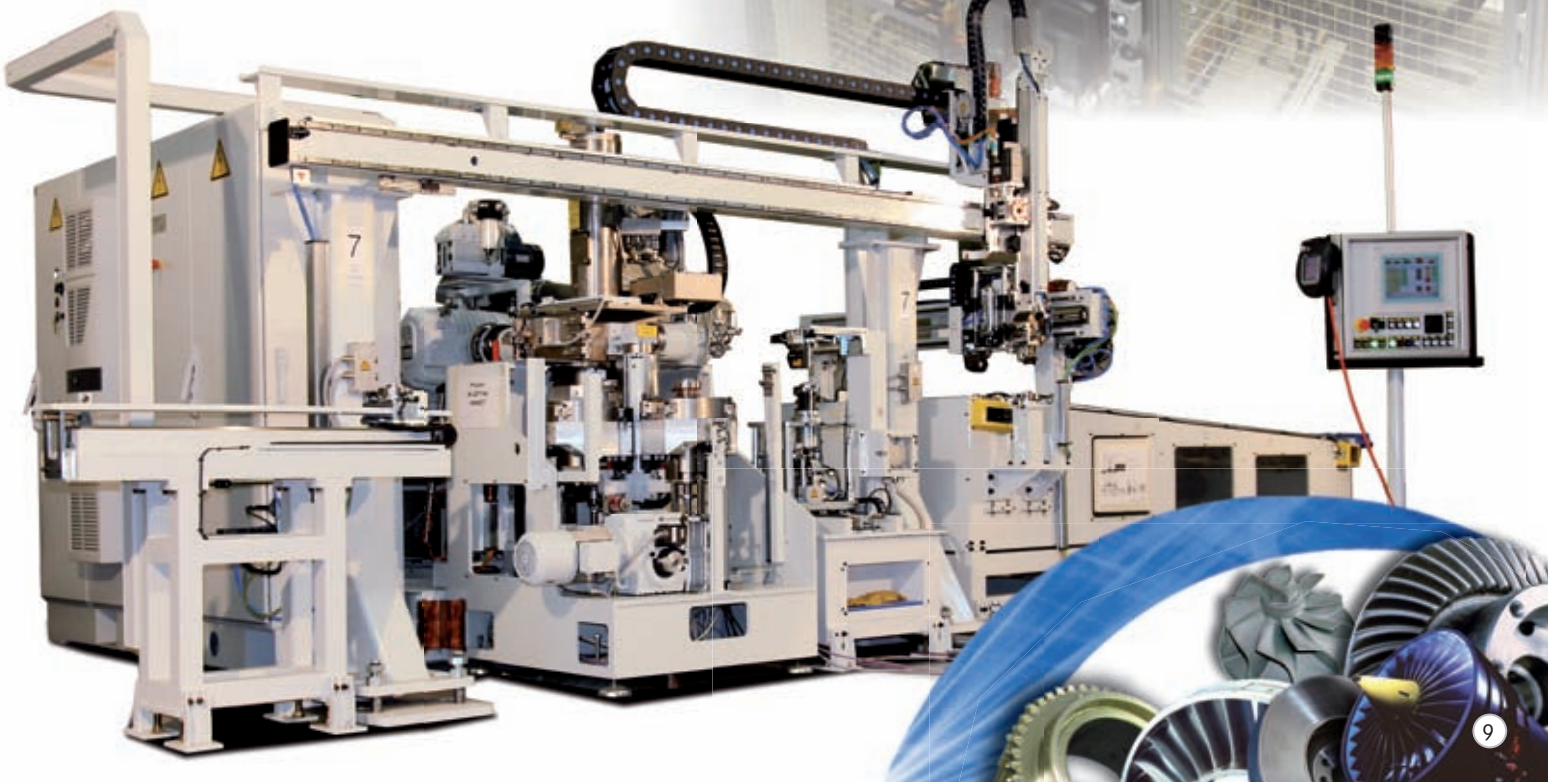
A system which adapts itself: effectively designing processes

We work together with our customers to determine the exact details required for workpiece production and process sequences. The plant is designed so that the complete product spectrum (e.g. a family of similar production parts) can be accommodated without major re-tooling costs. An EB machine can be equipped with several beam generators, depending on production requirements, and can work simultaneously on the same workpiece.



Outline of a completely automated production line for EB welding of automotive gear components.

The widest ranging automation processes are realised in the customer's production line, depending on the specific requirements.



GEAR PRODUCTION IN THE AUTOMOBILE INDUSTRY

"Electron beam welding is used on complex parts of the wheel assembly in gear production at the VW factory in Kassel. PTR Präzisionstechnik GmbH has been one of our partners for many years with currently 8 production cells in operation up to now.

It has to be highlighted that the production cells in use for manual gear shifts or for automatic gears are not only adapted for various types of gear wheels but are also fully automated as complex production lines which include other processing steps both up stream and post processing.

PTR has not only delivered EB machines to Kassel for gear production but also to other factories in our group – such as in the Czech Republic, Spain, Argentina, China etc."

Klaus Meyer, Manager gear production, VW Kassel

The electron beam rapidly welds extremely precise processed individual parts into complete assembled components.

PTR machines are used wherever the welding of large numbers of complex components is necessary with exact requirements for precision and durability.

PTR machines prove their ability and quality; hour by hour and day by day in gear production at leading automotive manufacturers. PTR also delivers turn-key packages for fully automated and linked production cells or lines with processing stations which are either upstream or post operation after the EB welding station.

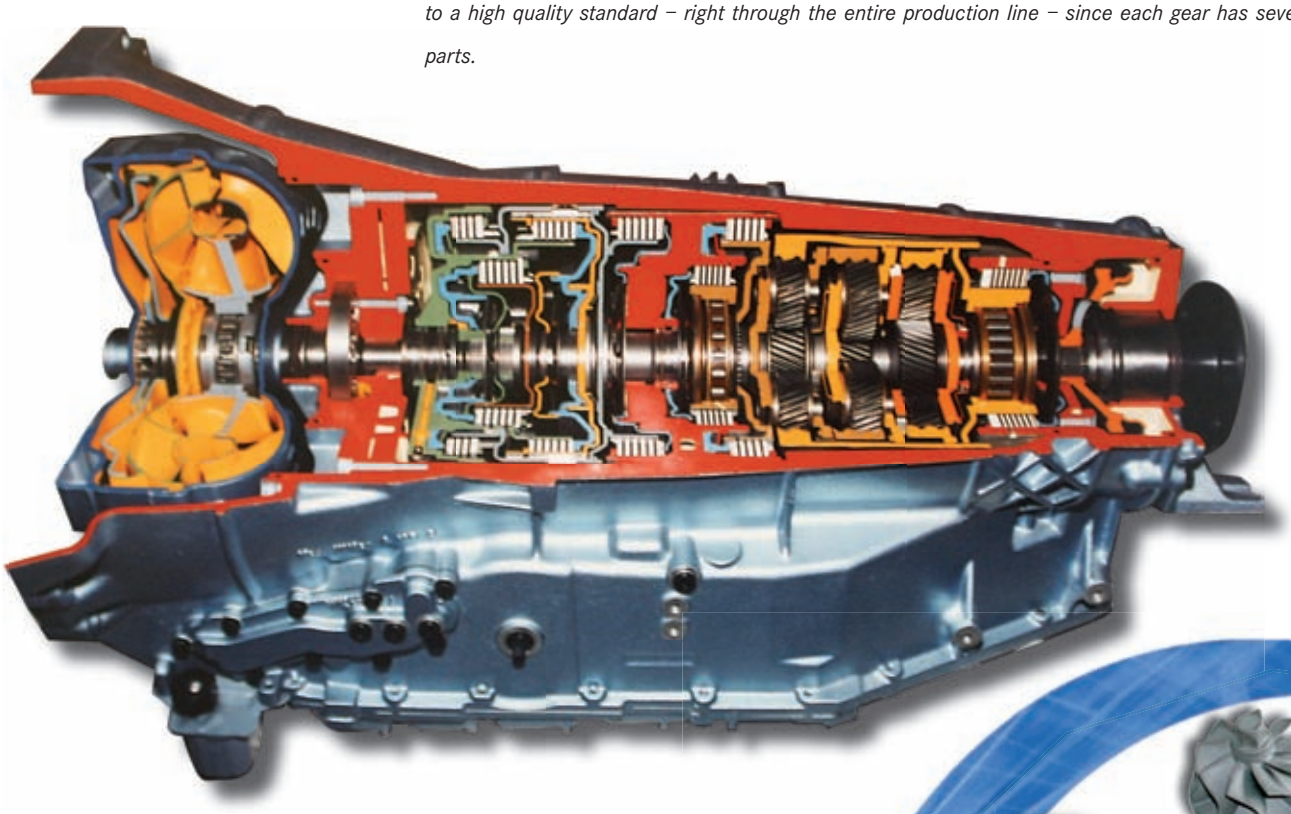
Reduced costs with higher quality!

”We, ZF-Getriebe GmbH, Saarbrücken, have incorporated several electron beam welding machines from PTR Präzisionstechnik GmbH into our production process. We have been using these EB machines in our large scale production for over 15 years to weld several very complex gear components whilst using all the technical advantages of the EB welding process.
The standards and indexing times we require are within our specification. The EB welding machines are integrated into the fully automatic process according to component specifications, or work as flexible individual machines.
The PTR machines work with an extremely stable beam quality, longer cathode life-times and always work with the latest state of technology because they are continuously developed and optimised. The support from PTR service is reliable and fast.“

Reinhold Drieß, head of process planning gears/planetary carriers Pre-production development / machine planning, **ZF-Getriebe GmbH, Saarbrücken**

There is trust in our EB technology

The completely automatic EB machines are equipped with the necessary flexibility to work economically and to a high quality standard – right through the entire production line – since each gear has several welded parts.



PRECISION FOR MAXIMUM RPM

Increase in performance and reduction in exhaust emissions are the driving forces for the increasing use of turbochargers in automobiles. A main element of these complex automotive components is the turbocharger impeller which is permanently subjected to the extreme temperatures from the exhaust gas. Its shaft transfers high rotational speeds of more than 200.000 RPM to the compressor in a stable manner, with low wear. The PTR machines weld the impeller and shaft; a demanding fusion of mixed bonded materials with great precision, in the shortest possible time and in large numbers.

A bond which has to hold – turbochargers are exposed to extreme conditions

Borg Warner Turbo Emissions Systems produces high performance turbochargers for the international automobile industry. The integrated turbochargers are welded with PTR EB technology.

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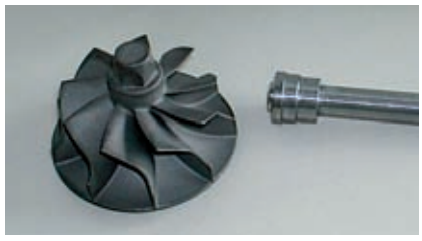
Secure function because of quality!

There are several ways of using electron beam welding to produce impellers for turbo-chargers:

- **variations of the materials used**
- **variations of the butt joint configuration**
- **variations in automation**

PTR develops the technologies, co-ordinates optimisation with the customer, welds sample parts for testing, designs and manufactures the production machines and finally provides customer service for many years to come. Our Job-Shop can also support the production process to the same quality – since it uses the same type of machines.

BorgWarner Turbo & Emissions Systems



MADE IN GERMANY – MADE FOR ASIA

Especially the rapidly growing markets in Asia require secure technologies in order to satisfy there steadily growing requirements. Products produced here whose sales markets also outside Asia, of course are subjected to steadily increasing quality standards. Automobile manufacturers, their suppliers and a wide range of other have been enjoying the advantages of PTR beam technology for years. PTR EB machines are in daily use in practically all the highly developed countries of Asia – the increasing number of machines delivered there confirm our commitment to this part of the world.

PTR machines are developed and produced in Germany. Technical components and materials of the highest quality are used. All the machines and production lines are installed on site and made ready for production by PTR engineers. Our agencies in Asia also take care of constant and direct contact with the customers also after commissioning.

Tried and trusted many times in practice

Renown manufacturers in the Asiatic area have confidence in secure PTR EB technology "Made in Germany"

HYUNDAI

KIA MOTORS

FAW

CHERY

WIA

慶昌産業株式會社
KYUNG CHANG INDUSTRIAL CORP.

THE AWT INNOVATION CENTER

The AWT group has many years of experience in the industrial application of the electron beam for welding, hardening or drilling. This globally unique know-how is always continuously combined with new developments in machine design, in production automation, in the elements for creating, shaping and influencing the beam and also in quality assurance.

Machine construction, service and Job Shop in house are also the best conditions for allowing knowledge from all relevant areas to be combined and taken into consideration.

The extremely modern features based on our fast beam deflection ”EBO-Jump“ are an important component here.

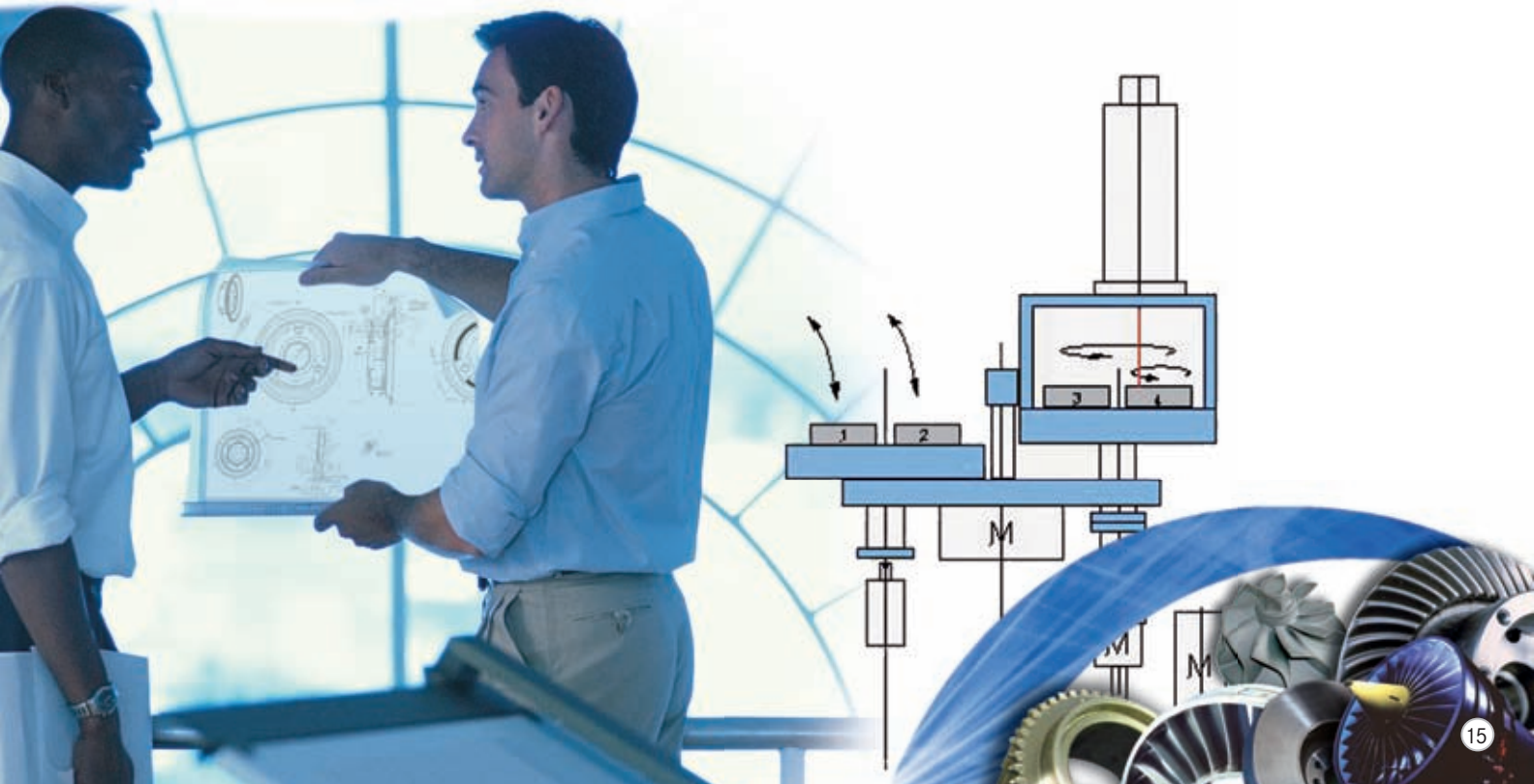
Solutions for your tasks

We take on completely your technical welding tasks, advise you on the best EB weld fusion zone, the suitability of weldable materials, the optimisation of welding and testing technologies, carry out trial and qualification welds with you on our own PTR machines.

The experience gathered in this way enables us to visualise the EB production task and to define requirements for the machines which are tailor made for you.

There is, of course, the option that one of the AWT companies undertakes your production whilst your own machine is still being manufactured.

We work out secure solutions also for complicated material combinations.



JOB-SHOP: WITH CONTRACT PRODUCTION FROM PROTOTYPE TO THE PRODUCTION SERIES

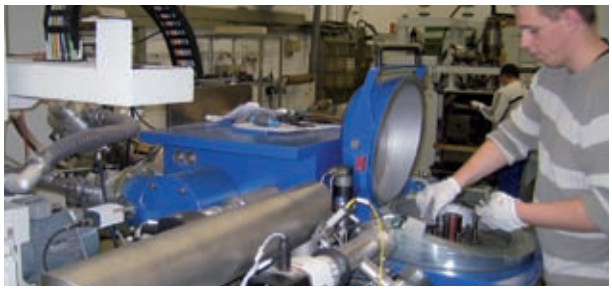
We use contract production to assist and advise you from prototype production through the planning stage of the machine right up to the acquisition of your own production plant. Our high quality machines and competent operating teams safeguard the delivery of your products with top class quality and on schedule.

We undertake for you:

- **PROTOTYPES**
- **SMALL PRODUCTION RUNS**
- **PRODUCTION SERIES**

Advantages for you:

- **PRODUCTION ON THE MOST MODERN EB MACHINES**
- **SHORT RESPONSE TIMES**
- **“JUST IN TIME” PICK UP AND DELIVERY**
- **MAXIMUM QUALITY**



We can achieve short delivery times with the highest quality whether it is a individual sample piece or a batch size of 5000.

e.g. for the automobile manufacturer and sub-supplier

e.g. for the commercial vehicle manufacturer

GLOBAL SALES AND DISTRIBUTION – GLOBAL CUSTOMERS

At the beginning an intensive consultation takes place – experienced engineers compare the requirements which are necessary together with the various technical solution options and work in dialog with the customers to develop basic ideas which are then converted into a concept in PTR's production and construction departments.
We take sufficient time for the co-ordination process where an individualised offer is assembled. Sustained contact with the customer is always a top priority.
The PTR sales and distribution engineers are globally active. The PTR agencies also work in a supporting capacity in many countries.

Your partner – from planning through to after-sales service

PTR customer service continues extends beyond delivery and commissioning. Comprehensive training programs are provided for the customer's staff and there is also a first-class after sales service which often extends over decades.
Our after sales service consists of:

- Continuous supply of consumables and spare parts
- We send engineers for trouble shooting, servicing and over haul, when excess wear is discovered, further technical developments and updates when new products are available
- Personal contact partner
- Comprehensive consultations when discussing change requirements
- Continuous training options
- Support in product developments

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Sale · consultation · service

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