

# Laser-welding Systems for Mass Production

**Laser systems for welding, cutting, laser-hardening and powder build-up welding are the core business of the Maschinenfabrik Arnold in Ravensburg. For more than twenty years, laser-welding systems – partially with integrated additional processes, such as pressing and pre-heating – are being used for the manufacture of gear wheels.**

Owing to mass production and new laser sources, the requirements towards such production systems have considerably changed in the past years.

As in former days of transmission manufacture, each gear wheel was manufactured on a different system, the machines rarely needed to be changed-over, and if, then usually only for redundancy operation. However, the complete system was then down during change-over periods and for servicing. Contrary to this, the amount of components subject to processing

needed to be very simple and ergonomically optimal.

Besides this, manufacturers increasingly utilize a single system for the manufacture of a complete transmission, so that the system is subject to a change-over after every fifty to one hundred parts.

Aside from the mechanical change-over, this also means a change of the NC control programs. Ideally, complete system change-overs occur automatically, without operator interaction.

The most commonly used energy source to date are CO<sub>2</sub> lasers, which, due

used as a protective device for other processes, such as handling systems.

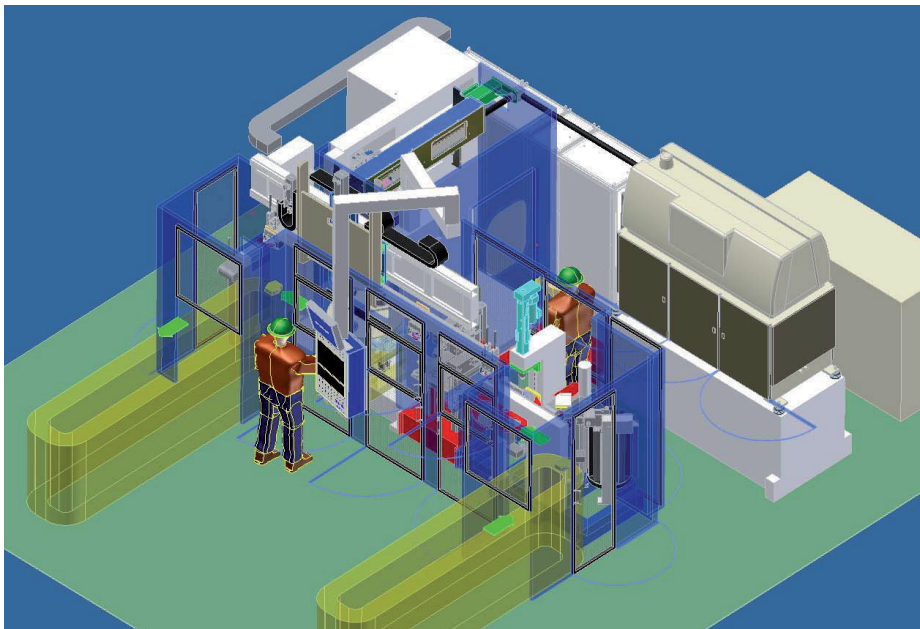
Today, however, the trend is increasingly heading toward the application of fiber and disk lasers for material processing, which requires systems to be accordingly compatible. As these lasers have short wavelengths, more complex protection devices are required, for which a simple Lexan window is no longer sufficient. A more flexible concept is necessary to meet these requirements. "This is a major challenge. In the future, we seek to stand out against our competitors in this area", according to Hansjörg Klotz, Sales Engineer at Arnold.

The answer is a modular designed system, in which the individual work stations can be completely separated from each other. This has the advantage that the individual stations can be operated independently, whereby each station has their own protective devices that can be adapted to the manufacturing process. In addition, the new system concept allows the employment of different laser types, particularly of fiber-bound lasers.

While the optical and mechanical path must be made congruent with CO<sub>2</sub> lasers, this requirement is no longer necessary with fiber-bound lasers. "Therefore, we have changed our strategy. We no longer view the laser as a fixed part of the system. Instead, our concept now focuses on being able to apply any respective laser required for the manufacturing process", states Klotz.

Due to the modular design, the individual systems are less complex. Besides, the loading and processing area are strictly separated from each other, so that full-automatic loading of the system is easily possible.

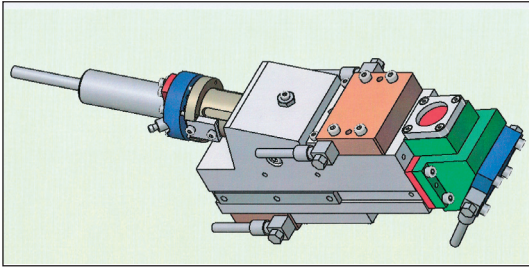
"Currently, we are building a system for a customer that is capable of wel-



▲ Automated system in modular design for manufacturing gear wheels

is nowadays high. For this reason, machine-loading must occur automatically, and the possibility of manual loading shall be possible only in exceptional cases. Nonetheless, the manual loading feature must be desig-

to their high wavelength within the infrared range, have protection devices that are easy to handle. A simple Lexan window (polycarbonate sheet) was sufficient for protection against reflection radiation. Usually, it was additionally



▲ Principle of reflection optics

ding, pressing and pre-heating, whereby the modular concept is being implemented. The practical modular design allows for component change-overs at any location of the system, parallel to the manufacturing process. This reduces the non-productive periods to a minimum", says Hansjörg Klotz, while describing the advantages of the new system.

A further advantage of the modular design is that the modules always have the same interface to the connecting module. This allows for various system configurations, with the added bonus of limiting the radiation-protection area to the laser-processing area.

Such a system allows for processing of transmission parts with diameters of up to 250 mm, as required for truck or bus transmissions. "The system can handle pretty much any possible gear-wheel application", so the Sales Manager of the Arnold Corp. This includes a new transmission type, the double-clutch transmission, which is also being produced on this system.

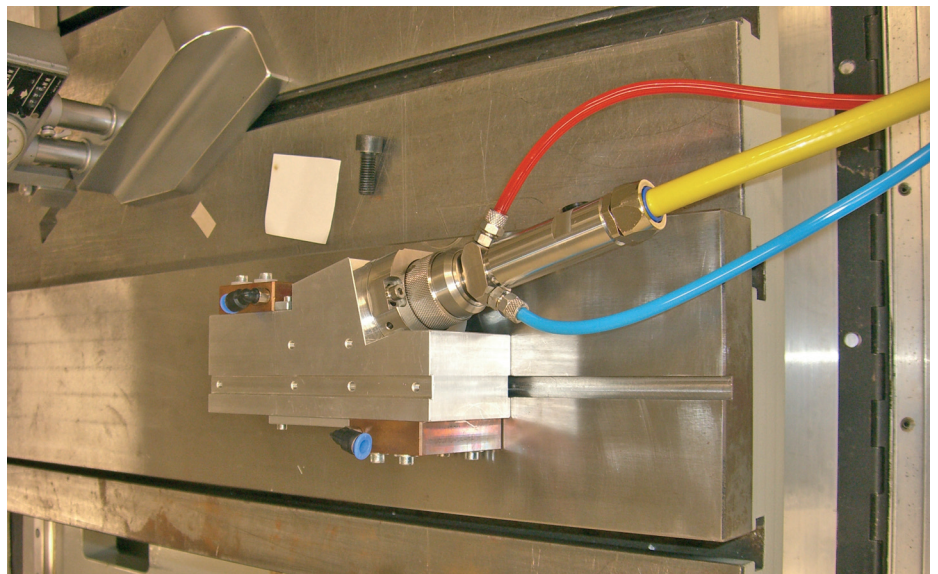
## New Reflection Optics for Focusing of Fiber Lasers

Systems with CO<sub>2</sub> laser require only few optical elements, as the focusing optics are moved via focusing carriage in a system of coordinates. In order to both optimize the use of high-performance fiber lasers for the systems as well as to realize the high beam quality of the fiber laser at the point of processing, Rüdiger Gnann, former Managing Director of the Maschinenfabrik Arnold, and his team have developed new reflection optics for focusing of the laser beam. "Because the future

will favor fiber lasers", as Rüdiger Gnann is convinced. Yet, an optimal manufacturing process requires a stable focus position. For this reason, it is important that such a focusing system is stable in terms of thermal growth. Practically all transmissive optical focusing systems, however, have a focus shift. It depends on the lens material, the material quality and the type of coating.

Gnann further states: "With the same collimation and focal length, the focus of eight examined lens optics on a

ple, can be influenced when laser-welding. "With this, welding seams can be achieved that are wide and have a rounded seam root, or such with a deep-reaching effect and an almost plane surface. Even astigmatic aberrations can be corrected by adjusting this reflector", so the former Managing Director of the Arnold Corp. Apart from this, the reflection optics can be cooled much better than transmission optics, as the reflectors consist of highly thermal-conductive OFHC copper. The complete optics were designed, developed and built by the Arnold Corp. "Merely the reflectors are



▲ Reflection optics for focusing, mounted on master gauge

single-mode-laser with a 14 µm fiber diameter at 500 W output power shifts by 1.5 to 3 mm, and by 3.5 to approx. 6.5 mm at 1.000 W, when compared to the focus position at 100 W".

These influences can be reduced with help of the new reflection optics. They are integrated into the fiber plug. Here, they concentrate the divergent laser beam emerging out of the decoupling crystal and focus it exactly onto the processing area.

The optical system consists of a hyperbolic and an elliptical mirror. By means of a third hyperbolic deflection mirror, the form, intensity distribution and size of the focus can be adjusted and adapted to the manufacturing process. In this manner, the keyhole, as an exam-

ple, can be influenced when laser-welding. The form and geometry of the reflectors are manufactured according to our specification", so Rüdiger Gnann, and points out that this reflector system is not only capable of focusing basic lasers, but also all fiber and disk lasers.

Author:  
Dr. Barbara Wantzen  
Editor of LASER MAGAZIN  
[www.laser-magazin.de](http://www.laser-magazin.de)

Contact:  
Maschinenfabrik Arnold GmbH & Co. KG  
Gottlieb-Daimler-Strasse 29  
88214 Ravensburg, Germany  
Phone.: 0751 36 169-0  
Fax: 0751 36 169-40  
E-mail: [info@arnold-rv.de](mailto:info@arnold-rv.de)  
[www.arnold-rv.de](http://www.arnold-rv.de)