# LASER WELDER FOR HEAVY GAUGE STRIP FOR THE STEEL INDUSTRY[1]

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**Abstract**
For many years, the flash butt technology for welding high gauge strip on pickling line and tandem mill has been the only option to steel suppliers. The laser technology gives an alternative with a high weldability on high strength and sensitive steel, lower operation and maintenance cost with a cleaner process. In 2000, SIEMENS VAI Clecim launched an extensive Research and Development program to develop new laser welders. This development was first lead on light gauge (LW21L) for galvanizing line, inspection line. The development of the laser welder for heavy gauge (LW21H) was started in 2004 for thickness ranges from 0.5 to 7 mm and for product mechanical characteristics until 1500 MPa. The development has been led in a systematic approach, starting from customers needs, to initial process qualifications and will be finalise with extensive workshop tests on a large product mix in 2007.
**Keywords:** Laser Welder; Pickling line equipment; Welding

## SOLDA À LASER DE CHAPAS GROSSAS PARA A INDÚSTRIA DO AÇO

**Resumo**
Por muitos anos a tecnologia de solda de topo para chapas grossas em linhas de decapagem e de laminação a frio têm sido a única opção para os fornecedores de aço. A tecnologia de solda a laser proporciona uma alternativa com alta soldabilidade em aço de alta força e sensibilidade, custos de operação e manutenção mais baixos e um processo mais limpo. Em 2000, a Siemens VAI Clecim lançou um extensivo programa de pesquisa e desenvolvimento para criar novas máquinas de solda a laser. Este desenvolvimento foi aplicado primeiramente em chapas finas (LW21L) para linhas de galvanização e inspeção. O desenvolvimento de solda a laser para chapas grossas (LW21H) foi iniciado em 2004 para espessuras de 0.5 a 7mm e para características mecânicas de produto até 1500 MPa. Tal desenvolvimento nos levou a uma aproximação sistemática, a partir das necessidades dos nossos clientes, a qualificações de processos iniciais, e será finalizado com testes de workshops extensivos em um grande mix de produtos em 2007.
**Palavras-chave:** Máquina de solda laser; Equipamento linha de decapagem; Soldadora.

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## 1 INTRODUCTION

VAI Clecim has been developing its activity as a welder manufacturer for the iron and steel industry for more than 10 years.
To meet the new market requirements, VAI Clecim has further developed its welder range based on customer requirements:

- Fully automatic welding machines.
- Increased reliability of welds
- Perfect welding quality criteria (weld robustness, overthickness,…)
- Welder reliability over 99 %.
- Emergence of new high yield strength steel grades (Dual Phase, TRIP, TWIP…)

The early stage of the programme was dedicated to developing a new « Flash Butt » welder concept (pickling entry section, fully continuous rolling mill …) and a new « Mash Lap » welder concept (galvanizing line entry, continuous annealing, inspection lines …). The programme was then pursued in 2000 with the development of the laser welding process. First stage of development focused on light gauge (LW21L) for galvanizing lines, inspection lines…
The development of the laser welder for heavy gauges (LW21H) was started in 2004 for thickness ranges from 0.5 to 7 mm.
The development was led following a systematic approach, starting from customers needs to initial process qualifications and finalized with extensive workshop tests over a large product mix.

## 2 BENEFITS OF A LASER WELDER

For many years the flash butt technology for welding heavy gauge strip on pickling lines and tandem mills has been the only option to steel suppliers.
The laser technology provides an alternative with various benefits.
For the production of high strength and sensitive steel (silicon, manganese steel), the laser process ensures perfect quality. Therefore, it is less necessary to apply additional treatment (like postheating treatment) than with Flash butt welder.
High performance could be reached on a wide range of products. Laser process is able to reliably weld from 0.5 mm to 7 mm, while for the flash butt process thickness is limited to 1.2 mm.
Compared with the flash butt process, the laser is a clean machine (welding operation without flashing parts and quite no fumes and no trimming operation).

## 3 PROJECT STEPS

Based on VAI Clecim's global knowledge, as a process lines and welders supplier for the steel industry, of the feedback and experience of both flash butt welders and light laser welders for thin gauge products, the laser welder for heavy gauge products has been developed following a systematic approach:
1/ Defining the customers needs

- Product to be welded
- Welding quality required (breakage, geometry of the weld and reweld rate)
- Cycle time
- Easy maintenance
- Price level

2/ **I**nitial process qualification
- Cutting test
- Welding test

3/ **D**efinition of the main features and functions of the welder
4/ Design
5/ Manufacturing and erection
6/ Workshop tests to be done over a large product mix

The first 2 steps have led to the following main features of our heavy laser welder:

- The mode of preparation: an innovative and high performing shear for ensuring perfect preparation necessary for the laser welding operation.
- Resonator installation: stationary for operational reliability.
- Strips perfectly kept in position during welding operation
- Laser type: $CO^2$ for ease of installation on « open » site.
- $CO^2$ technology: SLAB for the quality of laser beam and ease of maintenance.

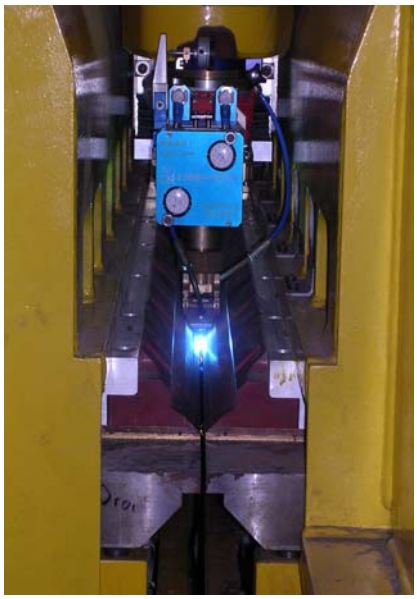

**Figure1**: Welding Laser Head

## 4 Description of LW 21 H welder

It consists of:

- a fixed shear for tail and head strip fine cutting
- clamping system
- Welding carriage and optical path

Shear

The shearing operation has been one of our main concerns in the development of the heavy laser welder as the quality of the shearing operation is one of the most important factors to reach a perfect and constant welding quality. The shear was designed according to the following criteria:

- Ability to cut steel up to 1500 MPa from 0,5 to 7 mm.
- avoiding any impact on shearing quality due to bad adjustment, shear displacement, guiding wear
- automatic adjustment according to the strip thickness
- easy to be maintain.

To meet such requirements, an innovative design has been defined with a completely stationary shear always in the same position in the line axis. The shear is not moved from a parking position to its working position with the risk of losing cutting quality due to wear or bad guiding adjustment. It has been calculated to cut steel up to 1500 MPa.
Shearing parameters are automatically adjusted according to the welded thickness to optimize the cutting quality and the shear blade life time.

Clamping system

- 2 movable frames featuring high rigidity confirmed by calculation for steel up to 1500 MPa with clamping and indexing system allowing the welding cycle to be run. A large opening (1 meter) of the welder permit an easy maintenance of the welder.
- Clamping by raising the lower welding die. The position of strip upper face is independent of strip thickness.
- Welding overhang dependent on strip thickness.
- Neutral fibre automatic adjustment when joining strips of different thickness.
- No need for precise stoppage of strip head and tail ends as the welder is equipped with a shield system integrated into the welder put in position for the incoming head and tail strip arrival.

Welding carriage and optical path

A welding carriage (C frame) is located on motor side and is moved from motor side to operator side for the welding, planishing and post heating operations.
This welding carriage is built around a double focus welding head :

- The follower rolls actuated by hydraulic cylinders to keep the strips perfectly in position during welding operation;
- The planishing rolls used to avoid any overthickness after the welding operation (mainly useful for weld rolling at the tandem mill);
- A post heat treatment used for high strength steel and sensitive steel.

To optimize its reliability, the laser source is fixed on the motor side. This design provides a very simple beam path with an easy access to the components travelling in only 1 axis. As for the light gauge laser welder, all optical components can be removed / re-installed without affecting the beam final impact point.

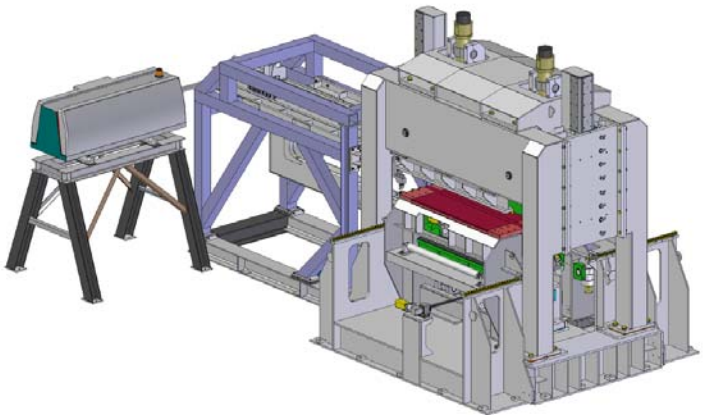

**Figure 2**: Welding Machine 3D View

## 5 CONCLUSION

Welding a strip head with a strip tail does not seem to be a complex operation; but doing it in a short time, never breaking the strip in the line and achieving more than 99 % line availability makes the task more complex.
That's the reason why only few companies are in a position to propose such welder concepts to iron and steel makers.
VAI Clecim, as a result of its extensive Research and Development efforts, has become one of the world leaders in the field of welding machines.
Development of the Laser welders is an integral part of this market strategy. With the development of a laser welder for heavy gauge strip, VAI Clecim is able to offer its customers the industrial solution geared to meet their requirements and objectives from more conventional but already proven processes (Mashed lap or Flash butt) to the laser process.