

FB 21—The Latest Generation of Flash Butt Welders

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The flash-butt-welding process, well known in the iron and steel industry, is commonly employed in the entry section of a pickle line or in a fully continuous rolling mill. This welding process must not only satisfy the special requirements of new metallurgical developments (e.g., dual phase and TRIP steels), it must also meet the increasing demands of end-users for higher-quality products (minimized weld breakage), total reliability and fully automatic operation.

To keep pace with such developments, VAI Clecim, together with its customers and partners, has developed the new, fully automatic Flash Butt Welder 21 (FB 21) which is characterized by the following features:

- A built-in shear, flash trimmer and tool carriage unit
- A new approach to the welding process distinguished by the use of direct current, speed control in the flashing phase, position control in the upset phase, operation in a reducing atmosphere and pre- and post-heating treatment, etc.
- Introduction of an "online" weld-quality-control process
- Fast change of operational spare parts

The FB 21 welder is installed and operating in a number of steel works with excellent results.

MAIN FEATURES

The FB 21 Welder developed by VAI Clecim and its customers/partners has been designed to be able to weld up to 7-mm thick (max. cross section: 12,000 mm₂) steel strip with a maximum of 1,200 MPa yield strength. The welding cycle time (approximately 50 s) corresponds to the operational sequences of a typical production line. A schematic diagram of the FB 21 Welder is seen in Figure 1. The main features of the FB 21 Welder are as follows:

- Fully automatic operation without the need for operator interaction
- 4-point centering of strip head and tail ends with automatic matching of the strip edges to minimize any strip-camber effects on the edges alignment
- Strip head and tail shearing by a built-in single-piece shear for perfectly parallel cutting of strip head and tail ends
- No transfer of strip head and tail ends between shearing and completion of welding to assure parallelism of welded edges
- Welding under DC voltage (patented) to obtain fine and regular flashing for improved weld quality

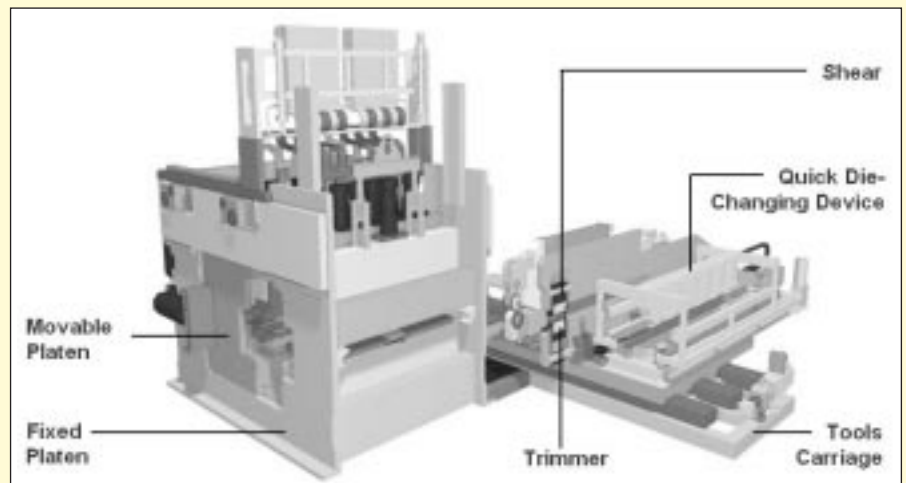


Fig. 1 – Schematic Diagram of the Flash Butt Welder 21.

- 1 kHz high frequency control (patented) of welding current in the flashing phase and position control in the upset phase for reliable weld quality and simplified parameter setting
- Welding operations under reducing atmosphere (oxygen-free) for high silicon-, high manganese- and high-chromium steels
- Collection of flashes to maintain welder cleanliness and to improve the "oxygen-free" efficiency
- Flash trimming without strip transfer by built-in trimmer: shearing, welding and trimming is carried out at a single location. Flash trimmer and shear are introduced between the welding dies. This movement is ensured by a tool carriage unit equipped with the shear and trimmer.
- High speed trimming at 0.8 m/sec to obtain "mirror" trimming
- Adjustment of trimming passes in such a way to ensure that the trimmer is positioned on the thinnest gauge when strips of different gauges are being joined. This prevents incipient cracks from forming during rolling, regardless of the welded joint configuration.
- Heat treatment (post-heating, annealing, tempering) of high-carbon, high-manganese and high-silicon steels between welding dies, regardless of the welded cross section (max. 12,000 mm₂)
- "Online" weld quality inspection (Cockerill Sambre patented license) for the detection of weld preparation anomalies (leveling, etc.)
- Automatic recording (100 Hz) and sto-

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range of main parameters (position, current, voltage, servo valve, etc.) of each weld

- High capacity notcher allowing the rolling coffin range to be increased by 400 mm
- Fast die change by dedicated car.

ONLINE WELD QUALITY INSPECTION

Weld preparation data (current, voltage, movable platen position, etc.) is automatically analyzed and processed to detect any anomalies. Weld qualification (good, re-weld) is done after welding and displayed on HMI screens.

APPLICATION AND RESULTS

Cockerill Sambre has installed an "online" flash-butt-weld quality-inspection system at its two pickle lines at FERBLA-TIL (Liege, Belgium). Since the start-up of the systems—in the year 1998 for Pickle Line No.2 and in 2000 for Pickle Line No.1—online weld breakages have been completely eliminated.

The FB 21 Welder was also installed at the fully-continuous rolling mill at Sollac Atlantique Mardyck in 2002 where an average of 1,250 tinplate coils and 2,600 coils of other steel grades are produced each year. The percentage of tinplate reduction is high (around 90%), meaning that the welds are subjected to high stresses.

At Sollac Mardyck (Mardyck, France) the FB 21 Welder installed in 2002 must cope with highly unfavorable welding conditions—frequent gauge, grade, and width variations. It is clear that any change in the strip gauges to be welded together involves a change the weld-rolling conditions, leading to high stresses applied on the weld. Despite these adverse factors, Sollac Mardyck still achieved the following results on a regular basis:

- Weld breakage: less than 0.2%
- Re-welds: less than 0.4%
- Reliability: over 97%
- Percentage of automatic welds (no operator required): over 97%.

Weld breakage percentages (not including tinplate) from July 2000 to March 2001 shown in Figure 2. Photographs of the entry and exit side of the FB 21 Welder as well as the operator control pulpit at Sollac Mardyck are seen in Figures 3-5).

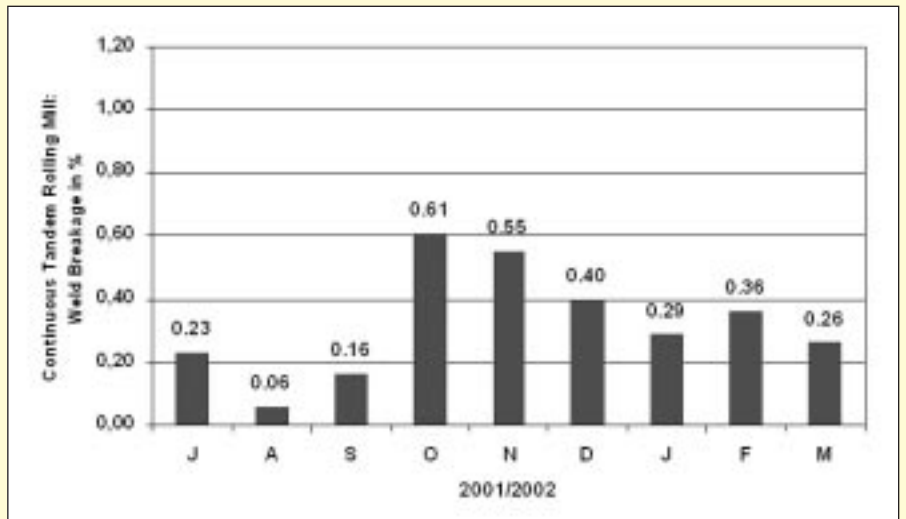


Fig. 2 – Percentage of Weld Breakage at Sollac Mardyck, France in 2001/2002 (not including tinplate).



Fig. 3 – Flash Butt Welder 21 (Front View, Entry Section), Sollac Mardyck, France.



Fig. 4 – Flash Butt Welder 21 (Front View, Exit Section), Sollac Mardyck, France.



Fig. 5 – Operator Control Pulpit of Flash Butt Welder 21, Sollac Mardyck, France.

CONCLUDING REMARKS

The Flash Butt Welder FB 21 Welder was jointly developed by VAI Clecim as a equipment supplier and Sollac Atlantique and Cockerill Sambre as steel producers. It has been applied with considerable success in the steel works of several major producers.

For example, VAI Clecim and ARCELOR have achieved the welding of new steel grades such as dual phase and TRIP steels.

Their high content in carbon, manganese and silicon make these steels extremely

difficult to weld industrially with traditional flash-butt techniques because of the high oxidation rate and the need for thermal treatment.

Intensive cooperation continues in the following areas:

- Incorporation of the "online" weld-quality-control system into Cockerill Sambre's 4-stand continuous rolling mill
- Extension of the applicability of the FB 21 Welder in accordance with Sollac Mardyck's expanding product range
- Capability to adjust the preheating cycle.

In the field of flash-butt-welding technology VAI Clecim, Sollac Mardyck and Cockerill Sambre maintain that they have successfully built the most efficient machine of its type in the market. The FB 21 Welder is characterized by competitive operating and maintenance costs, a reduced cycle time (compared with laser-based welding techniques), and satisfies the welding requirements of a broad range of products that extends even to high alloyed steels.