

# “EWR®” BILLET WELDING AND “SPO” SYSTEMS: COMBINED APPLICATION FOR ENDLESS ROLLING OF SPOOLED BAR IN COILS <sup>1</sup>

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## Abstracts

Today, effective solutions are available for increasing productivity and efficiency in rolling mills for long products and for substantial reduction of production costs thereof. Some of the most significant latest Danieli innovations are the EWR® Endless Welding Rolling process and the “Spooler Line” for bar-in-coil production. The EWR® system, through automatic continuous head-to-tail flash welding of billets at reheating furnace exit side, enables uninterrupted production of the mill for endless rolling of straight bars, wire rod and bar in coils. The process is particularly beneficial to wire rod and bar-in-coil mills as it enables production of “customized-size coils” (any coil weight according to specific Customer request) and with extra-high final coil weight, even starting from low-weight billets. The Spooler process is based on twist-free winding of hot-rolled rebars into highly-compact/ultra-heavy coils featuring a unique cobble-free un-coiling capability. This enables high-speed feeding of the downstream cold-processing lines with hot-rolled spooled coils coming directly from the rolling mill without the need of any traditional off-line operation (such as de-coiling, stretching & re-winding). The system results highly beneficial both to bar-in-coil producers and to the downstream lines operators. The latest step forward is the combined application of these two systems that has made it possible for endless rolling of spooled bar in coils, enabling to cumulate the benefits of the two processes, particularly as far as transformation costs are concerned.

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## THE EWR® SYSTEM

Endless rolling of long products is made possible by the EWR® Endless Welding Rolling line installed at re-heating furnace exit side.

By automatic continuous on-line head-to-tail flash-welding of billets, this innovative process enables uninterrupted rolling operation at the mill, resulting in higher production capacity, better plant efficiency, higher material yield, homogeneous and repetitive material quality, better production planning, easier plant management and lower production costs.



**Figure 1.** EWR® Billet Welding Line in operation.

All of this is made possible as the EWR® process eliminates interbillet time, bar head & tail cropping during rolling (as well as short bars in cooling bed for bar mills and coil trimming in wire rod production), minimizing possibility of cobbles and significantly reducing maintenance, spare parts & consumables demand, resulting in average 3.5÷4.5 €/ton savings in production cost.

This process is particularly appreciated in wire rod and bar-in-coil production. In fact, by giving the possibility to supply the market with “customized-weight” coils and by granting consistent and repetitive quality between coil and coil, it contributes to enhance product marketability.

Furthermore, extra-high coil weights can be obtained even using low-weight starting billets. To date the Danieli scorecard lists a total of 16 EWR® lines supplied since 1997, 13 of which in the last 4 years (situation at March 2006).

### **The EWR® line in operation at Sterling Steel Co- USA**

Particularly worth to be mentioned is the billet welding line in full industrial operation since January 2006 at Sterling Steel Company’s high-speed wire rod mill for engineering steels in Sterling (IL), USA.

Here, the new EWR® line operation has shown an amazing start and a very fast learning curve. First test-weldings were performed on January 23<sup>rd</sup> 2006 and, significantly, normal production operation started just one week later, to full Customer satisfaction.

The line performs automatic continuous welding of 130x130 mm, 11-m-long billets at rates of up to 100-sht/hr, in high carbon steel qualities in a wide range of grades for engineering steel wire rod for automotive applications, mainly for spring steels. The produced material is directly drawn to different diameters and oil tempered in various downstream Companies belonging to the same Group.

Coil weight selection out from the endlessly-rolled wire rod is performed by a new shearing unit installed in the coil reforming tube, at the end of the roller conveyor.

Operation of the new billet welder has brought in substantial benefits in plant productivity and efficiency (from previous 95.5% to 99.5% yield value, mainly thanks to the extra-rolling time coming from the elimination of roll gaps) and significant savings in plant manpower (less 12 people over 4 shifts, due to elimination of operators at roller conveyor and at trimming stations).

The consequent positive effects on production cost will end up in very short return of investment.

### The Spooler line

The Danieli Spooling process is the latest technological innovation that has introduced a major change in bar-in-coil production, with significant benefits for both hot-rolled coil producers and for the downstream coil end-users.



**Figure 2.** Panoramic view of a Spooler line.

This innovative process, based on twist-free winding of the hot-rolled bar into high-quality, ultra-compact, heavy-weight coils, provides cobble-free un-coiling, enabling high-speed feeding of the downstream cold-processing lines with “as-rolled” coils coming directly from the rolling mill.

This makes the traditional “off-line” un-coiling, stretching & re-coiling operations no longer necessary, with significant savings in transformation cost.

Further technological and operational benefits are:

On-line optimized bar cooling before spooling for consistent product quality, fully complying with tensile and ductility requirements.

Ultra-high weight and high coil compactness results in minimized storage requirements, handling and transportation costs.

Twist-free spooling avoids residual axial torsion in the material (as occurs in traditional coiling where this is often the cause of cobbles in the downstream cold processing lines).

Danieli was pioneer in designing and developing the patented torsion-free spooler process. The 1st Spooler line was installed at the Ferriere Nord bar mill in Italy and is in full industrial production since the end of 2002.

To date, Danieli has supplied 28 Spooler units, worldwide (situation at March 2006).

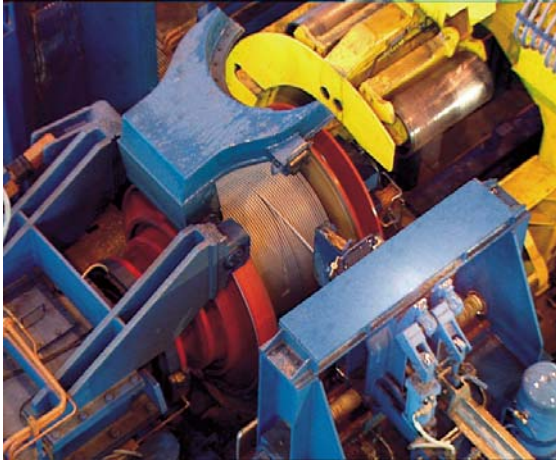


**Figure 3.** The Spooled coil.

### Spooler line main concepts and benefits

The innovative Spooling process basically consists in twist-free coil formation by regular and “intelligent” distribution of the hot-rolled & on-line control-cooled bar into subsequent homogeneous layers on the Spooler rotating drum. The result is an extremely compact and regularly-shaped coil, featuring an unbeatable “0.7” filling factor (against 0.3 of Garret coilers and 0.1 of wire rod coils).

Spooled coils feature fixed height and fixed inner diameter, whilst outer diameter varies in relation to coil weight and bar size.



**Figure 4.** The Spooler unit in operation.

Twist-free winding is a remarkable step forward in coiling technology.

In traditional coiling, in fact, axial torsion remains in the material as internal stress, which very often causes problems (cobbles and material losses) in the downstream cold processing lines.

The Spooled coil, thanks to its regular formation & twist-free winding, is therefore the right answer to today's more demanding bar-in-coil market.

Bar controlled cooling before spooling is another key factor playing an important role in this innovative process. Optimised bar cooling throughout the bar section makes it

possible to obtain a homogeneous product, fully complying with ductility requirements. Furthermore, optimised-cooling capability provides consistent quality with extremely small deviations in material characteristics amongst the various heats that form a production lot of the same steel grade.

As previously mentioned, the system results highly beneficial both to hot rolling mill operation and to the downstream lines operators. Main benefits to hot rolling operation are:

- Better product marketability. Hot rolled spooled coils mean added-value production, resulting in acquisition of new niches in the bar market.
- High finishing speed (35-mps) leads to high rolling mill productivity, also with the smallest bar sizes (i.e.: over 90-tph with 8-mm bars rolled on two strands)
- Higher material yield and plant efficiency
- Cheaper transportation, handling and storage.

Main benefits to end-users are:

- For material handling:
  - No need for special handling devices like spreader bars, etc.
  - No need to change orientation of the feedstock (spooler coils are always handled upright).
  - Safer / faster truck unloading and equipment loading operation.
- For equipment footprint requirements and operation
  - Up to 50% less space requirement for equipment layout.
  - Up to 50% faster equipment setup at beginning of campaigns.



**Figure 5.** Spooled coils storage and

- Up to 50% faster production cycles.
  - 65%-plus equipment utilization factor.
  - Zero cobbles due to the unique unwinding procedure and no residual axial torsion.
  - For material yield
    - Up to 6% increase of material yield (yield losses using spooler product are practically reduced to zero).
  - Possibility to use feedstock in coil up to 32-mm rebar (#11 rebar).
- Spooler process main benefits are summarized in Table 1.

**Table 1.** Summary of the Spooler process main benefits

<b>Benefits</b>	<b>Thanks to</b>
<ul style="list-style-type: none"> <li>- Safe uncoiling capability, enabling downstream processing lines direct feeding with hot-rolled coils coming right from the rolling mill.</li> <li>- Traditional “off-line” intermediate processes (Uncoiling/stretching/re-winding), no longer necessary. Up to 18 €/t cost saving (not operating with EWR)</li> </ul>	<ul style="list-style-type: none"> <li>- Twist-free winding of hot-rolled/on-line control-cooled bars.</li> </ul>
<ul style="list-style-type: none"> <li>- No residual internal stress on the material, from axial torsion (as in the case of traditional coiling systems), which are possible cause of cobbles.</li> <li>-Thus, safe coil feeding for the downstream processing lines.</li> </ul>	
<ul style="list-style-type: none"> <li>- Constant &amp; consistent material quality, within the same production lot.</li> </ul>	<ul style="list-style-type: none"> <li>- Optimised on-line controlled cooling.</li> </ul>
<ul style="list-style-type: none"> <li>- High mechanical characteristics &amp; good weldability, starting from low-carbon steel.</li> </ul>	
<ul style="list-style-type: none"> <li>- Higher efficiency &amp; productivity of the downstream cold processing lines, as well as higher material-yield.</li> </ul>	<ul style="list-style-type: none"> <li>- High-speed, cobble-free uncoiling.</li> <li>- Ultra high coil weight.</li> </ul>
<ul style="list-style-type: none"> <li>- Substantial reduction in coil handling, transportation and storage.</li> </ul>	<ul style="list-style-type: none"> <li>- Ultra high coil weight &amp; compactness</li> </ul>
<ul style="list-style-type: none"> <li>- Uninterrupted production of “Customized-weight” coils, if operating jointly with EWR-Endless Welding Rolling line.</li> <li>- Production of spooled coils of any weight up 5,000 Kg, even starting from low-weight billets.</li> <li>- Up to 22-24 €/t transformation cost saving by joint operation with the EWR</li> </ul>	<ul style="list-style-type: none"> <li>- Joint operation with EWR billet welding line for rolling mill endless rolling.</li> </ul>

### Technical data

Danieli Spooler process is suitable and designed for a wide application field, in terms of product type and size range (round, square & flat bars) and steel grades, depending on requirements.

Product range (\*):

8 to 32-mm-dia (water quenched or Vanadium-alloyed) deformed bars

8 to 52-mm-dia plain bars

Spooled coil weight:

Up to 5,000 Kg.(“customized-weight” if operating with EWR system)

Operative rolling speed:

Up to 35 mps (design speed 40 mps).

(\*) The Spooler system is also suitable to process 20x3 to 70x20-mm flat bars, 12 to 50-mm, square bars and correspondent hexagons.

#### 4.2 - Spooler line description.

A typical Spooler line is basically composed of the following three main areas, namely:

- > The on-line bar temperature control and conveying system.  
Installed between the finishing mill and the spooling area, it is made up of a set of water boxes and conveying sections for on-line temperature adjustment and control of the bar to be spooled, in relation to product size and material grade.  
A crop shear is located at ingoing side of the spooler units for head and tail trimming and for coil weight selection in case of endless rolling by EWR® process.
- > The spooling area basically composed of:
  - >> “Smart” pinch rolls and a looper set to enable “under-tension” winding and regular step-up at every new bar layer formation on the spooler drum.
  - >> Bar feeding system for regular and homogeneous rolled stock distribution on the spooler drum for perfect coil formation.
  - >> Two spooling units alternately operating, one for bar winding, the other for coil unloading and vice-versa. Each unit is basically made up of a rotating drum for coil formation and a bar head clamping/guiding device to start the winding cycle. The drum is fitted with expansion sectors to enable coil extraction.
  - >> Robotised manipulator, for coil extraction and deposit on the coil carrier at exit side.
- > The spooled coil finishing area, where coils are automatically strapped in 4 points, weighed and conveyed to the final collection point.

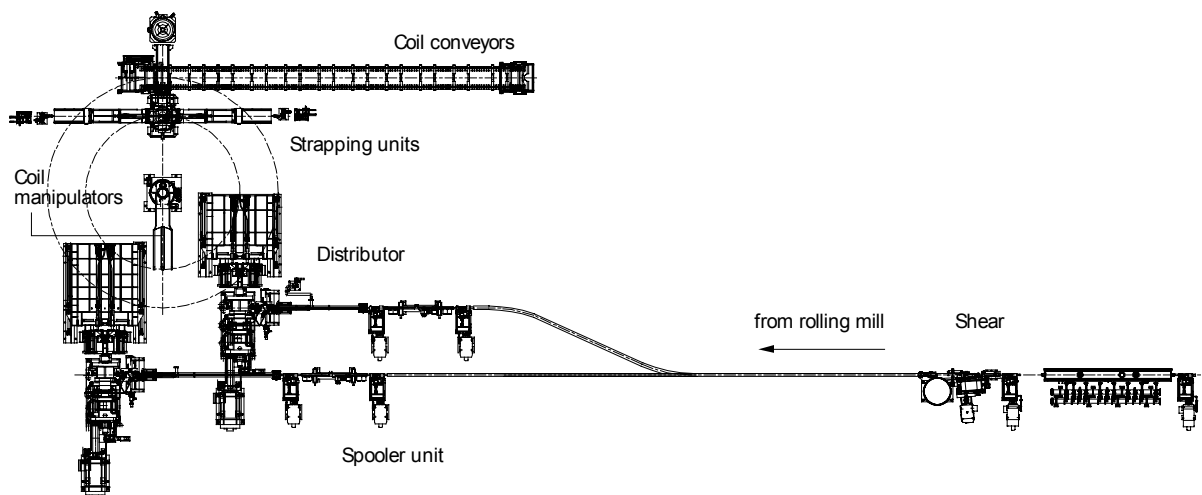


Figure 6. Typical layout of a Spooler line

The entire spooling process is governed by an intelligent control system, particularly dedicated to supervise both bar temperature adjustment & control before spooling and regular bar winding distribution of the on the spooler drum for layer formation and layer step-up, until coil formation is completed.

### The EWR & SPO combined operation

The latest technological innovation was the joint application of the EWR® Endless Welding Rolling and the Spooler processes.

The first plant to experience this winning combination of advanced technologies was Alfa Acciai in Italy where an EWR unit operates in connection to a Spooler line since March 2005.

This enabled production of spooled coils in endless rolling mode for the first time in the world, with all consequent benefits coming from the combined operation of the two processes.

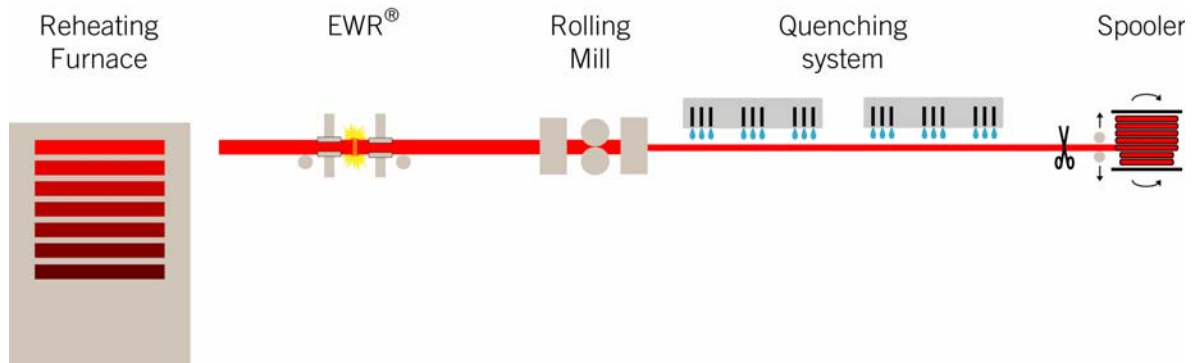


Figure 7. Typical scheme of an Endless Rolling Spooler Plant

### ALFA Acciai, Italy: the 1<sup>ST</sup> endless-rolling spooler line, worldwide

On March 3rd 2005, a milestone in the history of long product rolling mills was set at Alfa Acciai #2 bar mill in Brescia, introducing for the first time worldwide the combined application of the EWR® Endless Welding Rolling and the Spooler line.

Alfa Acciai endless-rolling operation started at beginning December 2004 with production of straight bars.

Line's tuning continued then up to the full integration of the EWR line in the rolling process on industrial production basis. In the meantime installation and cold tests of the new Spooler line continued until the first hot-rolled spooled coil was successfully produced at beginning March 2005.

During the same month, 8-mm-dia endlessly-rolled spooled rebar was also successfully produced for the first time, to full Customer satisfaction. The combined application of these two technologies introduced a generational change in bar-in-coil production, as it gives now steel producers the possibility to join and cumulate the benefits of each system, with significant positive repercussions in plant productivity, efficiency, product marketability

and considerable savings in transformation cost (up to 22-24 Euro/t).

These new processes made Alfa Acciai:

- 1st in Italy to operate in endless-rolling by billet welding



Figure 8. Spooled coils produced at ALFA Acciai

- 2nd in Italy and 3rd in the world to produce spooled coils
- 1st in the world to produce spooled bar in coils in endless-rolling mode.

Alfa Acciai Spooler line is designed for producing 8 to 16-mm-dia twist-free wound deformed bars in up to 3-t ultra-compact coils.

Electricals and automation for the new facilities, as well as an advanced automation system for the entire bar mill #2, were supplied by Danieli Automation for better coordination and control of the whole production process.

## **CONCLUSION**

Spooler process is the breakthrough technological innovation that has led significant technological step-forward in bar-in-coil production, enabling bar producers to reduce transformation costs and to create important new niches in the market. The joint application of the EWR® process for endless rolling of spooled coils has further enhanced the benefits of the two systems.

The excellent results achieved in the various plants in operation and the large number of Spooler lines under supply and construction are the best confirmation of this revolutionary technology which reconfirms Danieli absolute worldwide leadership in the field of long products.

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