

Continuous Evolution of Rolling Method

by:

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Disruptive technology can fundamentally change the rules of the game for an entire industry, either because it represents a shift in efficiency, a shift in economics or ideally both.

Continuus-Properti, SpA was established in 1947 when **Ilario Properti** registered his first patent for the continuous casting and direct rolling (CCR) principle used in the production of nonferrous wire rod. He was truly a genius. His patented process would revolutionize the production of wire rod throughout the world.



Properti CCR Line exhibited at Milan Trade - 1948.

The term that can be used to describe Ilario Properti's invention is Disruptive Technology. This is defined as "those technological advances that fundamentally change a market or industry, often by displacing an existing technology". Disruptive technology can fundamentally change the rules of the game for an entire industry, either because it represents a shift in efficiency, a shift in economics or ideally both. This is exactly what Ilario Properti did for the production of wire rod—his in-line casting and direct rolling process displaced the existing technology for wire rod production—his technology enabled it to be done more safely, more efficiently and more economically. He fundamentally changed the wire rod industry forever.

The Properti organization continues this spirit of innovation through the leadership of **Giulio Properti** and his highly motivated and technically oriented staff. Continuus-Properti holds more than 400 patents throughout the world—a true testament that this innovative spirit is firmly ingrained deep in the company's DNA.

Over the past 70+ years, Continuus-Properti has continued to introduce leading-edge technology and continuous improvements in the casting/rolling/coiling processes to facilitate the production of quality rod on a consistent, repeatable basis. Our core business includes the manufacture of CCR lines, from furnace set to coiler, for the production of nonferrous wire rod. The organization has grown into a pow-

erful engineering company able to design and manufacture sophisticated machines to meet the most stringent demands of the global market. In the words of **Albert Einstein**, "Scientists investigate that which already is; Engineers create that which has never been." The company caters to hundreds of customers throughout the world that are involved in many different industries including nonferrous metals, wire and cable, steel wire/rope and automotive. We work with our customers to address the demands posed by the global market and we devise innovative solutions to meet these challenges and exceed customer expectations.

In-Line Plastic Casting & Rolling System

The Properti CCR system was probably the first in-line plastic casting and rolling system to find an industrial application, that of producing nonferrous wire rod, and it also paved the way for those who later studied other processes for different metals and different products.

The heart of wire rod production is the wheel and belt-type casting machine, which can be thought of as a rotating heat exchanger. Molten metal is introduced into the groove about the circumference of a wheel that forms three sides of the casting mold, while the fourth side of the mold is formed by a steel belt. The liquid metal is quickly solidified in the rotating mold as a result of cooling water being distributed in a controlled and repeatable manner through calibrated spray nozzles precisely distributed about the casting wheel to provide cooling on all four sides of the rotating mold.

The resulting continuous hot bar that exits the casting machine is then immediately introduced into a series of rolling stands. The transition of the hot bar directly into the rolling train was one of Ilario Properti's most brilliant concepts. If the casting machine is the heart of the wire rod line, then the rolling train is the lungs, which breathe life into the CCR process.

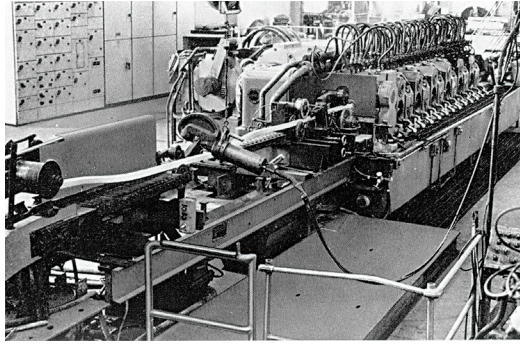
The modern rolling train consists of a breakdown rolling mill (roughing mill) and a finish rolling mill (finishing mill). The roughing mill, designed for higher area reductions to be imparted upon the material being processed, is comprised of rolling stands, which have a two-roll configuration thereby providing an oval-round reduction sequence.

The Properti finishing mill, on the other hand, makes use of the famous Properti three-roll technology. This technology facilitates a nearly perfect balance of lateral spread and longitudinal displacement of the metal during each reduction step. It contains the spread of the material under the rolling forces much better than the two-roll configuration. The three-roll rolling system provides a triangle-round reduction sequence and allows excellent control of the rod geometry, far superior to that which can be obtained through a two-roll rolling configuration.

Properti first began using the tandem rolling mill approach,

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roughing mill + finishing mill, in the early to mid 1960s. The picture (below) shows a 1964 Properzi rolling train that utilizes two two-roll stands in tandem with the three-roll stands (in this case, the two-roll stands and the three-roll stands are mounted on the same frame).



Properzi Rolling Train (CU Rod) – two-roll stands in tandem with three-roll stands - 1964.

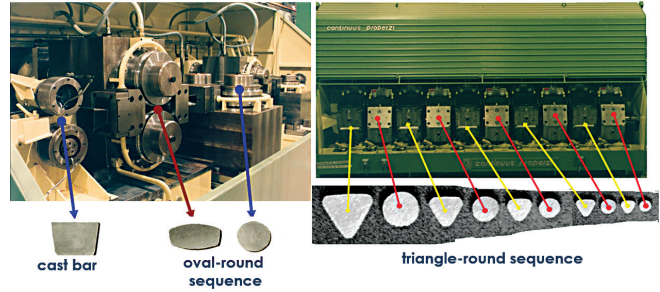
Continuous-Properzi has designed, engineered, manufactured, supplied and commissioned hundreds of CCR lines since its inception. The evolution of a modern rolling train (roughing mill + finishing mill) is depicted in the images below. In most cases, the roughing mill and finishing mill are separate machines.



Modern Rolling Train for aluminum – Roughing Mill + Finishing Mill (top) and Modern Rolling Train for copper – Roughing Mill + Finishing Mill (at right).



The number of rolling stands in both the roughing mill and finishing mill, as well as the diameter of the work rolls, on a given CCR line is contingent upon the material that is being processed by the line, the desired production rate in tons per hour and the required rod diameters to be produced. The



An example of rolling sequence showing oval-round and triangle round pattern.

tables that are shown below illustrate the different capacities of Continuous-Properzi CCR lines for aluminum and copper. Regardless of the size of the CCR line, the material that is being processed, or the rod diameter(s) to be produced, all of the lines contain a finishing mill with the Properzi three-roll configuration. **Continued...**

CCR COPPER ETP (Electrolytic Tough Pitch) ROD LINES

- **SMALL OUTPUT RATE**
 - Production rate: from 5 tph to 10 tph
 - Expected yearly output: from 25,000 t to 58,000 t
- **MEDIUM OUTPUT RATE**
 - Production rate: from 12.5 tph to 20 tph
 - Expected yearly output: from 61,000 t to 115,000 t
- **LARGE OUTPUT RATE**
 - Production rate: from 25 tph to 40 tph
 - Expected yearly output: from 125,000 t to 250,000 t



CCR ALUMINIUM ROD LINES

- **SMALL OUTPUT RATE FOR EC GRADE AND THE MOST COMMON ALLOYS**
 - Production rate: from 1.5 tph to 3.5 tph
 - Expected yearly output: from 7,500 t to 17,500 t
 - Alloys range: 1350, 1370, 6101, 6201 and similar
 - Coils type: loose coils (most used) or tight coils
- **MEDIUM OUTPUT RATE FOR EC GRADE AND THE MOST COMMON ALLOYS**
 - Production rate: from 4.5 tph to 6 tph
 - Expected yearly output: from 30,000 t to 40,000 t
 - Alloys range: 1xxx, 5xxx (Mg<2.5%), 6xxx, 8xxx
 - Coils type: loose coils or tight coils (most used)
- **MEDIUM OUTPUT RATE FOR EC GRADE AND THE MOST COMPLEX ALLOYS**
 - Production rate: from 4.5 tph to 8 tph
 - Expected yearly output: from 22,000 t to 40,000 t
 - Alloys range: 1xxx, 2xxx, 3xxx, 4xxx, 5xxx (also high Mg content), 6xxx, 7xxx, 8xxx
 - Coils type: tight coils
- **LARGE & EXTRA LARGE OUTPUT RATE FOR EC GRADE AND THE MOST COMMON ALLOYS**
 - Production rate: from 8 tph to 15 tph
 - Expected yearly output: from 50,000 t to 100,000 t
 - Alloys range: 1xxx, 6xxx, 8xxx
 - Coils type: tight coils (also jumbo coils)



Continuous Evolution of Rolling Method ...continued

Alternative to Conventional Breakdown Machines

In the late 1970s, after 30 years of experience in the field of CCR lines, and the utilization of the three-roll configuration for the finishing mill, Giulio Properzi embarked upon another innovative concept—to use the finishing mill outside of the CCR line context in order to process materials through a cold-rolling process. And so was born the Properzi Microrolling® mill.

The Microrolling® mill's main objective was to address the difficulties with processing those hard-to-draw materials. In other words, the Microrolling® mill would become an advantageous alternative to the conventional breakdown machines (cold drawing). The Properzi Microrolling® technology was first brought to market in 1979 and has been very well proven for processing wire rod in both hot and cold rolling conditions.

The patented Microrolling® system, with its compact rolling stands and its ability to process hot material, processes the material without subjecting it to any axial tension or compression thereby reducing the work hardening to an



Modern Properzi Microrolling® Mill .

absolute minimum.

It excels with those materials where the conventional breakdown drawing process must be divided into several steps with intermediate annealing. The major advantages of the Microrolling® mill compared to a traditional breakdown drawing machine include:

- Energy savings
- Low maintenance
- Self-threading (extremely user-friendly)
- Increased safety (self-threading eliminates potential pinch points)
- No pointing required
- No rod pickling required
- Reduced work hardening of the material
- Improved wire surface smoothness
- Absence of residual lubricant on wire surface
- Possibility of hot rolling without loss in output and efficiency
- Greater reduction between anneals on hard material

- Possibility to eliminate intermediate anneals on many materials
- All together: lower production costs

Presently, around the world, we have Microrolling® mills processing numerous types of materials including low, medium and high carbon steels; steel cord wire; CO₂ welding wire; strong mechanical aluminum alloys (welding wire alloys); brass and bronze alloys (Cu based); nickel-titanium alloys; copper-phosphorus; copper-zinc; Tantalum; etc. Some of these materials, depending upon their characteristics, are heated to a specific temperature upon entrance to the Microrolling® mill in order to render them more easily workable.

MICROROLLING® PROCESS CHART

Material	Microrolling® can process all materials that can structurally bear the total required reduction: Al, Cu, Carbon Steel, Stainless Steel, CO ₂ wire, FC (Flux-cored) wire.
Diameters	Maximum entry diameter: 12.0 mm (.472") Minimum exit diameter: 1.80 mm (.070")
Production Speed	Referring to 1.80 mm dia.: 16 m/sec for hard materials 25 m/sec and higher for soft materials
Pointing / Threading	Rod pointing is not required and the threading of the rolling mill is automatic.
Tension	There is no axial tension on the material between rolling stands.
Capstans	There are no capstans or loop sensors to control synchronization. The material follows a straight path from feedstock coil to collecting device.
Work Hardening	The wire is not subjected to useless stresses such as tension, bending or localized heating that induces supplementary work hardening (compared to natural work hardening due to the simple area reduction of the wire).
Rod Pickling	Not required. A normal mechanical descaling device is sufficient to prepare steel rod for rolling.
Rod Temperature	The configuration of the rolling mill allows introduction of material that has been pre-heated up to 750°C.
Productivity	Over 90% on the basis of continuous operation.

Innovations for Aluminum/Copper Industries

Our latest innovations for the Properzi Microrolling® technology cater to both the aluminum and copper industries.

- We are using our Microrolling® technology for both a hot rolling process and a cold rolling process within the production of aluminium welding wire. The hot process is a continuous cast wire (CCW) line where molten aluminium (specifically welding alloys) is continuously cast and rolled via an eight-stand Microrolling® mill (hot rolling process) to produce 6 mm wire. The subsequent cold process, which replaces a traditional breakdown drawing machine, is a second eight-stand Microrolling® mill, almost identical to the rolling mill used in the CCW line, that further processes the 6 mm material to a diameter of 2.15 mm. This integrated process is flexible, appropriately sized, energy efficient, and easily controllable from molten metal to the final product.
- We have also developed a specialized Microrolling® mill to process 8 mm copper rod. The patented Properzi Self Annealing Microrolling® (SAM) method makes use of the Properzi Microrolling® technology in order to replace the conventional drawing/annealing processes while providing tremendous energy savings. Giulio Properzi's patented idea is based on the Properzi Microrolling® process and a fundamental concept of physics: the Law of Conservation of Energy that states energy can neither be created nor destroyed but can be changed from one form to another. The SAM method processes 8 mm cop-

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per rod down to a diameter in the range of 2.0 mm. The energy of the rolling process is transformed into heat thereby increasing the wire temperature, step by step, rolling stand by rolling stand, to a level that provides the desired characteristics of an annealed wire ready for subsequent processing in multiwire drawing applications. The SAM process totally avoids the costly, energy intensive, resistance annealing process thereby providing significant OPEX savings.



Self Annealing Properzi Microrolling® Mill (SAM).

As we have stated, the rolling process, and specifically the well-known Properzi three-roll rolling process, is common to all of our CCR lines and Microrolling® lines. However, this is not the only thing our customers have in common. They can also take advantage of the Properzi Technical Consultancy Service to optimize the efficiency of their Properzi equipment, even if it has been in service for the last 25 years. In order to continue to garner profitability from the operation of Properzi CCR or Microrolling® lines, the equipment needs to operate near maximum efficiency and this consultancy service is designed to assist our customers with this task. The Properzi organization will deploy its dedicated and qualified engineering/process team to assist our customers until the specific problem/issue is resolved. The service is available through three different avenues:

1. Written Consultancy—It is a fast “problem solving” approach based on information exchange via e-mail.
2. Remote Assistance Service—It is a direct point to point connection, via the internet, between Properzi’s control room and the PLC of the Customer Line. To enable the Remote Assistance Service, a communication module, which is included in all recently supplied PLCs, has to be installed and connected to the Internet.
3. Technical Audit at Customer Site—This requires dispatching Properzi’s specialist(s) to site in order to assist

the customer in resolving the most critical issues, those which cannot be addressed remotely.

Conclusion

At Continuous-Properzi, SpA, we work hard and strive to keep our customers’ full satisfaction at the forefront of our service objectives. In order to obtain additional information regarding the Properzi Consultancy Service, please contact consultancy@properzi.it.

In the year 1947, Properzi was the pioneer of the continuous casting and rolling process for nonferrous metals. Today, the company is the seasoned veteran that is able to design and build the equipment required to meet current and future complex rod requirements.

The Continuous-Properzi mission has remained consistent since the company’s founding—innovation, engineering, quality and service.

All of the engineering, design, manufacture, assembly and electrical automation of our Continuous Casting & Rolling Lines is accomplished in-house at Continuous-Properzi headquarters just outside Milano, Italy.

This in-house capability guarantees that our equipment will perform as designed and will allow our customers to produce top quality rod that will meet and exceed the stringent demands dictated by current and future wire and cable product requirements.

Our commitment to the industry and to the customers we serve started over 70 years ago and continues to grow stronger with every passing year. Additional technical specifications on the equipment available from Continuous-Properzi, SpA can be found at the Continuous-Properzi website.

www.properzi.com

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Company Profile:

“Directly from molten metal and in one minute”, this was the goal of the late Ilario Properzi (1897 – 1976) when he gave birth to the Continuous Casting and direct rod Rolling technique that changed an entire industry worldwide. Available from Continuous-Properzi, SpA are hot process machinery and technology for copper, aluminum, lead and zinc as well as cold process machinery and technology. Continuous-Properzi is able to offer to its customers engineering and consulting service during the design phases of a new production line as well as in case of revamping or upgrading of existing production equipment. Continuous-Properzi provides spare parts for over 250 running lines, the majority with tailor-made design and sometimes for equipment, still running, but started up more than 35 years ago. The high level of Continuous-Properzi after sales service is witnessed by the repetition of purchase orders from big international companies. www.properzi.com