

Complete solution from molten aluminium to overhead conductors

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In June 1999, Continuous-Propenzi acquired the technology and engineering capabilities of three wire and cable machinery manufacturing companies from the Redaelli Group. This acquisition included R.T.M. of Italy, J.A. Kraft of Germany and O.T.T. of France.

Together, these three companies represent over 250 years of combined experience, having more than 700 wire and cable lines installed worldwide. These three brands have been integrated into the Continuous-Propenzi family under the name of 'Continuous Wire Machinery Division'.

Moreover, in 2015 Continuous-Propenzi acquired the technology and engineering capabilities regarding continuous rotary extrusion from Threesixty. This technology can be utilized for many applications:

- Al solidal cables and conductors
- Cu and Al profiles/bus bars
- Al tubes
- Al alloy rod direct from cast bar
- Cladding of steel wire with aluminium.

With the implementation of the above-mentioned technologies, Continuous-Propenzi is the only company in the world that can offer a complete technological solution to the market for the production of power transmission and distribution cables, such as the traditional Aluminium Conductors Steel Reinforced (ACSR) and the advanced Aluminium Conductors, Aluminium Clad Steel Reinforced (ACSR/AS).

Overview of the aluminium rod market

In 1949 Ilario Propenzi, the founder of the Continuous company, invented and promoted a new technology for the production of aluminium rod. The system, well known as the 'Propenzi Method', was based upon continuous casting and direct rolling (some countries still generically refer to all aluminium wire rod as being 'Propenzi Rod'). The first machines were designed for aluminium rod production followed by continuous casting and rolling systems for copper rod. Propenzi casting and rolling technology industrialized the production of EC grade aluminium, making it a serious 'competitor' to copper in transmission and power distribution applications.

Aluminium rod is produced all over the world and is considered a commodity having a consistent price on the world markets and with standardized characteristics. The most common wire rod diameter is 9.53 mm (3/8").

During the past 70 years over 350 Propenzi Continuous Casting and Rolling (CCR) lines for copper and aluminium wire rod have been commissioned. For the production of aluminium wire rod, these lines have capacities which range from less than 10,000 tpy up to 100,000 tpy.

The bulk of the aluminium wire rod produced by these CCR lines is specifically for high conductivity uses and made from commercially pure aluminium or from aluminium conductor alloys containing added silicon and magnesium, such as 6101 and 6201.

Presently, aluminium wire rod production by final application is approximately divided as follows:

- 75-80% EC grade pure Al
- 15-20% Electrical conductor Al alloys
- 5-7% Mechanical applications and master alloys

Wire rod is usually shipped as coils. The standard coil weight is 2,000-2,500 kg. On some large Propenzi CCR lines, jumbo coils weighing 3,800 kg are produced and shipped.

The genesis of a new idea

The majority of conductor-grade aluminium wire rod is used in overhead (or similar) power conductors or cables. However, during the past few years the international market demand for technologically advanced mechanical grades of aluminium wire rod has been increasing at a very attractive rate.

Aluminium alloys in AA1000 through AA6000 series cover most of the present market demand due to their highly specialized mechanical and physical characteristics.

However, most wire rod lines currently in use are not well suited for the relatively low tonnage required by the market for each alloy. Therefore, a technologically advanced CCR line that is able to produce relatively small quantities of various alloys which have a higher added value would be in compliance with the requirements of this market niche. Following this developing opportunity and with the objective of satisfying this market, Continuous-Propenzi has developed a specific prototype Casting and Rolling Line. This CCR line is capable of producing mechanical grades of aluminium wire at a rate of 1-1.5 t/h, depending upon the alloy being cast and the final size of the product being rolled.

As compared to the classic wire rod transformation technology in use, this new Propenzi development directly produces wire rolled to a final diameter of 2.5-3.5 mm (0.098-0.138"). In most cases, such wire is ready to be used and thereby completely avoids breakdown drawing from conventional wire rod as well as frequently required in-process thermal treatment costs.

The objective in the development of this small CCR line was to directly produce small size wire having a diameter between 2.5-3.5 mm (0.098-0.138") instead of traditional 9.53 mm (0.375") wire rod. The further goal is to supply the growing market demand for special aluminium alloys and at the same time saving transformation costs relevant to rod breakdown operations, in-process thermal treatments and significant improvement to the transformation efficiency rate. The Propenzi development, referred to as CCW (Continuous Cast Wire), already in operation in several plants, has been designed to directly transform molten aluminium to finished wire of suitable dimensions that is directly coiled onto stems, ready for final use or to be processed on subsequent multi-wire drawing machines.

Examples of ACSR Conductors-wire composition

Aluminium		Steel	
No. of wires	Ø of wire (mm / inch)	No. of wires	Ø of wire (mm / inch)
6	2.70 / .106	1	2.70 / .106
6	3.20 / .126	1	3.20 / .126
26	1.85 / .073	7	1.44 / .057
26	2.15 / .085	7	1.67 / .066
26	2.44 / .096	7	1.90 / .075
30	2.70 / .106	7	2.70 / .106

The logical progression was to apply CCW capabilities to the production of EC and other grades of aluminium wire for bare overhead electrical conductor applications.

From molten metal to overhead conductors

ACSR conductors are reviewed with a projection towards AAAC conductors based on use of aluminium alloys such as 6101, 6201, 5005.

The table does not include all standardized conductors but only the most common ones. 90% of the global production of ACSR conductors make use of EC grade aluminium wire having diameters of 2.44 mm (0.096") and 2.15 mm (0.085"). The smaller diameter can be obtained by processing the wire on a multi-pass drawing machine derived by O.T.T. technology for steel cord. A typical 1+6 ACSR conductor is shown in the photo.

The aluminium conductor, steel reinforced (1+6) can be obtained by processing the CCW aluminium wire which has been coiled on bobbins of 630 mm diameter and then onto a type SK630/6 'High Speed Strander', designed by RTM of the Continuous Wire Machinery Division.



1+6 ACSR conductor

Aluminium steel clad with Pro-form

The new Properzi rotary extrusion machinery has been branded under the name Pro-Form, which stands for Properzi Forming. The extrusion machine consists of:

- a base frame, providing a fabricated steel structure with mountings for:
 - a Continuous Rotary Extrusion head including the main drive shaft, an extrusion wheel and the extrusion shoe assembly. The Extrusion head for the production of aluminium clad steel is tangential type
 - a reduction gearbox
 - a main drive motor
- hydraulic, pneumatic and electrical control sub-systems.

Properzi's R&D department updated the design, and the Pro-Form machine is now operating in our factory with short production runs of special profiles and semi-industrial runs with different solidal conductors.

This new Pro-Form is equipped with a 300

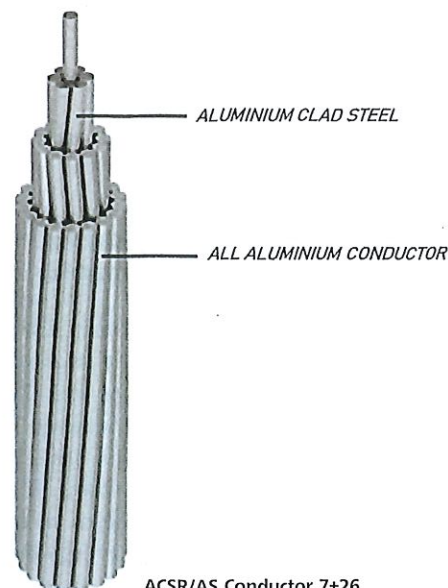


Partial view of a Pro-Form line

mm wheel and motorized for producing a wide range of products and conducting tests on specialty profiles starting from Al and/or Cu rod. The Pro-Form range of machinery includes 420 and 500 mm wheel diameters.

The range of applications is almost infinite whereas the major ones have been listed above, but currently our attention is focused on the Aluminium-Clad Steel (ACS) wire. Continuous-Properzi is the only company that can offer all the machinery involved in the entire ACS wire manufacturing process, which includes:

- CCR Al Rod Line
- Steel Rod Drawing Machine
- Feedstock Preparation Line
- Pro-Form Line



ACSR/AS Conductor 7+26

- Wire Drawing Machine for processing the ACS wire
- Pay-offs and take-ups
- Wire Stranding Machine if required

The aluminium clad steel application will become extremely important in the very near future considering the efforts made by the cable makers to push the use of ACSR/AS, since the bimetallic conductor resolves many of the problems typical of ACSR wire such as galvanic corrosion and sparks.

Aluminium Conductors, Aluminium Clad Steel Reinforced (ACSR/AS) are typically concentrically stranded conductors with one or more layers of hard drawn 1350-H19 aluminium wires on aluminium clad steel wire core. The core can be single wire or stranded depending on the size.

The mechanical properties of ACSR/AS conductors are similar to ACSR conductors but offer improved capacity and resistance to corrosion because of the presence of aluminium clad steel wires in the core. These conductors represent a better replacement for ACSR conductors where corrosive conditions are severe.

The main ACSR/AS features are:

- Good mechanical properties
- Improved electrical characteristics
- Excellent corrosion resistance
- Better SAG properties.

Continuous Wire Machinery division view of the Skip Strander Sk630/6

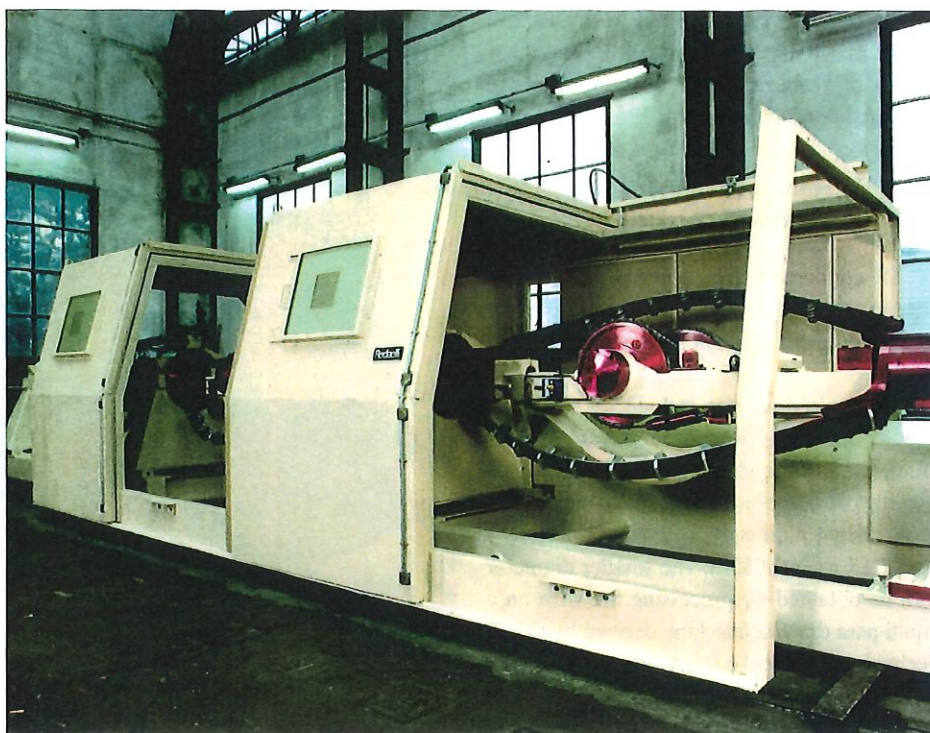
The Skip Strander machine is characterized by the low mass of a rotating body made of

the bows and supporting rotors to allow high revolution speeds. The basic design has been studied and optimized for use of both ferrous and non ferrous wire.

The machine is suitable to process six bobbins of aluminium wire having a diameter ranging from 1.4-4.5 mm (15-5 GA) as well as a core made by steel or ACS wire having a diameter of 2.7 mm (10 GA) coiled on bobbins of 630 mm (24.8") diameter according to DIN 46395.

The final diameter of the strand is 8.1 mm (0.319"). Assuming that the pitch of the helioid is 145 mm (5.7"), the theoretical linear production speed is 203 m/min (666 ft/min) which, considering an eight hour shift operating at 85% efficiency, allows an output of about 82,500 m/shift (270,669 ft/shift).

The finished strand is collected onto bobbins of suitable diameter. The combination of the CCW technology and the available stranding technology allows the cable producers to obtain stranded wire while completely avoiding any problems and/or costs associated with the reduction in wire rod size. Properzi CCW technology makes it truly possible to go from aluminium ingots to bare overhead conductors while using two production lines only. By adding the Pro-Form machinery, the

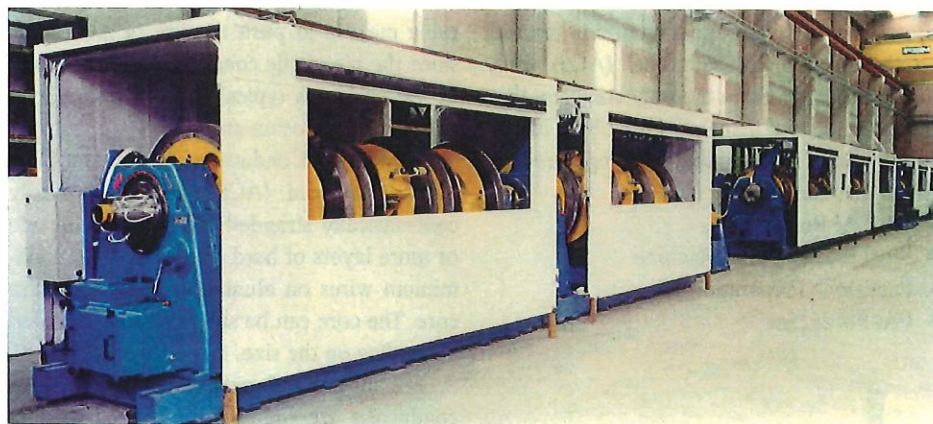


Skip Strander machine

and ACSR composition can be obtained by use of the Skip Stranding machine to produce the steel reinforced core (1+6) and type ZSAK Cage Stranding machine, specially

the stranding point, the nose of the cage.

Since the bobbins are not subject to centrifugal forces, all resulting in negative aspects of such dynamic necessities, it is possible to strand at a much higher speed with better overall stranding quality. The machine is suitable to manufacture conductor cables having up to 61 wires, as well as with tandem applications.



Zsak Strander machine

aluminium clad steel can also be produced in-house in order to monitor all production phases.

More complicated conductors of AAAC

designed for copper and aluminium applications.

**Continuous Wire Machinery division
view of the Zsak Strander machine**

The cage consists of multiple rotor units. Each unit provides six pairs of bobbins mounted upon the main shaft. The bobbins and the main shaft operate on heavy-duty bearings.

A flyer connected to the main shaft is installed between each pair of bobbins. The flyer takes the wire from the bobbins up to a point where the wire is guided through the shaft by a special guiding system to arrive at

Conclusions

Continuus-Properzi, with the implementation of all the technologies described in this article and in its portfolio, is the only company in the world that can offer a complete technological solution to the market: from the melting equipment for aluminium ingots/T-bars to wire rod, including the Properzi forming machinery to produce the aluminium clad steel, to the finished wire used to strand conductors for the production of power transmission and distribution cables such as the traditional Aluminium Conductors Steel Reinforced (ACSR) and the advanced Aluminium Conductors, Aluminium Clad Steel Reinforced (ACSR/AS).

Our sales team is at your disposal for any further clarification and to offer our equipment for your projects.

Author

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