# PTA and COBALT

COMMERSALD

THE WELDING GROUP

# COMMERSALD IMPIANTI

# PTA and Cobalt – longer working life and higher resistance for plungers

## NICKEL VS COBALT ALLOYS

### Nickel alloys

Until now, the use of nickel alloys has had a fundamental role in the coating of plungers for the glass sector, filling the gap between the wear of the mould – collar – bottom, and the plunger. The name 'nickel' is used to describe the series of nickel – chrome – boron – silicon alloys (Ni Cr B Si) which have a relatively low melting temperature of between 1050°C and 1150°C. If we consider that cast iron or steel have melting temperatures of around 1400-1450°C, it's easy

A recent visit to Commersald Impianti gave us the opportunity to look into one of the most recent developments this company is providing for glassmakers – PTA welding on plungers and more robust and long lasting life – using cobalt.

to see how these alloys can be easily coated and recast without causing the base material to melt. In fact, the difference in melting temperature between nickel-based alloys and base material is around 250°C, allowing the operator to perform the recasting of the nickel-based alloy in complete safety. Remelting is necessary as nickel based alloys are mainly coated using two methods: oxyacetylene flame and HVOF technology. During these two methods, the nickel-based powders are fused and impacted against the base metal, creating a series of more or less porous layers (depending on the speed at which the particles impact the target surface) and must then be recast to remove porosity.

Remelting can take place with different methods, in some cases by means of an induction system to bring the deposited layers close to the melting temperature, but the 'final touch' must be carried out by hand by experienced staff.

### Cobalt alloys

We use the word Cobalt to actually define an alloy with the following chemical composition: Cobalt-Chromium-Tungsten, or Cobalt-Chromium-Molybdenum, in some cases, with the best performing alloys: Cobalt-Chromium-Tungsten-Molybdenum-Silicon-Carbon-Boron.

Cobalt alloys, usually called Stellite®, owe their hardness and the persistence of their hardness – even when hot – mainly to the formation of Carbides or Borides. Some Stellites®, in fact, have a very high percentage of carbon that can reach up to 2.5 per cent. Other Cobalt alloys such as Tribaloy®, having practically no Carbon (<0.08%), with hardness coming from the formation of the Laves phase which, in some cases, can reach and exceed 50 per cent of the matrix.

The main feature, in both these cases, is the persistence of hardness when hot.

## THE USE OF COBALT COATING FOR PLUNGERS AND OTHER MOULD ACCESSORIES

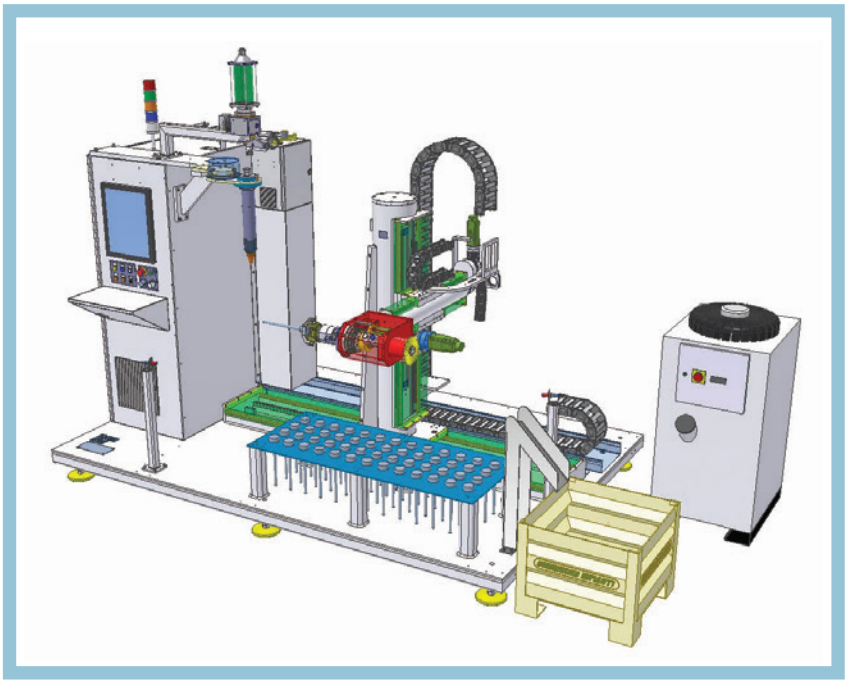
**Speaking to Commersald**

### Methods use to coat plungers

***Massimo Trigari – General Manager:*** One of the important parts of moulds used by glassmakers are plungers. So let's consider PTA (Plasma Transferred Arc) machines, which use a flame to melt and weld the powder material onto moulds. However, in the case of plungers, which are long and thin, the welded material tends to slide downwards. Another important fact to consider is that the coating of plungers is mostly carried out 'by hand' and not automatically.

Another method often used is HVOF – a system to spray the powder onto plungers. This method, however, involves large spraying cabins where the powder is fixed onto the surface of the plungers mechanically and forcefully.

We therefore needed to invent a method to weld the material onto the surface of the plungers while, at the same time, main-



taining a regular speed in carrying out this operation. Not so difficult, right? And that's exactly what we thought until we started to test various methods.

***Alberto Sgarbi - Technician:*** Let's start from smaller plungers such as Blow Blow, which were, until recently, made of Carbon steel or cast iron, then coated by hand (sprayed and then welded) by experienced and skilled workers. These operations had to result in a surface as compact as possible and then smoothed.

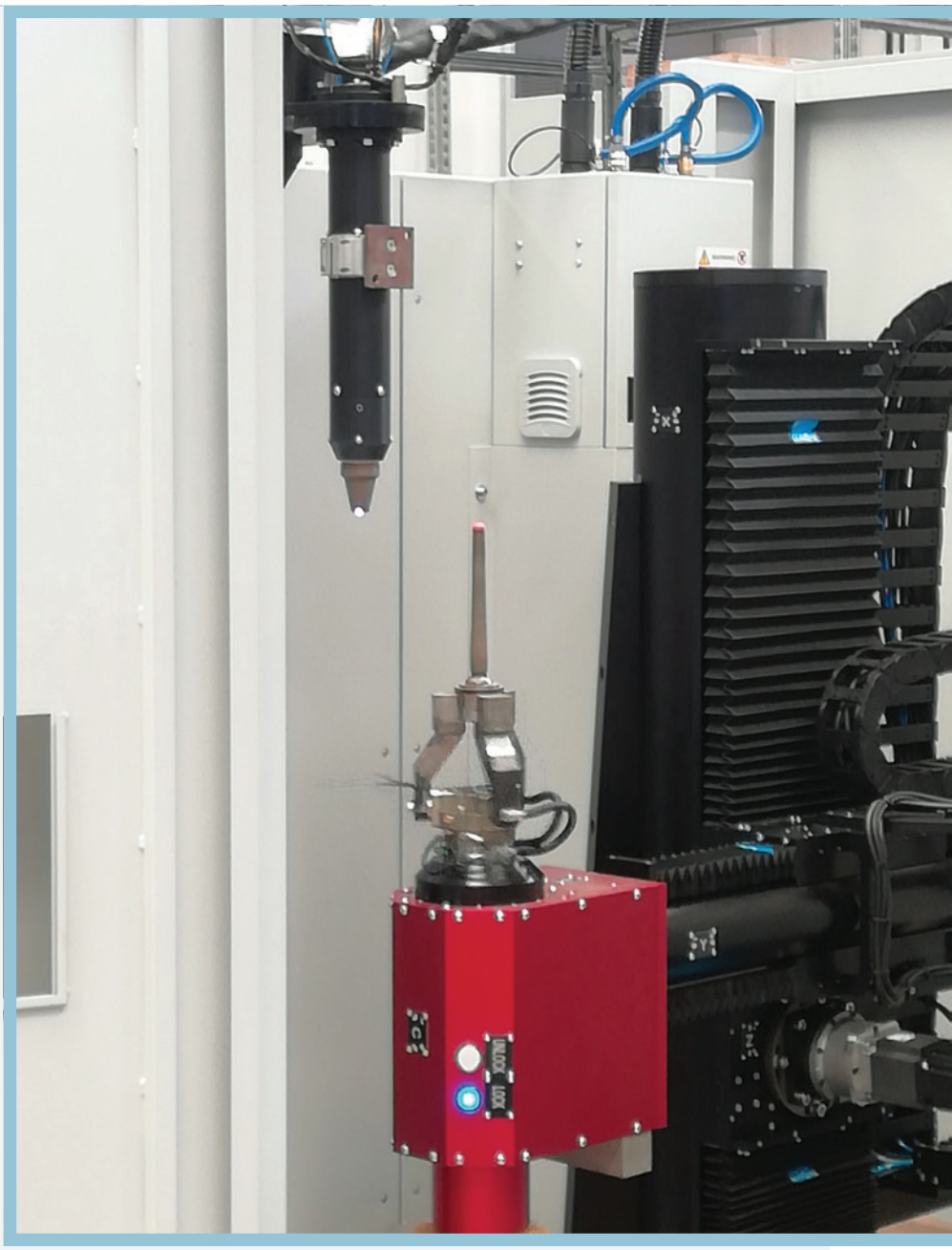
The main problem in this processes is that the base materials used have a melting temperature of about 1450°C while the powders used – nickel – chrome – boron-silicon, melt together well at 1050°C. And this is where the skills of the operator come in, because he has to carry out further work to weld the powders onto the surface 'by hand'.

And as said previously, these plungers were then turned and processed to reach the smoothness required.

We were contacted by clients, who showed us that after 92 hours of work, the nickel in the coating of small-sized plungers started to 'lift away' from the surface of the metal. This meant that when the plunger came out of the bottle being produced – with glass at very high temperatures – it dragged some of the molten glass with it because the surface of the plunger was no longer smooth and compact.

Glassmakers then started to request higher hardness – 40 Rockwell instead of 30, even requesting plungers with 50 or even 60 Rockwell hardness.

This extreme hardness meant that after 92 or 100 hours of work the plungers needed to be replaced completely, with relative production downtimes to change the parts.



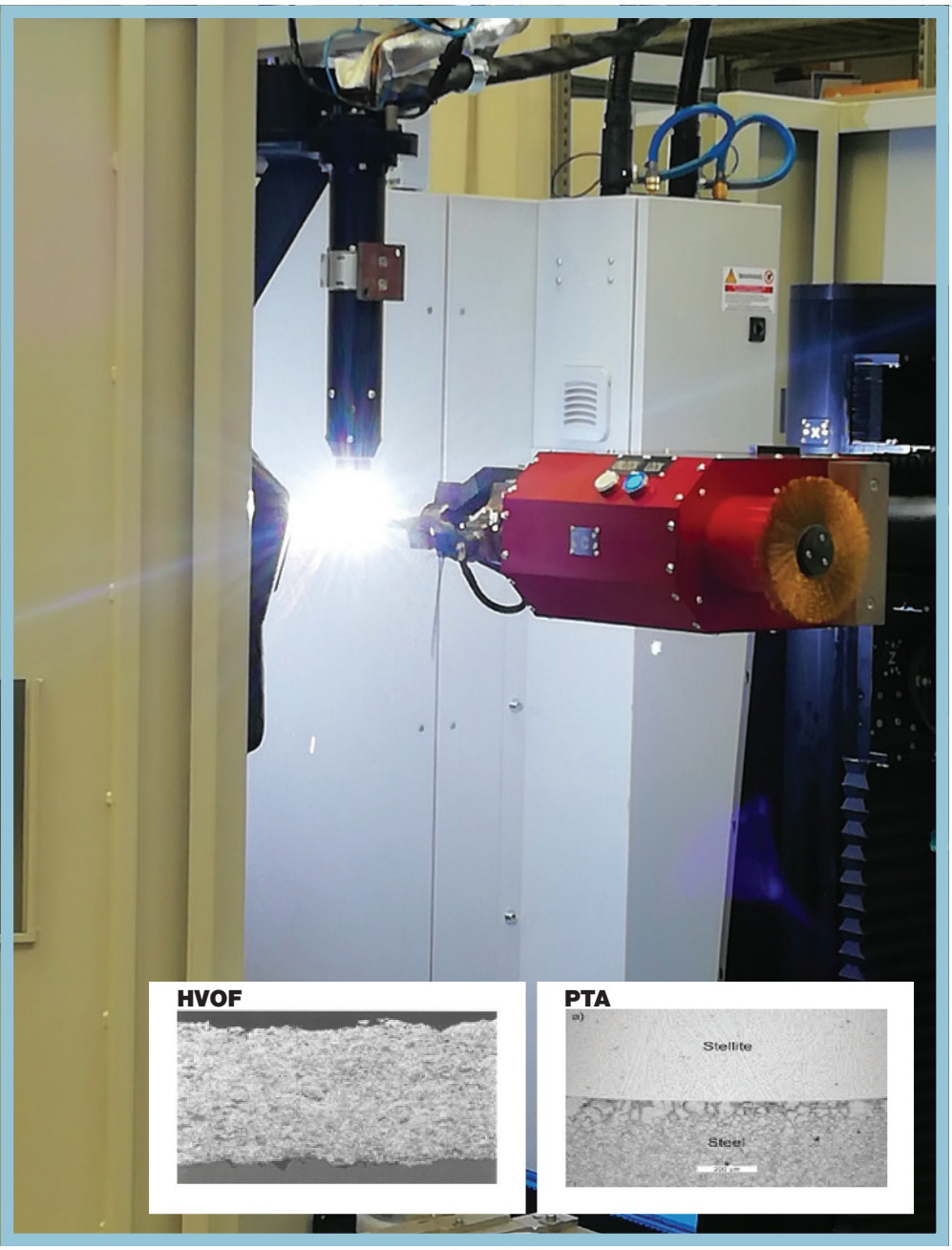
## Hardness at environmental temperature

After searching on the Internet – we came up with (it's there for everybody to see) the following information, which speaks about the hardness of plungers at environmental temperature. But why do we need to have this confirmation if plungers work at high temperatures: 1200, 720, 650 or even 580°C, depending on the type of glass used.

What's more, processing alloys with hardness of 60 Rockwell is extremely difficult, and even the strongest metals soften when working at high temperatures, such as nickel – chrome – boron-silicon alloys, which are hard at environmental temperatures.

The only alloy that does not soften at high temperatures is a cobalt alloy. In fact, cobalt alloys with a hardness of 40 Rockwell at environmental temperature, also maintain this level of hardness at high temperatures.

This means that we can have a plunger that is not so hard at environmental temperature – but is easy to process – which maintains




this same hardness when working at extremely high temperatures. An important advantage for both mould and accessory manufactures, as well as for glassmakers.

The conclusion that we came to was that instead of coating using nickel – chrome – boron-silicon alloys, we needed to use cobalt-based alloys for plungers. But there was a problem which involved the fact that carbon steel and cast iron have a different melting temperature, which is about 1400-1450°C just like the cobalt alloys.

This means that these alloys can be sprayed using the same blowpipe or by means of HVOF, but when these are re-melted, the part below the coating melts – so these alloys can be deposited using traditional methods, but not re-melted. Our next step was then to look for another method of coating, and this is exactly what we have done.

## The use of PTA

We used PTA, which we have always believes strongly in, which is a special method of hard-facing, also for the smallest diameters, creating a new plant, which works at very high rotating speed, with extremely efficient numerical control, and practically all new accessories, starting right from the nozzle.

And, of course, using PTA to melt the coating onto the plungers, there is no need to re-melt, as PTA welds the material onto the surface at 18,000°C. The only part that is melted is the very external surface.

When we then tested the plungers in glassworks coated using this new method, we discovered that the plungers working life was three times longer than other plungers – no longer 90 hours, but more than 300 hours – sometimes up to 600 hours depending on the type of glass being used.

There is, however, another important advantage. With the traditional HVOF method of coating, a great deal of the material – about 70 per cent – to be coated is dispersed in the air. As an example, a small-sized plunger needs 90 to 100 or even 120 grams of powder.

With PTA, we can coat three plungers with the same amount of powder, as the process is completely automatic and numerically controlled – without human intervention.

This also means that the machine can process up to 52 plungers in the same time it takes to coat a single plunger manually, without operator intervention for at least three hours – all with the exact same coating results.

## Testing the 'new' plungers directly with the glassworks

Testing was carried out not with mould manufacturers but directly at glassworks, the end users of these accessories. We actually manufactured plungers with third-party companies.

During these tests, with cobalt-

coated plungers working alongside nicked-coated plungers, the results were clear to see – especially with regards the duration of the plungers, but also the quality of the glass bottles produced.

Glassworks then started to request cobalt-coated plungers from mould manufacturers, who obviously needed our PTA machine to coat the plungers. These machines can also coat with nickel, with the advantage of coating a higher number of plungers.

### New machines

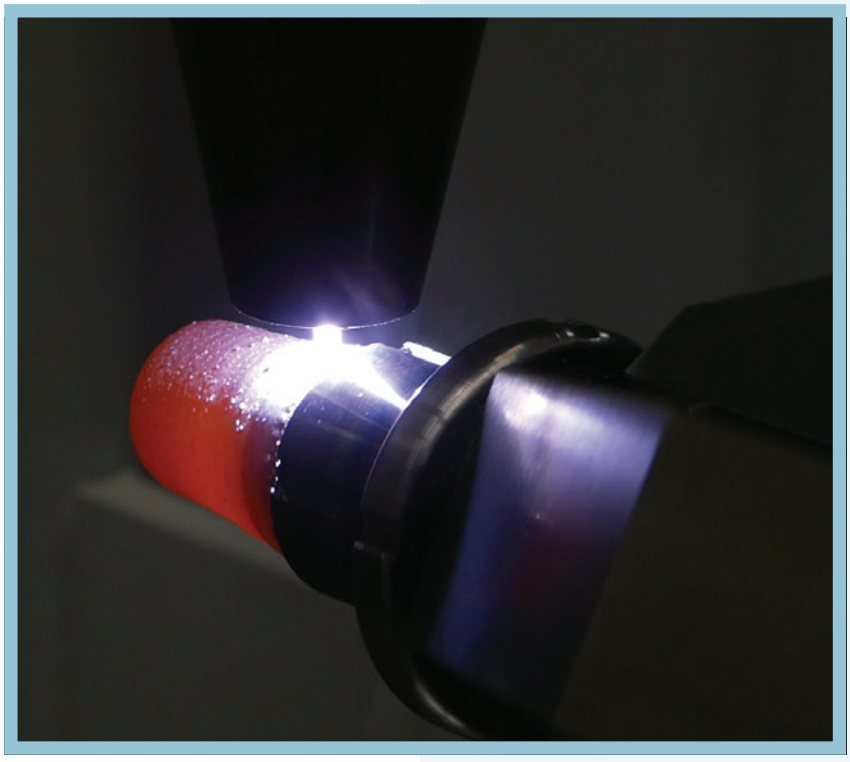
Obviously, our machines needed to be designed specifically to process these plungers. And when speaking to mould manufacturers, many told us that they manufacture plungers for the first part of the month only, and therefore wanted a machine that could also process neckrings and bottom plates, etc..

***Massimo Trigari:*** However, for the first machines that we sold, starting from glasstec 2018, customers wanted a machine that processed neckrings too, but actually during the first year they processed plungers only, processing over 18,000 plungers. Thanks to this new machine these companies have been able to increase its workload of plungers incredibly – first of all with nickel coating, and then followed by cobalt-coated plungers.

The same machine can be easily adapted to work with neckrings and other accessories simply by changing the tray containing the items to be coated, the gripper to pick the items up, and changing the programme of the machine.

At present, however, only plungers are coated with cobalt. This is due to the fact that other accessories are made of cast iron or bronze, which cannot be coated with cobalt. In the future, if mould manufacturers start to manufacture these accessories in stainless steel, there will also be the possibility of coating them with cobalt.

With this new machine we have, indirectly, created a new type of demand in the market – for our PTA machine.



### Ease of use; very little operator intervention

PTA machines are is really simple to use, as the operator needs to stay near the machine for the first 15 minutes only, just to set up the programme of the process to be carried out.

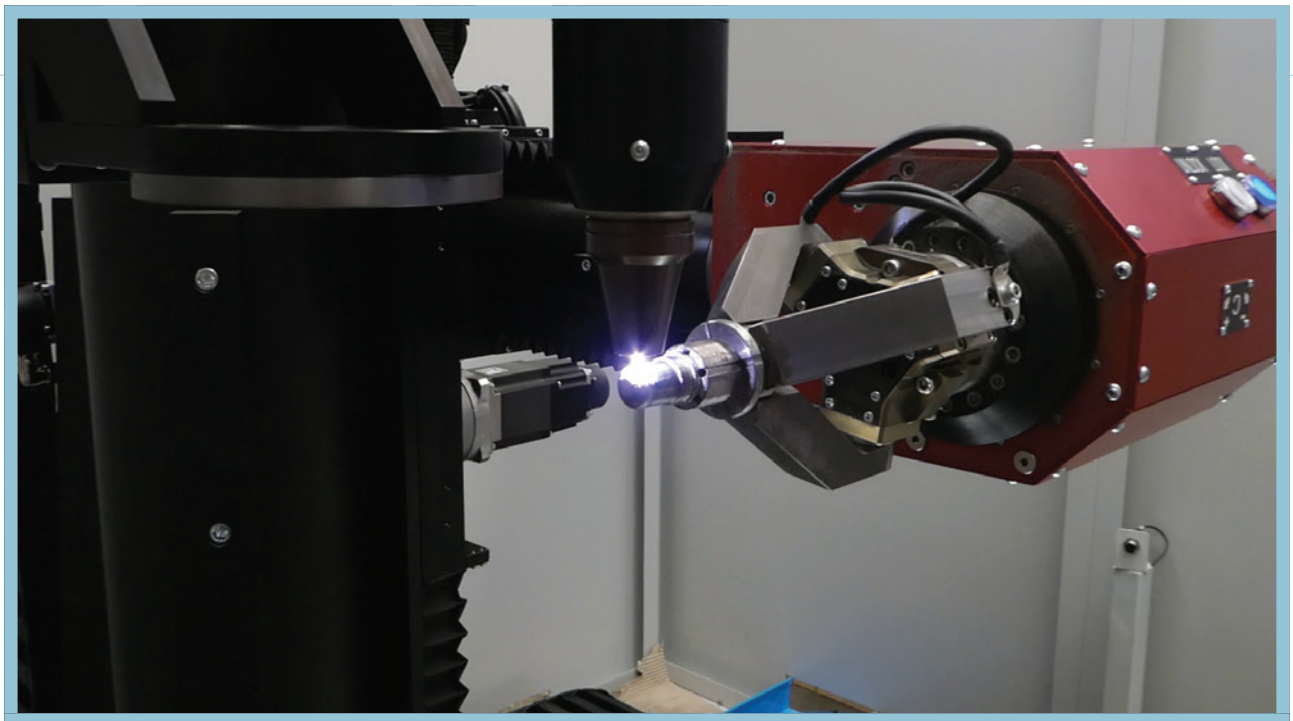
The important characteristic of this machine is its standard format, able to process 52 items – working without operator intervention for almost 3 hours.

***Alberto Sgarbi:*** When we were developing this type of process and machine, we also had some unexpected 'surprises'. When bottles are created with an IS machine, for example, temperature management is fundamental. In fact, the shorter the time it takes to create the bottle, changing the glass from liquid state to solid state, the better the results will be. On the other hand, if the glass temperature is low and the glass is too dense, it will damage the plunger.

When IS machinery users replaced some of the plungers used with our cobalt-coated plungers, they saw that our plungers worked at 100°C lower temperatures because the heat exchange created by the air flow was extremely efficient. This, in turn, means that cobalt-coated plungers cool down faster and, therefore, can work more, manufacturing more bottles.

***Massimo Trigari:*** Important glassmaking groups have already informed their mould manufacturers that they would prefer to have cobalt-coated plungers from now on. So in turn, mould manufacturers are starting to buy our machines – also thanks to the benefit of automatic working – loading and unloading included.

A further important characteristic of this machine is that with a single numerical control, we programme both coating and all



handling operations – also pre-heating operations if required.

We have created three types of this machine: standard – which carries out automatic coating of plungers, followed by a 'top' version that also coats neckrings and accessories and includes a 12 kw induction pre-heater, as well as a 'manual' version which requires automatic loading and unloading of plungers.

***Alberto Sgarbi:*** Another advantage regards to possibility of short production runs – not just for 52 items, but also for smaller batches such as 10 to 15 items and this is our manual machine, for smaller mould manufacturers.

All this is an important example of the benefits that technological developments and human insights that lead to these developments are essential to improve the quality of final products and, ultimately, to improve the working conditions of operators.

COMMERSALD IMPIANTI

**COMMERSALD IMPIANTI Srl**

Via Labriola 42
41123 Modena (MO) - Italy
Tel.: +39-059-822374
Fax: +39-059-333099
E-mail: info@commersald.com
www.commersald.com