HAIRPIN TRACTION SOLUTIONS

WINDING AND ASSEMBLY TECHNOLOGY FOR E-MOBILITY







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IMA AUTOMATION FLAWLESS ASSEMBLY

IMA AUTOMATION IS THE SEGMENT OF IMA GROUP COMPOSED OF LEADING COMPANIES IN THE AUTOMATION AND ASSEMBLY INDUSTRY, WITH OVER 50 YEARS OF EXPERIENCE.

With its integrated network of companies which guarantees a worldwide coverage, IMA Automation designs and manufactures advanced technology lines for handling and assembling parts for different applications fields, such as Automotive, E-Mobility, Electrical Motors, Medical Devices, Eye Care, Caps & Closures, Electro Mechanics and Watchmaking.

IMA Automation companies have developed top-of-theline technical skills, earning excellent market reputations and positioning themselves as leaders among those offering specialized technological solutions. IMA Automation hub is a perfect addition to the already consolidated packaging experience of IMA, allowing a synergy in the sharing of clients and widening our offer of technological solutions.





IMA, A SOLID LEADING GROUP IN PROCESSING, PACKAGING & AUTOMATION

Established in 1961, with the headquarters in Bologna, Italy, IMA is world leader in the design and manufacture of automatic machinery for processing, packaging and assembling products for several application fields. With a turnover of more than 1.600 million euros and 6000+ employees, the Group is present in about 80 countries, supported by a sales network made up of several branches, representative offices in central-eastern Europe and more than 50 agencies. IMA Group has more than 40 production plants in Italy, Germany, France, Switzerland, Spain, the UK, the USA, India, Malaysia, China and Argentina.



A WIDE NETWORK OF LEADING COMPANIES, A UNIQUE EXCELLENT OFFER.



STATE-OF-THE-ART SOLUTIONS FOR HAIRPIN MOTORS IN

While covering the full spectrum of technologies, IMA AU-TOMATION ATOP is a state of the art player in hairpin, confirmed as the reference technology for large scale production of stators for traction electric motors.

Focus on continuous e-traction technological development in hairpin stators and other winding technologies, with highest flexibility upon customer requirements.

Main applications of hairpin motors in e-mobility field, produced by IMA AUTOMATION ATOP equipment:

- M-HEV MILD Hybrid Electric Vehicle 48V
- **HEV** (FULL) HYBRID ELECTRIC VEHICLE
- P-HEV Plug-in Hybrid Electric Vehicle
- **BEV** BATTERY ELECTRIC VEHICLE
- **FCEV** FUEL CELL ELECTRIC VEHICLE



Tailor made technological solutions for traction hairpin stators.



From product design analysis and prototyping to series production:

- Early entry in product design analysis aimed at optimizing the production (productivity and quality)
- LABORATORY FOR SAMPLES PRODUCTION AND PRODUCT DEVELOPMENT VALIDATION
- Fully automatic stator line with high production rate

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PRODUCT DESIGN ANALYSIS

IMA AUTOMATION ATOP approach is based on a win-win cooperation with our customers.



FROM CUSTOMER NEEDS IDENTIFICATION

Preliminary product design evaluation

PAMO: Product Analysis for Manufacturing Optimization

Manufacturing project definition from **LAB concept machines to Mass Production**

Dedicated facility for A,B,C stator construction at IMA AUTOMATION ATOP

Customer product definition & manufacturing process flow



TO PROJECT ACQUISITION

Customer PO

Dedicated Project Management Team

- Plant/machines Design review option
- Sourcing & parts manufacturing, equipment assembling, pre testing
- Commissioning at Customer & SAT
- Training and support to production

PROCESS FLOW OF HAIRPIN STATOR PRODUCTION LINE



HAIRPIN FORMING AND INSERTING

STATOR ASSEMBLY

Tailored solutions with high technological content to meet specific customer requests, even the most complex, worldwide.

OTHER PROCESSES INTEGRATION



A WIDE RANGE OF SOLUTIONS AT EVERY STEP OF MANUFACTU



RING PROCESS





Visual Inspection

Hairpin Palletizing Station

STATOR INSULATING





AUTOMATIC MACHINE FOR SLOT INSULATION FORMING AND INSERTING.



HIM Hairpin Insulating Machine

- Paper forming unit based on insulation material specification and specific product design
- Stack length measurement for correct paper length
- Paper length cut through CN motor according to stack length
- Paper position guaranteed by the inserting process mechanism and by specific tooling
- Paper presence and final position (on one side only) controlled with a dedicated sensor



HAIRPIN FORMING







HAIRPIN FORMING MACHINE WITH CONDUCTOR FEEDING SYSTEM, LASER WIRE DECOATING, SINGLE HAIRPIN CREATING AND INSERTING STATIONS.



HFM Hairpin Forming Machine

- Machine capable to perform all hairpin, pitches, lengths, product specification
- Wire insulation removal
- IMA AUTOMATION ATOP proprietary flexible system for the creation of hairpins by means of robot manipulator with 6 brushless motors
- Robot system to transfer the formed hairpins towards the nest forming system



HAIRPIN INSERTING



























SHUTTLE WITH TRANSFER HEADS, MOVING NESTS TO THE INSERTION STATIONS THROUGH A PORTAL SYSTEM.



HSI

HAIRPIN SHUTTLE AND INSERTING

- Transfer heads move and insert inner and outer layer nests into the stator at the insertion stations
- Insertion stator tooling holding hairpins during insertion and protecting insulation
- \cdot A load/unload device transfers the stator between pallet and insertion station
- Different configurations are available



WIDENING AND TWISTING





AUTOMATIC MACHINE WITH HAIRPIN WIDENING AND TWISTING STATIONS INTEGRATED.



HWT

HAIRPIN WIDENING AND TWISTING

- Loading/unloading portal
- Widening group to widen the hairpins and prepare them for the twisting operation
- Twisting group bending the conductors according to the twisting angle as per customer's diagram
- Motor torque monitored and limited to a max value
- \cdot 100% control stations for each process



WIRE CUTTING











THREE-STATION MACHINE FOR SINGLE WIRE CUTTING, STATOR TILTING AND MULTIPLE WIRE CUTTING.





HCM HAIRPIN MULTIPLE CUTTING MACHINE

 Machine for multiple conductors cutting at constant length by means of NC mandrel

HRD HAIRPIN REVOLVING DEVICE

Machine for 180° stator revolving



HCM HAIRPIN SINGLE CUTTING MACHINE

• Machine for single conductor ends cutting



HAIRPIN LASER WELDING















HAIRPIN LASER WELDING MACHINE WITH OPTICS USING LASER BEAM DEFLECTION WITH MOTORIZED MIRROR SYSTEM.



HWW

HAIRPIN WIRE WELDING

- Motorized mirror system on multi-axis device for correct laser beam orientation during welding
- Optical tracking system for accurate welding target detection with integrated camera in the welding head for welding position correction
- Two independent units gripping and holding each couple of conductors to guarantee a perfect junction and position
- The system allows to maintain each couple of wires under constant pressure
- Laser unit including generator, coaxial fiber, PFO head
- 6-axis robot moving the welding head



BUS-BAR ASSEMBLY AND WELDING







AUTOMATIC MACHINE FOR BUS-BAR ASSEMBLY AND WELDING WITH LASER SYSTEM.



HBW

HAIRPIN BUS-BAR WELDING

- One robot for BUS-BAR pickup from tray and assembly
- One robot for laser welding
- Laser unit including generator, head for centering
- Optical tracking system or welding target with camera integrated into the welding head
- Welding quality checked by the 3D control system integrated into the robot arm
- Other customized solutions are available



ELECTRICAL TESTING







TESTING MACHINE, INSTRUMENTS, HW AND SW BASED ON IMA AUTOMATION ATOP KNOW-HOW AND TECHNOLOGY.



HTS Hairpin Testing Station

- Stator electrical testing system operating on conveyor
- Hi-pot test up to 3500 V at 30 mA
- Surge test up to 6000 V
- RL test for resistance and field measurement
- Hi-current test up to 200 A
- Insulation resistance up to 200 $\text{M}\Omega$
- $\boldsymbol{\cdot}$ NTC sensor measurement and insulation vs. winding test
- Partial discharge surge test/high-voltage measurements
- Pyrometer/environmental sensor for temperature compensation



OTHER PROCESSES INTEGRATION

Based on customer request and product specification, IMA AUTOMATION ATOP proposes dedicated and customized process solution







3D vision systems for stator inspection:

- In-process control
- End-of-line control





MANUAL OPERATIONS

Dedicated manual station based on customer request.





Manual station for stator inspection and rework.







Automatic systems for loading and unloading of stators and components.

imautomation.com



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