Manufacturing field F7
Laminated core production
4.1.2.7 Manufacturing field F7 - Laminated core production

4.1.2.7.1 Range of services

The magnetic circuit of electric machines includes the stator and the rotor laminated core. These consist of laminated electrical sheets. Depending on the size and diameter of the laminated cores, there exist a number of options for manufacturing the corresponding sheets.

Sheets up to a laminated core outside diameter of 1,250 mm are usually cut out as a complete contour, thus creating a ring. With laminated core outside diameters exceeding 1,250 mm, the sheets are manufactured as segments and combined into the complete core. Our company has a variety of processes available for producing the individual contours.

**PRODUCTION OF INDIVIDUAL SHEETS**

**Laser cutting**

The programmable machine control of the laser cutting units allows the production of any desired contour for the electric machine.

With a very low cutting tolerance and a high repeat accuracy, this procedure is the optimum solution for the production of high-quality contours.

It is used for the manufacturing of prototypes, repair and small series of electric machines, but also for realizing deliveries of electrical sheet contours within a short time frame.

**Water-jet cutting**

For contours that cannot be cut using the laser cutting method, we apply our water-jet cutting system.

With a pressure of up to approx. 4,000 bar and the addition of an abrasive agent, non-ferrous metals up to 100 mm, aluminum up to 250 mm and steel up to 100 mm material thickness can be processed.

As this procedure allows the processing of a large variety of materials, many parts of the electric machine, such as pressure plates, press rings or copper parts can be manufactured.

**Post-treatment of sheets**

During the manufacture of electrical sheet contours, a cutting burr is created, which can cause an electrically conductive contact between the sheets when pressing the laminated core. This facilitates the generation of eddy currents over various sheets, thus increasing the hysteresis losses of the laminated core.

This effect can be eliminated by post-treatment of the electrical sheets.

During post-treatment the cutting burr is removed and the sheet is recoated on both sides.
4.1

Laser cutting unit

Water-jet cutting system

Water-jet cut contour

Deburring and coating system
ASSEMBLY OF LAMINATED CORES FOR STATORS AND ROTORS

In our company we offer a number of assembly methods. Please feel free to contact us – we are always happy to help you select the appropriate method for your application and advise you on the corresponding advantages and disadvantages. We can layer the sheets in a so-called layer cage or directly into the housing. The layer cage is used as an auxiliary means and is adapted to the outer contour of the sheet. The laminated core is pressed to shape under a press or using a pressing machine and fastened accordingly (e.g. by welding or clamping).

Another option is the assembly using a stacking mandrel. The mandrel is adapted according to the inner diameter of the rotor or stator core and will be removed after the completion of the layering. In case of machines with a laminated core outside diameter exceeding 1,250 mm, segments are used. These segments can also be layered directly into a cage or the housing. The core layered into the cage is then pulled into the housing completely.

Apart from the solutions given above, laminated cores can also be produced using free layering.

Here, the core is layered using auxiliary means and then fastened without applying a housing, mandrel or cage. Auxiliary means used for layering cores may include, for example, stacking strips or needles. These are ground in order to obtain dimensional accuracy.

Depending on the laminated core length, intermediate pressings are performed, thus ensuring dimensional accuracy.

In shrinking processes used for the assembly of laminated cores in housings or on shafts, the components to be joined are measured at room temperature and aligned vertically. After the uniform heating or cooling (shafts) of the corresponding components, these are subjected to the joining process and accurately aligned with one another.
CORE CONSTRUCTION

Production of:
- Rotor cores as individual core or on a shaft
- Main and commutating poles
- Stator insertion cores
- Bonded cores

The cores can be layered freely or integrated into the housing. The fastening of the cores is realised by clamps, welding or shrinking processes, among others.

Laminated cores made of whole sheets or segments with or without pressure plates

We develop individual solutions for the repair of laminated cores and provide assistance in the manufacture of prototypes. With the support of our welding engineering staff and the 3D measurement of large cores by our quality assurance team we can handle major complex projects.

Technical parameters
- Max. core size: L x Ø: 2,500 mm x 2,500 mm
- Max. weight: 40 t
- Max. pressing force: 6,000 kN
- Max. housing size: Ø 5,500 mm x 2,000 mm

Larger dimensions and weights may be feasible following technical evaluation.

WELDING PROCEDURES

The following welding procedures are used in laminated core production, in manufacturing and repair of components for rail vehicles:
- Metal active gas welding (MAG; 135)
- Tungsten inert gas welding (TIG; 141)
- Manual arc welding (E; 111)
- Resistance spot welding (21)

In these procedures materials of the material groups 11, 1.2 and 8 are processed.

Permits and test certificates

The PARTZSCH Group is certified according to DIN 18800-7:2008-11, Class D for the welding of steel structures with predominantly static load and is permitted to perform welding work within the specified scope for certification level CL1 according to EN 15085-2.

The final weld inspections are performed by our certified staff using the following procedures:
- Magnetic particle inspection
- Dye-penetration method
- Visual weld inspection
4.1.2.7.2 Technical parameters and machinery

TECHNICAL PARAMETERS
PRODUCTION OF INDIVIDUAL SHEETS

Decoiling of sheets from coil
- Max. coil weight: 10 t
- Max. coil width: 1,260 mm
- Max. sheet thickness: 1.0 mm
- Min. sheet thickness: 0.35 mm

Laser cutting
Material thicknesses:
- Thin sheet metal and electrical sheet from 0.2 mm to 3 mm
- Steel panels (mild steel) from 3 mm to 20 mm
- Max. working area: 2,050 mm x 4,000 mm

For thin sheet metal and electrical sheets up to a thickness of 1 mm we guarantee a cutting accuracy of +/- 0.05 mm.

Water-jet cutting
Water-jet cutting with and without abrasive agent at pressures of up to 4,000 bar for a variety of 2D contours.

Typical materials:
- Stainless steel up to 100 mm
- Mild steel up to 100 mm
- Aluminum up to 250 mm
- Non-ferrous metals up to 100 mm

Max. working area:
- 3,000 mm x 3,000 mm

Additional materials and material thicknesses may be feasible following technical evaluation.

Spot welding of sheets
- Spot or projection welding of sheets for the production of ventilation and cover plates.

Deburring and coating of electrical sheets
- Removal of cutting burr on cut and punched contours
- Subsequent application of insulating varnish on both sides of the sheets
- Workpiece length: 350 mm to 1,250 mm
- Workpiece width: 350 mm to 1,250 mm
- Workpiece thickness: 0.35 mm to 1.0 mm

Coating specifications
- Viscosity: 60 to 150 DIN 4s
- Minimum application thickness: 2 to 3 μm on each side, dry
TECHNICAL PARAMETERS
WELDING

For the performance of welding work we apply state-of-the-art welding equipment, thus providing optimum results.

Inert gas MAG/MIG
- Max. output: 400 A
- Max. wire diameter: 1.6 mm

Inert gas TIG
- Output: 160 to 400 A

Resistance spot welding
- Nominal power: 40 kVA
- Max. welding power: 118 kVA
- Max. short-circuit current: 26.2 kA
MACHINERY
LAMINATED CORE PRODUCTION

For the production of laminated cores the following machines are at our disposal:

- 9 double-head laser cutting machines
- 1 water-jet cutting system
- 1 continuous deburring and coating system
- 1 decoiler
- 1 light measuring table

Decoiler

Large-format scanner for testing laser cutting

Laminated core in stacking tower with pressing machine

Double-head laser cutting machine