Built-in Motors

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Elektromaschinen und Antriebe

Contents

of

Advice for handling of

E + A motor elements

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Motorelemente
Motorlieferungen
Entwicklungen
Dienstleistungen

A Advice for handling of asynchronous E + A rotors

1 General advice

1.1 Types of rotors

In principle there are two different rotor types or rather rotor variants. The difference is the conductor material, which is aluminium or copper.
If the rotors with closed slots are implemented, this nearly always applies to copper rotors and very frequently to aluminium rotors, the laminated core covers the rotor bars.
Then the conductor material is only visible by regarding the short-circuit rings at the ends of the rotors.
The laminated core consists of single sheets, which are arranged in layers into axial direction. Therefore it is also called a laminated sheet package.

1.2 Delivery condition

The rotor types described here are unmachined.
However, as an additional option, E+A preturns rotors with a grinding stock allowance up to an outside diameter of 170 mm. For most applications the rotor can be shrunk directly on the shaft without any further machining.
Die-cast aluminium rotors can be recognised by their aluminium-coloured short-circuit rings. Dependent on the manufacturing variant and the type of rotor in detail, the surface of the laminated core can be polluted with aluminium residues. Copper rotors go through a soldering process during the manufacturing. By its characteristics soldering residues on the rotor surface cannot be avoided and they mainly appear within the range of the rotor ends. At the same time manufacturing residues on the surface of the outside diameter of the rotors lead to the fact that the outline of the surface is no longer round.
The rotors are no rugged, metallic tubes, even if they look like. The laminated sheet package is only kept together by the rotor bars, which are inside the slots. Therefore both rotor variants are not able to take up forces.
In delivery condition copper rotors are particularly susceptible to mechanical damage. The supposed carrying copper rotor bars are annealed by the thermal treatment during the manufacturing. A fall on the side of a copper rotor standing vertically on a work surface can lead to a bending of the entire lamination, whereby the rotor cannot be used anymore or rather its quality is reduced considerably.

1.3 Transport and storage

Aluminium and copper rotors have to be regarded separately due to their different material properties.
In principle copper rotors have to be stored only vertically (standing), unless they are supplied with a special transportation mandrel. After receiving the goods from E + A, the mandrel should be used as long as the rotor is stored horizontally.
The rotors standing next to each other have to be protected by corrugated cardboard for example against direct contact to each other. The cardboard protects with vibrations of the rotor freight against hitting together.
As already explained in the section *delivery condition*, copper rotors cannot take up forces. This applies in special way to loads in radial direction. Soldering residues within the range of the short-circuit rings lead in extreme cases to the fact that the outside diameter of the rotors is smaller in the center of the laminated core than at the rotor ends. Thus the rotors with horizontal storage do not rest on over their entire length. The dead weight of the rotors is sufficient to bend these during transport or by a longer storage period respectively. Thus errors in the following treatment become possibly unavoidable.
In principle the same interrelationships apply to aluminium rotors as to copper rotors, however they - the aluminium rotors - are mechanically not that susceptible in delivery condition and can be stored also horizontal

during appropriate cover with corrugated cardboard. Depending on size of the aluminium rotors it is quite permissible to store these in two or several layers.
It applies to both rotor variants that the security of the vertically stored rotors must be so good that possible tilting is avoided. Beyond that it must be absolutely prevented that rotors during transport cannot roll around and strike against each other. A transport in a padded box is recommended. The rotors have to be separated and fixed by paperboard strips or corrugated cardboard.
Lying aluminium rotors or carefully on the side put copper rotors can be horizontally lifted by mutual grabbing into the rotor bore (only permissible, if they will be lifted immediately, e.g. for the further transport to the processing center). Lighter rotors can be covered likewise with both hands at the outside diameter and lifted thereafter. Particularly heavy variants can ideally be raised and transported with a round, straight rod, which is led by the bore. In all cases the rotors must be gently put down. They may not be left to fall.

1.4 Reference outline

In order to be able to machine the rotor centrically, the rotor bore must be selected imperatively as reference outline.
During the production process of the rotor sheets as the first procedure the rotor bore is punched. This serves as reference for the rotor slots.
The outside diameter of the rotor is punched in a later work procedure. It is quite possible that the outside diameter of the rotor exhibits an eccentricity error opposite the rotor bore. This eccentricity will be balanced by using the reference of the rotor bore during the machining of the outside diameter. Ignoring this recommendation and using the outside diameters as the reference, on the one hand cyclic testing errors have to be accepted due to the polluted rotor surface and on the other hand the slots can be eccentrically transferred in relation to both diameters. The eccentric misalignment of the slots is hardly recognisable or rather measurable, because these are not visible e.g. with aluminium rotors. As consequence an increased unbalance appears. Apart from the mechanical disadvantages an electrical unbalance develops.

2 General advice for machining of E + A rotors

E + A is aware of the fact that sometimes the machining of the rotor elements can represent an extremely ambitious task. Apart from the equipment with appropriate machine tools belong suitable clamping tools, experiences and competent personnel to the successful machining of rotors. The choice of the tools or the machine tools respectively can quite vary for the successful machining of the same type of rotor. For this reason in this section it is refrained from presenting a concrete way as the "king way". Rather some general advice are given, which should offer a reference point, to avoid serious processing errors.
Therefore E + A appreciates to deliver the rotors machined.

As already mentioned in the section "reference outline", the rotor bore must be selected imperatively as reference outline. In a first step the rotor must be clamped best possible on the **full surface** in the rotor bore, in order to be able to machine the outside diameter of the rotor. Then the rotor has to be clamped best possible on the full surface (surface covering) at the outside diameter and finally the rotor bore can be machined.
The used clamping tools should show a minimum clearance opposite the rotor. Since in principle each re-clamping procedure causes a shift of the mass center of the winding of bar from the geometrical center of the rotor by the clearance of the tool opposite the rotor, the number of re-clamping procedures should be kept minimal.
Furthermore it has to be particularly noted that accordingly easy cutting tools with polished cut should be used. During the machining a moderate feed and cutting speed has to be selected. Ignoring this, the rotor package can expand into axial direction. The original length of the rotor must be maintained.
Thermal relieve or drying of the rotor in a furnace is permissible. The maximal permissible temperature amounts to 300°C.

B Advice for handling of asynchronous E + A stators

1 General advice

1.1 Types of stators

E + A offers three different stator types. The difference is their end winding designs. The conventional variant consists of vacuum-impregnated end windings, which are not encapsulated. For particularly ambitious electrical as well as mechanical winding protection the end windings are encapsulated under vacuum. Additionally with particularly high power densities the end windings are protected with a special aluminium cap and only afterwards encapsulated under vacuum. Therewith the stator winding is completely locked and no longer visible. An ideal protection from humidity is reached. The stators of the encapsulated variant *without* aluminium cap are called ENCA stators and are available up to an outside diameter of 90 mm. The stators *with* aluminium cap are called ALKA™ stators and are available starting from an outside diameter of 106 mm.

1.2 Delivery condition

The outside diameters of the stators described here are unmachined in the conventional and ENCA design. The stator bore is already finished and may not be machined at all. However in principle the possibility exists to let both variants as additional option completely machining by E+A. In ALKA™ design usually the stator is delivered fully machined.
Depending on scope of delivery the stators possess at least 3 power leads and further connecting leads of different thermo feelers or sensors respectively for the temperature monitoring of the stators. Furthermore in the two design variants ENCA and ALKA™ the stators have a defined positioning of the connecting leads.

1.3 Transport and storage

During transport the stators have to be placed vertically on the end windings of the non-connection side. Thereby the connecting leads rise up into the air or put carefully into the stator bore. In no case they may be bent. The leads of the sensors and feelers, which possess a clearly smaller diameter than the power leads and are substantially more flexible, should not hang down on the outside diameter of the stator. It is recommended to put them into the stator bore in order to a better protection of their isolation during transport.
It must be ensured that the underground of the stators is free from dirt, metallic splinters or other pointed objects. The outside diameters of the stators have to be separated by corrugated cardboard from each other, so that these cannot hit together. Additionally it must be guaranteed that the stators are secured against tilting and cannot slip around. An ignoring can lead with conventional, vacuum-impregnated stators to the damage of the isolation of winding, which apparent by a failure of the winding become quite only to a substantially later time in the inserted condition of the stator element.
In principle the stators on stock can lie as well, if they are secured and cannot roll away. Make sure that the isolation of the leads are not hurt by a sharp edged environment or the connecting leads are clamped or rather even are gotten jammed between 2 stator laminations.
During the transport of the stators over short distances within the manufacturing it is permissible to seize with both hands into the stator bore and lift the stator. In the conventional, vacuum-impregnated design it must be guaranteed that the isolation of winding is not damaged by sharp edged objects. Heavier stators can be lifted with lifting magnets, which are fixed at the laminated core or with a straight, round iron rod, which is to be led by the stator bore. In no case stators may be carried or pulled on their connecting leads.
Vertically stored, vacuum-impregnated stators may not be pushed or pulled on their end winding over the underground.

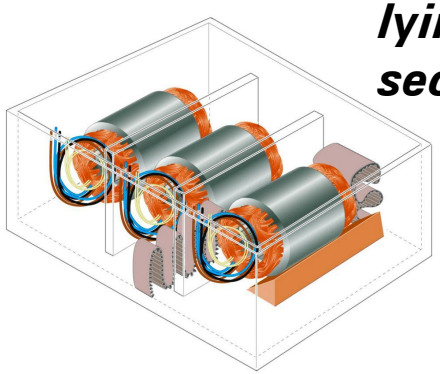
2 General references for machining of E + A stators

E + A is aware of the fact that sometimes the machining of the stator elements can represent an extremely ambitious task. Apart from the equipment with appropriate machine tools belong suitable clamping tools, experiences and competent personnel to the successful machining of stators. The choice of the tools or the machine tools respectively can quite vary for the successful machining of the same type of stator. For this reason in this section it is refrained from presenting a concrete way as the "king way". Rather some general advice are given, which should offer a reference point, to avoid serious processing errors.
Therefore E + A appreciates to deliver the stators already fully machined.

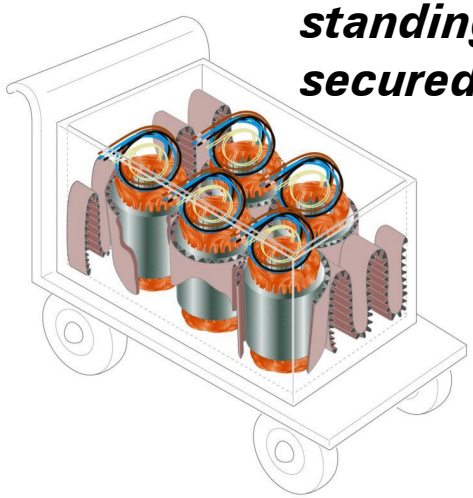
As previously mentioned the stator bore may not be machined. It serves as reference outline for the machining of the stator outside diameter. In addition the stator must be clamped best possible on the full surface in the stator bore. It should be refrained from fixing the rotor at the left and the right of the bore by using two spikes. If this proceeding is selected nevertheless, bending of the stator element is possible during the machining. Sometimes a machined stator outside diameter can lead to an improved cooling, as the contact between stator and external cooling housing is wide created.
Abrasive dust and cooling lubricants can lead to a quality impairment of the insulation strength of the winding. Therefore it should be already avoided during the machining that the end windings are unprotected exposed to the abrasive dust and the cooling lubricant.
Wet and dirty stators may be washed, if they are dried afterwards. Thereby a maximal permissible temperature of 110°C may not be exceeded for vacuum-impregnated stators. The dryness has to be controlled only after the complete cooling on ambient temperature over the insulation resistance of the winding against earth. Measurements of the hot stator are not meaningful. In addition a testing voltage of 500V is to be put opposite earth to the three parallel switched phases with an isolation measuring device. Thereby the insulation resistance has to be larger than 500MΩ. During the test procedure all temperature sensors must be short circuit, so that these are not destroyed. In addition in the ALKA™ design it must be ensured that the aluminium cap is mutual connected with the laminated core. This can be simply accomplished with magnets, which connect the cap with the package on both sides.
Any machining of the end windings is not permissible. A damage of the isolation of winding would be the result.
In principle ENCA and ALKA™ stators are very well protected and comparatively insensitive from the possible mechanical and electrical damages mentioned, because of the protecting vacuum encapsulation. In addition ALKA™ stators are assembled with an aluminium cap over the winding. If it is necessary to wash the stator this can be accomplished due to the vacuum encapsulation and the completely closed slots heedlessly. Nevertheless it is advisable to dry these. Thus humidity, which can penetrate for example between the individual sheets of lamination in the laminated core, can be again extracted from the stator package. The selected drying temperature in the furnace may not exceed 60°C. An ignoring of this limit value can lead for example to a thermal deformation of the ALKA™ cap, so it could be possible that the stator does not fit anymore into the cooling housing without an additional expenditure. Ideally ENCA and ALKA™ stators can be dried in the vacuum.
Due to the considering isolation characteristics of the ENCA and ALKA™ stators a start-up under liquid residues would be thinkable. However E + A recommend a control of the insulation resistance like it is indicated further above for conventional, vacuum-impregnated stators.

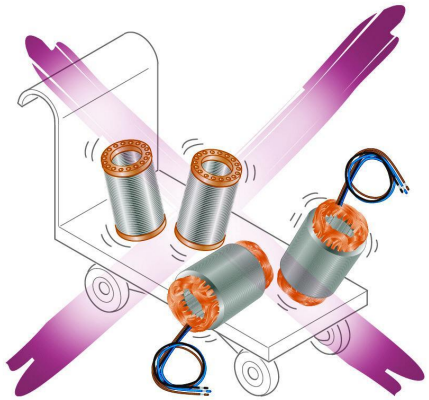
storage and transport

lying, secured



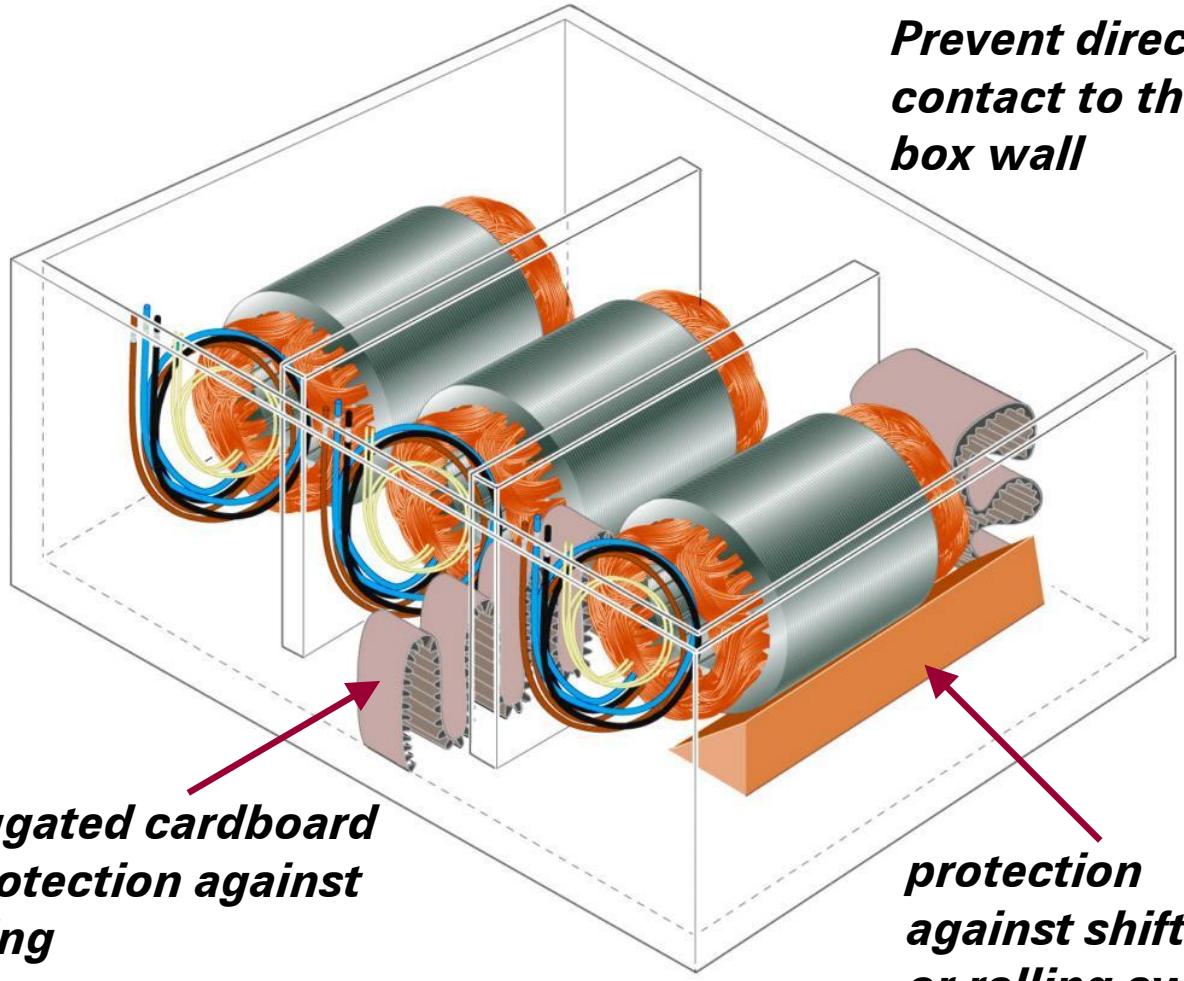
standing, secured





without safety devise

storage and transport



Prevent direct contact to the box wall

corrugated cardboard as protection against shifting

protection against shifting or rolling away

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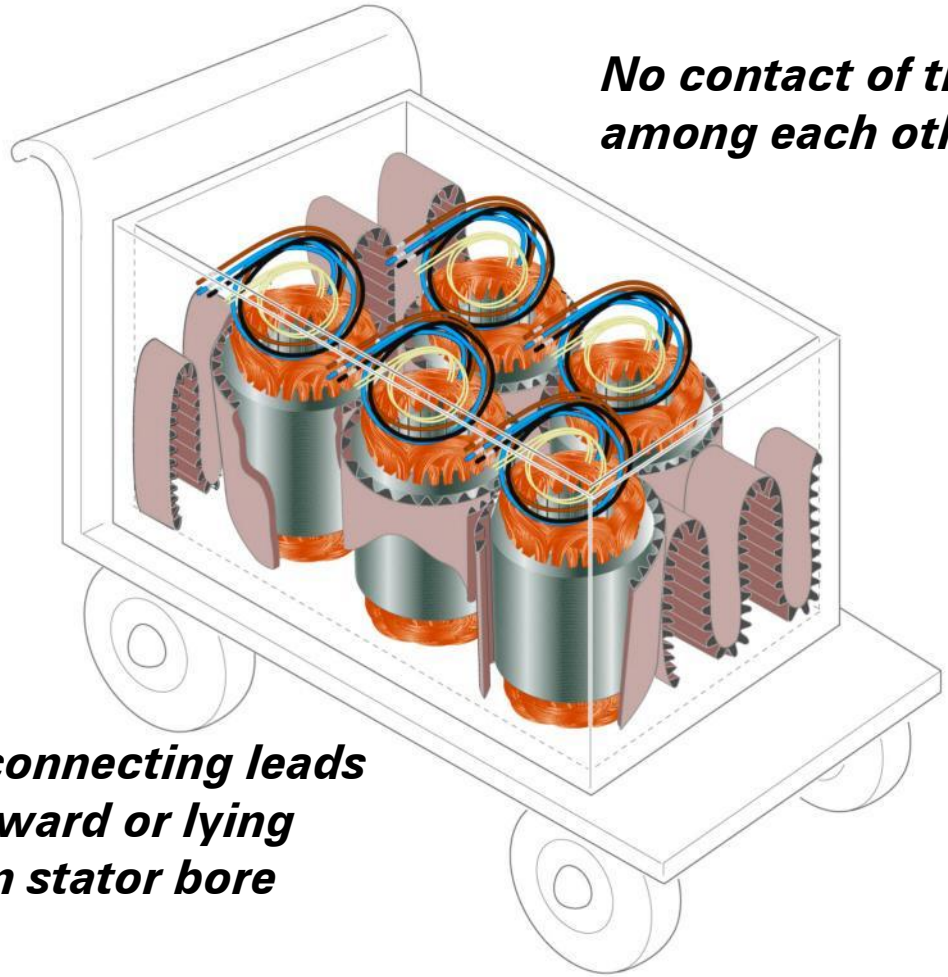
storage and transport

- *standing*

- secured against shifting or tilting

- let stand connecting leads always upward or lying carefully in stator bore



No contact of the stators among each other

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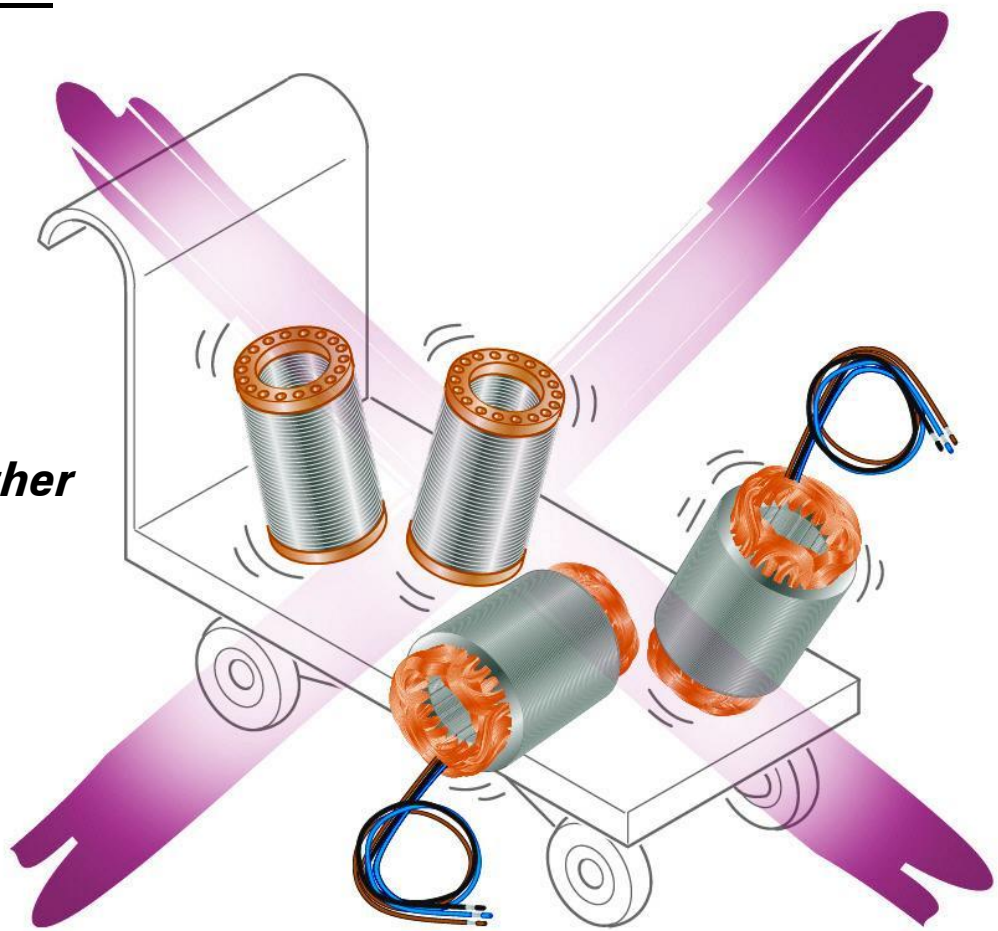
transport of stators and rotors

Not permissible:

- ***unsecured stators and rotors on pallet or trolley***
- ***no protection against each other (may not hit together)***
- ***tilting vertical standing stators or rotors***



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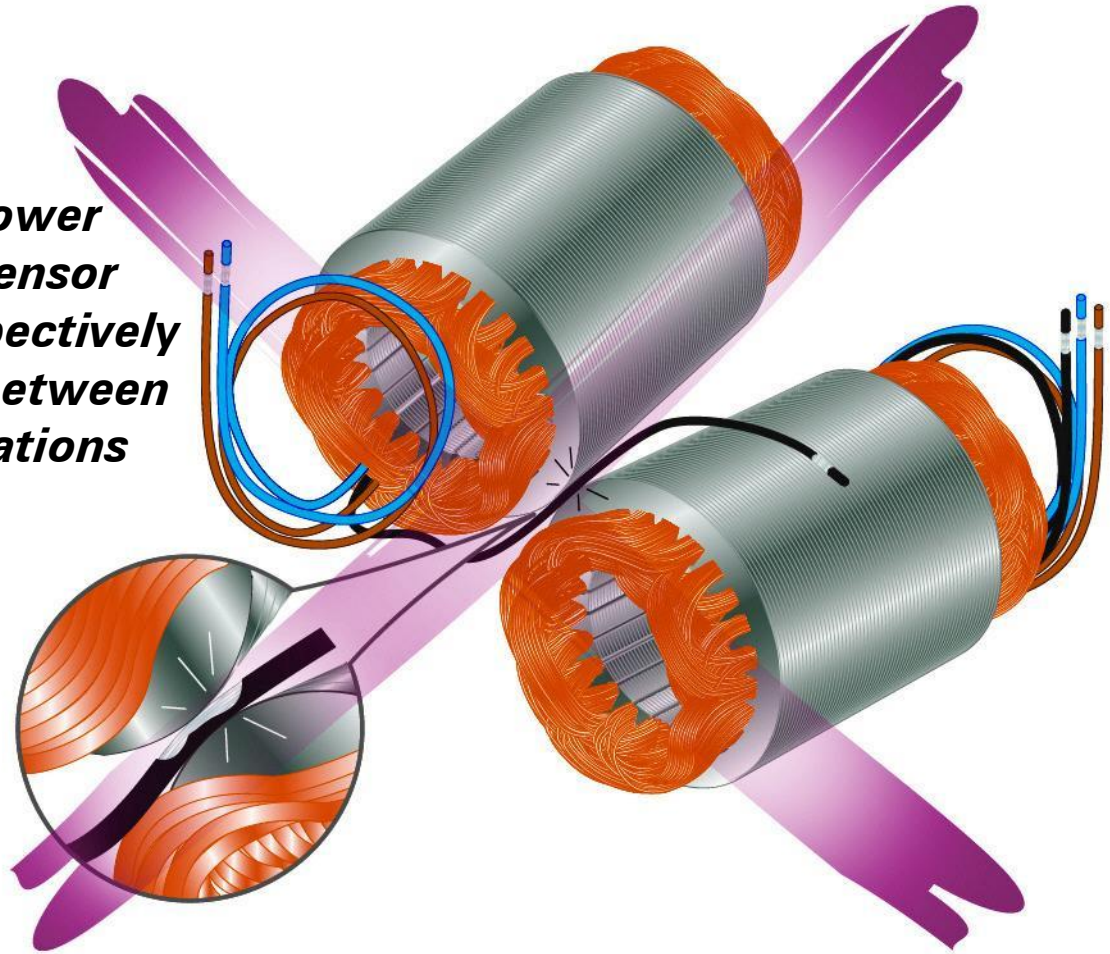
storage and transport

Prevent:

Get the power leads or sensor leads respectively jammed between the laminations

➡ ***damage of the isolation***



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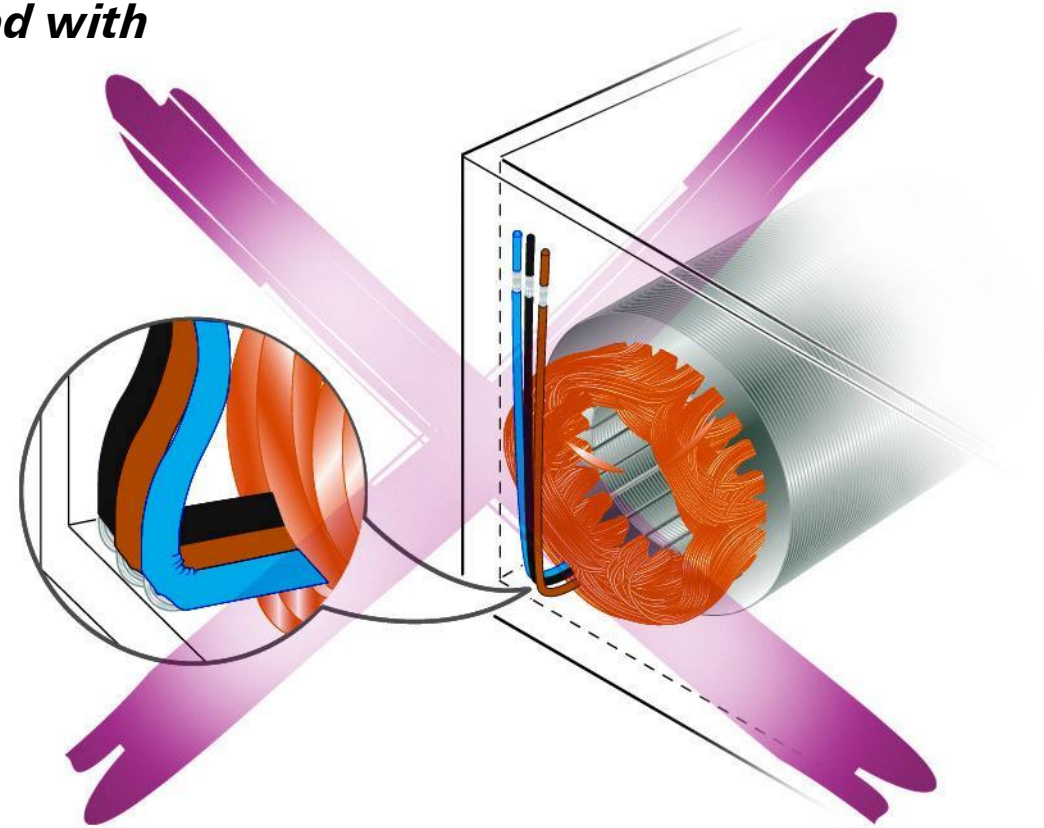
storage and transport

Prevent:

Stator pressed with power leads on the wall

➡ ***damage of the isolation***



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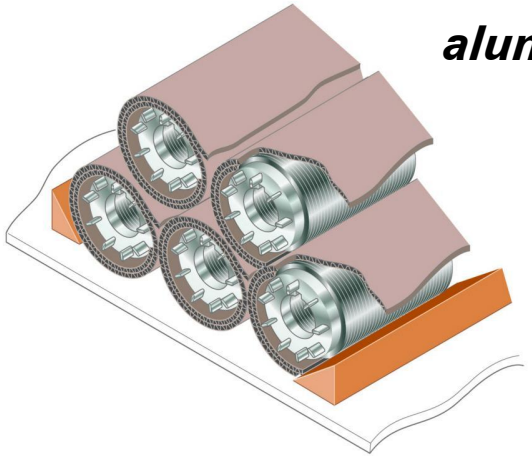
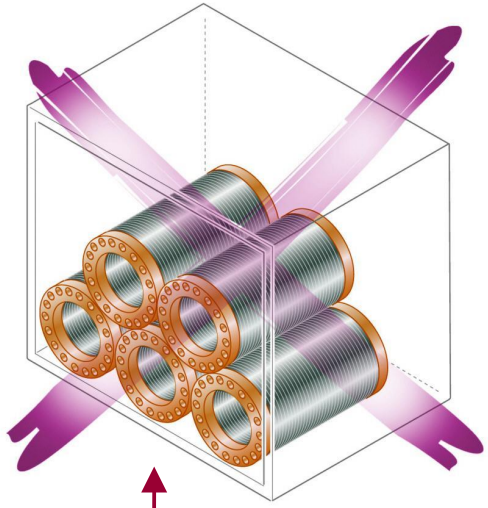
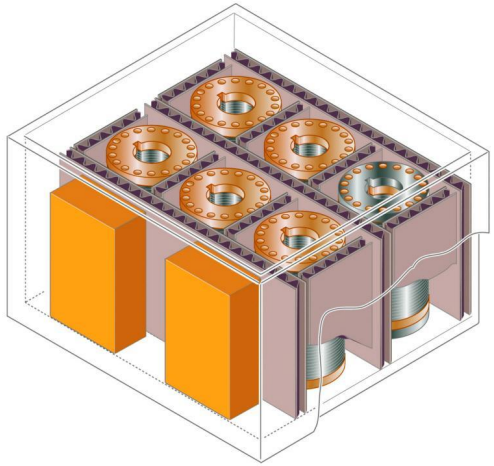
storage of asynchronous rotors

aluminium rotors







copper rotors

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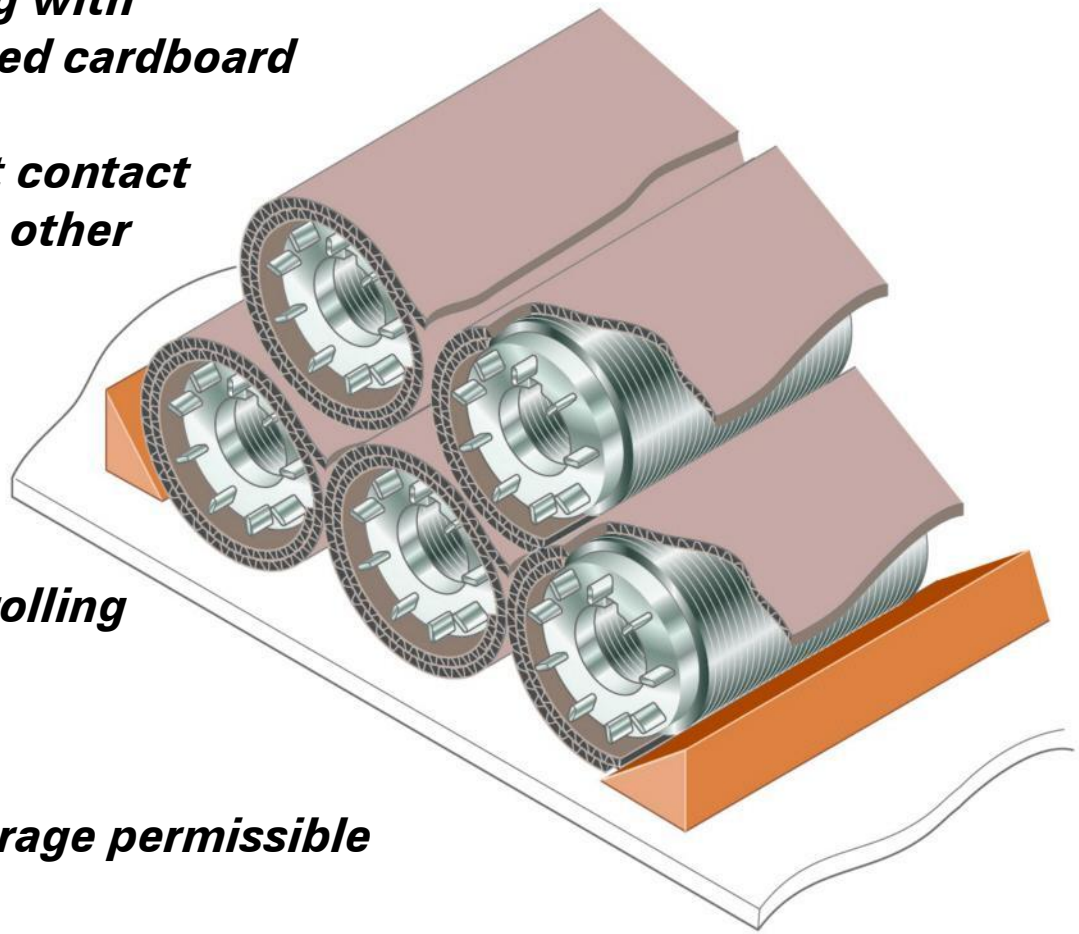
storage of asynchronous aluminium rotors

- ***wrapping with corrugated cardboard***
- ***no direct contact too each other***
- ***protect against rolling away***
- ***lying storage permissible***



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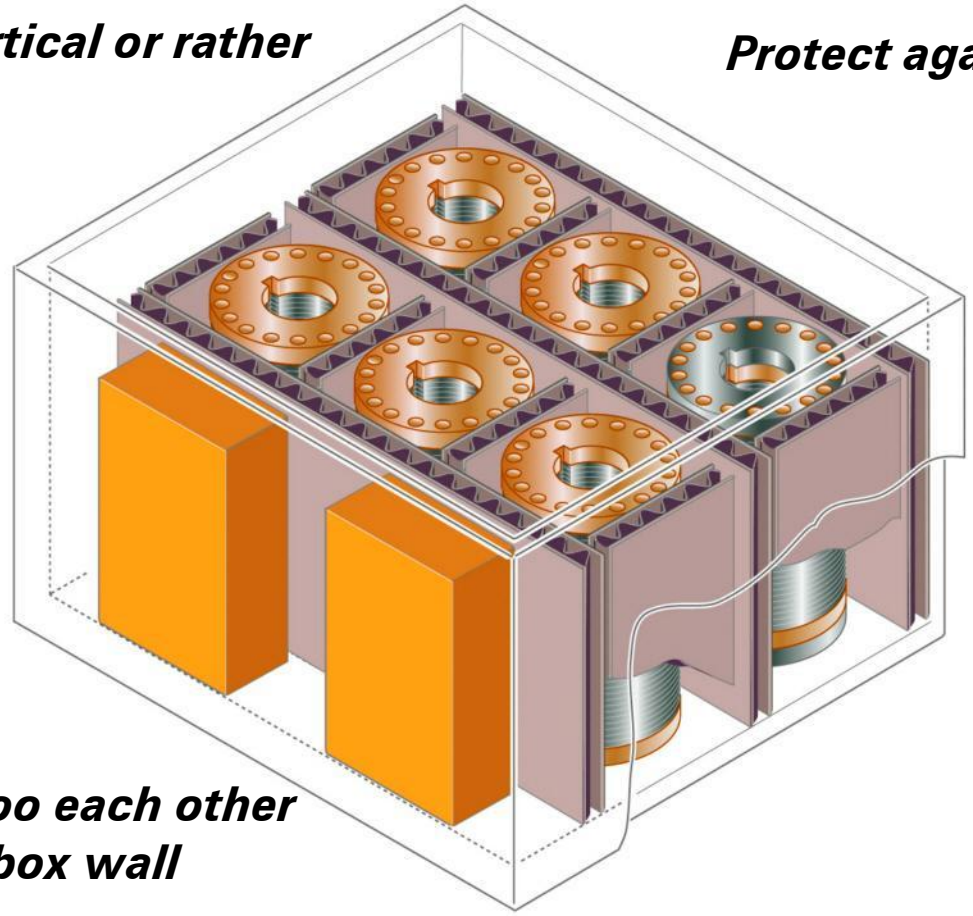
storage of asynchronous copper rotors

Store copper rotors
<u>always</u> vertical or rather
standing

Protect against tilting



No direct
contact too each other
or to the box wall

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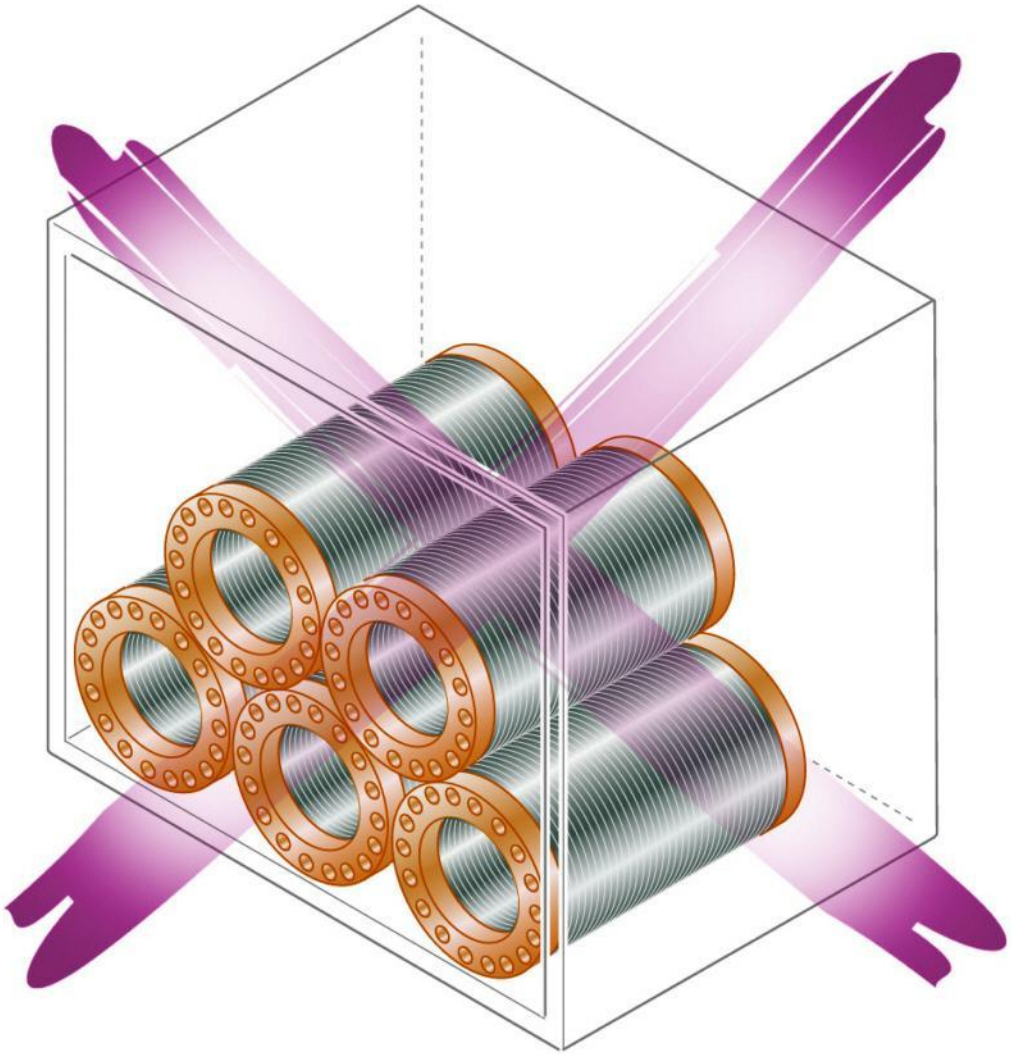
storage of asynchronous copper rotors

Never store lying!

Danger of bending!



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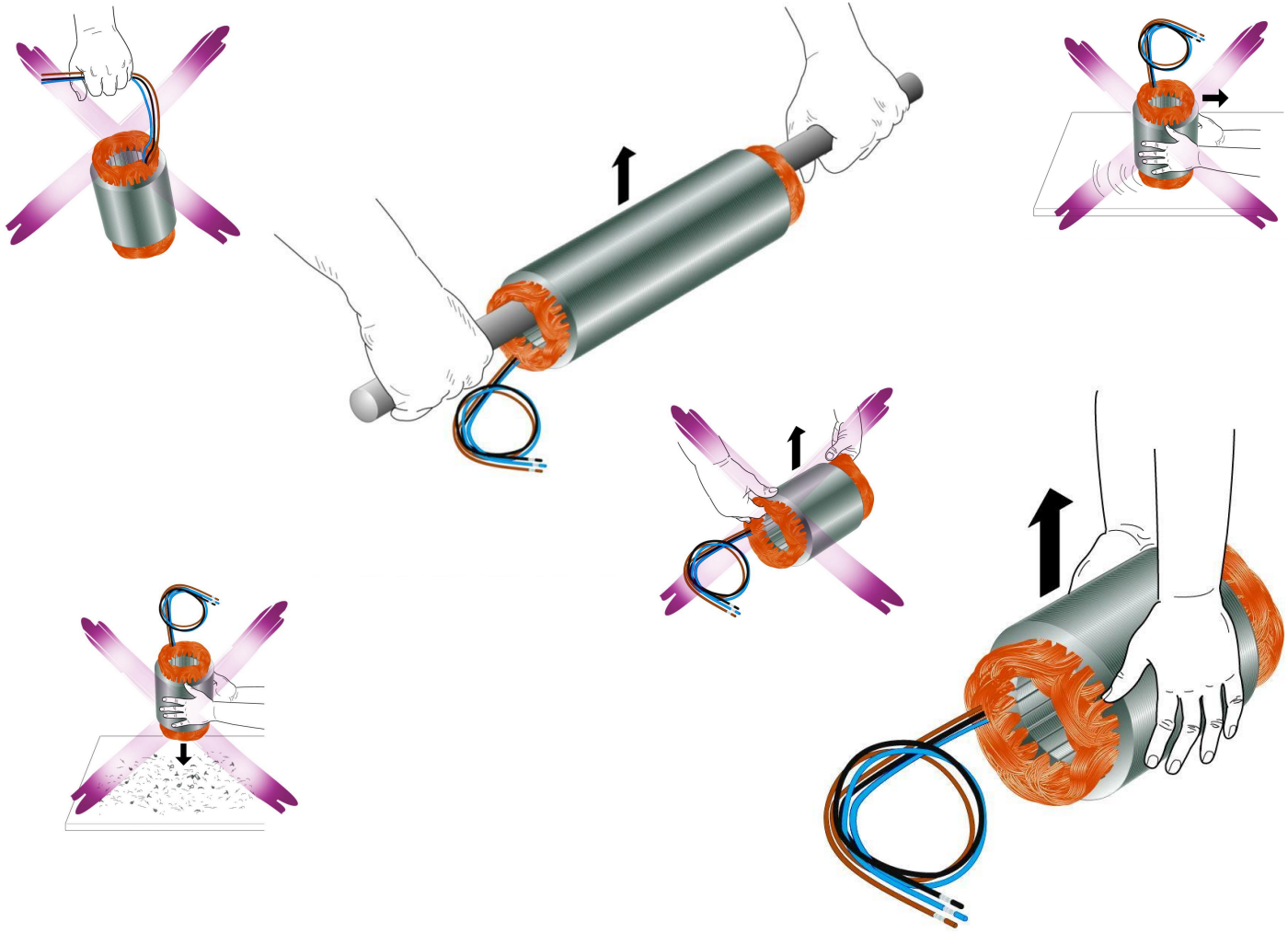
lift - set - move



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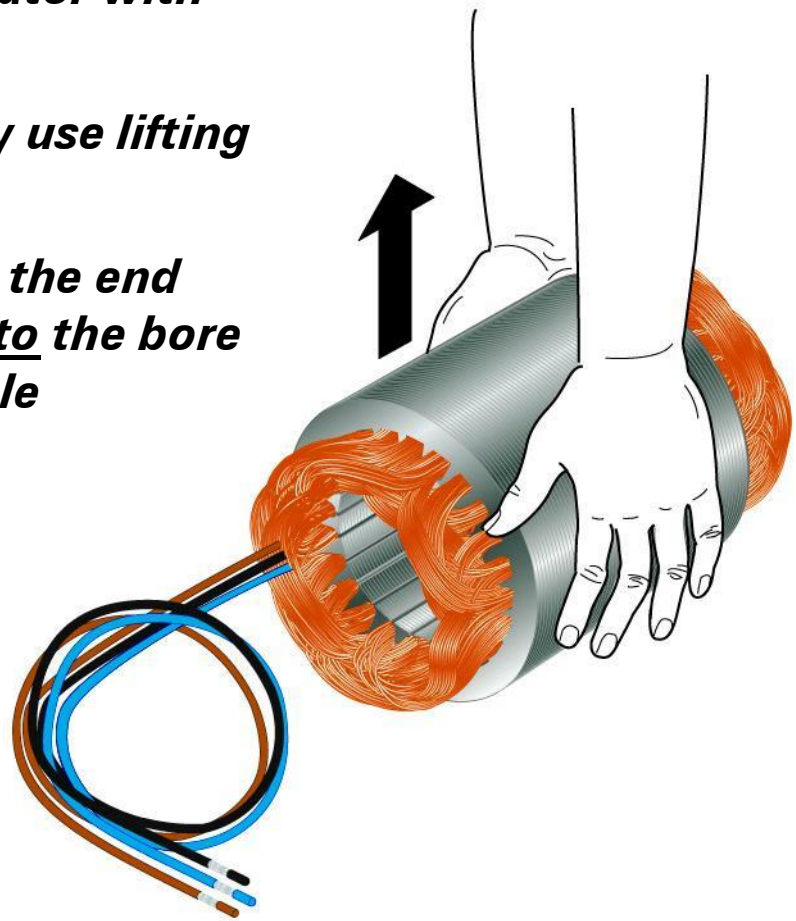
lift

- ***cover the stator with both hands***
- ***alternatively use lifting magnet***
- ***grip around the end windings <u>into</u> the bore is permissible***



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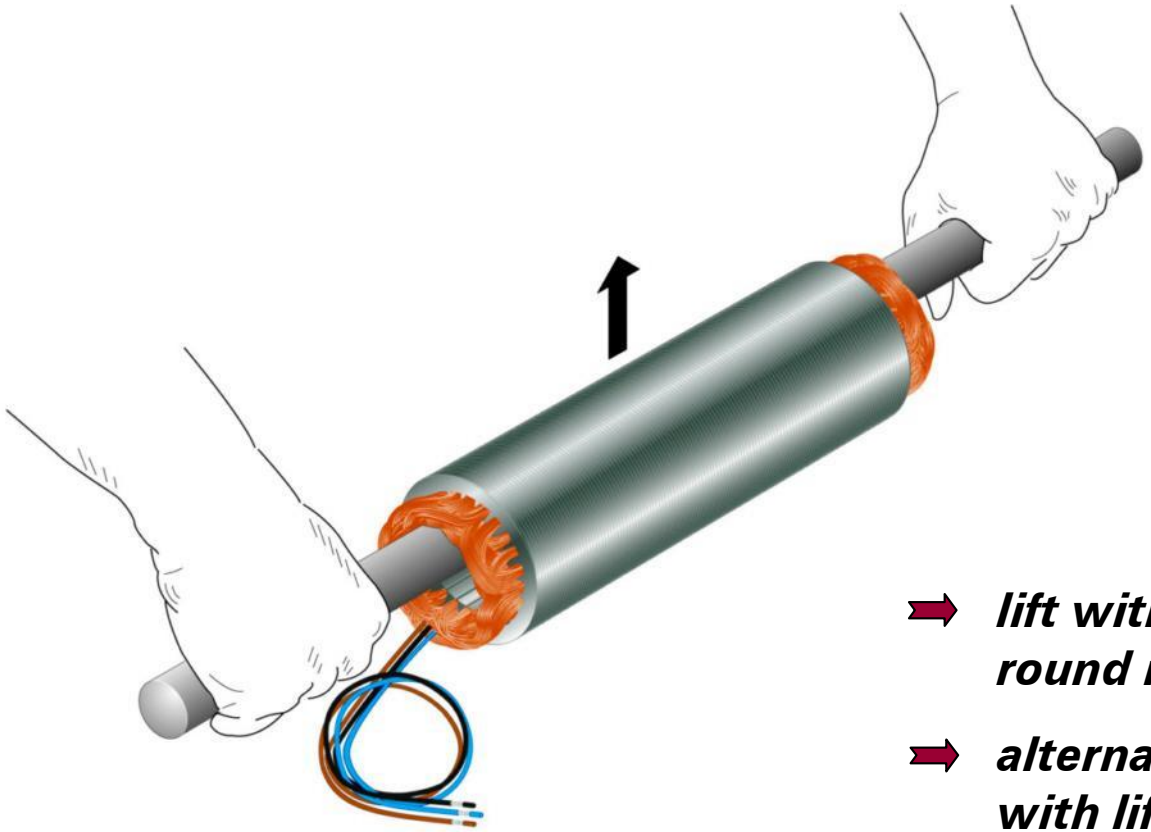
lift



- ***lift with straight, round rod***
- ***alternatively handle with lifting magnet at the laminated core***

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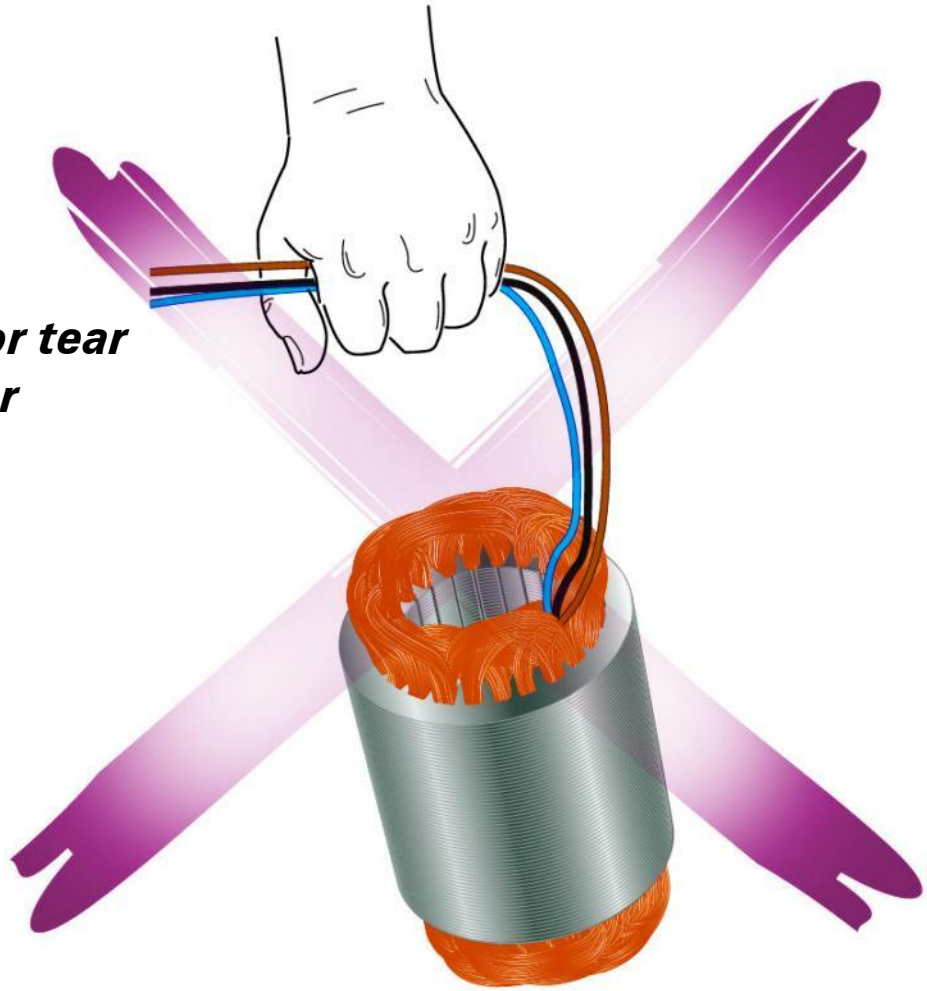
lift - carry

incorrect:

Carry, pull or tear at the power leads



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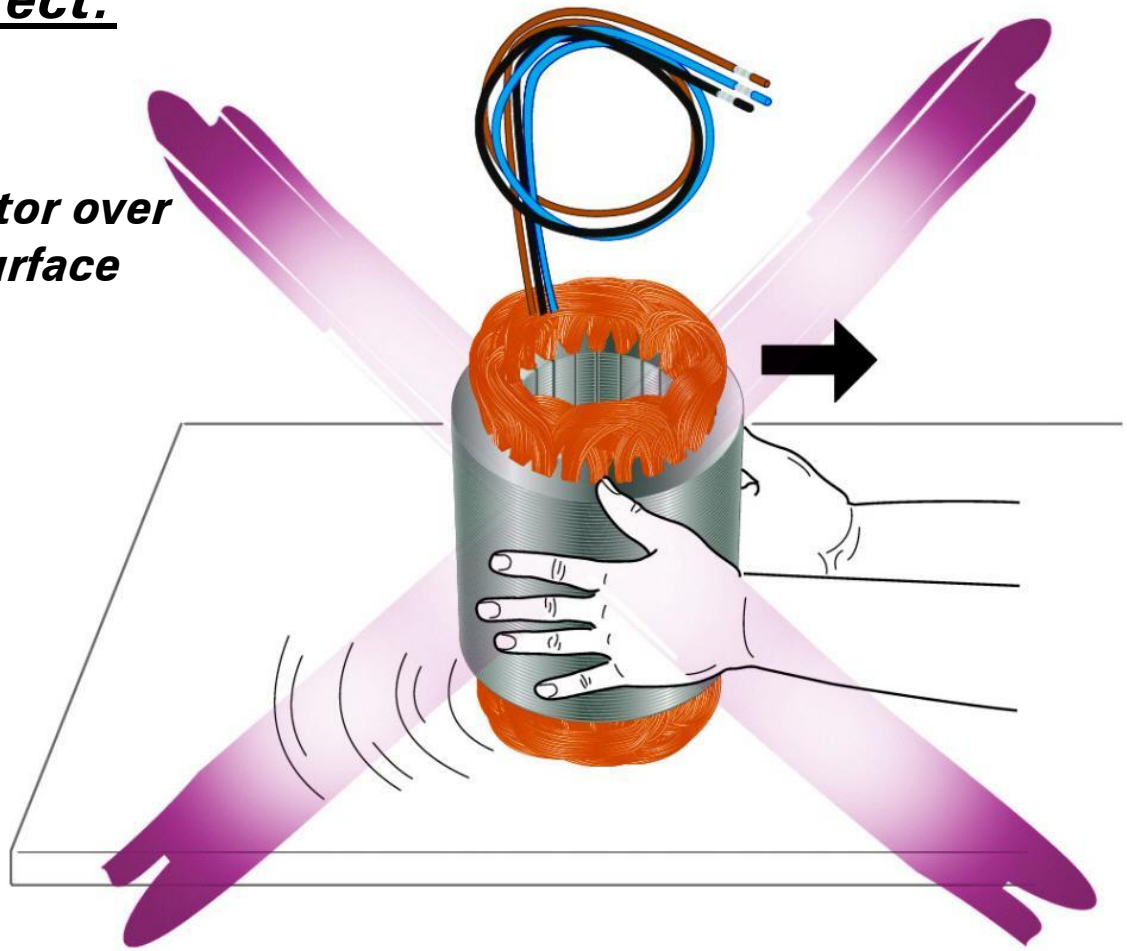
move

incorrect:

Pull stator over work surface

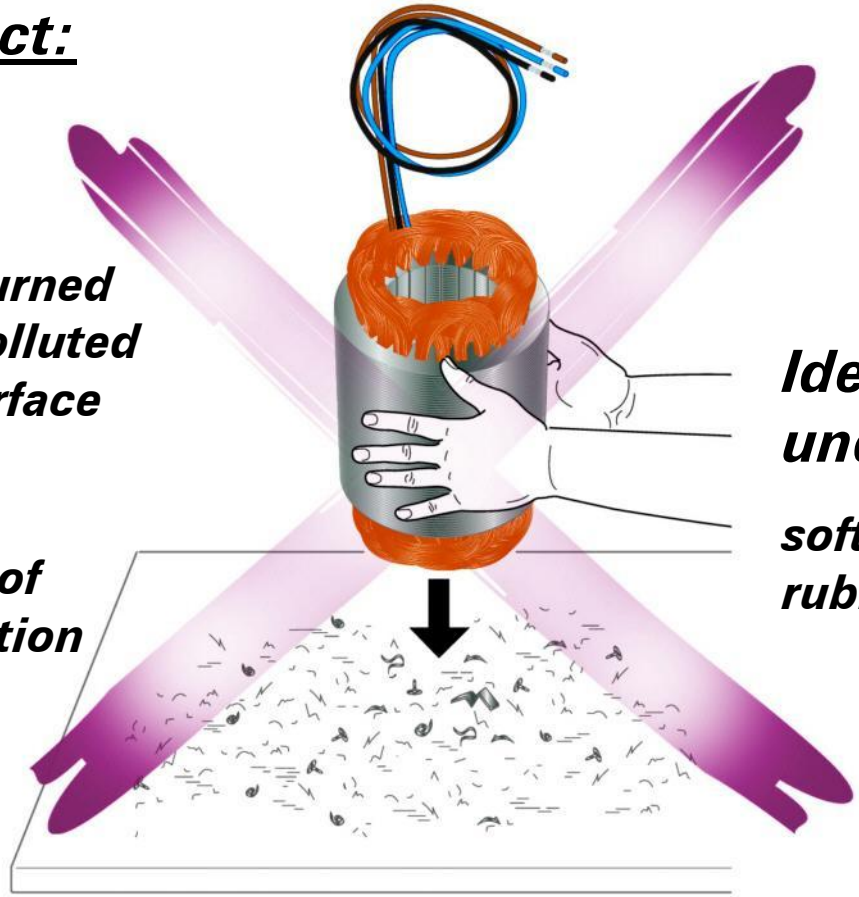


set

incorrect:

Stator turned off on polluted work surface

➡ ***damage of the isolation***



Ideal underground:

soft pasteboard, rubber, carpet

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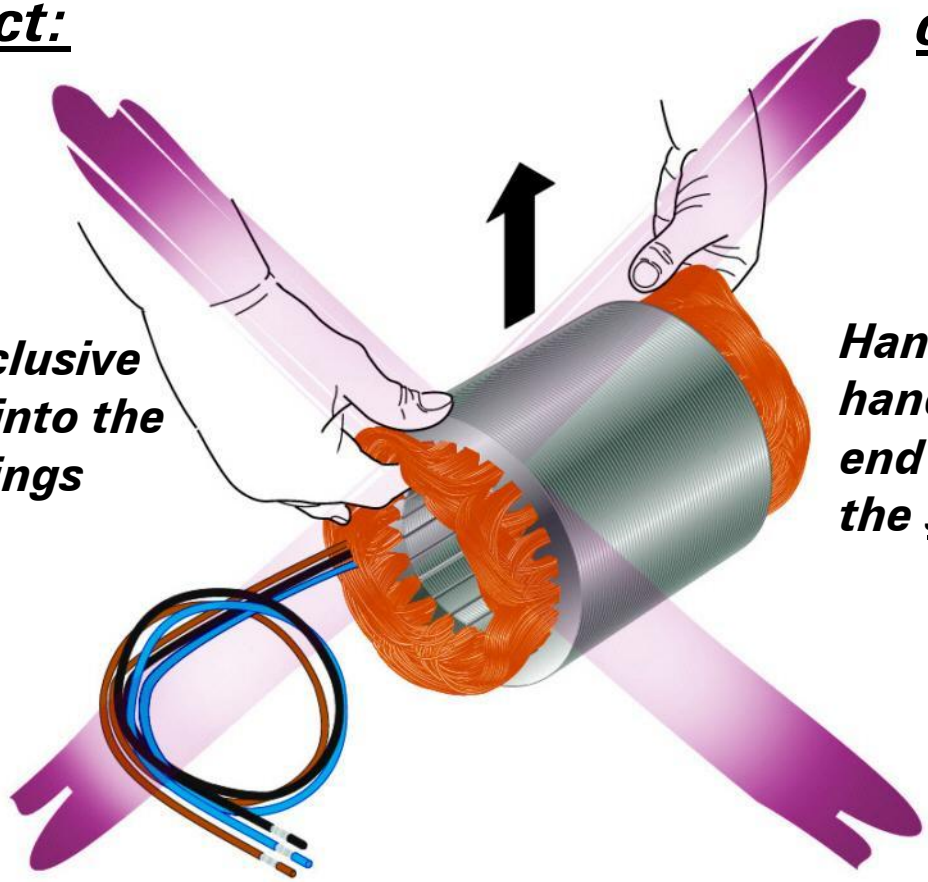
lift

incorrect:

Lift by exclusive handling into the end windings



correct:

Handle with both hands around the end windings into the stator bore

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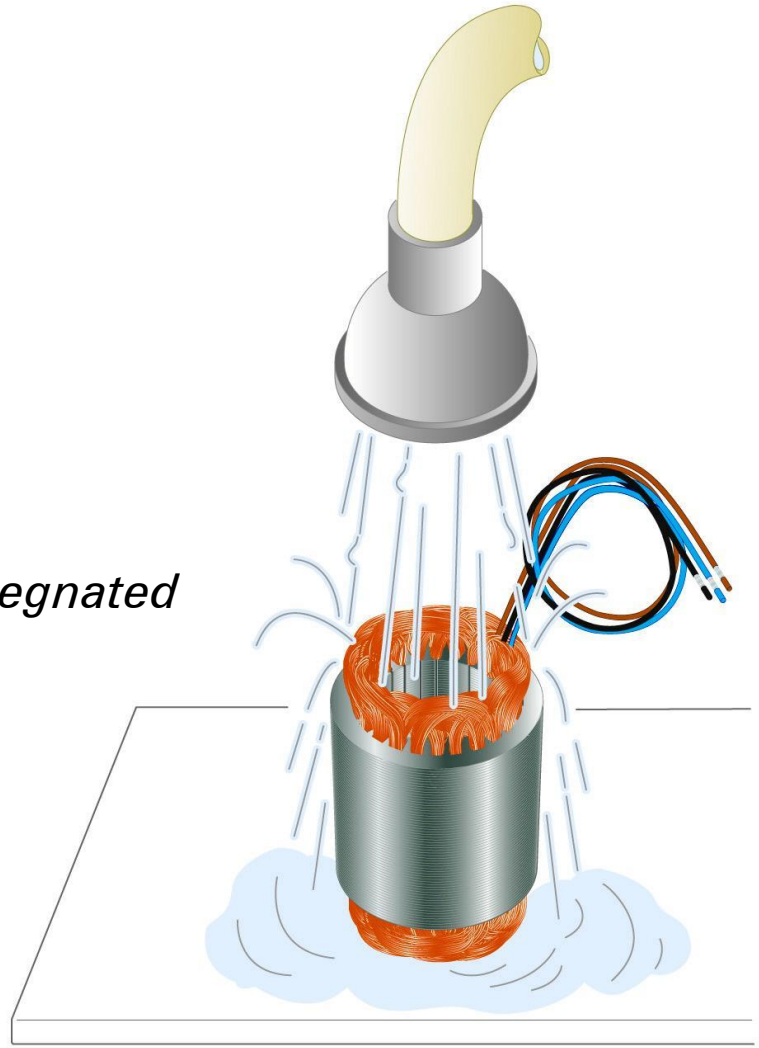
Wash polluted stators

***Wash**, if „dirt“*
(machining residues)
in the winding end



Drying temperatures:
(1) vacuum-pressure-impregnated
*=> max. **110°C***
(2) ENCA / ALKA™ stators
*=> max. **60°C***

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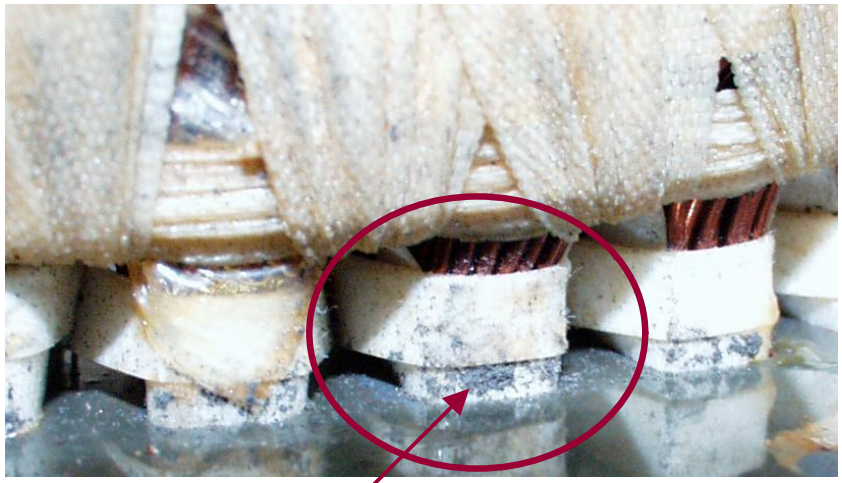
manufacturing residues in the end winding



machining residues

ground fault

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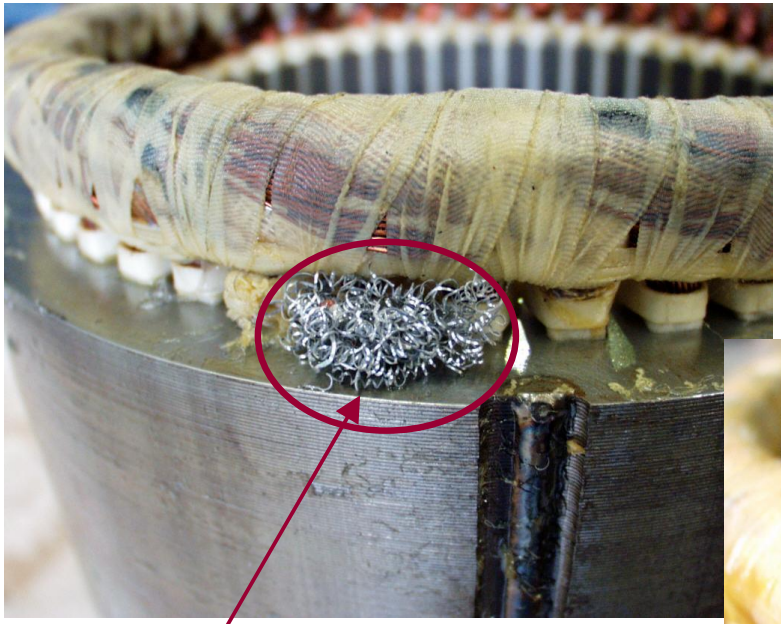
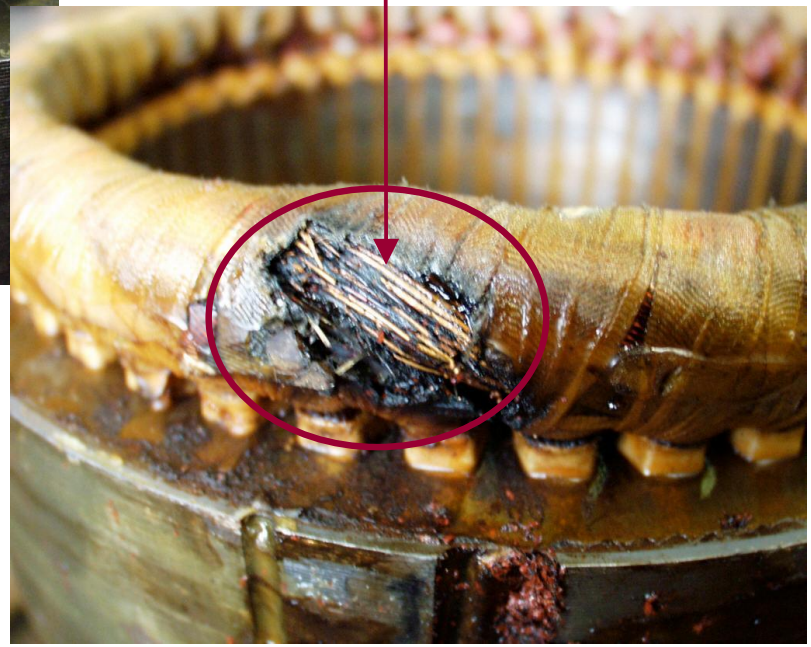
manufacturing residues in the end winding



steel splinters

ground fault due to steel splinters



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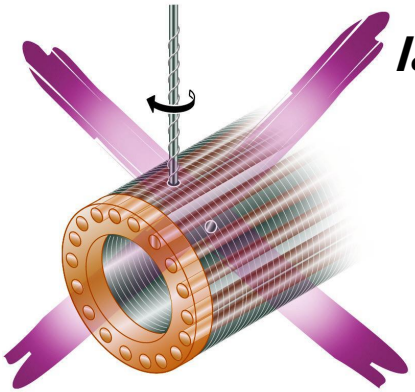
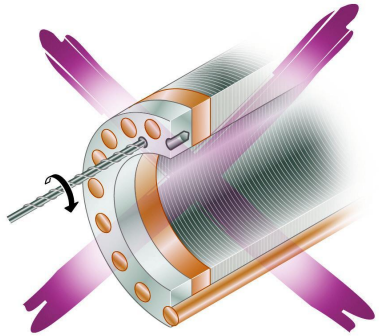
balancing of copper rotors

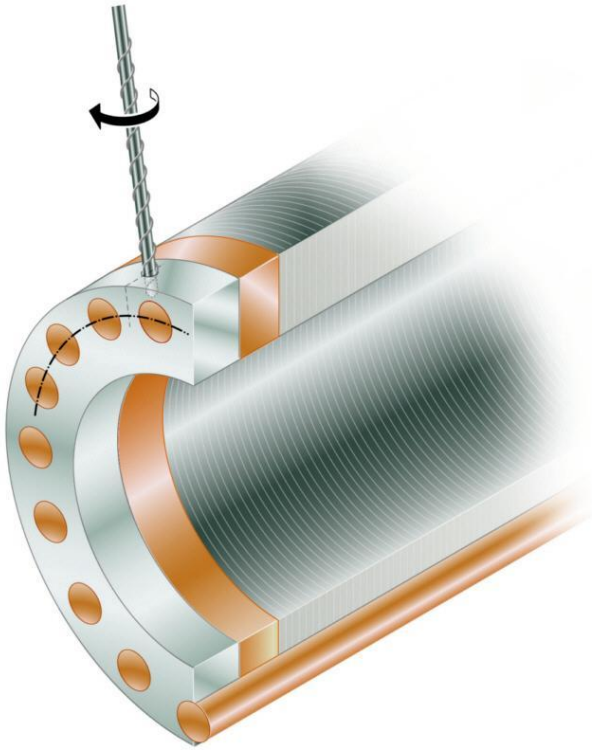
(aluminium rotors)



laminated core



steel ring



steel ring

Elektromaschinen und Antriebe

Advice for handling of E + A motor elements

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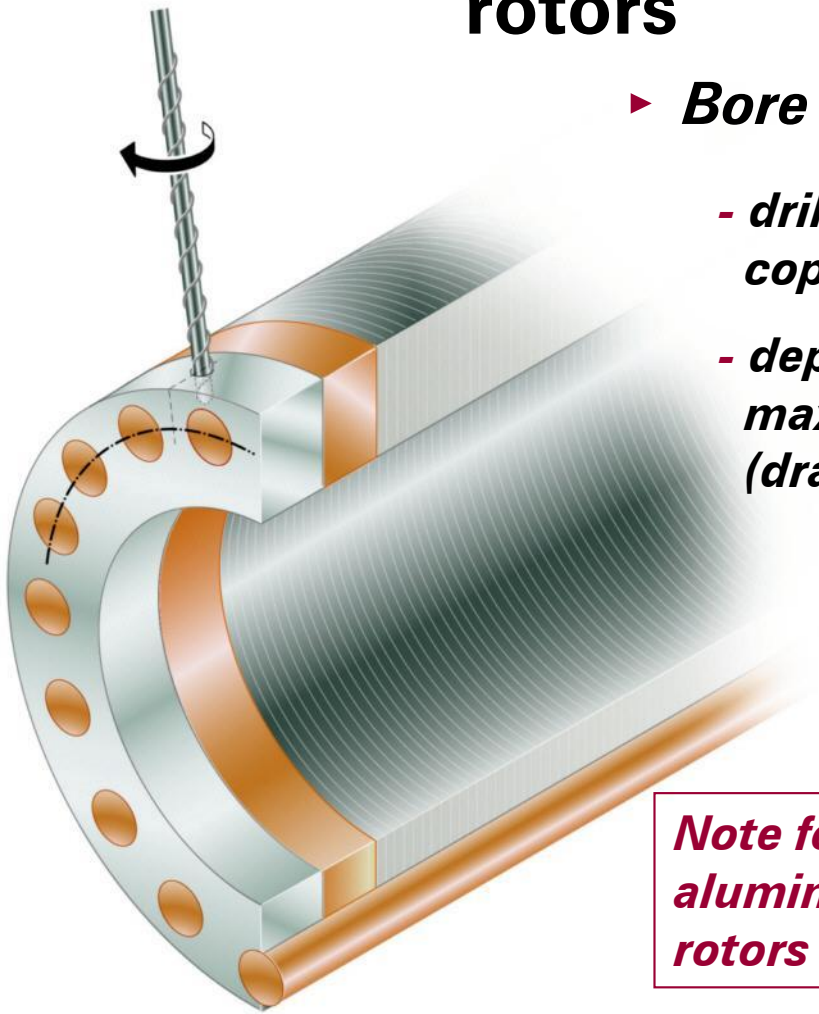
balancing of asynchronous copper-steel rotors



- ***Bore into the steel ring***
  - ***drilling between two copper bars***
  - ***depth of the drilling to max. center of round slot (drawn in pitch circle)***

Note for:
aluminium rotors and copper rotors <u>without</u> steel ring

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balancing of asynchronous aluminium rotors and asynchronous copper rotors without steel reinforcement ring

Elektromaschinen und Antriebe

For aluminium rotors and copper rotors without steel reinforcement ring additional balancing disks must be used for balancing!
For the rotor types mentioned it is not permissible to bore into the laminated core or the short-circuit ring.

In the case of ignoring electrical or mechanical failure can be caused.

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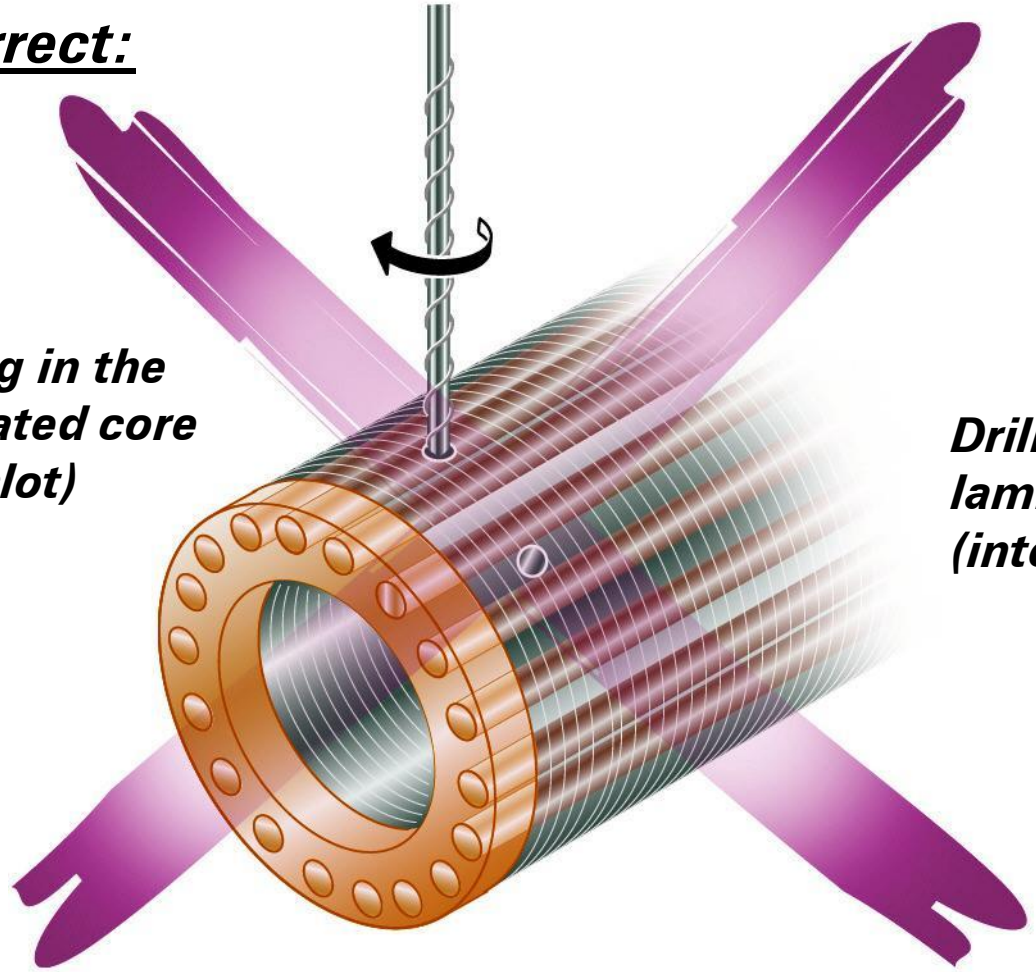
balancing of copper rotors

(aluminium rotors)

incorrect:



Drilling in the laminated core (into slot)

Drilling in the laminated core (into tooth)

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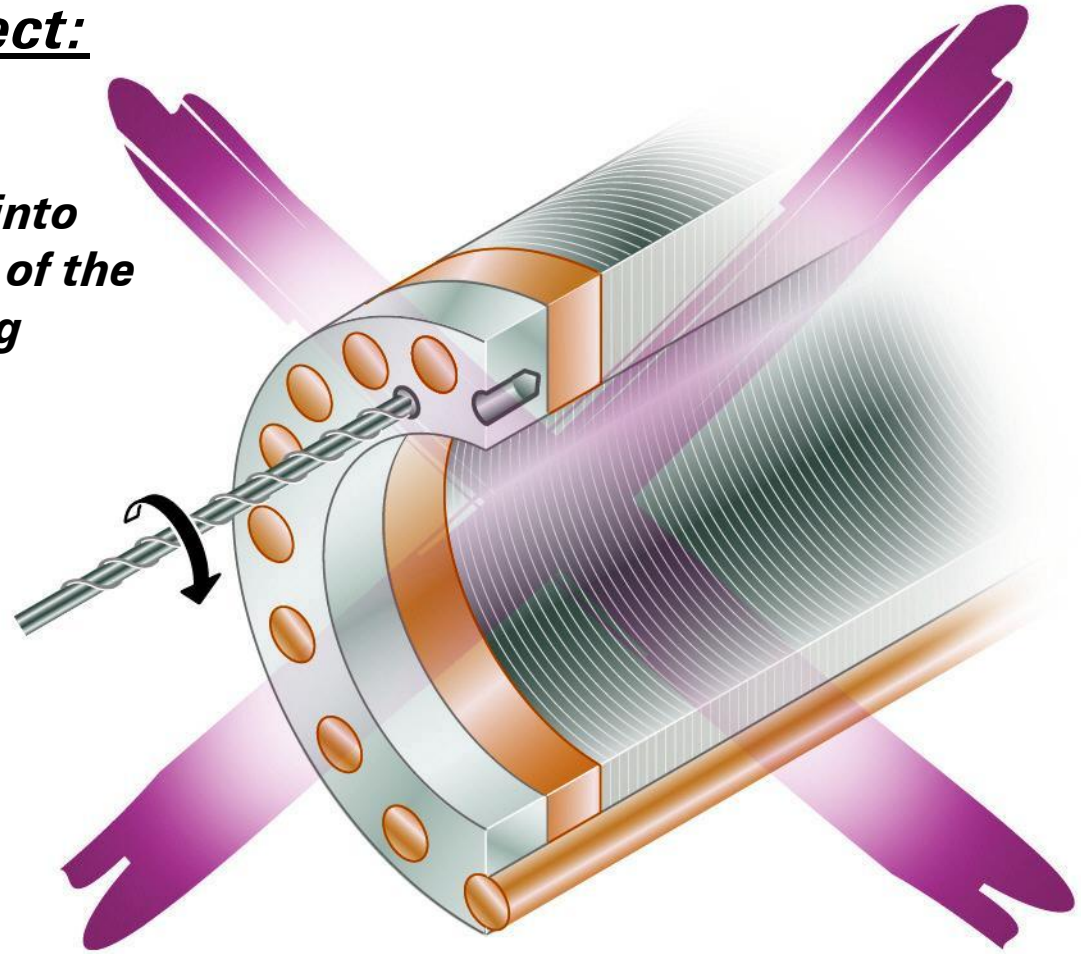
balancing of asynchronous copper-steel rotors

incorrect:

Drilling into the face of the steel ring



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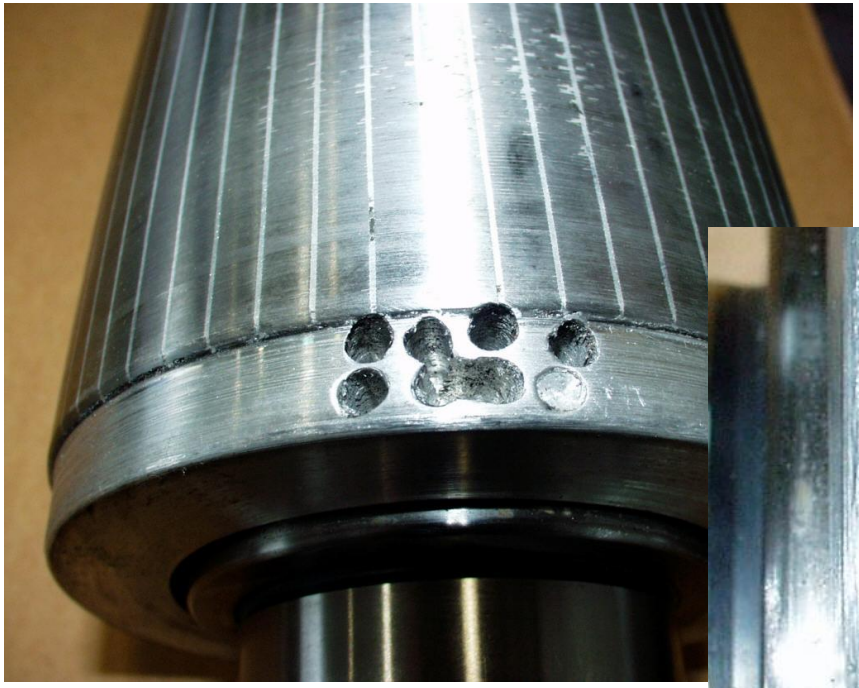
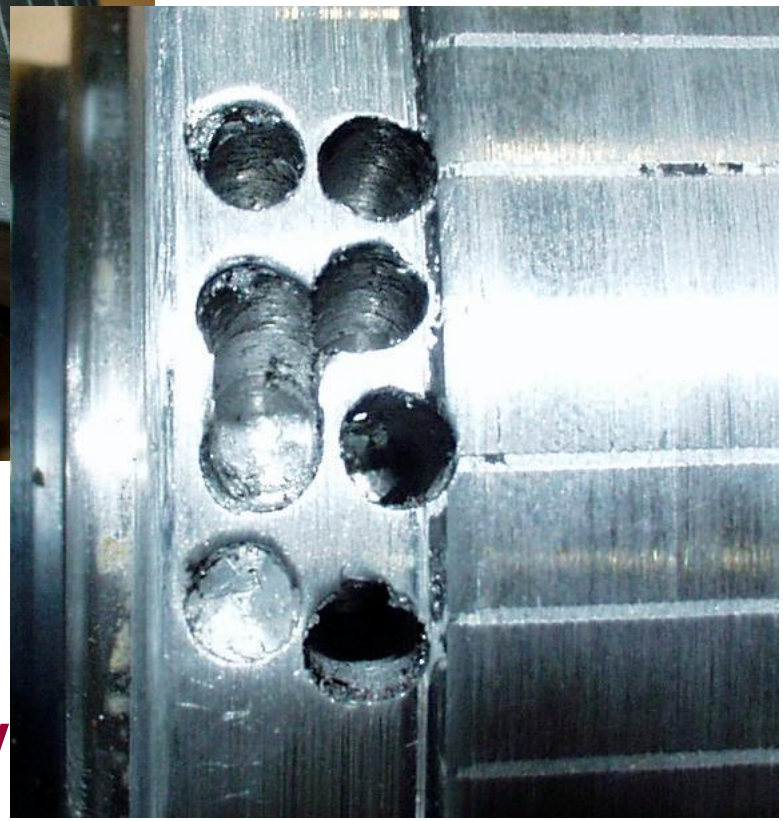
negative example of balancing



aluminium rotors



incorrect:

Drilling in short-circuit ring !

➡ ***interruption of circuit!!***

Elektromaschinen und Antriebe

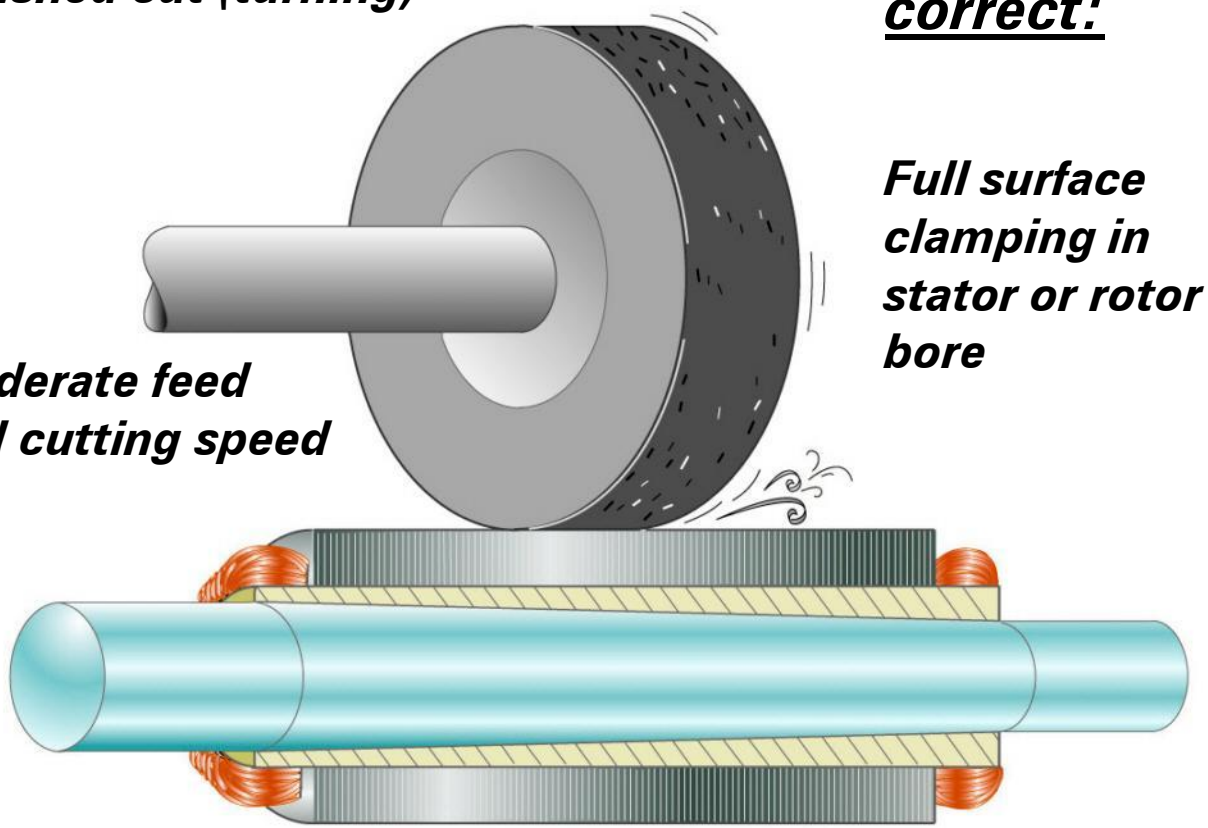
machining of stator and rotor

Easy cutting tools with polished cut (turning)

correct:

Full surface clamping in stator or rotor bore

Moderate feed and cutting speed



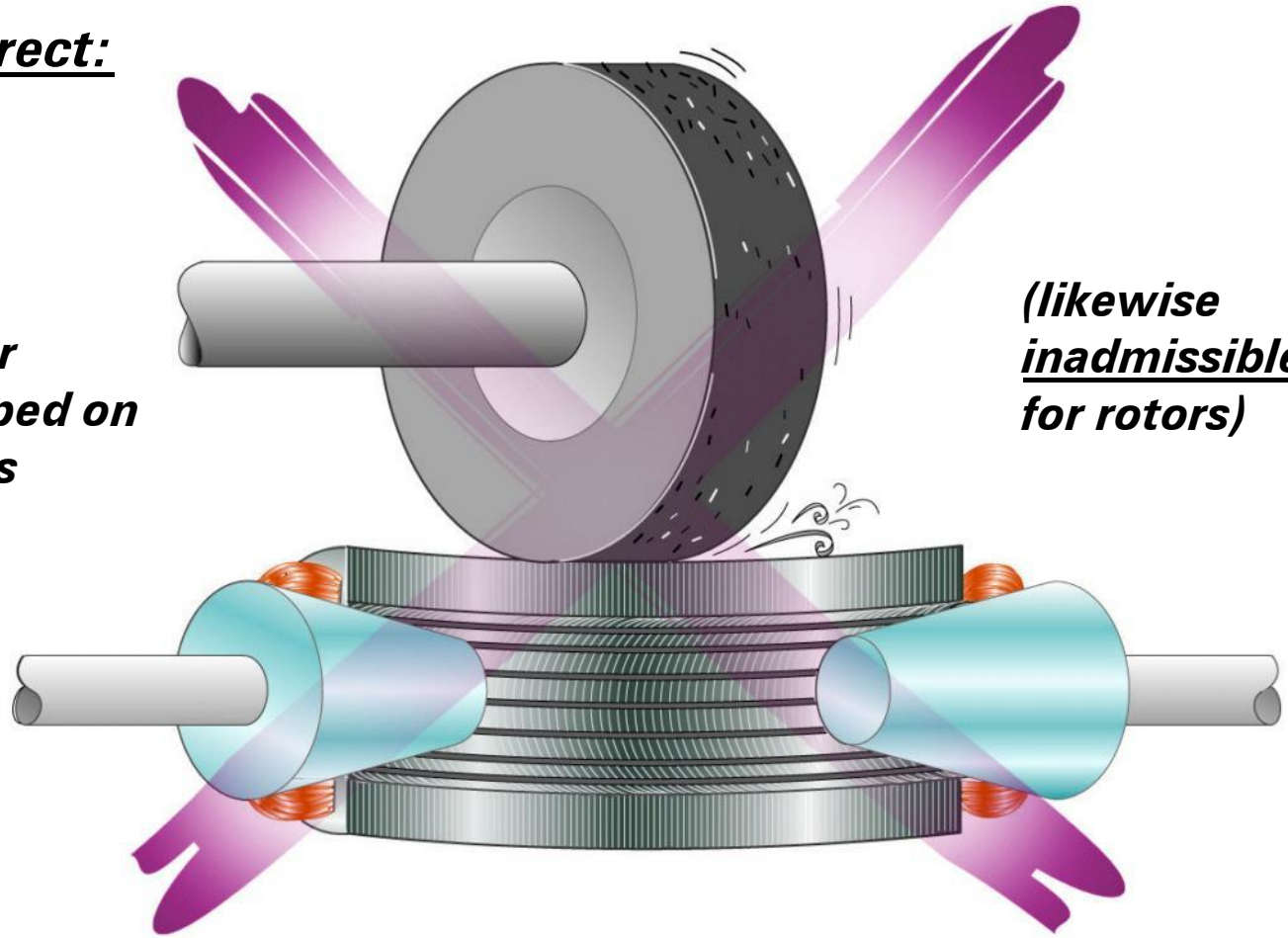
Original length of stator/rotor must remain preserved!

Elektromaschinen und Antriebe

machining of stator and rotor

incorrect:

Stator clamped on spikes



(likewise inadmissible for rotors)

Elektromaschinen und Antriebe

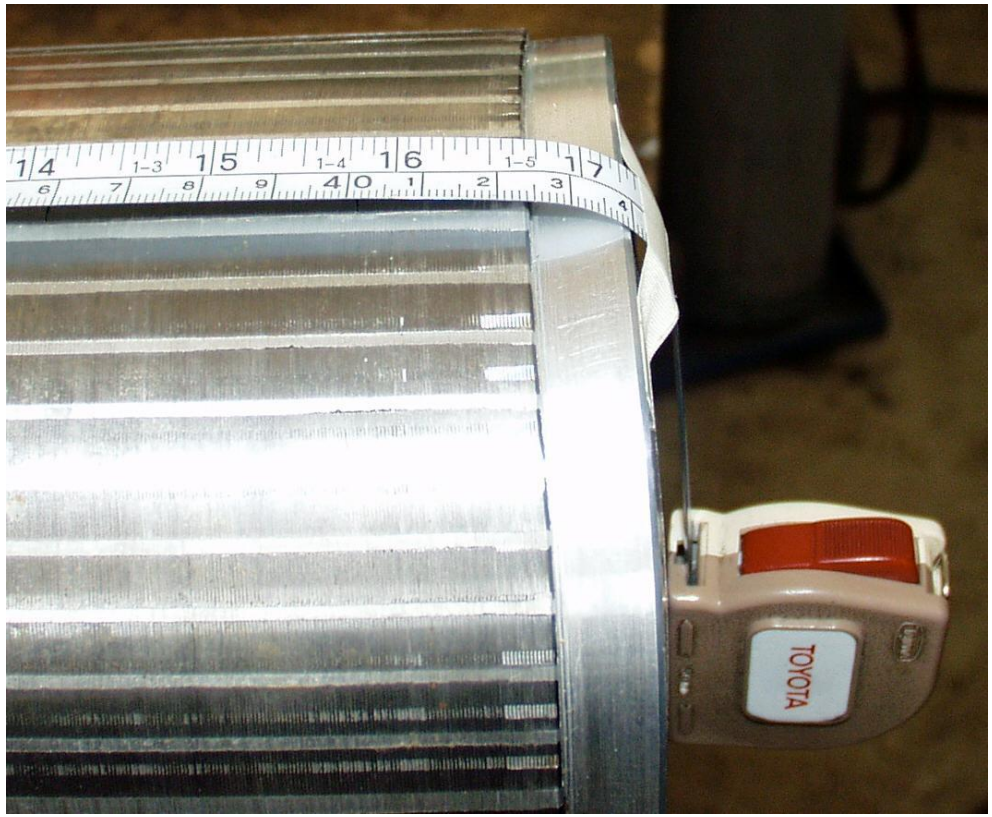
incorrect machining of rotor

Expansion of the rotor package by inadmissible high feed and cutting speed

Further possible faults:

- cut-in depth

- blunt cutting tool



Elektromaschinen und Antriebe

incorrect machining of stator

Expansion of the stator package by inadmissible high feed and cutting speed

Further possible faults:

- cut-in depth

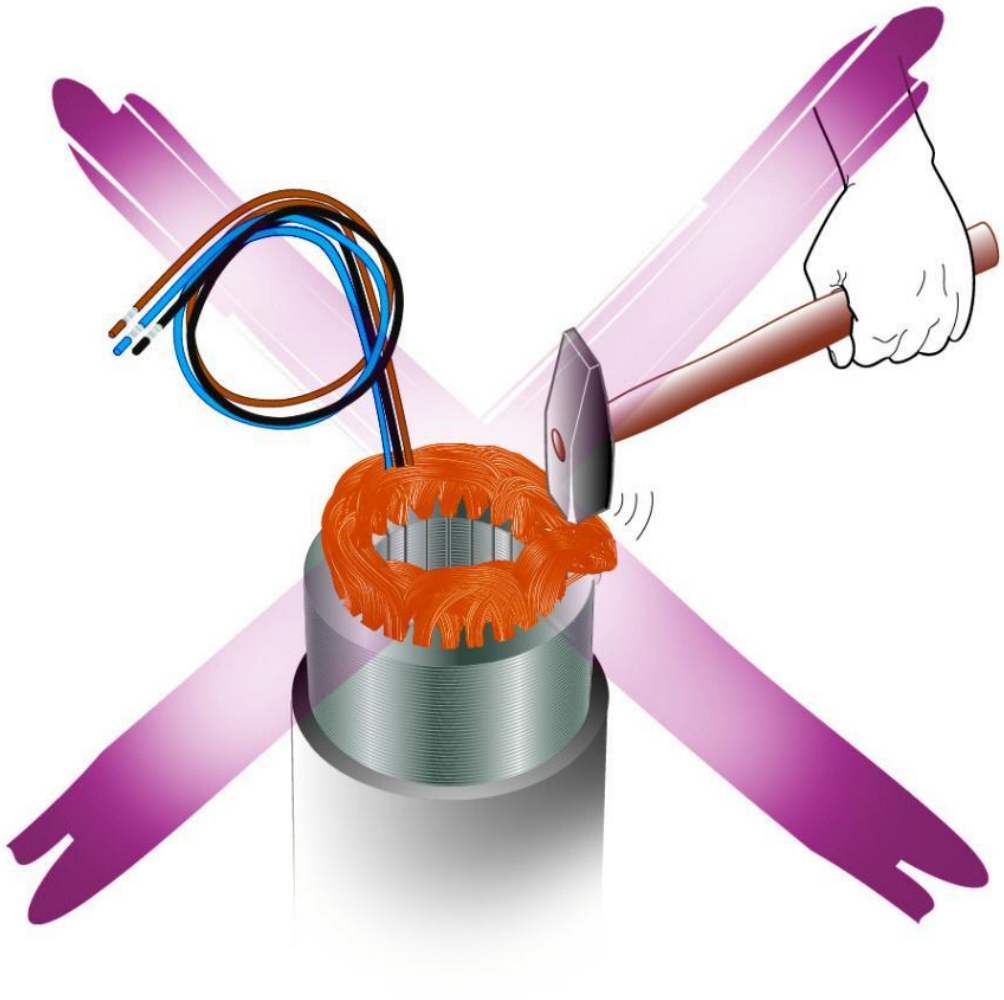
- blunt cutting tool

Elektromaschinen und Antriebe

assembly in the housing

incorrect:

Force on end winding with pressure or impacts



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