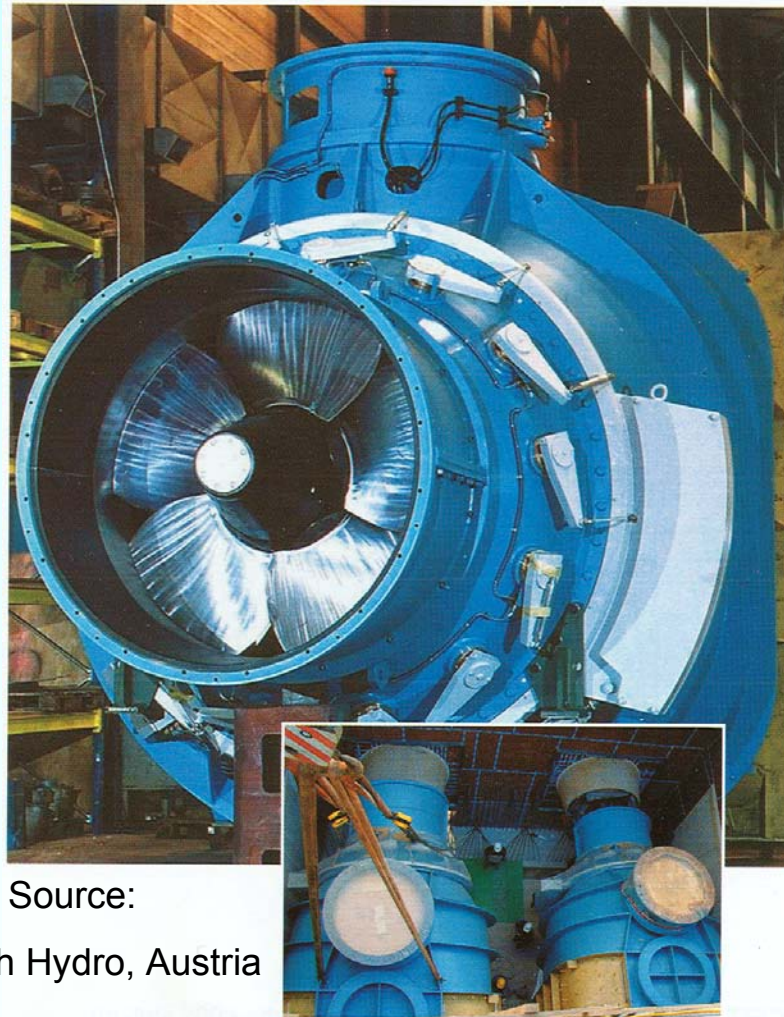


9. Examples of hydro energy conversion



Source:

VATech Hydro, Austria



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Variable speed pump storage power plant



Conventional pump storage power plant with synchronous motor-generators



Generator

Pelton
turbine

Kaprun/Austria:

Synchronous motor-generators at fixed synchronous speed, directly grid operated

Source:

VA Tech, Austria



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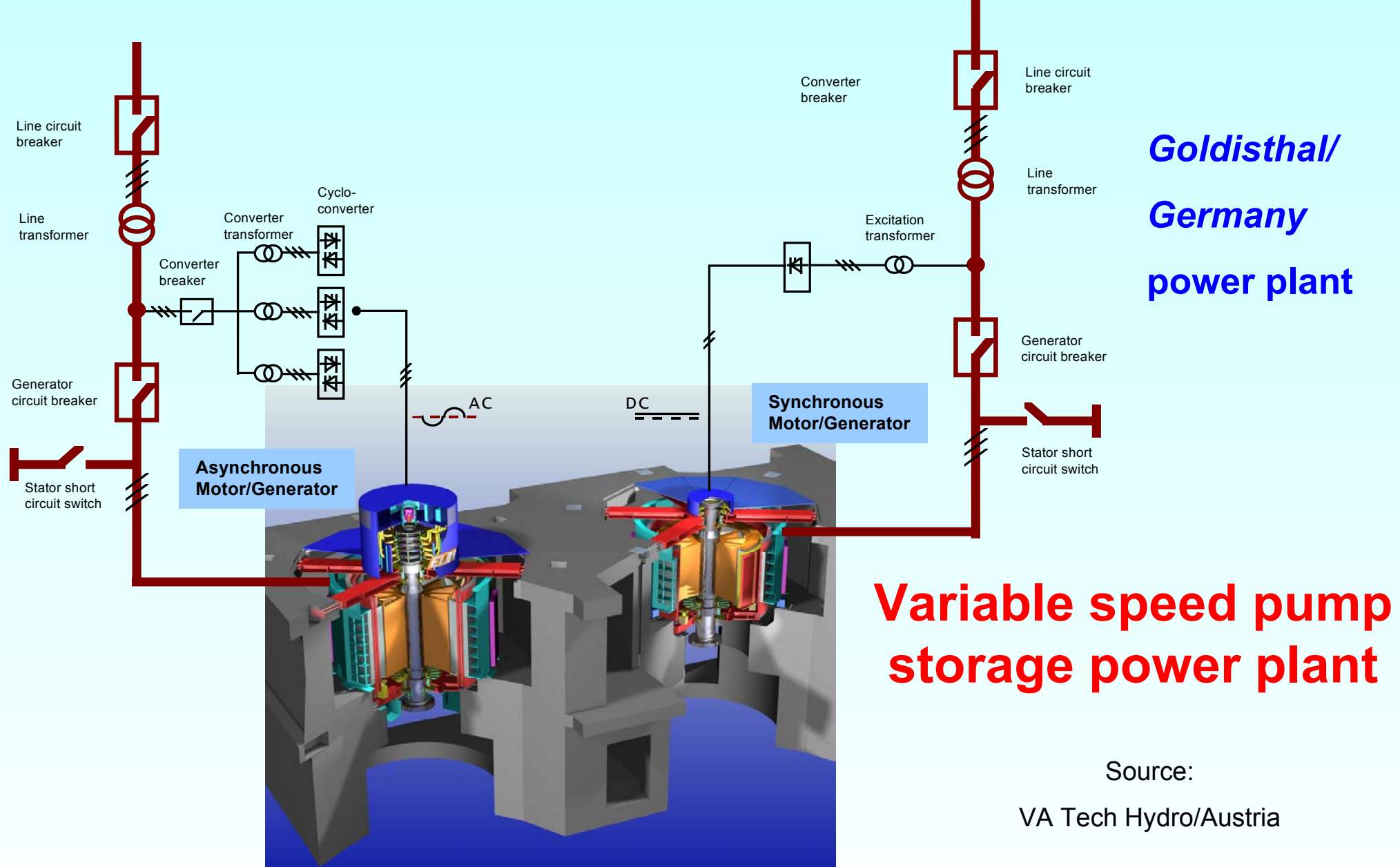
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Source:

VA Tech Hydro/Austria



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Variable speed pump storage power plant

Pump storage power plant *Goldisthal/Thuringia, Germany*:

a) **Grid operated synchronous Motor/Generator:**

Data: 331 MVA, 333.3/min, 18 poles, 50 Hz

b) **Doubly fed induction motor-generator:**

Data: 340 MVA, 300 ... 346/min, 18 poles, 50 Hz

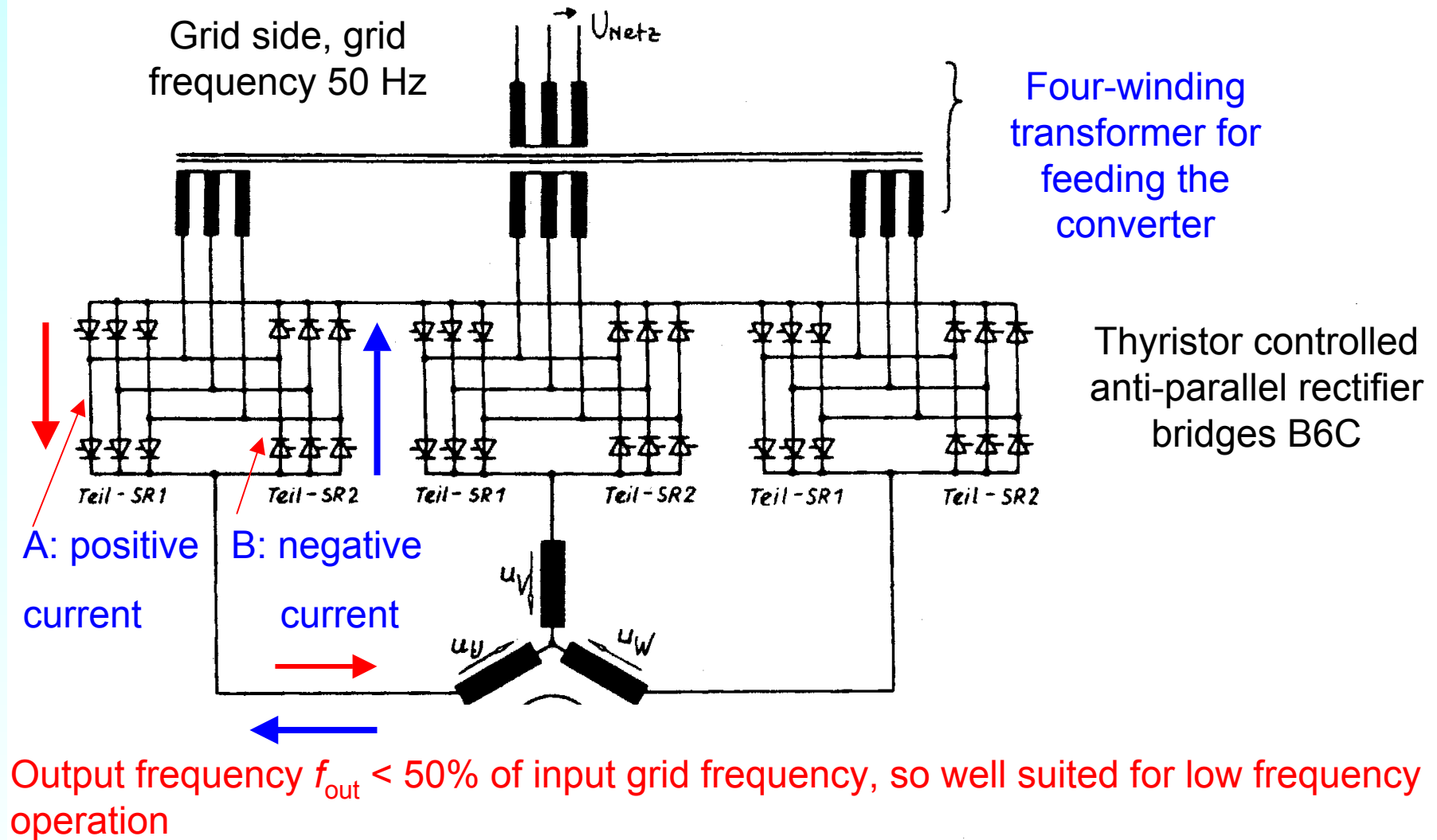
Rotor side converter: Cyclo-converter for low frequency

Rotor slip: +10% ... 5% slip = max. frequency in rotor 5 Hz

Variable speed pump operation saves energy. At low water flow speed and power is decreased, at high water flow rate speed is increased.

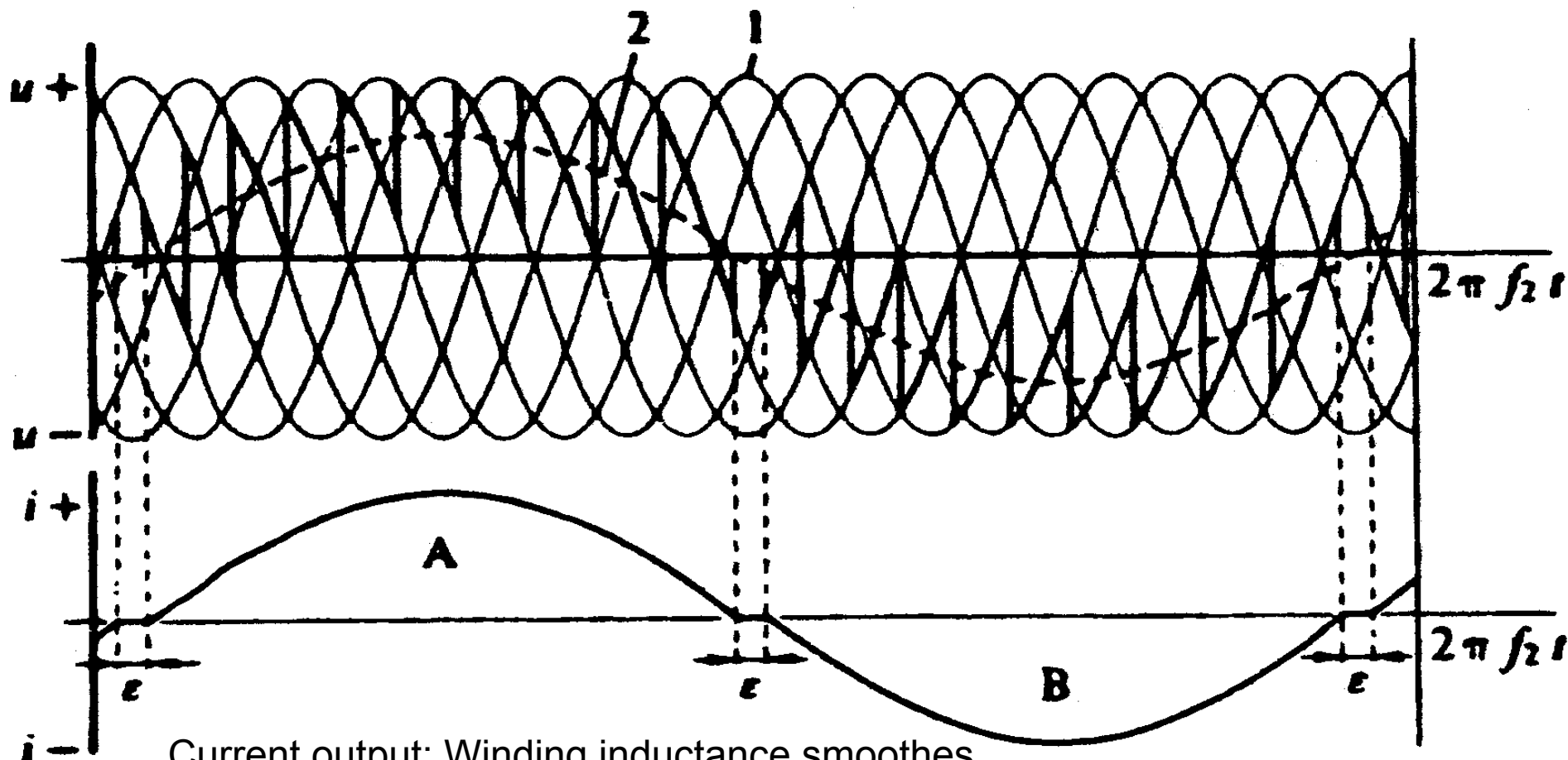


Principle of cyclo converter



Output wave form of one leg (phase) of cyclo converter

Voltage output: Consists of primary grid voltage at different firing angle to get sine wave



Current output: Winding inductance smoothes wave to nearly sinusoidal shape

Synchronous generators for small hydro power



Stator iron core for salient pole synchronous generator



Radial
ventilation
ducts

Source:

VA Tech
Hydro,
Bhopal,
India

Low speed operating synchronous generator, river power plant



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Rotor salient pole manufacturing

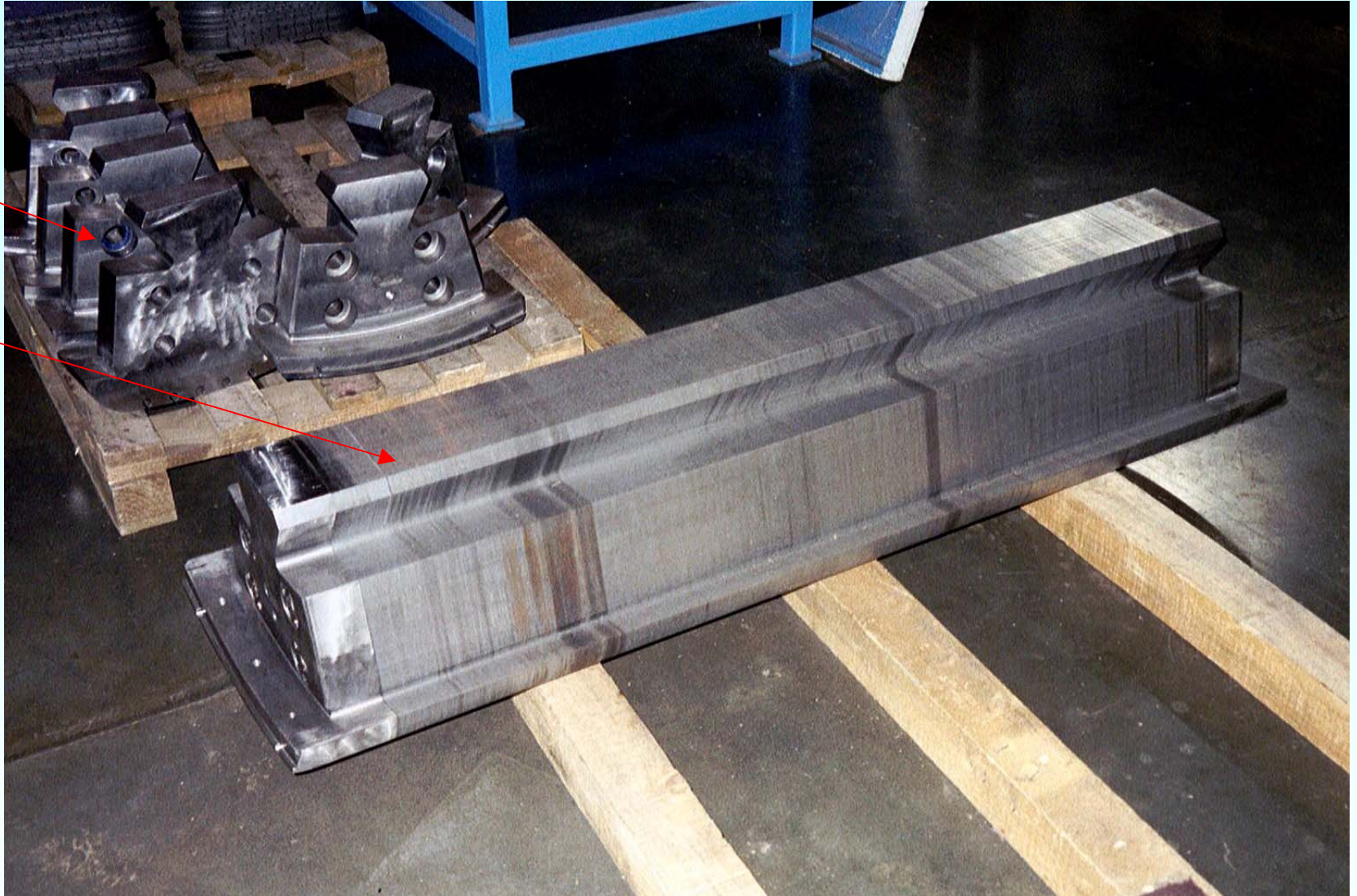
Massive
pole
pressing
plates

Dove tail
rotor pole

Lamination
pressed by
pressing
plates

Source:

VA Tech
Hydro,
Bhopal,
India



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Completed salient pole synchronous rotor, 8 poles

Fly wheel to increase rotor inertia to limit acceleration in case of load drop

Shaft mounted fan with forward bent radial blades for rotation in clockwise direction at fixed speed

Source:

VA Tech Hydro,
Bhopal, India

Kauli power plant



Stacking round rotor for synchronous generator



Hydraulic cylinders for pressing rotor iron stack

Rotor cylindrical iron core

8 pole rotor with 72 rotor slot pitches, but only 48 rotor slots for 24 rotor field coils

- 3 concentric field coils per pole
- 72 rotor round damper bars

Source:

VA Tech Hydro,
Bhopal, India

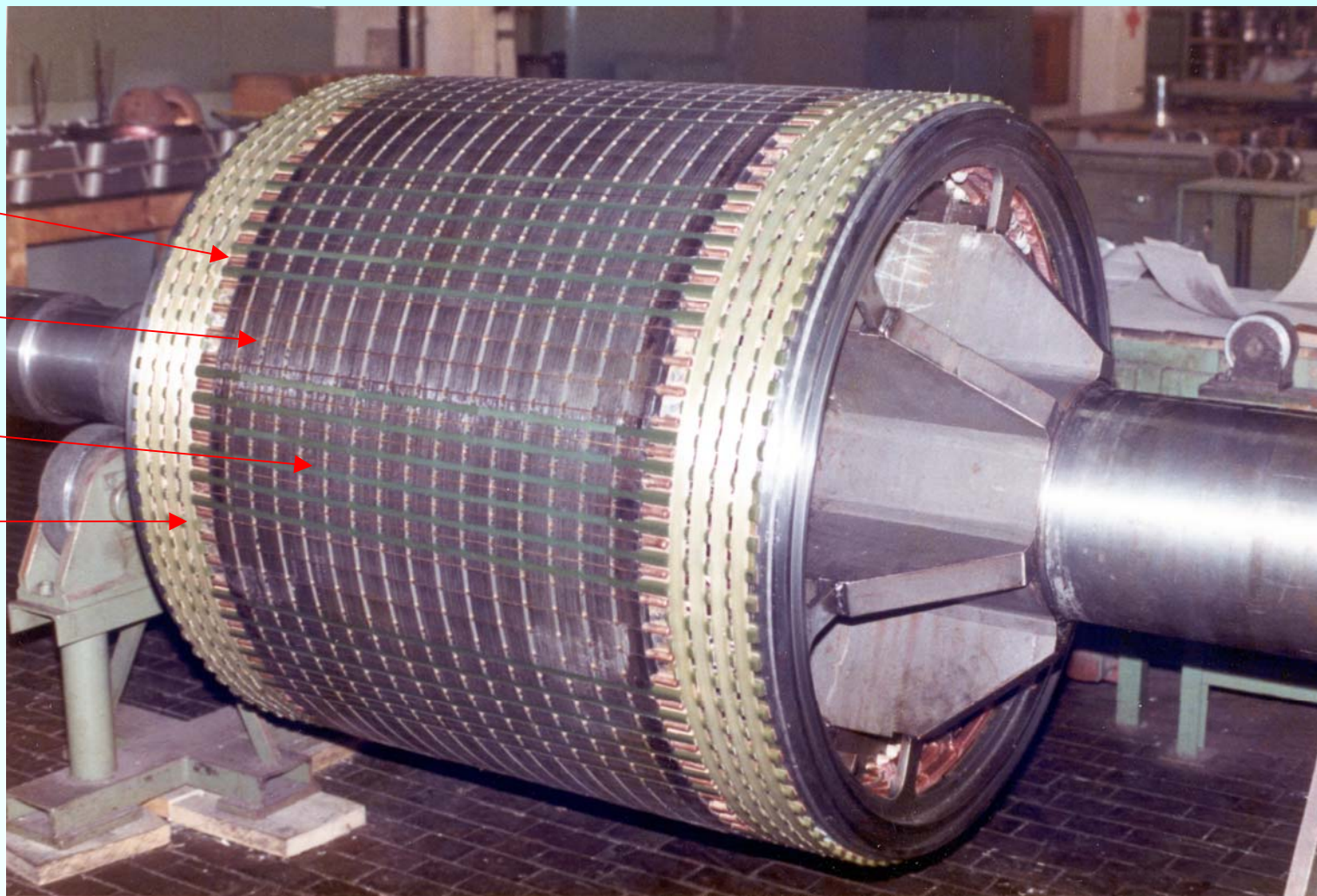
Round rotor synchronous machine, 8 poles

Three field coils
per pole: $q_r = 3$

Damper cage with
9 bars per pole

Radial ventilation
ducts

Glass fibre
bandage for fixing
rotor coil overhang



Source:

VA Tech Hydro,
Bhopal, India



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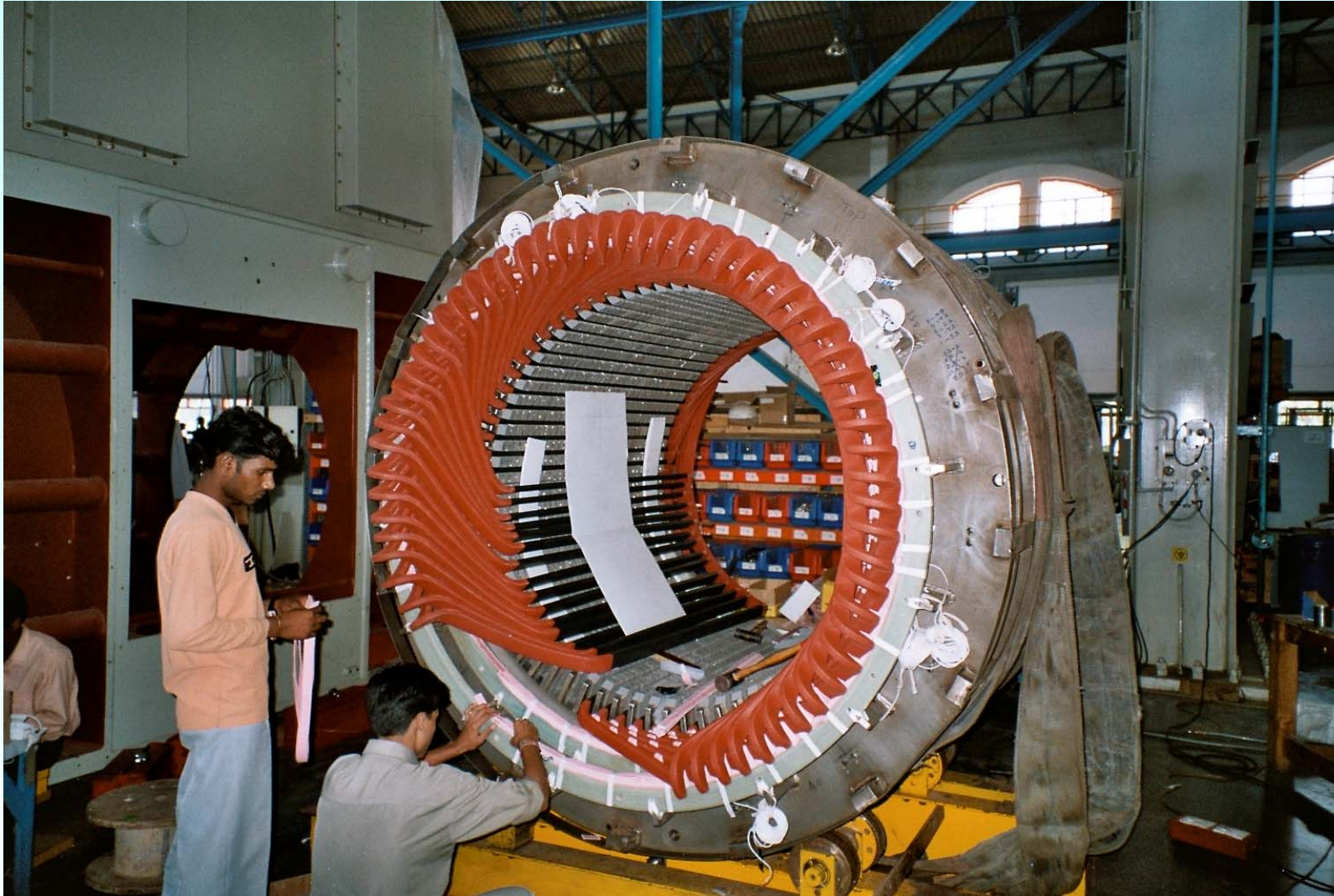


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Inserting two-layer form wound HV stator coils



4 pole
winding

pitched stator
coils

Source:

VA Tech Hydro,
Bhopal, India



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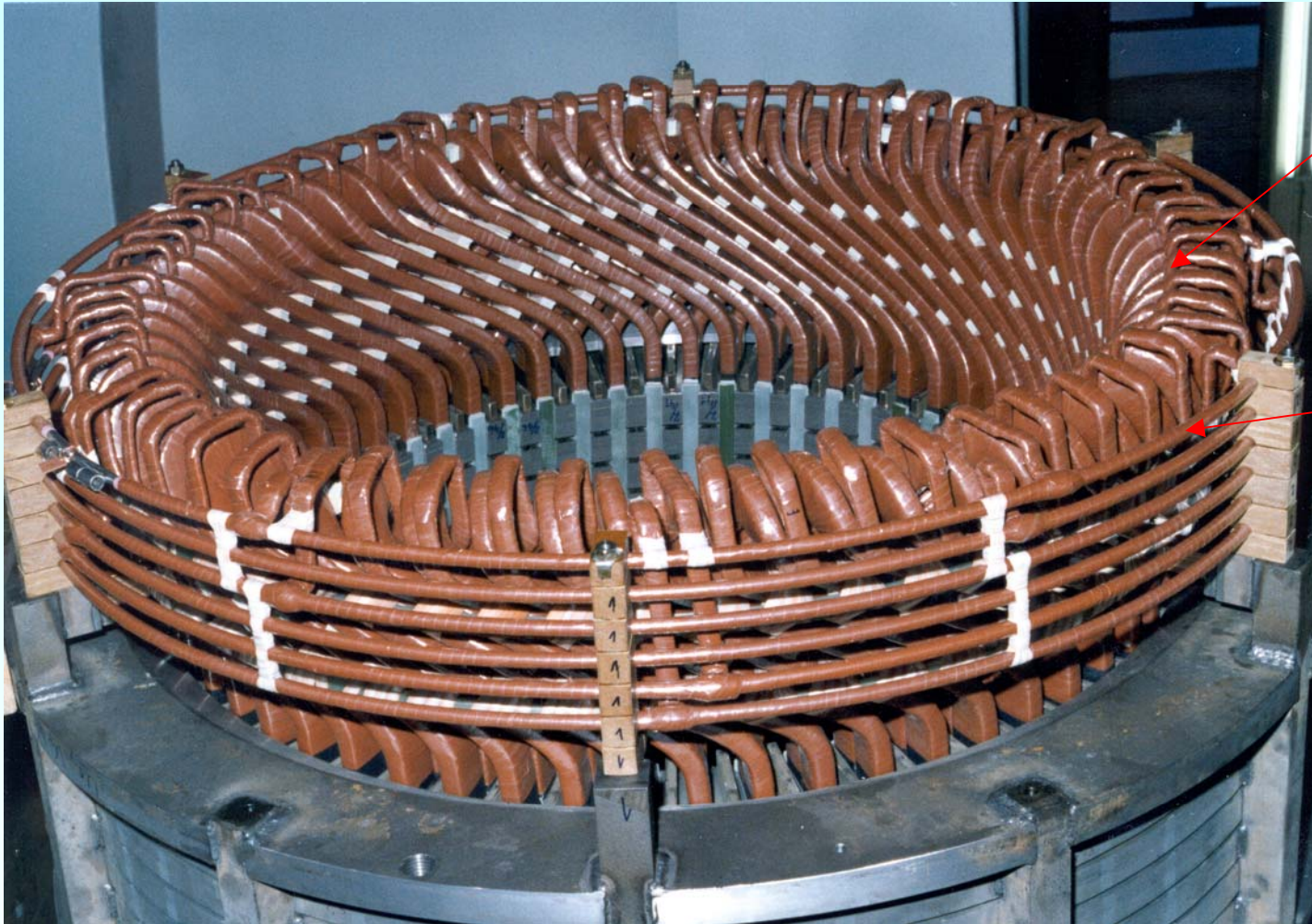
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Completed stator form-wound HV winding



Stator winding
overhang of two-
layer pitched coil
winding

connecting
copper rings for
parallel
connection of
stator coils

Source:

VA Tech Hydro,
Bhopal, India



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Stator housing for cylindrical rotor synchronous machine



Welded housing for air-air heat exchanger

Housing for stator iron core

stator iron core before being inserted

stator coils before inserting into stator slots

Source:

VA Tech Hydro,
Bhopal, India



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