

# LECTURE 2

# Advantages of rotating field and stationary armature

- Ease of construction
- Number of slip rings required
- Better insulation to armature
- Reduced Rotor weight and Rotor Inertia
- Improved ventilation arrangement

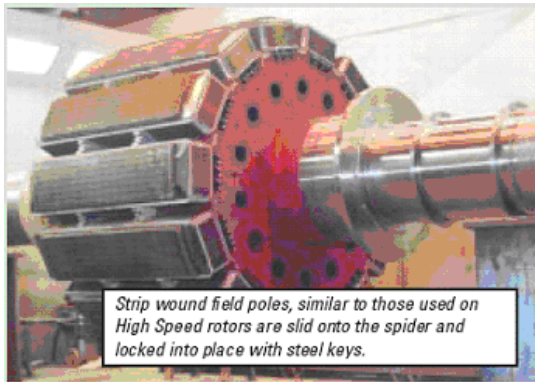
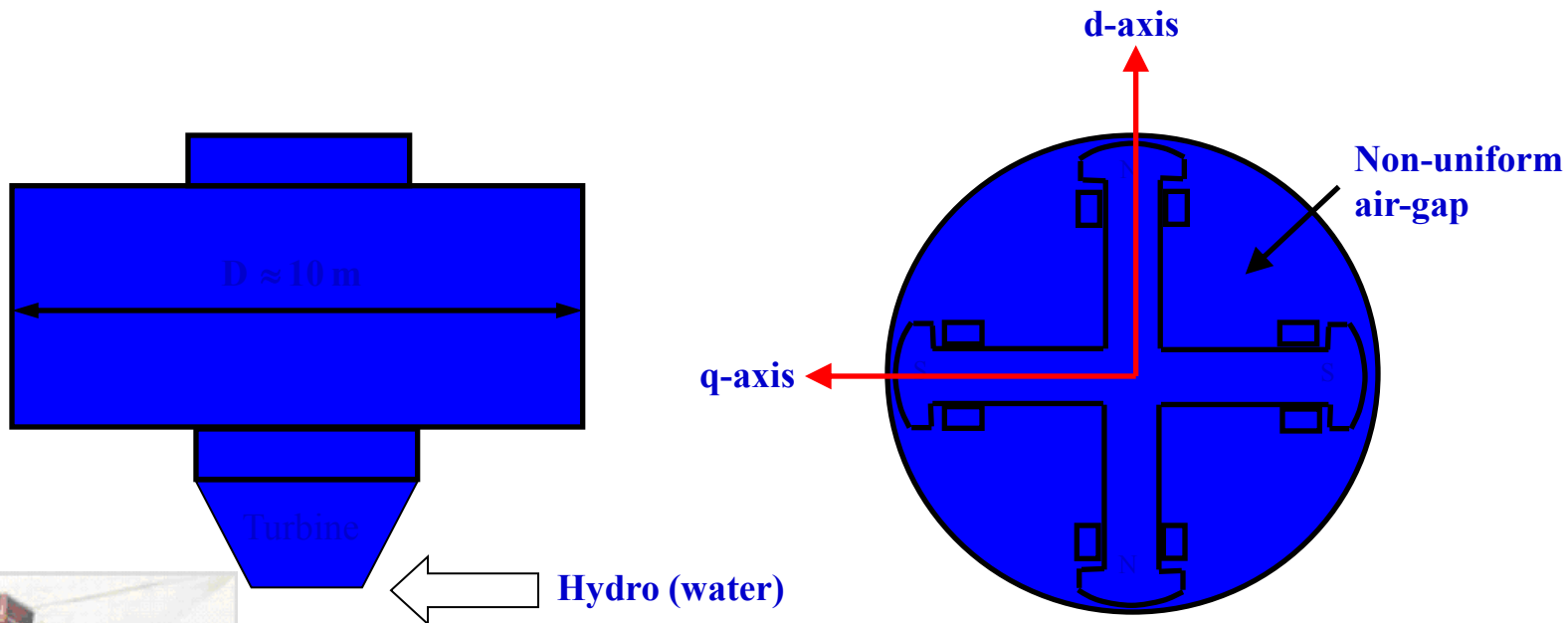
# Various Types

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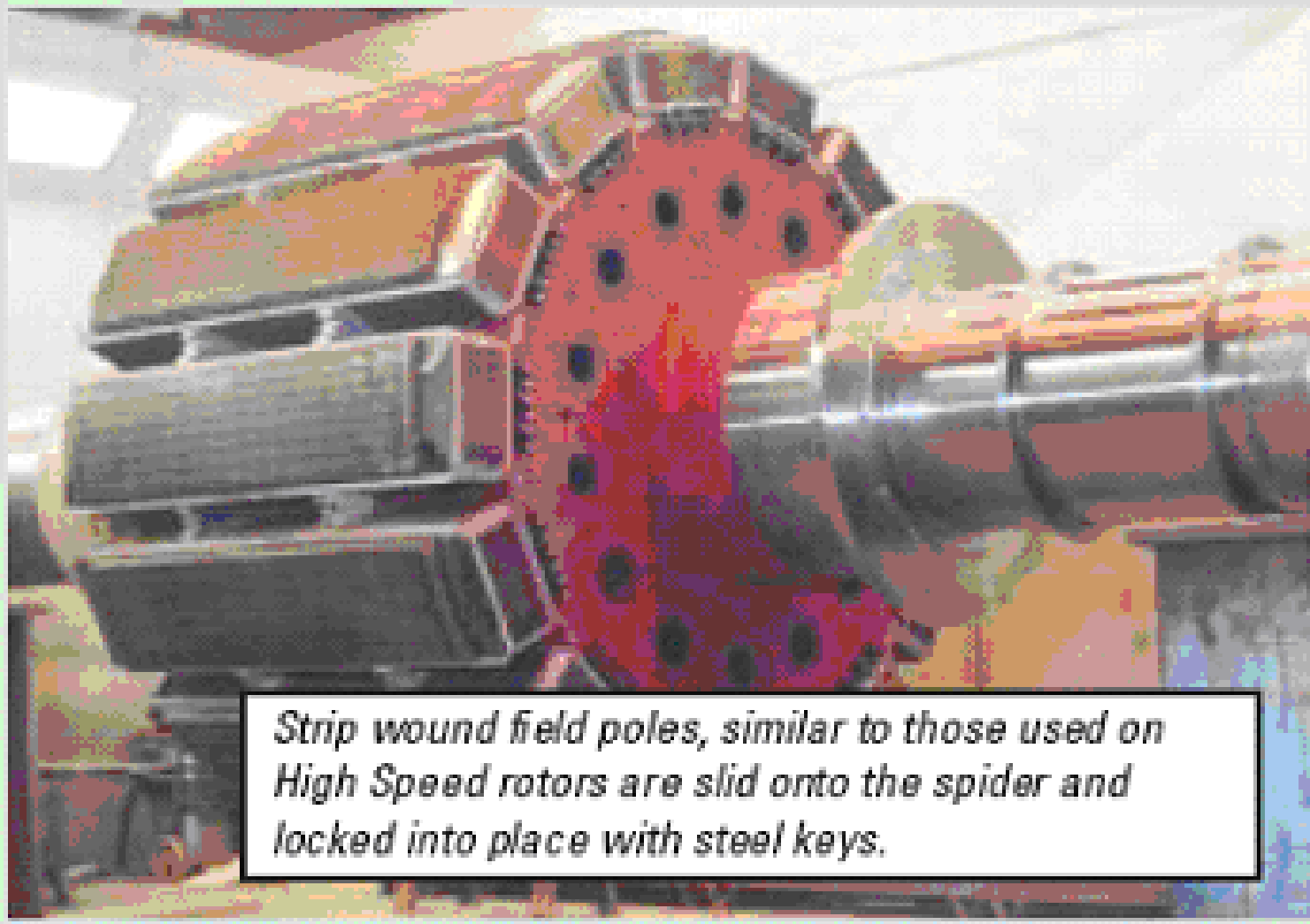
- ❑ **Salient-pole synchronous machine**
- ❑ **Cylindrical or round-rotor synchronous machine**

# Salient-Pole Synchronous Generator

1. Most hydraulic turbines have to turn at low speeds (between 50 and 300 r/min)
2. A large number of poles are required on the rotor



Hydrogenerator



*Strip wound field poles, similar to those used on High Speed rotors are slid onto the spider and locked into place with steel keys.*

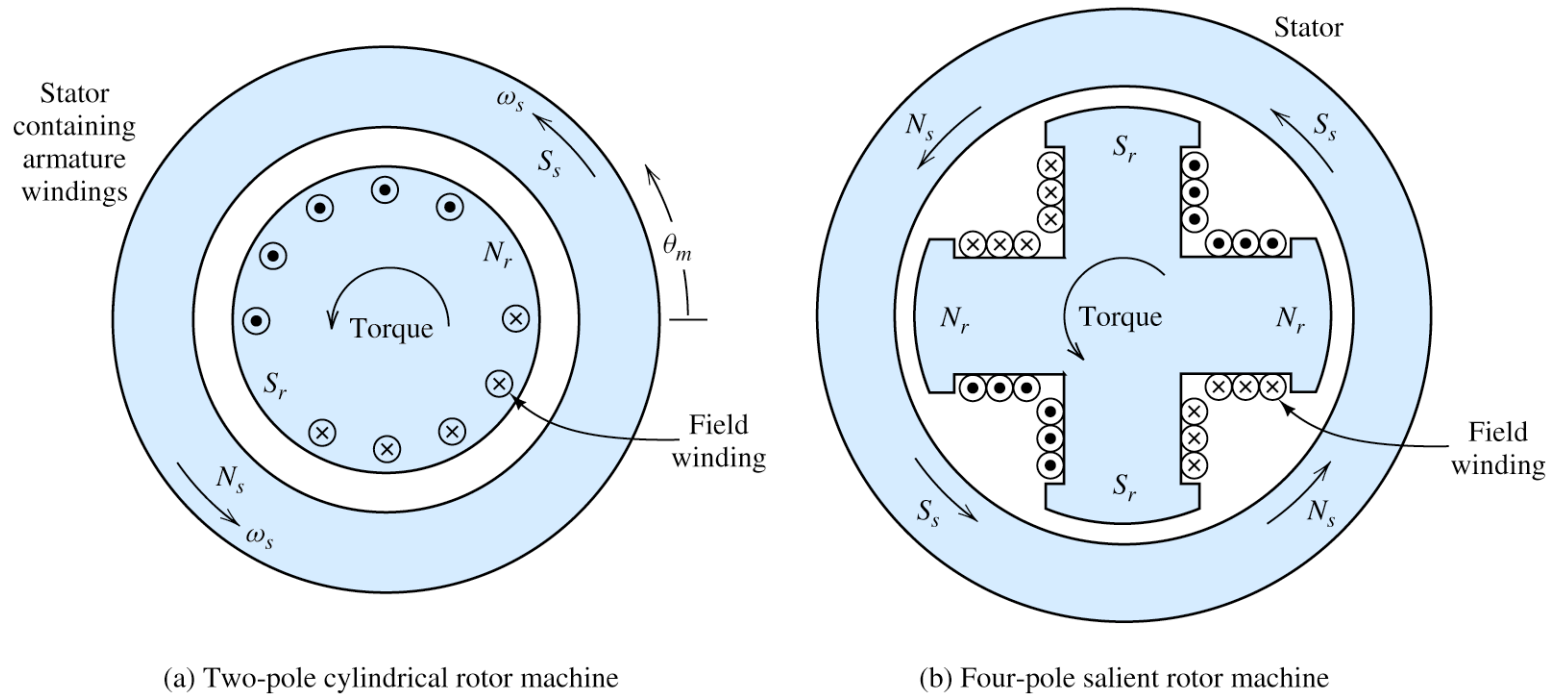
# Synchronous Machine

- The stator is similar in construction that of a induction motor
- The rotor can be Salient or Non-Salient
- Field excitation is provided on the rotor by either permanent or electromagnets with number of poles equal to the poles of the RMF caused by stator
- Non-excited rotors are also possible as in case of reluctance motors

# Synchronous Machine (2)

- The rotor gets *locked* to the RMF and rotates *unlike induction motor* at *synchronous speed* under all load condition
- All conventional power plants use synchronous generators for converting power to electrical form
- They operate at a better power factor and higher efficiency than equivalent induction machines

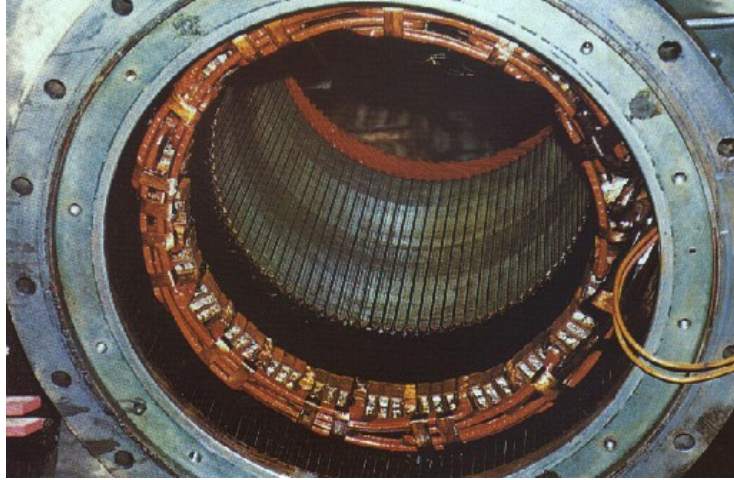
# Synchronous Machine Construction



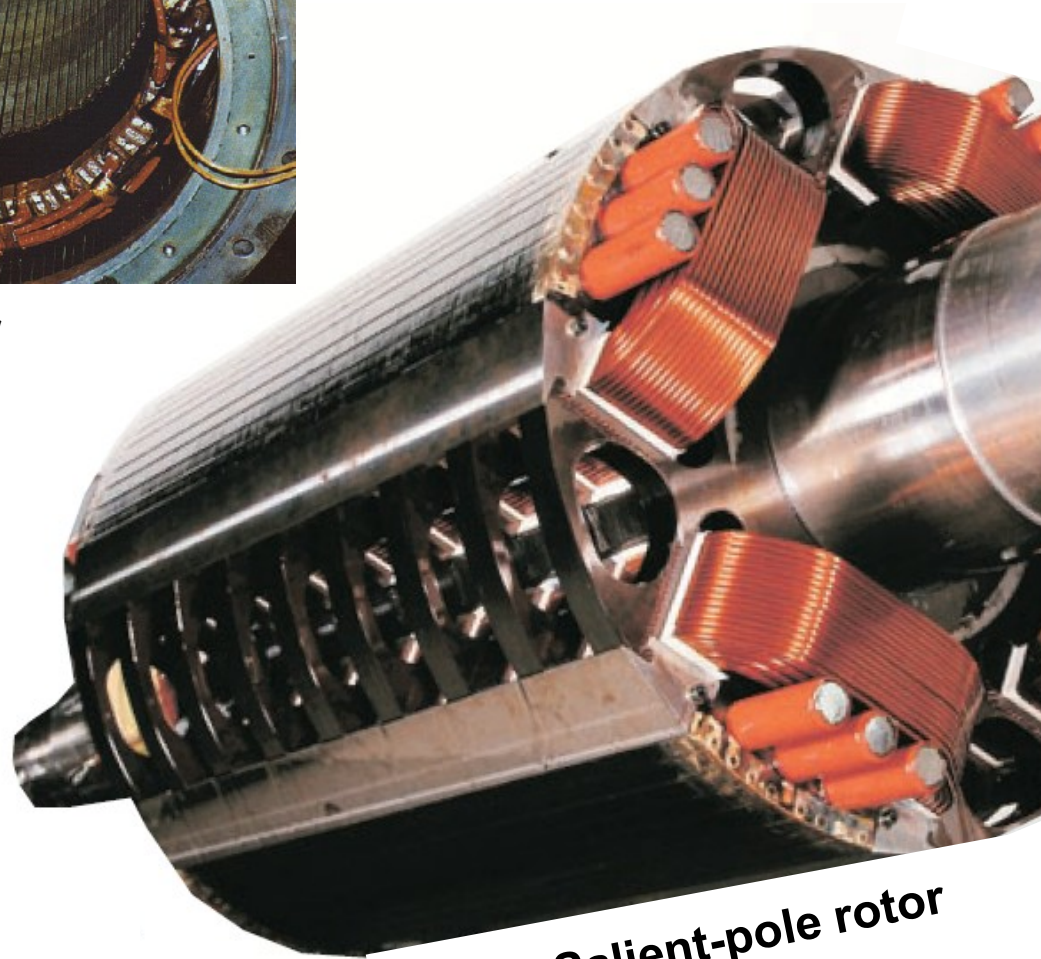
**Figure 17.17** Cross sections of two synchronous machines. The relative positions of the stator and rotor poles are shown for motor action. Torque is developed in the direction of rotation because the rotor poles try to align themselves with the opposite stator poles.



# Salient-Pole Synchronous Generator

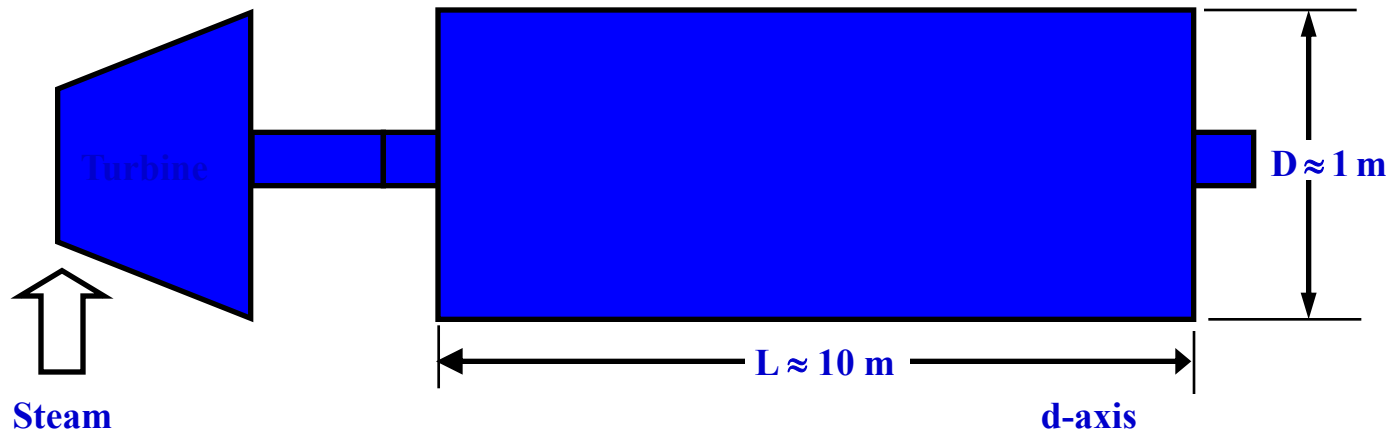


**Stator**

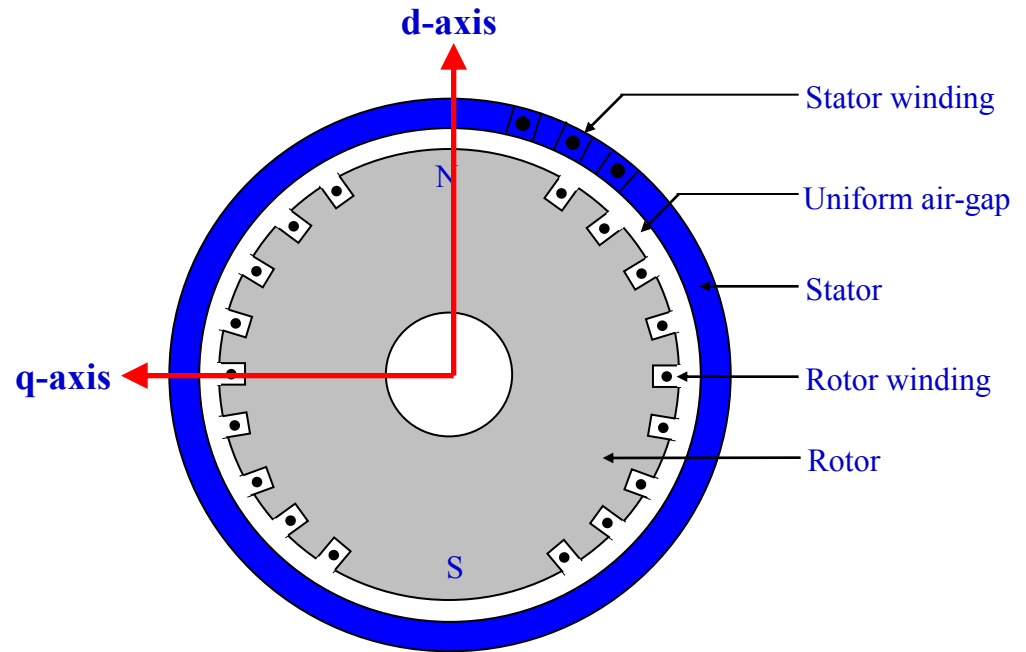


**Salient-pole rotor**

# Cylindrical-Rotor Synchronous Generator



- High speed
- $3600 \text{ r/min} \Rightarrow 2\text{-pole}$
- $1800 \text{ r/min} \Rightarrow 4\text{-pole}$
- Direct-conductor cooling (using hydrogen or water as coolant)
- Rating up to 2000 MVA

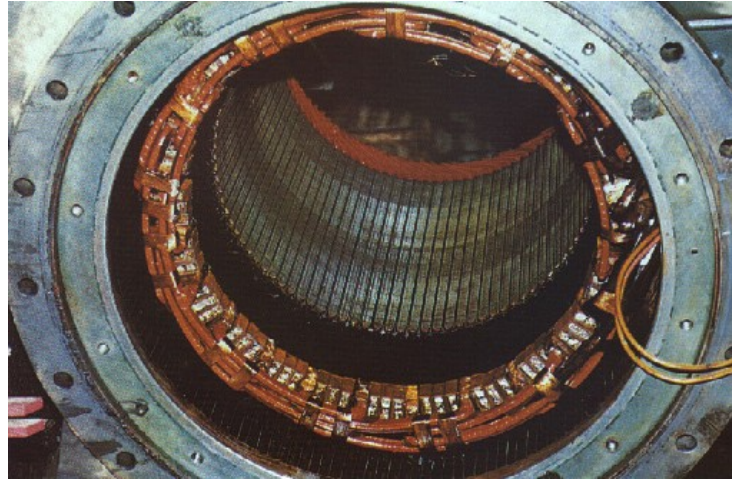


**Turbogenerator**

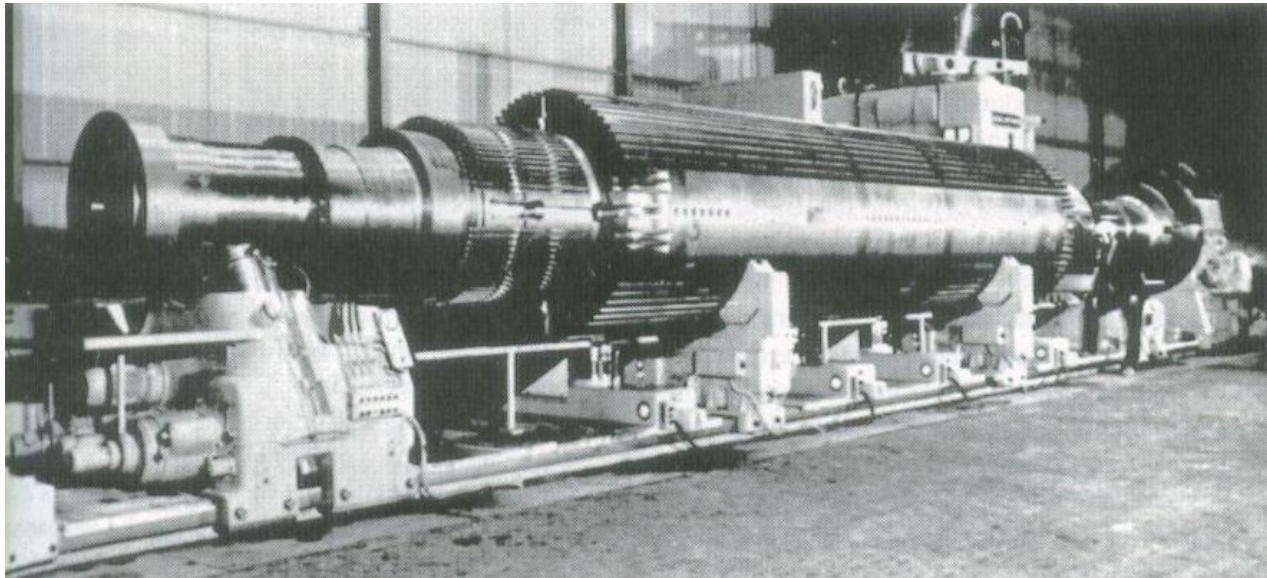
## Synchronous Generator: Rotor

- Salient-pole rotors
  - Used for low speed applications ( $<300\text{rpm}$ ) which require large number of poles to achieve required frequencies (e.g. hydro turbines)
- Cylindrical rotors
  - Used for high-speed applications (steam/gas turbines).
  - Minimum number of poles is 2, so for 50Hz the maximum speed is 3000rpm.
  - High speed of rotation produces strong centrifugal forces, which impose upper limit on the rotor diameter

# Cylindrical-Rotor Synchronous Generator



**Stator**



**Cylindrical rotor**