

# BRODSKI STROJNI KOMPLEKSI



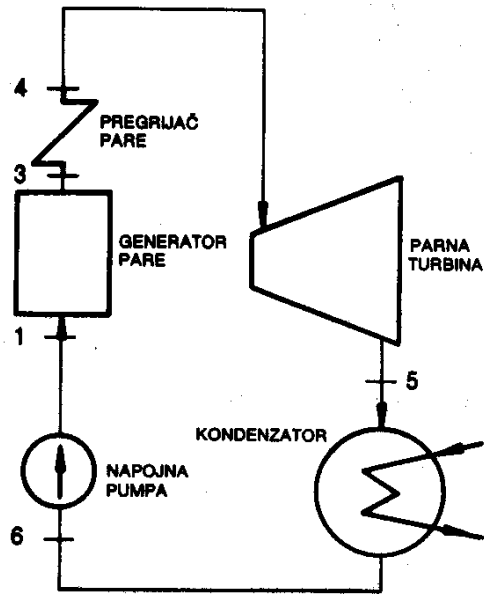
Brodske parne turbine



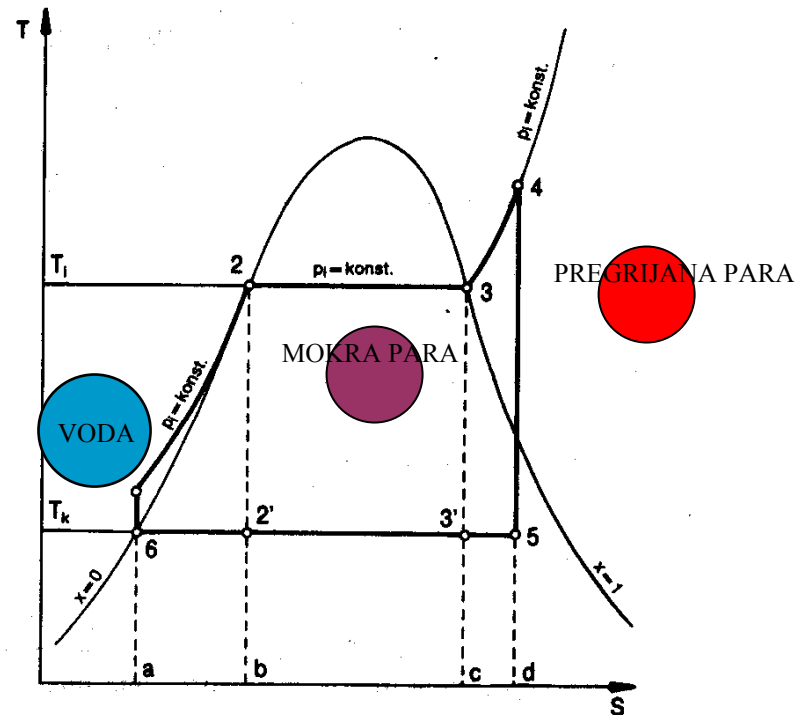
# TIPOVI (Podjela)

- Akcijska (de Laval) – 1883.
- Reakcijska (Parsons) – 1884.
- Sa stupnjevanjem brzine (Curtis)
- Jedno- i višekučišne
- Radijalne i aksijalne
- Visoko-, srednje- i niskotlačne
- Glavne i pomoćne
- Kondenzacijske i protutlačne

# PARNI PROCES



OSNOVNA SHEMA PARNOG PROCESA



T-s DIJAGRAM PARNOG PROCESA



# Toplinski st. iskoristivosti

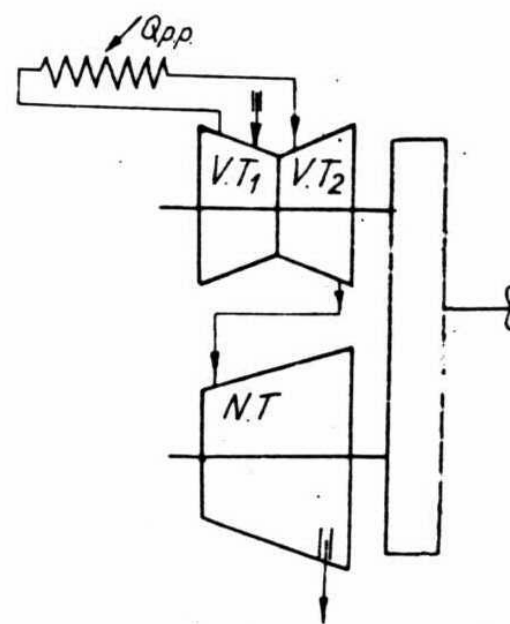
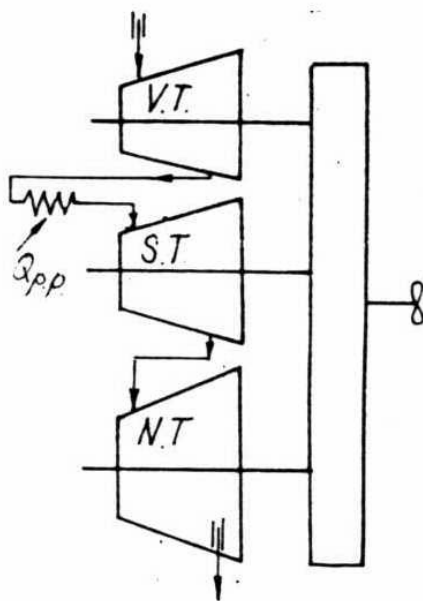
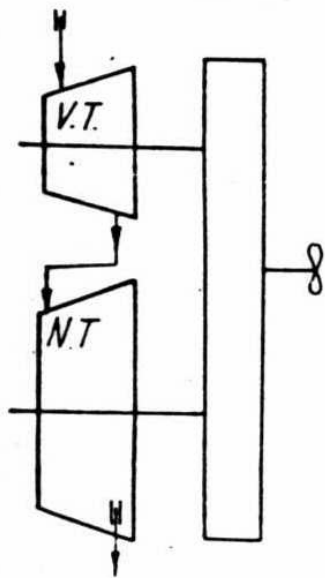
$$\eta_t = \frac{L}{Q_{dov}} = \frac{D(h_4 - h_5)}{D(h_4 - h_1)}$$



# Porivne

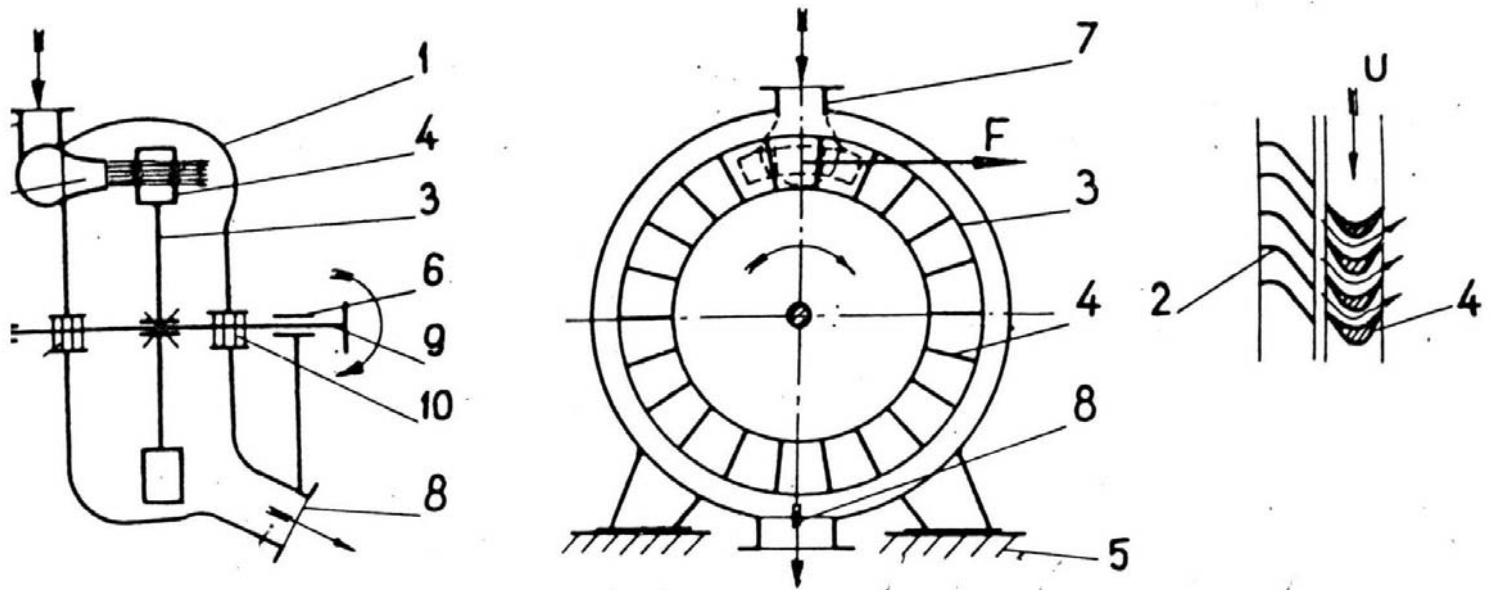
- Više kućišta
- Višestepene - Parsons
- Curtis za vožnju krmom
- Kombinacije s plinskim turbinama
- Danas: EM porivi

# Porivne

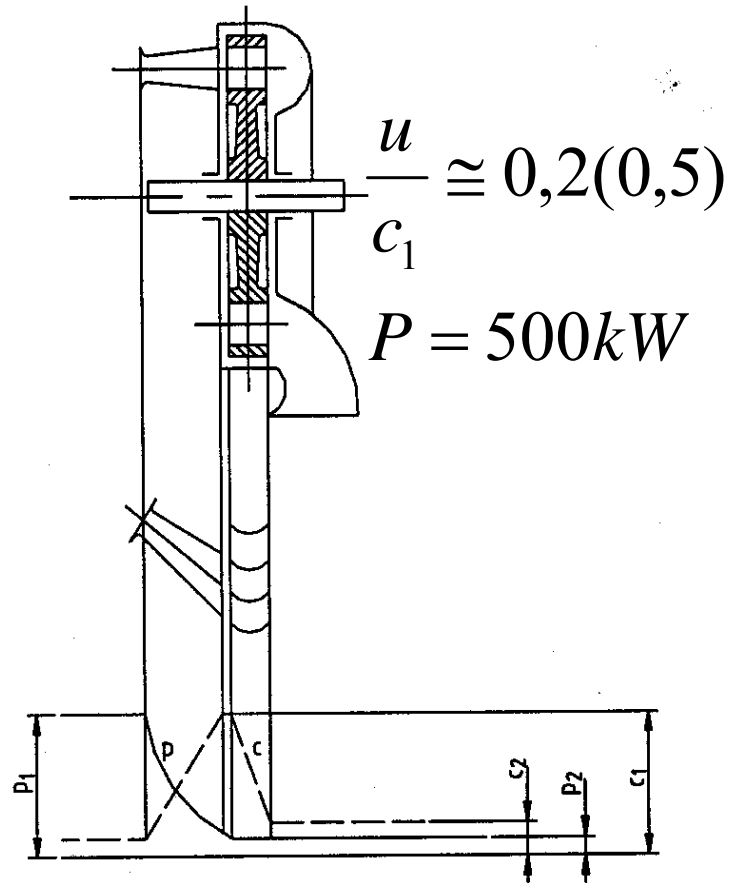


# De Laval

10000-30000  $\text{min}^{-1}$ ,  $\eta_e=0,3-0.4$

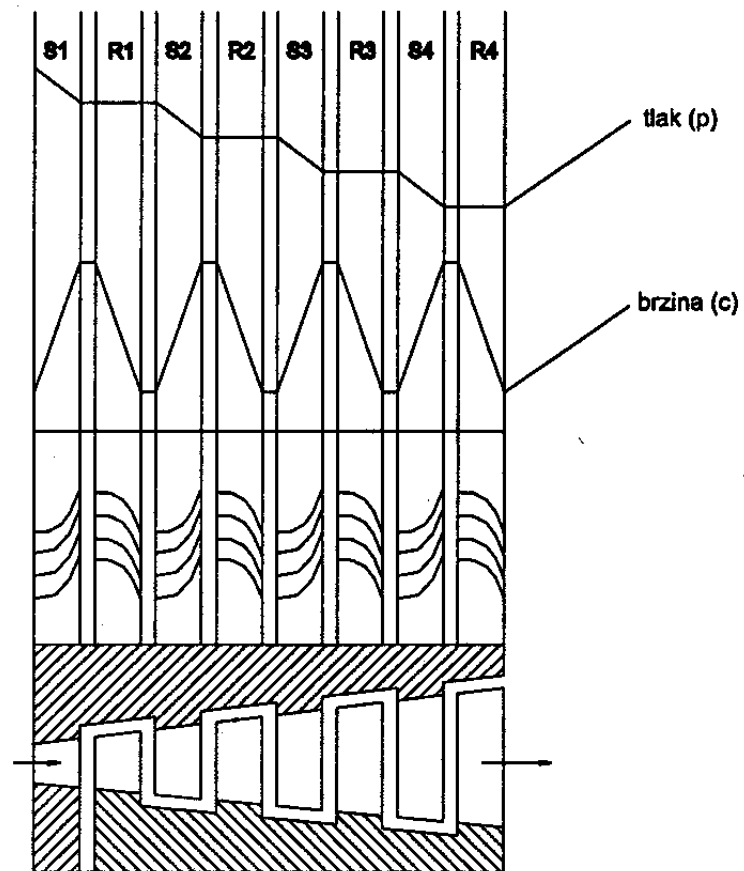


# De Laval

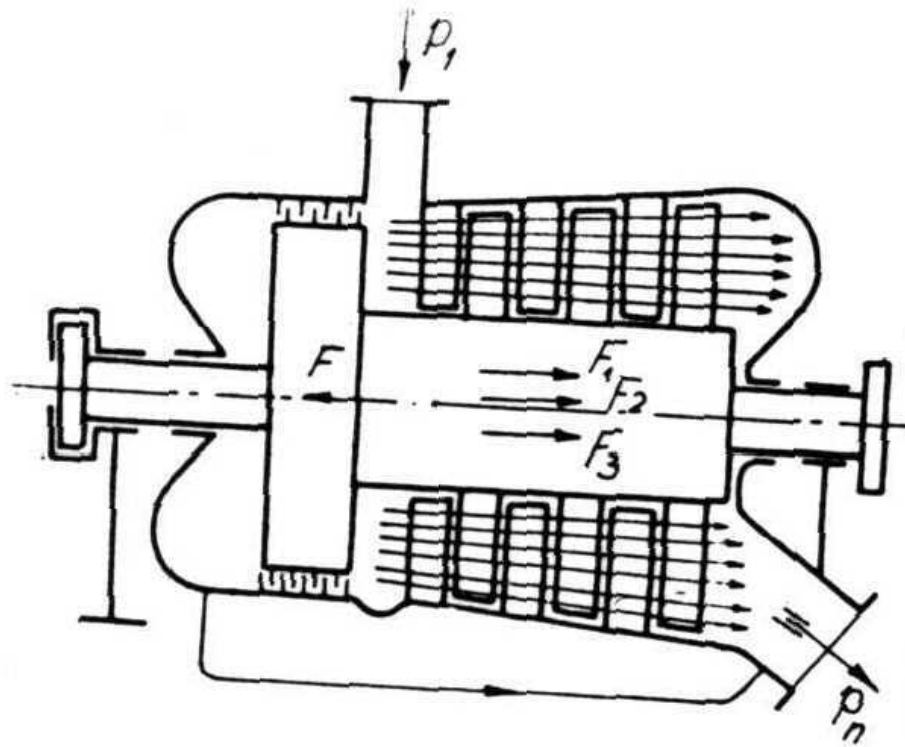




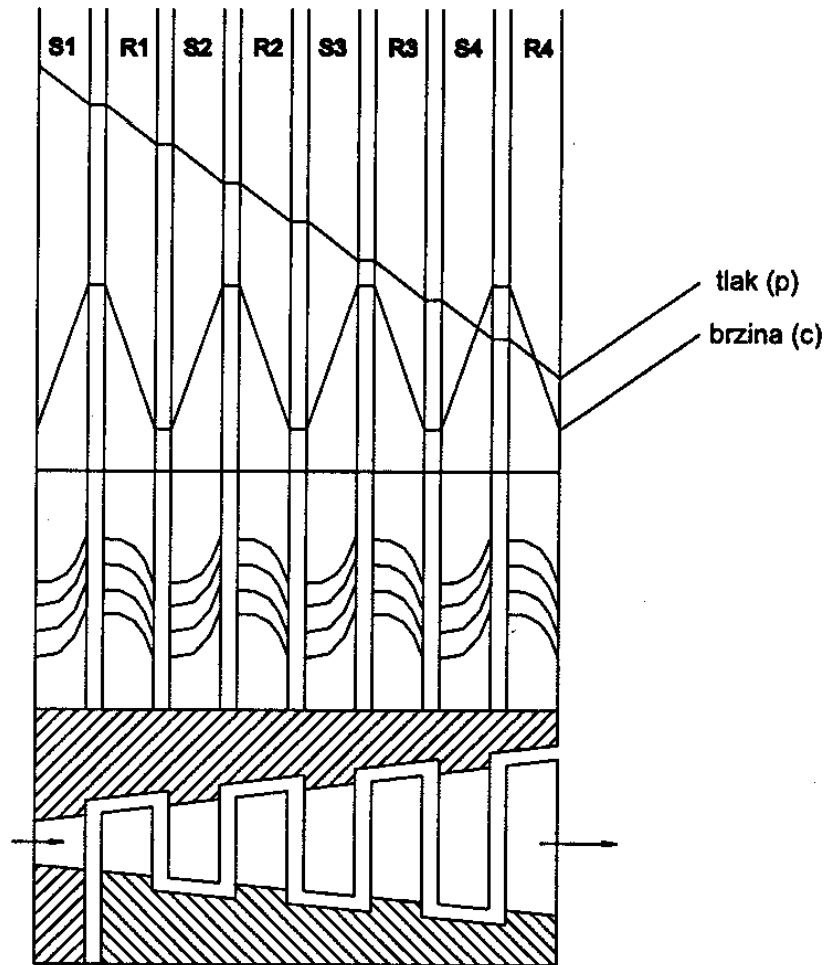
# De Laval



# Parsons

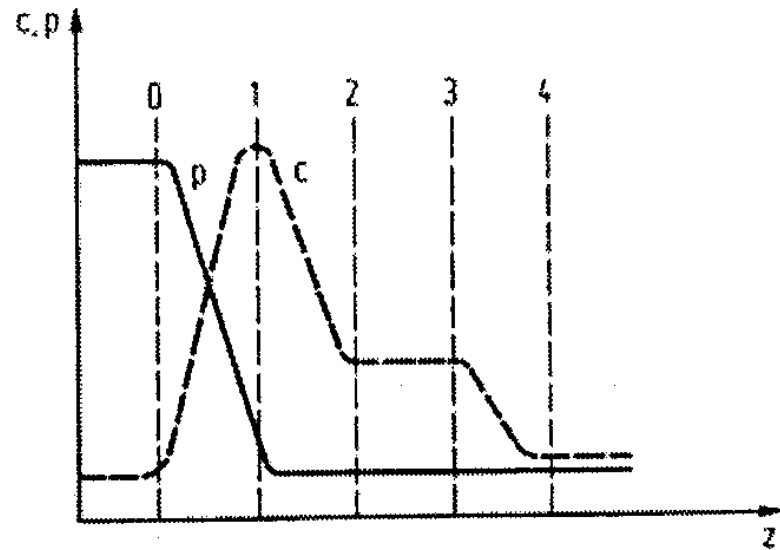
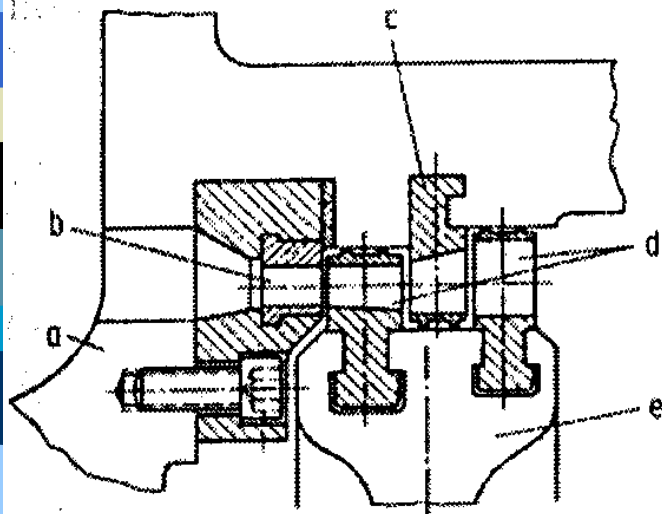


# Parsons



# Curtis kolo – 1900.

3000-10000  $\text{min}^{-1}$ ,  $\eta_e = 0,4$  i više



# Potrošak pare i stupanj djelovanja

- $P = D \cdot H \cdot \eta_{eo}$
- $\eta_{eo} = \eta_t \cdot \eta_i \cdot \eta_m \cdot \eta_p$
- Gubici: 1) unutarnji (utječu na stanje radnog medija u turbini), 2) vanjski
- Ad.1)      1- u ulaznim ventilima 3-5%  
                  2- u sapnicama ili statorskim rešetkama (ovisi o obradi sapn.)  
                  3- u rotorskim rešetkama (bridni, zazori, trenje, skretanje...)



# Potrošak pare i stupanj djelovanja

- 4- zbog izlazne brzine  $\Delta h_{iz} = c_2^2/2$ , 3-5%
- 5- unutarnji zazori (statorske lop./rotor)
- 6- trenja i ventilacije
- 7- zbog vlažnosti pare
- 8- na izlazu  $\Delta p_{iz}$  (difuzor)



# Potrošak pare i stupanj djelovanja

- Ad.2) 1- kroz vanjske labirintne brtve  
2- mehanički 0,6-1%



# Povećanje iskoristivosti

- Viši tlakovi
- Više temperature pregrijanja
- Međupregrijanje pare
- Niži tlakovi u kondenzatoru

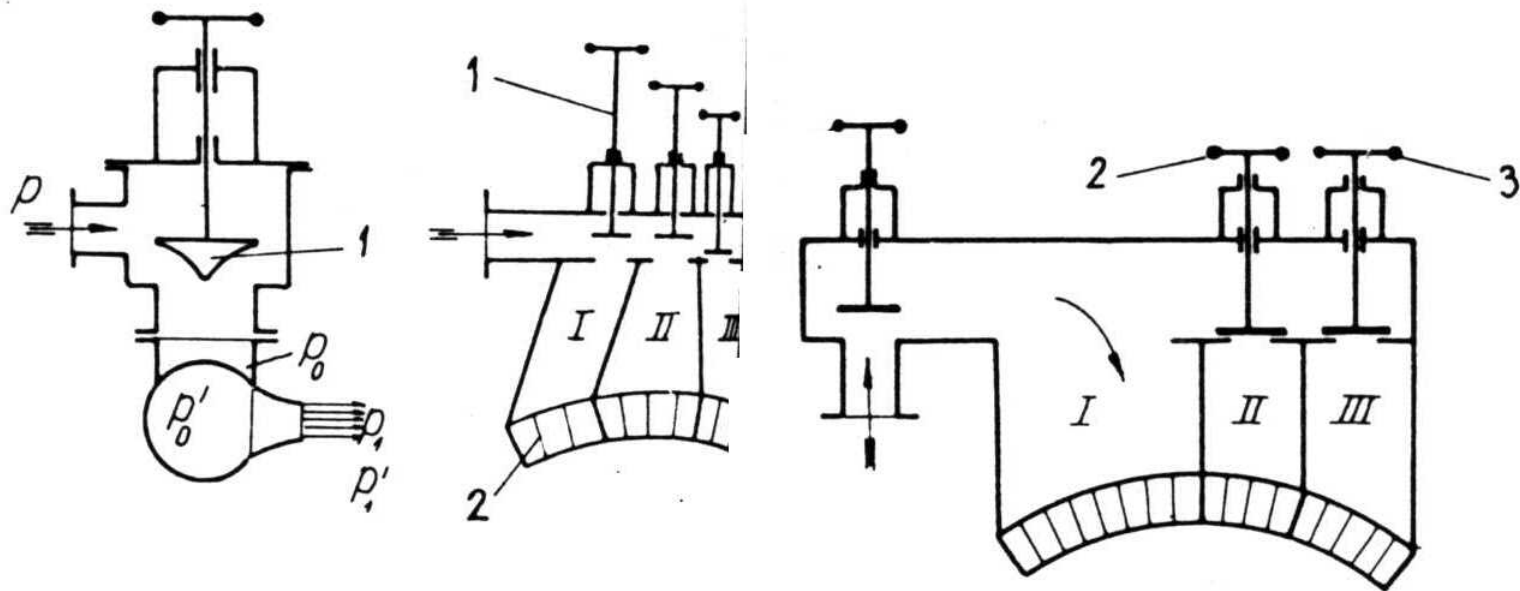




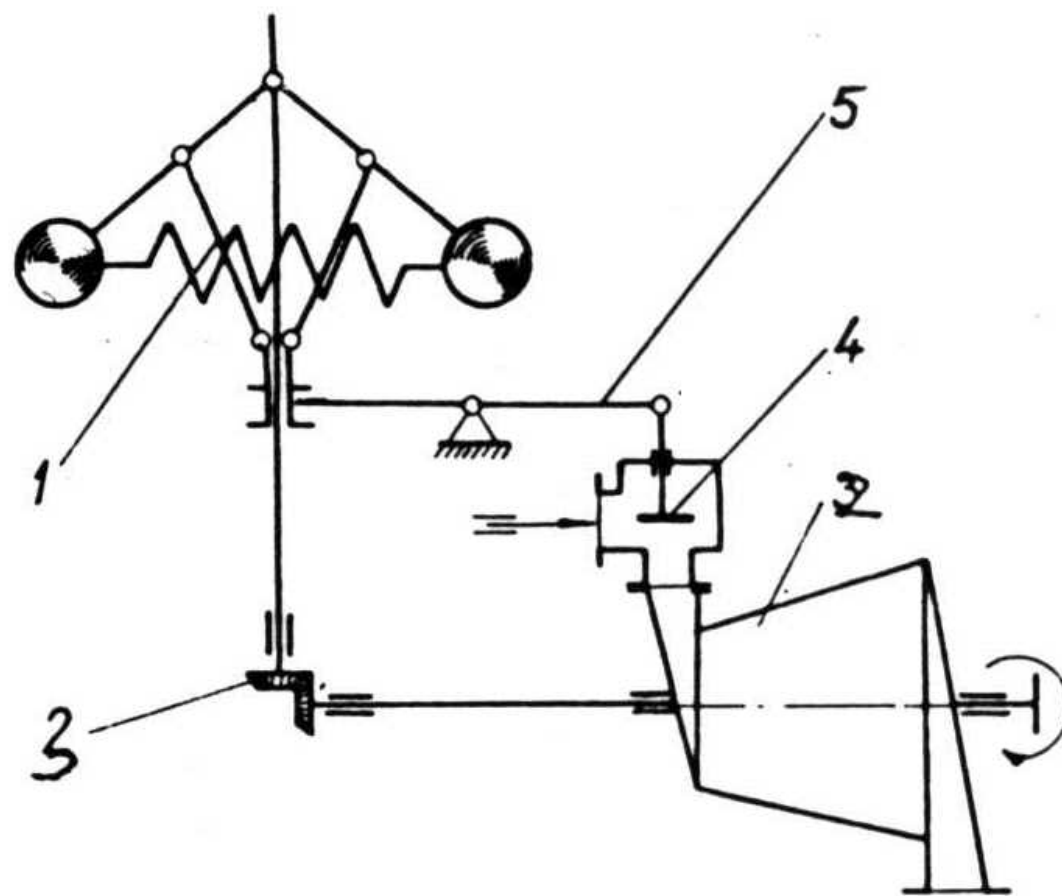
# REGULACIJA

- PRIGUŠIVANJEM (TLAKOM)
- KOLIČINSKA
- KOMBINIRANA

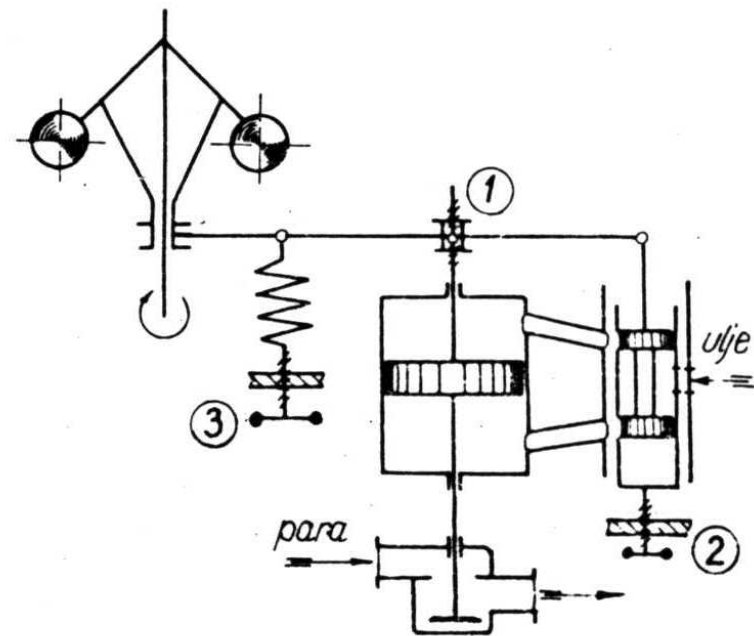
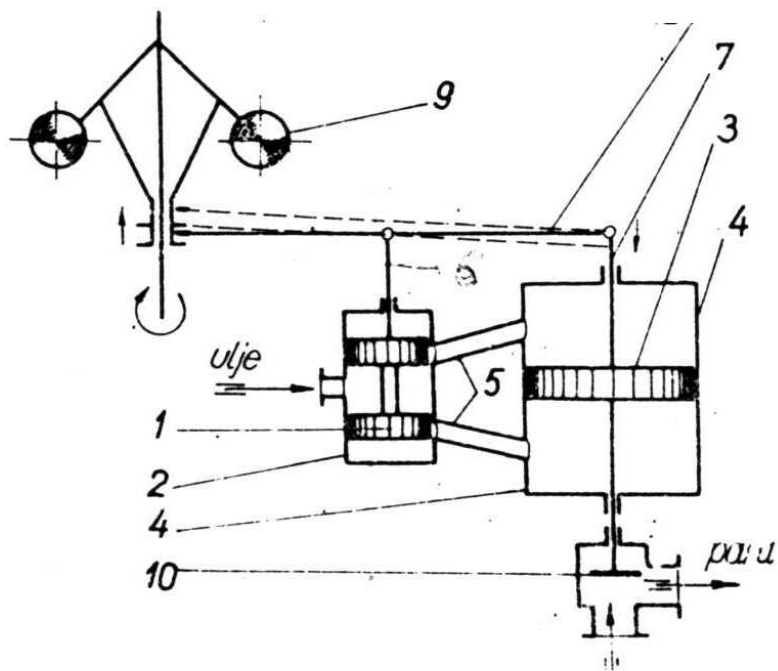
# REGULACIJA



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# ZAŠTITA

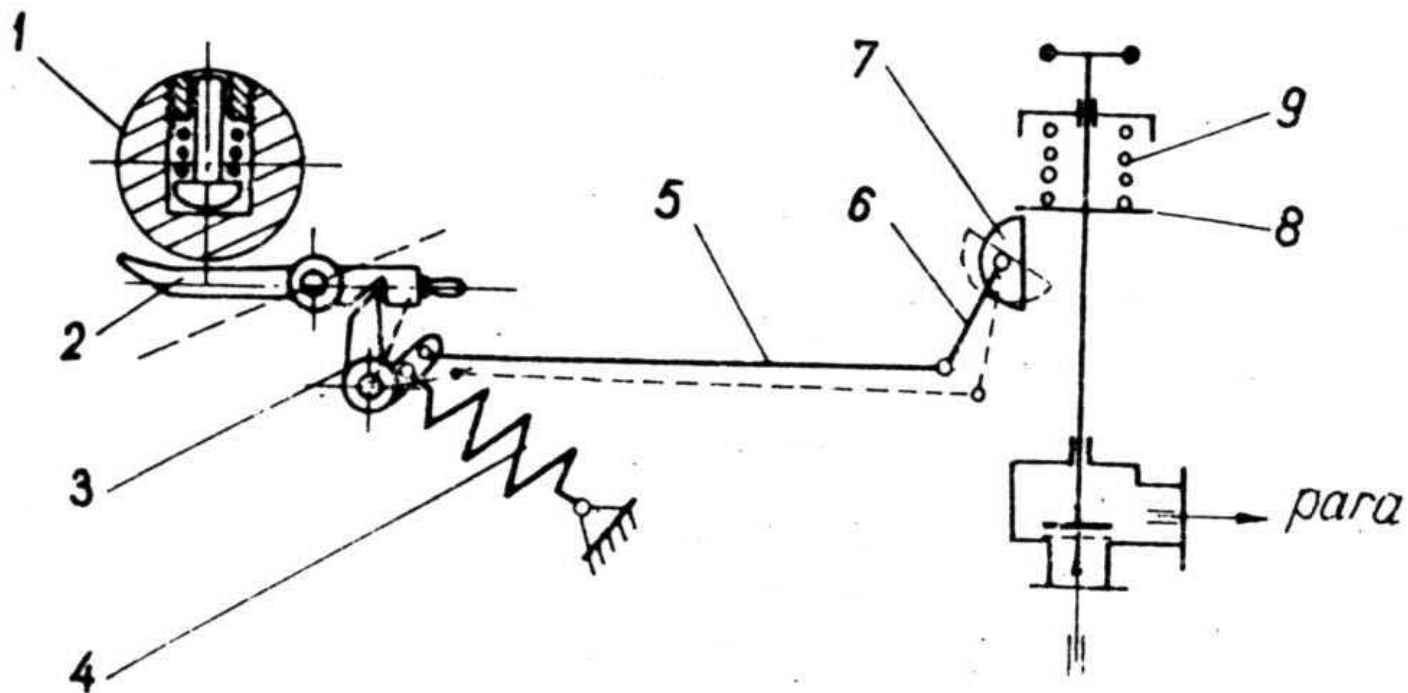
- Tlak pare u kondenzatoru
- Tlak ulja za podmazivanje
- Vibracije
- Prekoračenje brzine vrtnje
- Aksijalni pomak (0,8 mm)
- Greška na kotlu



# ZAŠTITA - sustav ulja

- Gravitacijski tank
- Tlačno: privješana pumpa, elektromotorom pogonjena, u nuždi

# ZAŠTITA (centrifugalni izvrstioc)





# Priprema za pogon

- “Dreniranje” cjevovoda pare
- Pumpa predpodmazivanja ležajeva turbine
- Pumpa rashladne vode kondenzatora
- Ejektor kondenzatora i labirintna para
- Na 60% podtlaka – para u turbinu
- Šumovi i vibracije
- Postepeno povećanje opterećenja





# Kontrola u radu

- Tehnički godišnji pregled
- 3-6 godina – remont turbine
- Redovito održavanje: brtve, sustav ulja, armatura...