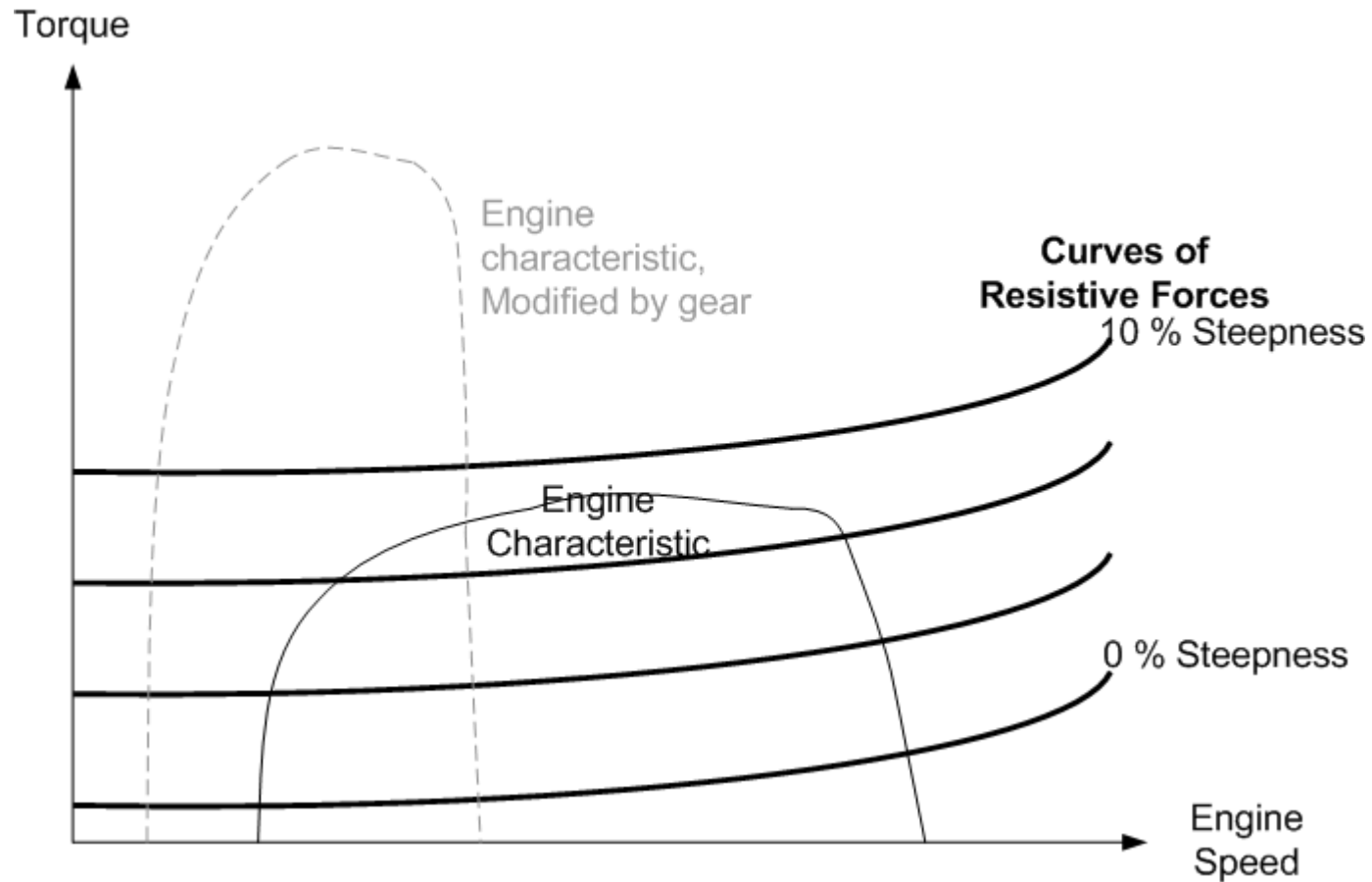


Contents

- 1 Internal Combustion Engines**
- 2 Overview of Engine Test Cells**
- 3 Brakes and Dynos**
- 4 Mechanic Design**
- 5 Measurement Systems**
- 6 Test Bench Control and Automation**
- 7 Test Cell Buildings**
- 8 Safety**

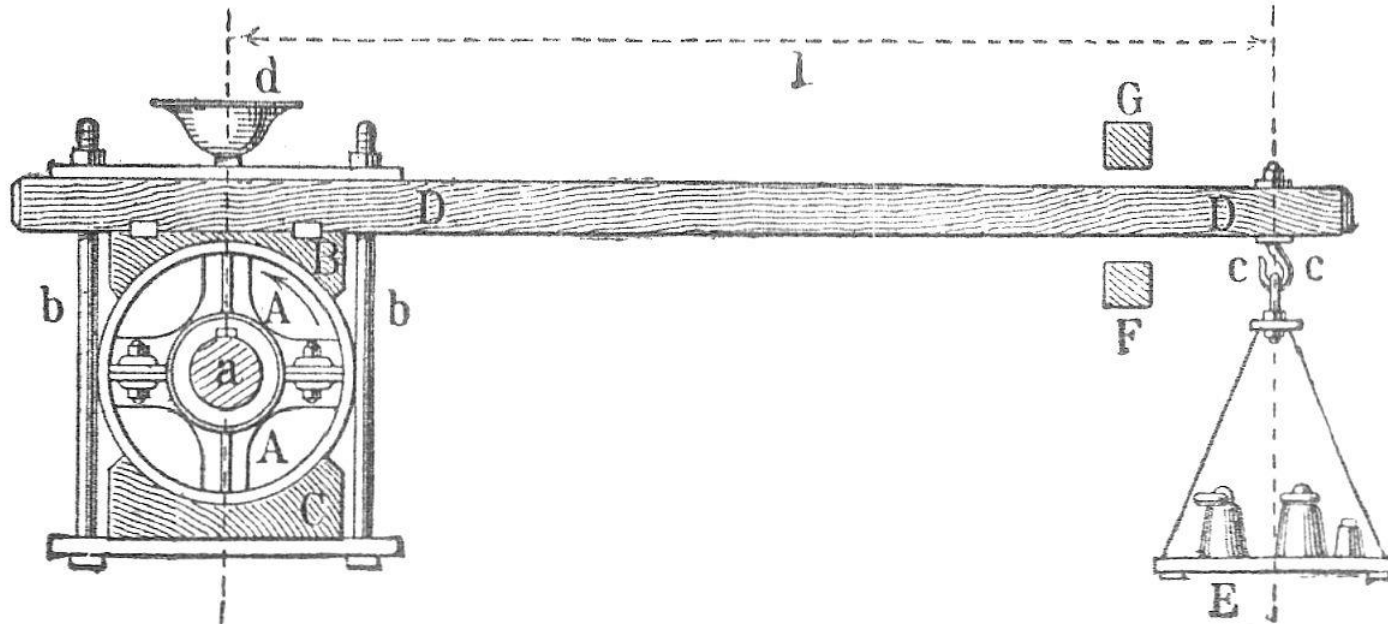
Brakes and Dynos

Load Curves



Brakes and Dynos

History



Prony's
Brake

Source:

<http://de.academic.ru/pictures/meyers/large/050324b.jpg>

Brakes and Dynos

Disk Brake???



Source:
UAS Köln

3 Brakes and Dynos

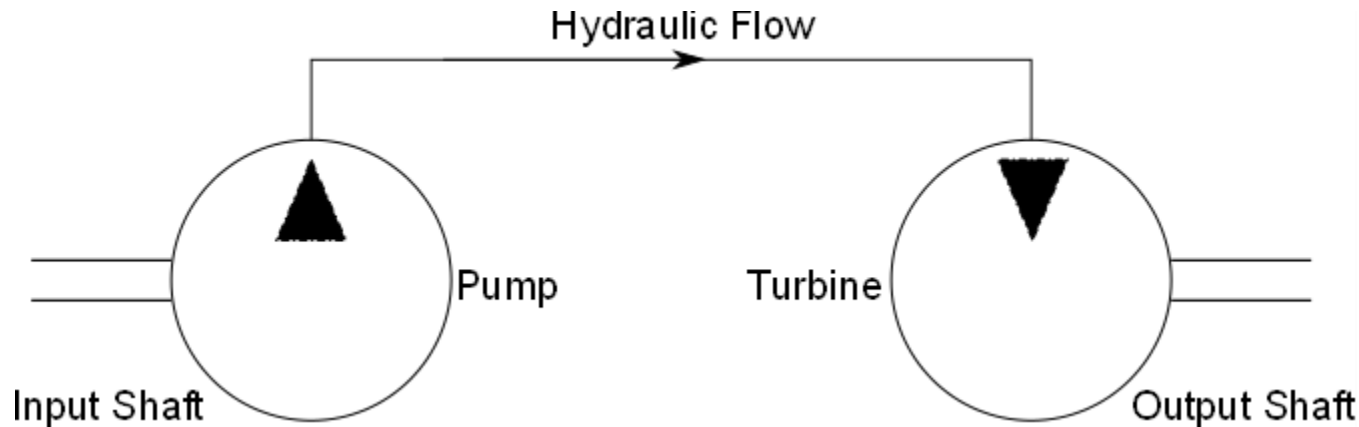
3.1 Hydraulic Brakes

3.2 Eddy Current Brake

3.3 Other Magnetic Brakes

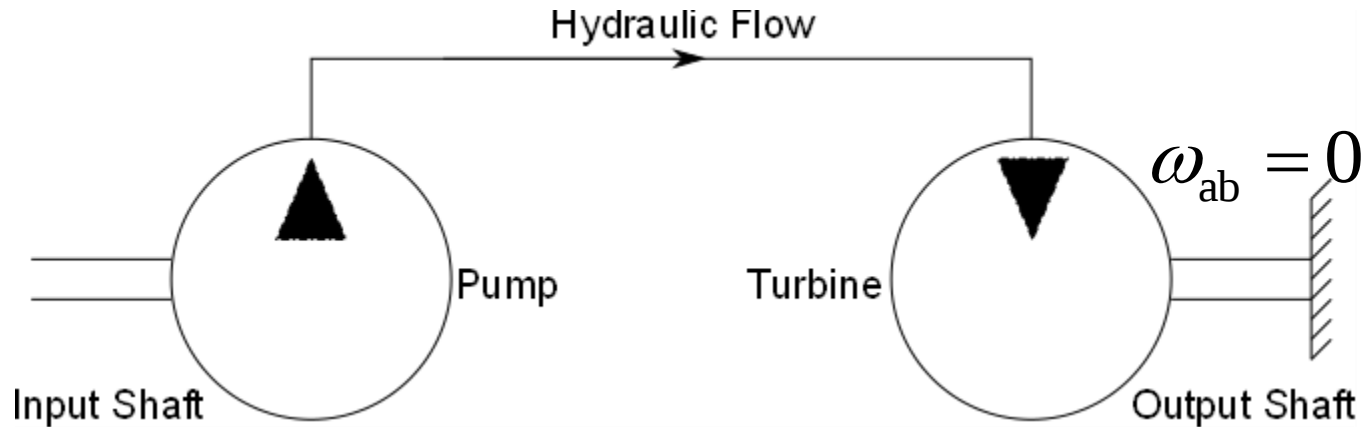
3.4 Electrical Dynos

Ideal Hydrodynamic Transmission



$$\underbrace{M_{an} \omega_{an}}_{\text{Input Power at Pump Shaft}} = \underbrace{\Delta p \frac{dV}{dt}}_{\text{Hydraulic Power}} = \underbrace{M_{ab} \omega_{ab}}_{\text{Output Power at Turbine Shaft}}$$

Hydraulic Brake



$$\underbrace{M_{an} \omega_{an}}_{\text{Input Power at Pump Shaft}} > \underbrace{\Delta p \frac{dV}{dt}}_{\text{Hydraulic Power}} > \underbrace{M_{ab} \omega_{ab}}_{\text{Output Power at Turbine Shaft}}$$

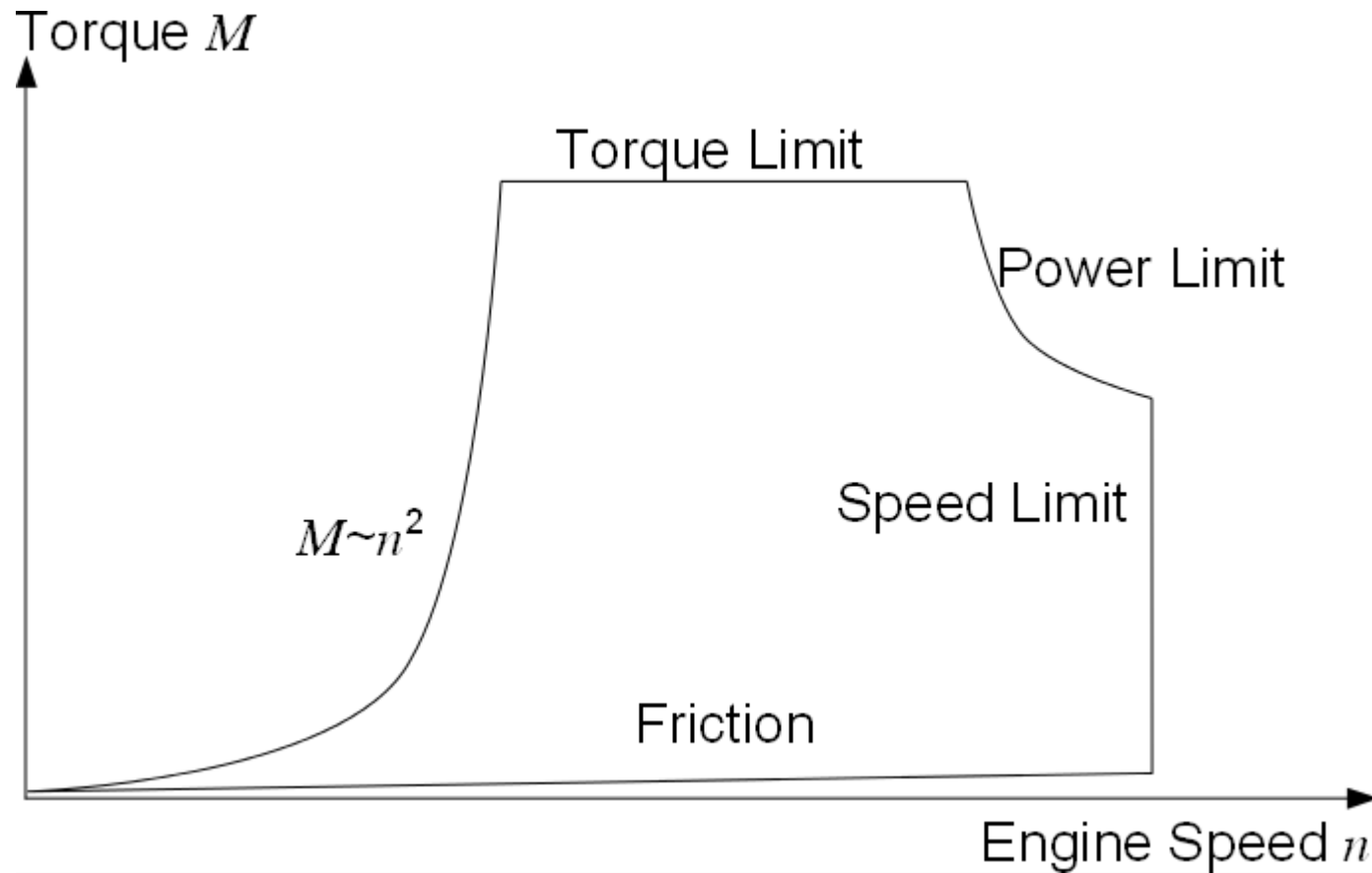
Heat Losses

Brakes and Dynos

Hydraulic Brakes

$$M = f(n)$$

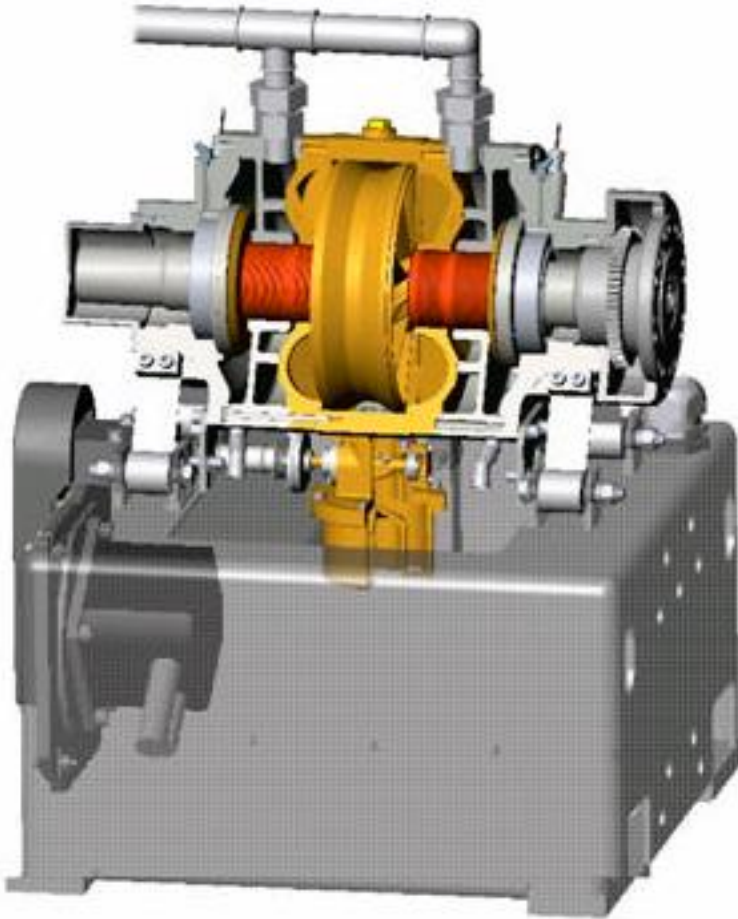
$$P = f(n)?$$



Brakes and Dynos

Hydraulic Brakes

Source:
Horiba,
Darmstadt,
Oberursel



Animation

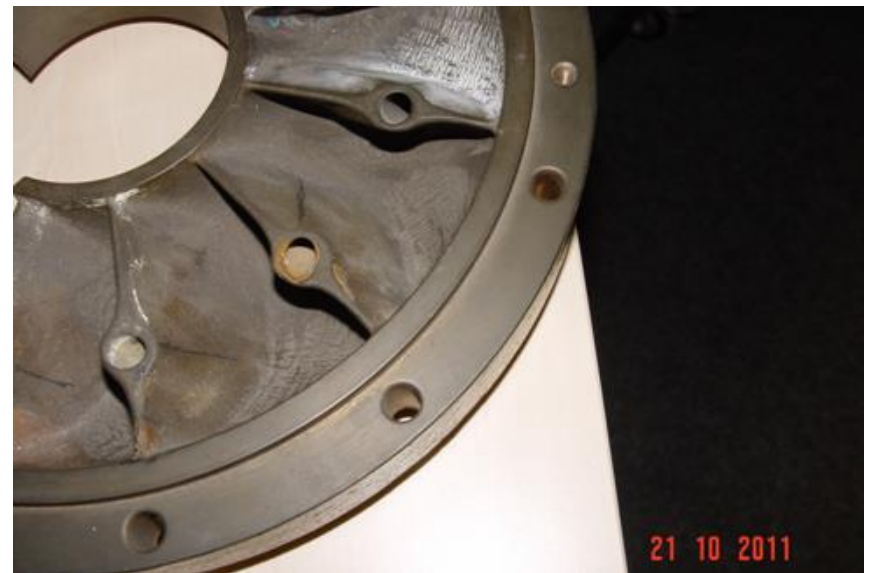
http://www.youtube.com/watch?v=6idqUJCgt5Q&feature=player_embedded

Brakes and Dynos

Hydraulic Brakes



Left picture:
www.tum-gasturbines.de



Brakes and Dynos

Hydraulic Brakes



Source: Horiba,
Darmstadt, Oberursel

3 Brakes and Dynos

3.1 Hydraulic Brakes

3.2 Eddy Current Brake

3.3 Other Magnetic Brakes

3.4 Electrical Dynos

Brakes and Dynos

Eddy Current Brakes

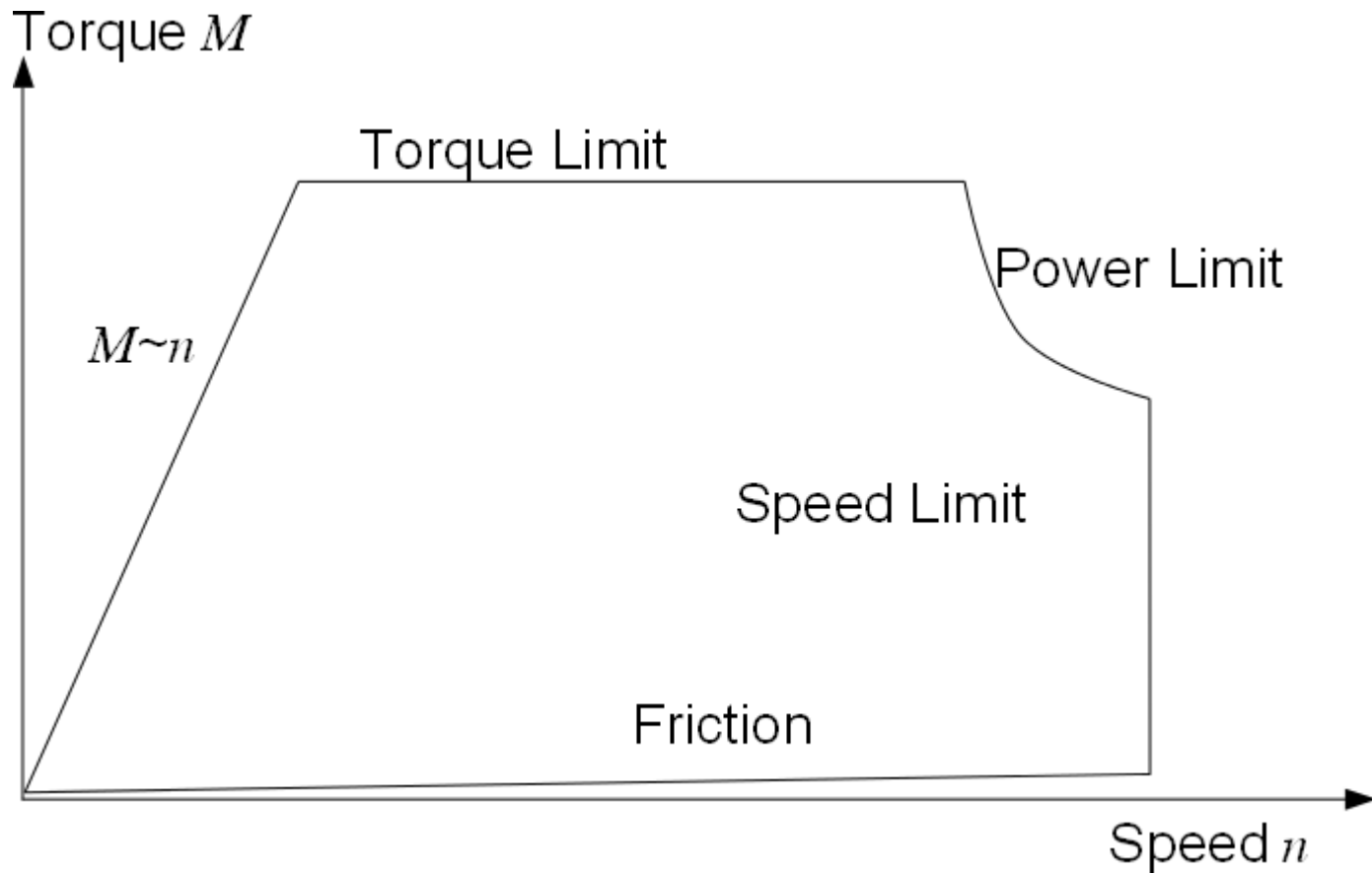
What are Eddy Currents?

Brakes and Dynos

Eddy Current Brakes

$$M = f(n)$$

$$P = f(n)?$$



Brakes and Dynos

Eddy Current Brakes



Source:
Dynamometer World

Source:
A.J. Martyr, M. A. Plint:
“Engine Testing”

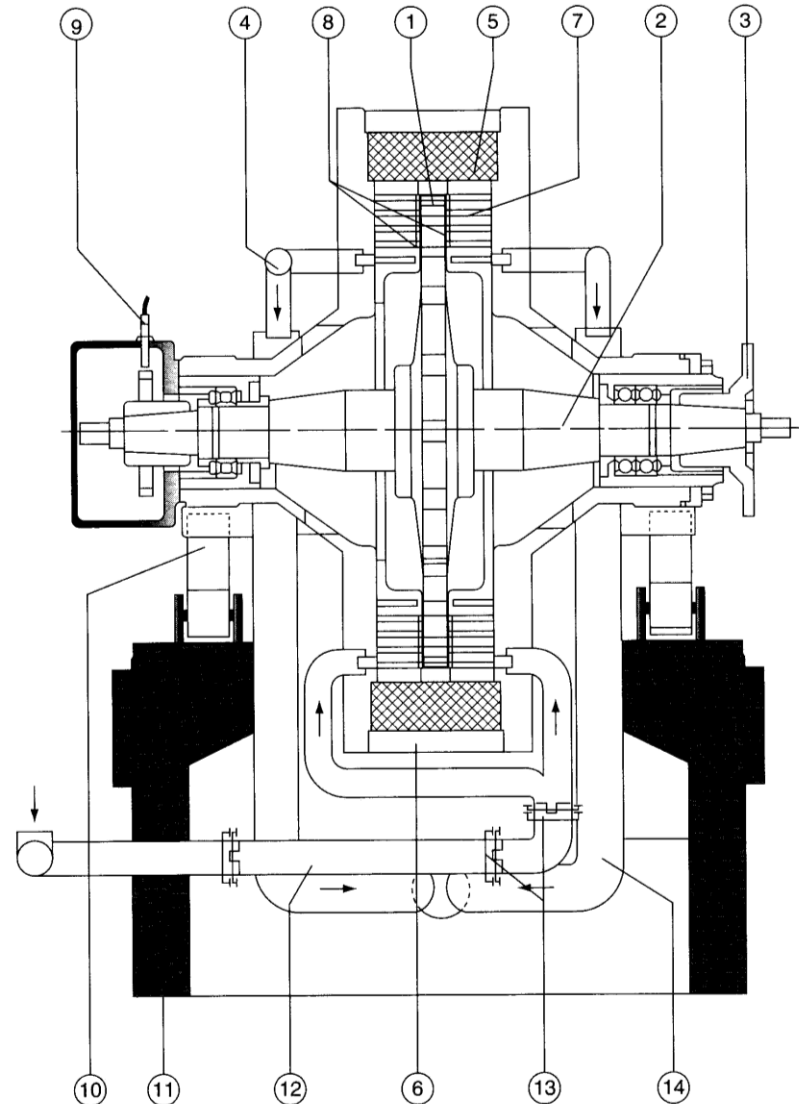


Figure 8.3 Schenck, dry gap, disc type eddy-current dynamometer 1, rotor; 2, rotor shaft; 3, coupling flange; 4, water outlet with thermostat; 5, excitation coil; 6, dynamometer housing; 7, cooling chamber; 8, air gap; 9, speed pick-up; 10, flexure support; 11, base; 12, water inlet; 13, joint; 14, water outlet pipe

Brakes and Dynos

Eddy Current Brakes

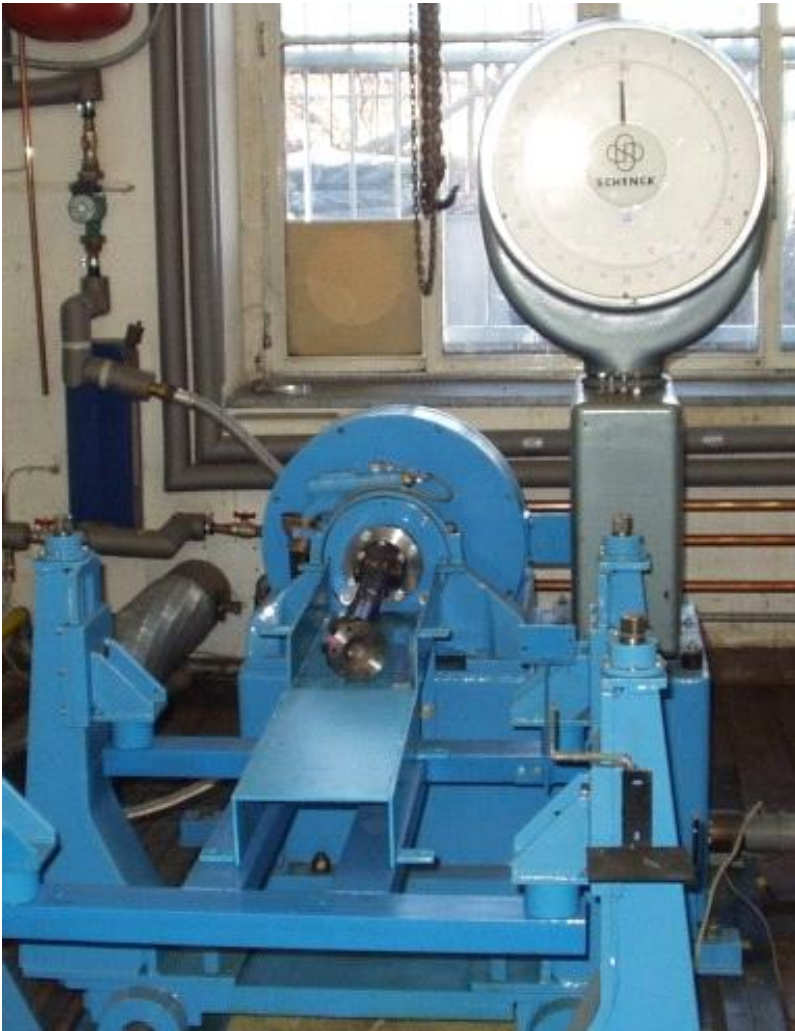


How Eddy Current Brakes fail

(Cooling Side of a Loss Plate)

Brakes and Dynos

Eddy Current Brakes



Eddy Current Brake

Source:
Wikimedia Commons,
User "Golle Motor"

3 Brakes and Dynos

3.1 Hydraulic Brakes

3.2 Eddy Current Brake

3.3 Other Magnetic Brakes

3.4 Electrical Dynos

Brakes and Dynos

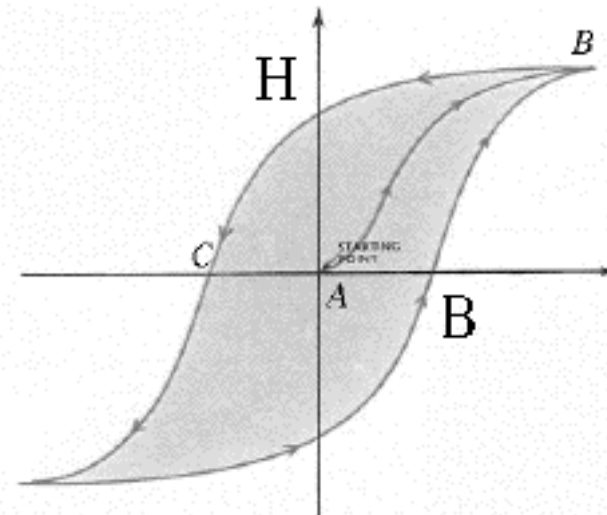
Hysteresis Brakes (Unusual)



Source: Magtrol

application only for small engines $< 10 \text{ kW}$

dissipated energy in grey



Source:
<http://www.phy6.org/Electric/-E25-Tech.htm>

Brakes and Dynos

Magnetic Powder Brakes (Unusual)

Source: Magtrol



In Future Magnetorheological Liquids?

3 Brakes and Dynos

3.1 Hydraulic Brakes

3.2 Eddy Current Brake

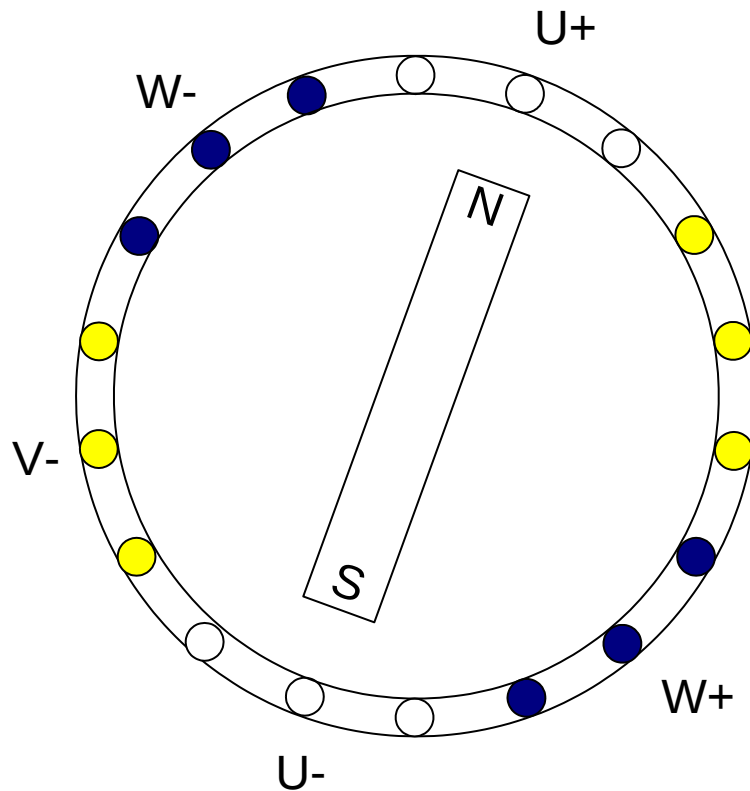
3.3 Other Magnetic Brakes

3.4 Electrical Dynos

- **DC Dynos**
- **Asynchronous Dynos**
- **Synchronous Dynos**
- Reluctance Dynos (maybe in Future)

Brakes and Dynos

AC Dynos

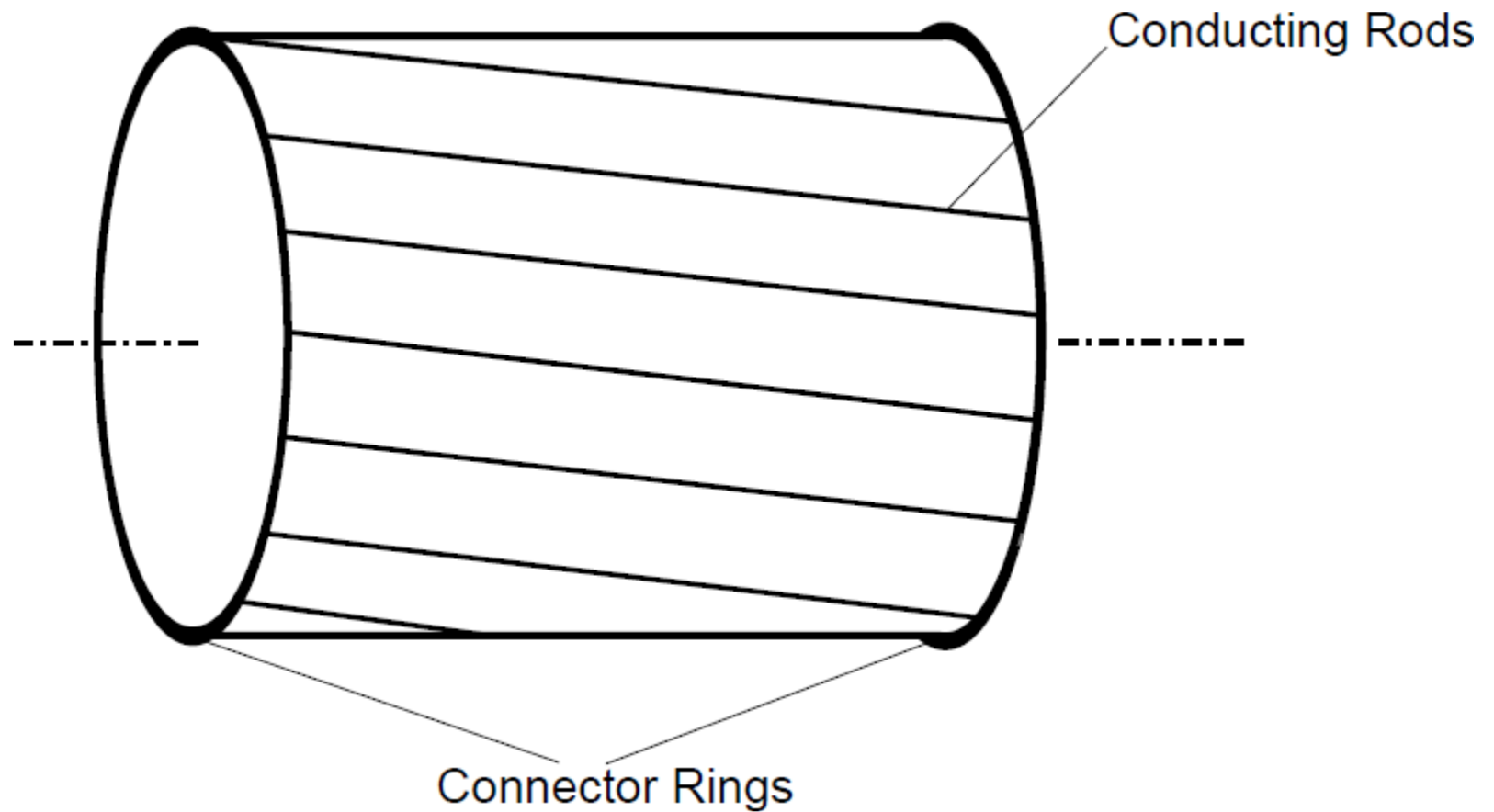


Principle of 3~ - Machines

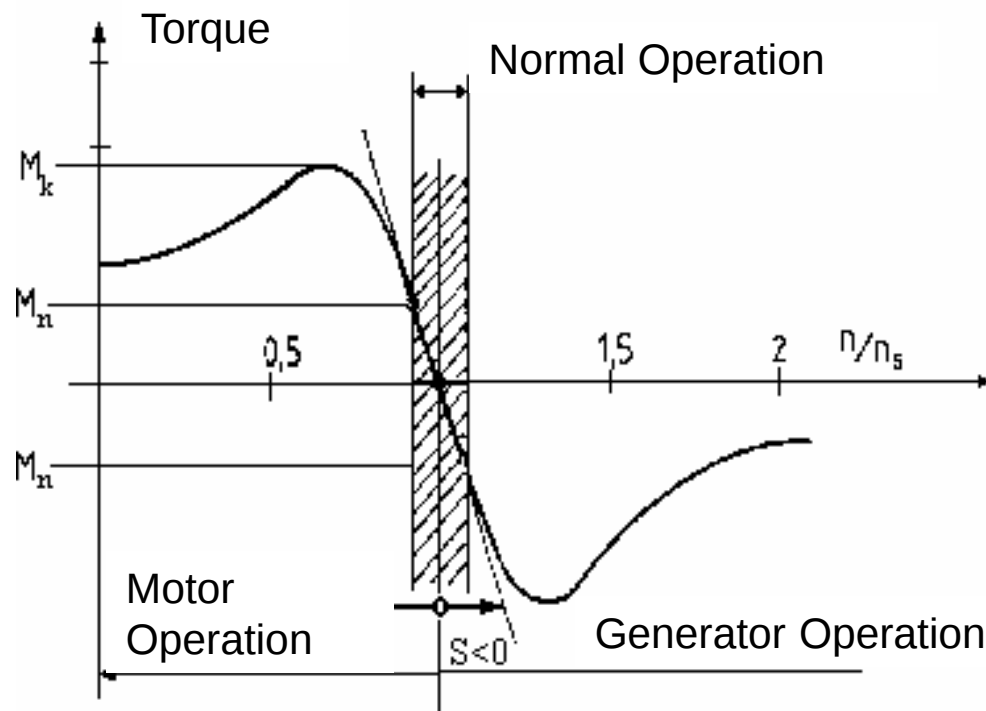
Here: Synchronous Machine

V+

Principle of Squirrel Cage Rotor



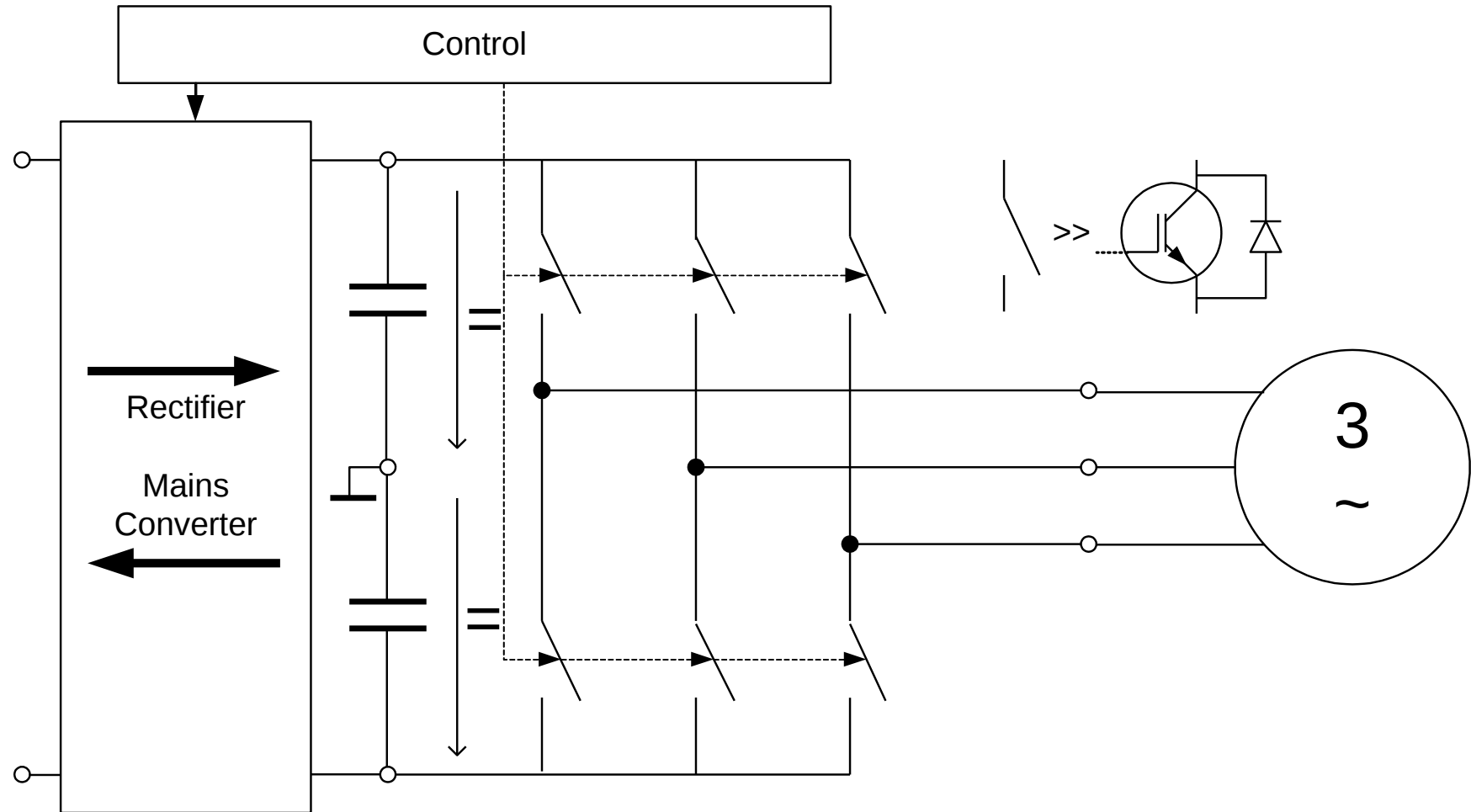
Characteristics of Asynchronous Machine



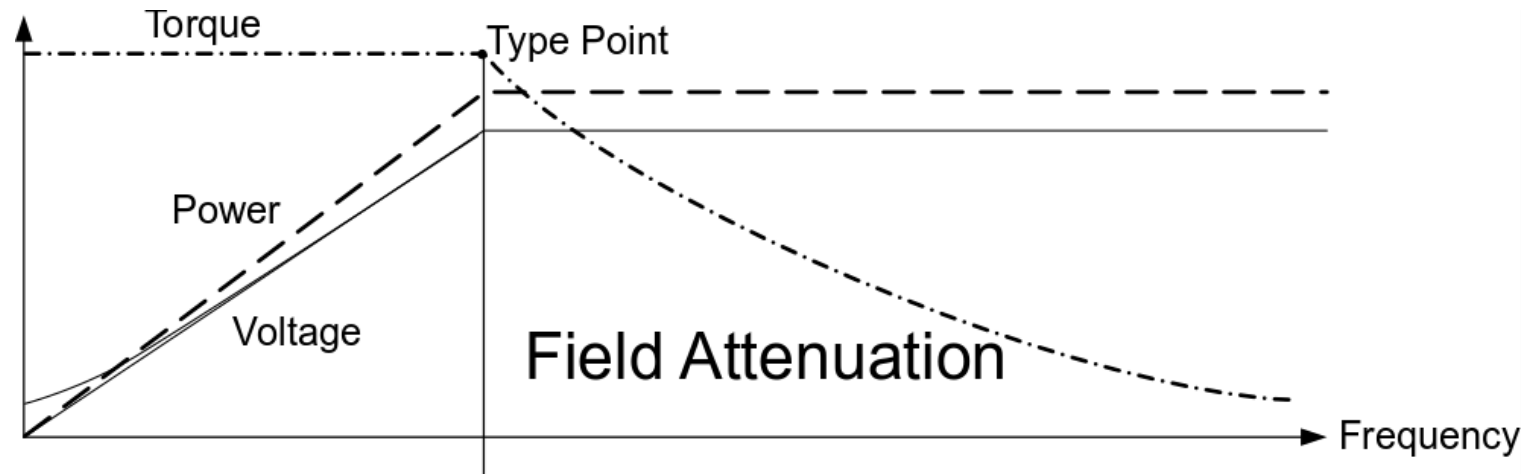
Source:
TU Berlin/UAS Stralsund

Brakes and Dynos

Asynchronous Dyno



Characteristics of Asynchronous Machine with Converter



Brakes and Dynos

Asynchronous Dyno



Comparison of Usual Brake Types

Hydraulic/Eddy Current/Asynchronous

Hydraulic Brakes

Eddy Current Brakes
(compromise in between)

Asynchronous Brakes

(+) durability

+ control/measurement

+ power density

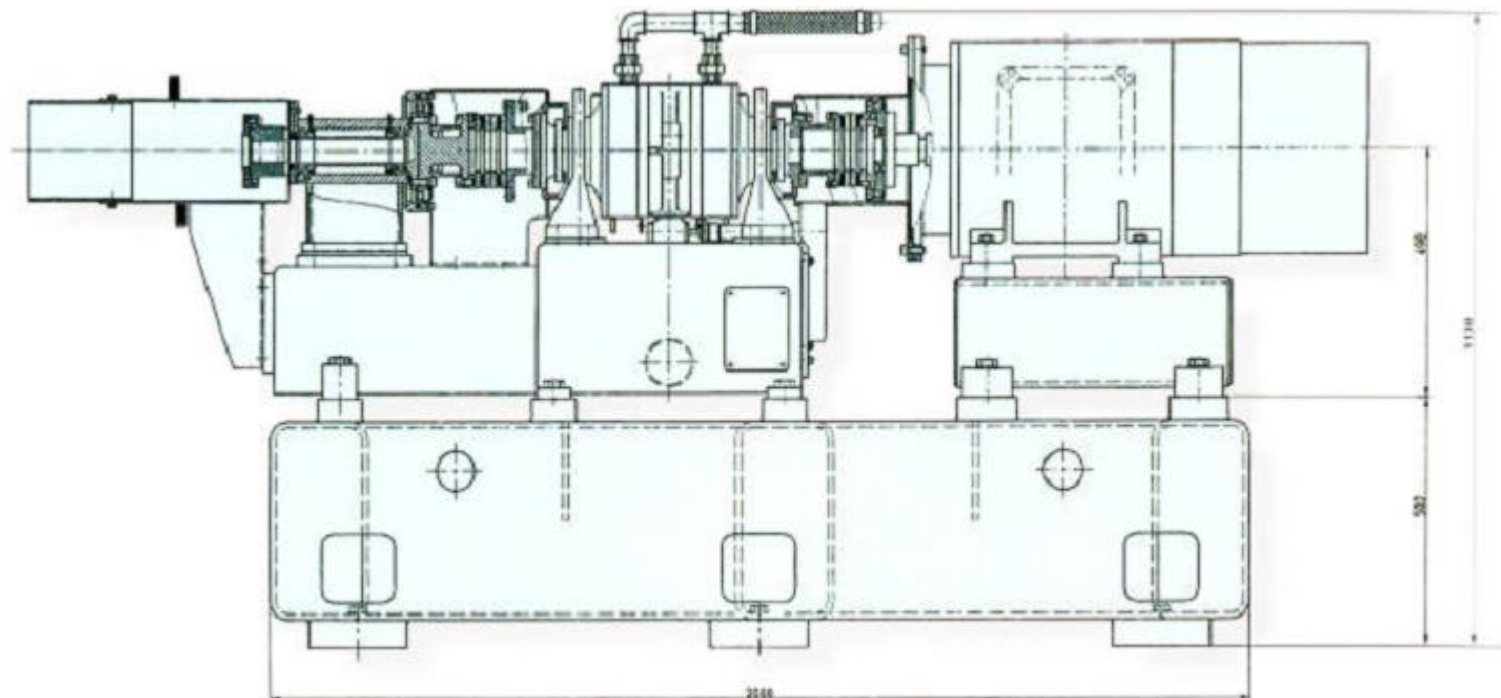
+ motor operations

+ simple design

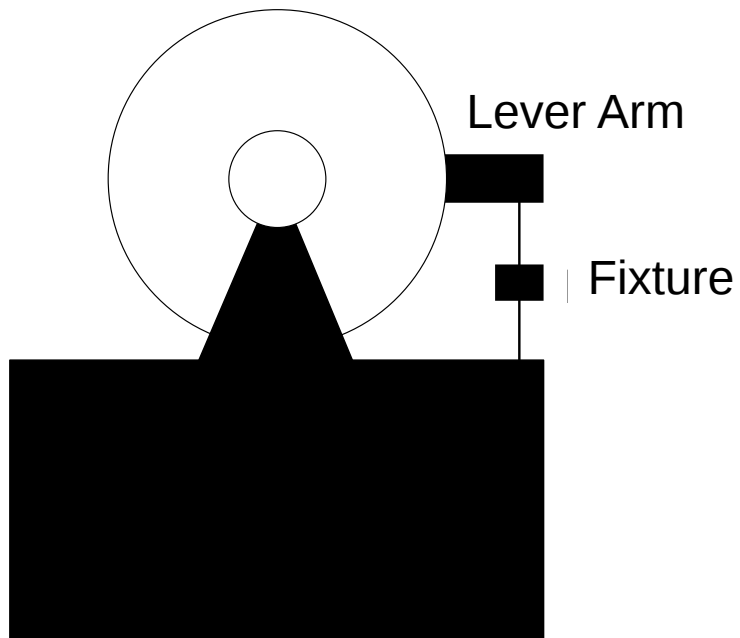
If you cannot decide...

Tandem Unit (Hydraulic/AC)

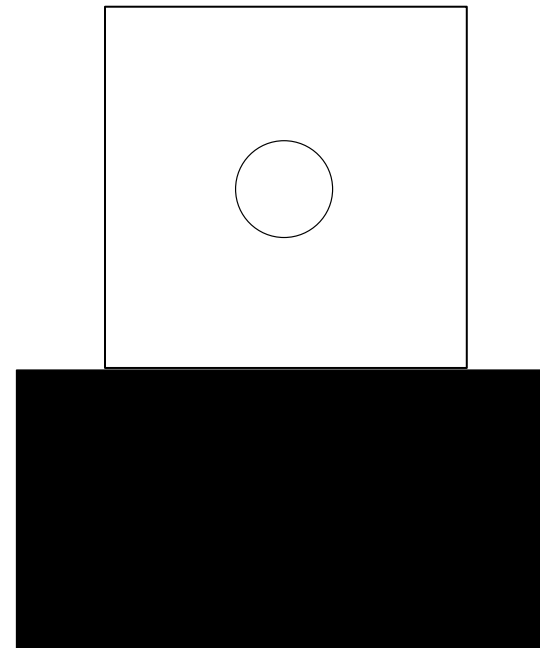
(Source: Horiba)



Case Shape



Cradle Mount



Foot Mount