

**PH** Pädagogische Hochschule Wien

# **ENERGY - OVERVIEW**

I.Hantschk/H.Fibi 2009



**LLP/AT-230/26/08**

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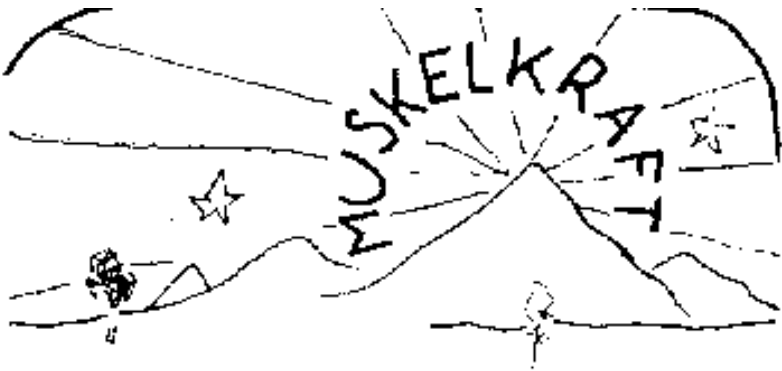
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2009

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**Horse Power**

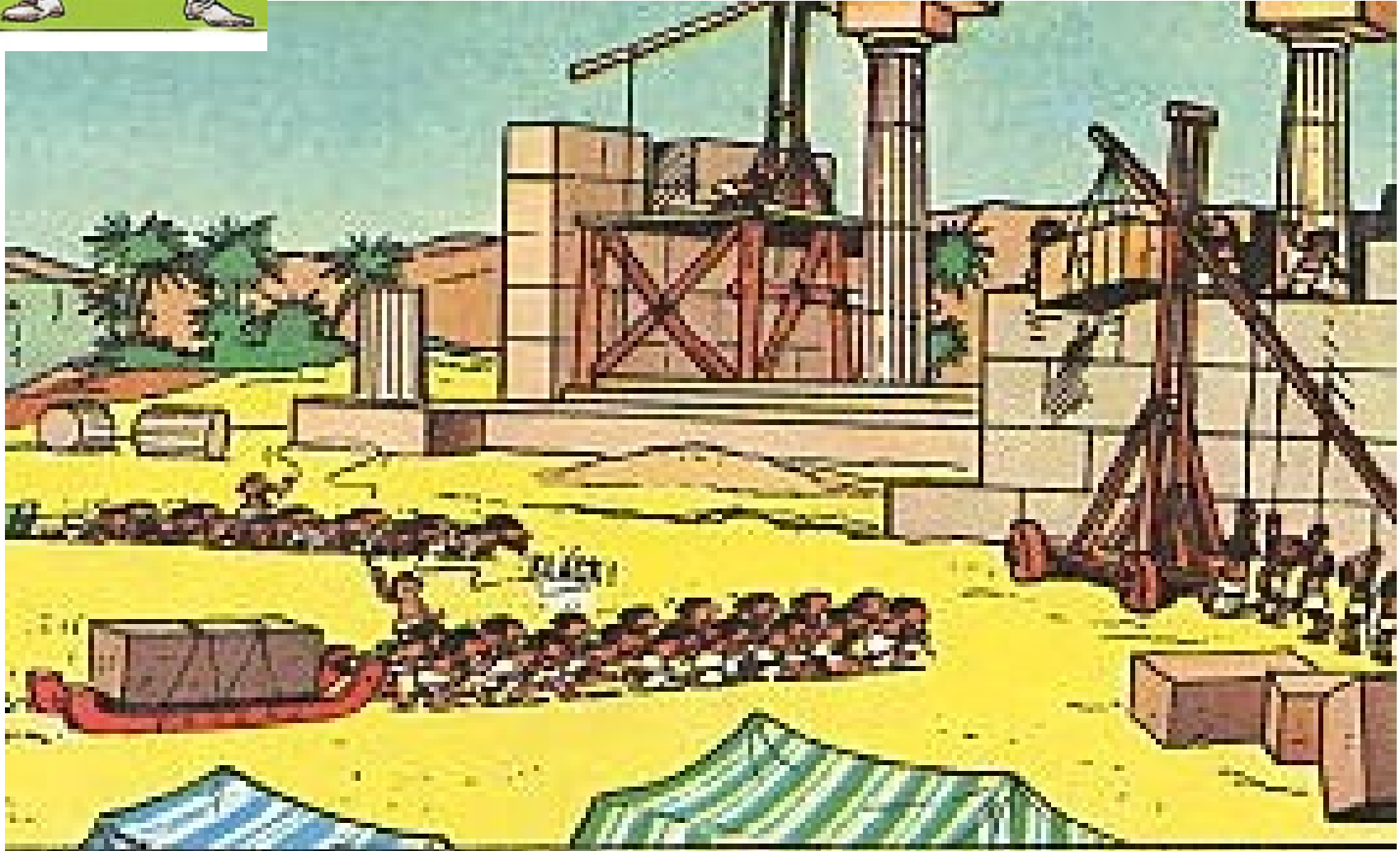
**Men Power**



**In former times men and sometimes animals like donkeys did the work.....**

**as it presently is the fact, too.**

**Rolls, levers and inclined plane helped for achieving better force effects, but saved no work.**





This it was....  
 Besides water,  
 wind and fire.

# Die grundlegenden Erfindungen

Jede Maschine, egal wie kompliziert und ausgeklügelt sie auch ist, basiert auf einer oder mehreren der sechs grundlegenden Erfindungen. Erst sie ermöglichten unsere modernen Geräte:

## 1 Der Hebel

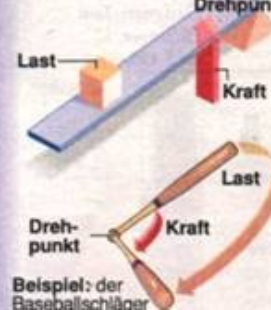
Man unterscheidet drei Anordnungen von **Drehpunkt**, **Kraft** und **Last**.



### ■ Einseitiger Hebel A



### ■ Einseitiger Hebel B



## 2 Rad und Achse

Eigentlich handelt es sich um einen drehbaren Hebel. Die über die Kurbel ausgeübte Kraft wird auf das um die Achse gewundene Seil übertragen und dabei verändert.

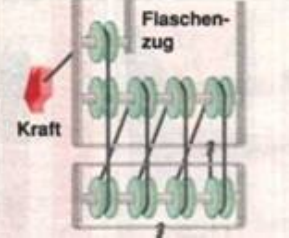


## 3 Der Flaschenzug

Die einfache Rolle verändert die Kraft nicht, lenkt sie aber in eine günstigere Richtung.

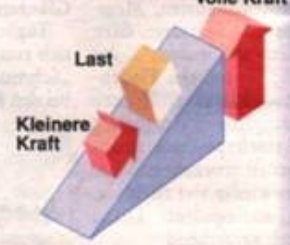


**Großer Flaschenzug:** mehrere lose und feste Rollen verringern die Zugkraft stark.



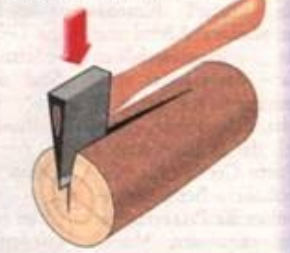
## 4 Die schiefe Ebene

Um eine Last eine schiefe Ebene hinaufzubefördern, ist viel weniger Kraft nötig als für senkrecht Heben.



## 5 Der Keil

Eine Art schiefe Ebene, welche z. B. ein Stück Holz auseinanderdrücken kann.

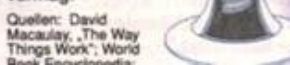


## 6 Die Schraube

ist eigentlich eine schiefe Ebene, die um einen Zylinder bzw. einen Kegel (bei der spitzen Holzschraube) gewickelt wurde.



Ein **Wagenheber** kombiniert die Wirkung von Hebel und Schraube. Er kann Kraft bis zum Faktor 50 vergrößern, so daß man leicht ein Auto zu heben vermag.

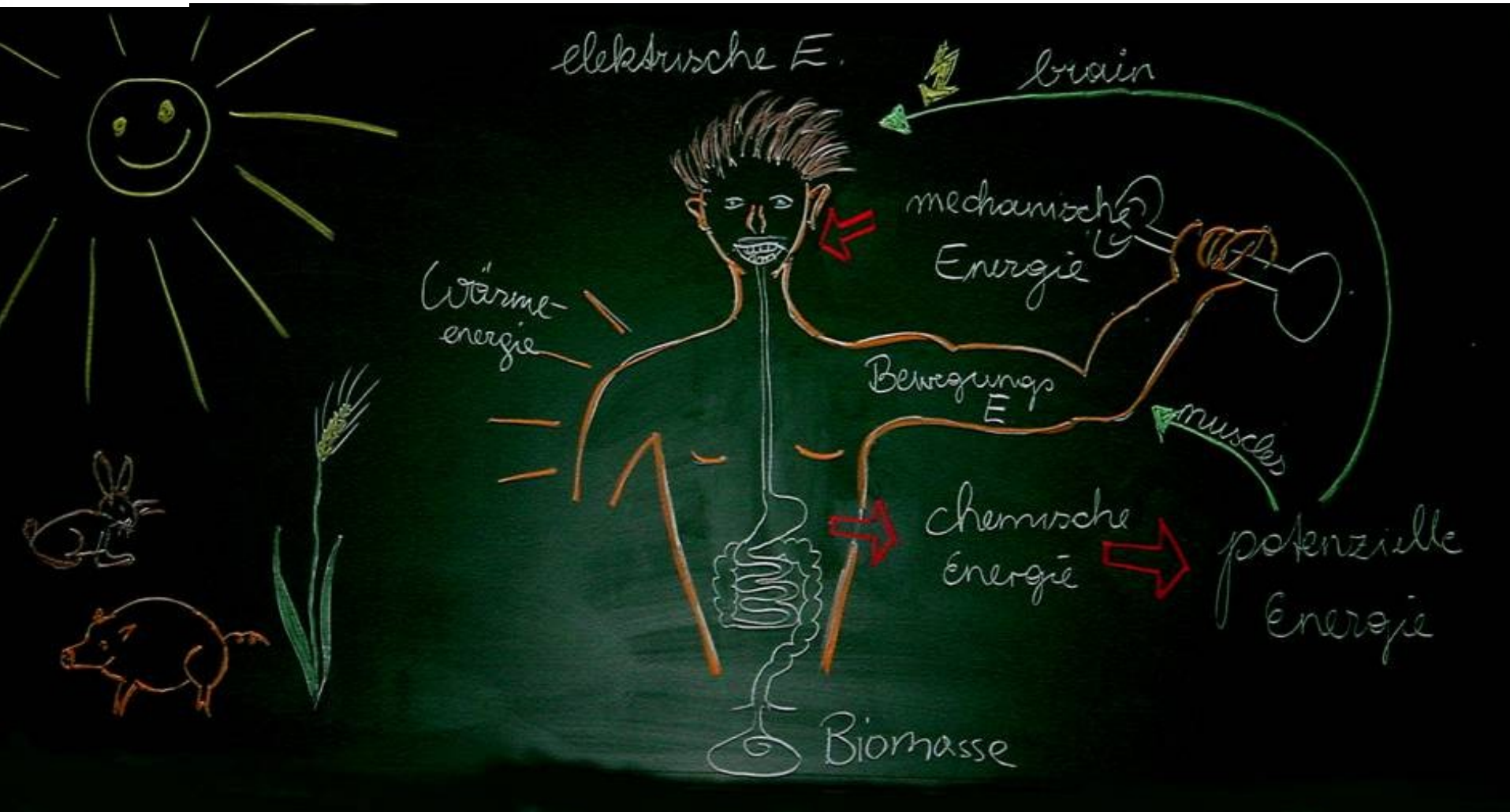


Quellen: David Macaulay, „The Way Things Work“; World Book Encyclopedia

More modern tools are added.

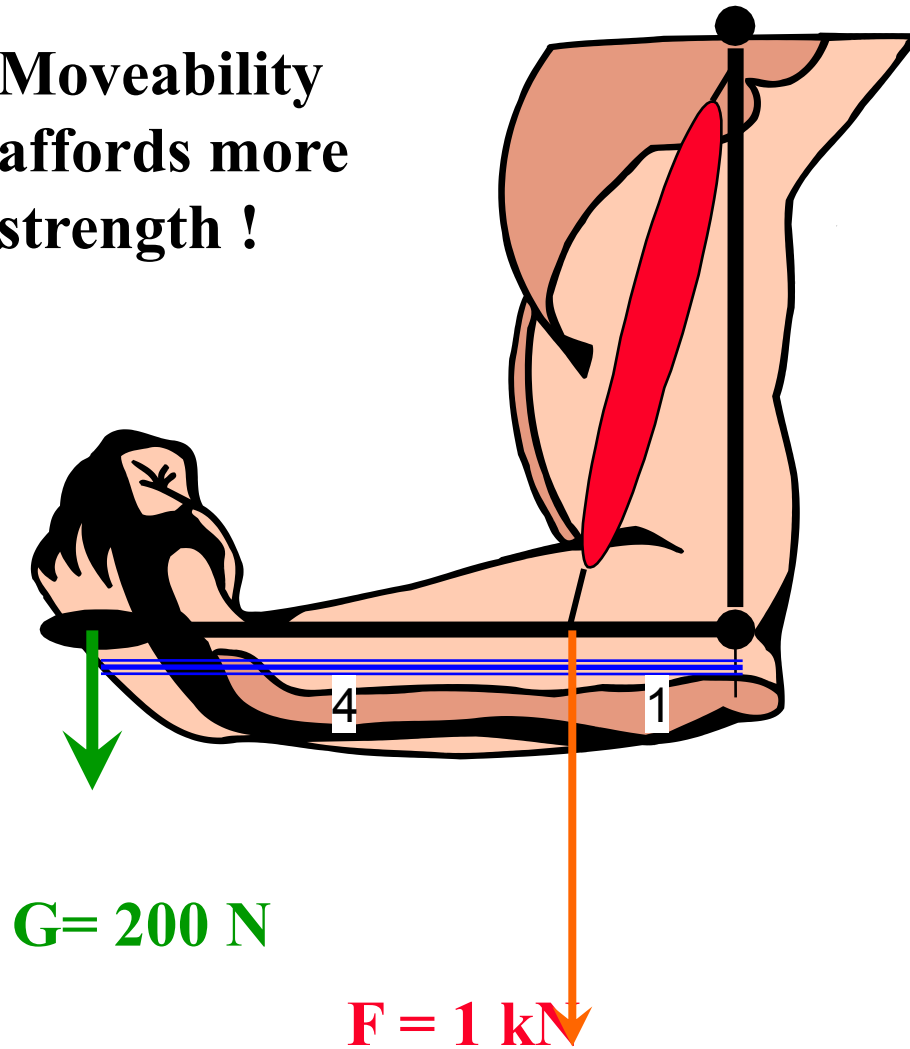


# „Human Energy“, once upon a time pictured by our students

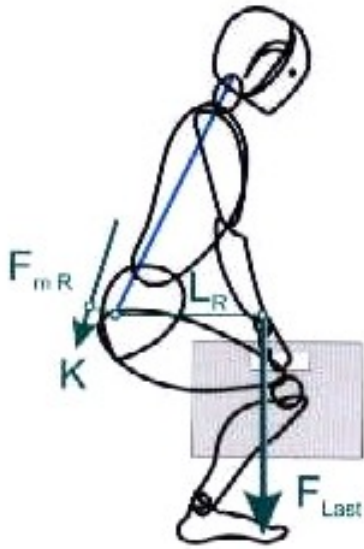


# Human Lever

Moveability  
affords more  
strength !







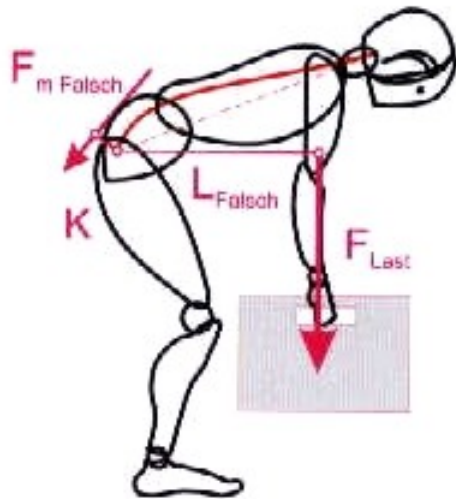
$$K = 0,05 \text{ m}$$

$$L_{\text{correct}} = 0,20 \text{ m}$$

$$F_{\text{LOAD}} = 700 \text{ N}$$

$$F_{\text{STRENGTH}} = 2800 \text{ N}$$

**Damaged disc**  
**Slipped disc**

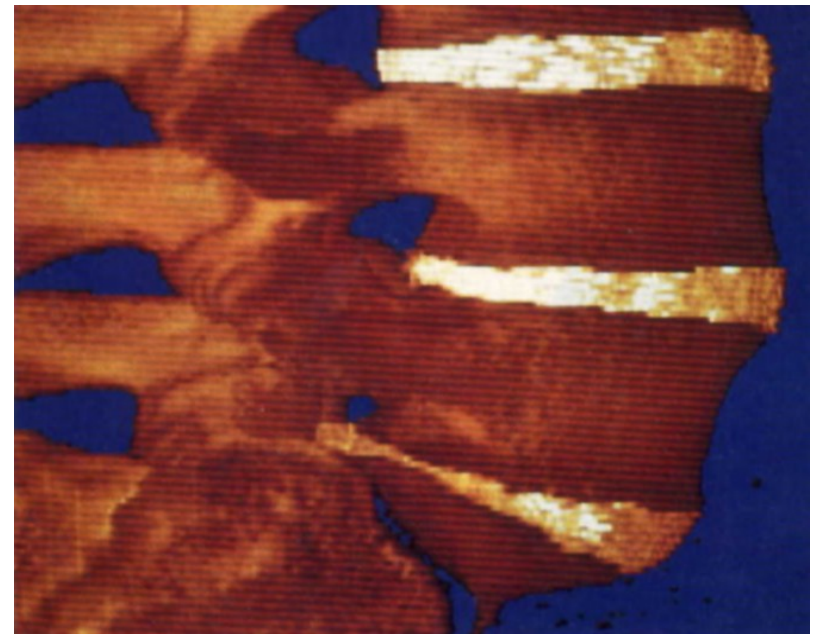


$$K = 0,05 \text{ m}$$

$$L_{\text{wrong}} = 0,30 \text{ m}$$

$$F_{\text{LOAD}} = 700 \text{ N}$$

$$F_{\text{STRENGTH}} = 4200 \text{ N}$$





# HUMAN BEING NEEDS...

**Energy**

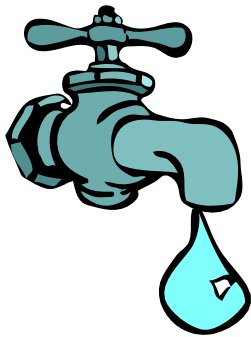
**Food:**

**Adult: 500 kg/a**

**Child, one year old:**

**340 kg/a,**

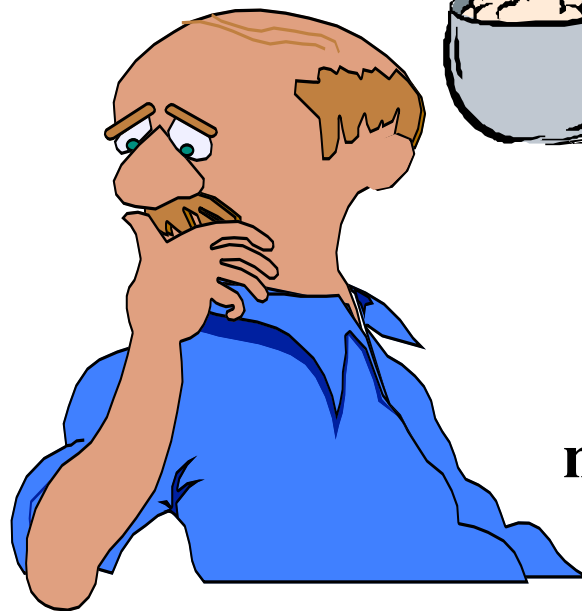
**from this 50% milk**



**Water:**

**2,2 litres / day**

**Solution, Concentration  
in the cells**



**m = 70 kg**

**Transfer to  
Energy (ATP)**



**Air:  
20 l air / minute  
30-40 m<sup>3</sup> air / day**



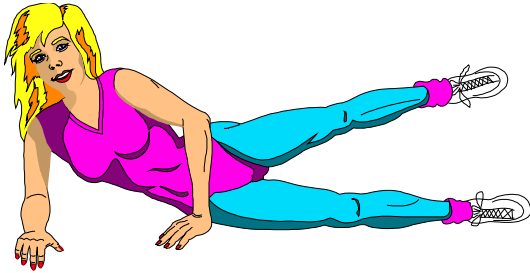
**1 l air ... 1 kJ energy**

**Drinking water**  
5-12 °C  
colourless  
clear  
odourless  
neutral  
well tasting

Without water:  
death after some days

Human being consists of about  
70 % water  
reducing the bodily water by  
2 %: thirsty  
5-12 %: you must drink, otherwise  
headache, burning of the mucous  
membrane of eyes, nose, mouth,  
throat, fever  
15-20 %: kidneys stop working,  
death.





**aerobic energetic turnover (respiration):**



**6 mol O<sub>2</sub> ... 6x22,4 l = 134,4 l**

**regarding to 2830 kJ**

**1 l air ..... 20% O<sub>2</sub> ..... from this 25%  
used ...**

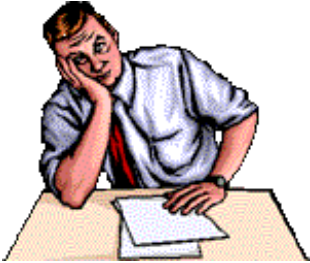
**1 l air → 1 kJ energetic turnover.**

**standardized men: 200 cm<sup>3</sup> air/breath -  
20 l / min.**

**anaerobic energetic turnover**

**(lactic acid- fermentation)**

**about 200 kJ / mol C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>**



**daily demand about 10-14 MJ,  
from this basal metabolism 7,2 MJ,  
from this heart: 200 kJ  
and respiration 250 kJ.**

**fast  
jumping up  
in the morning:  
1 kW !!**

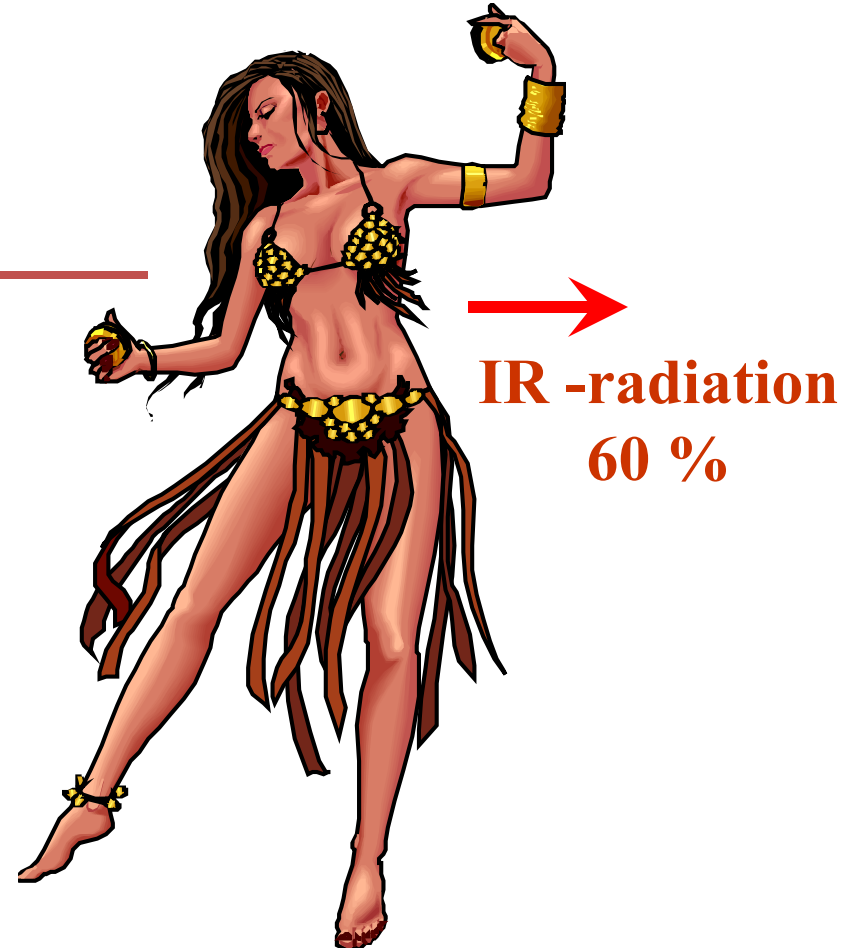
Permanent work: ~ 70 Watt (small horse is better), like a lamp  
Maximum high jumping ~ 3 kW or weight lifting ~ 8 kW



Air temperature: 25 °C  
relative humidity: 40-60 %  
wind speed: < 0,3 m/s

**Evaporation:**  
25 %

**Heat conduction  
and  
heat convection:**  
15 %



300 W till 1 kW heat emission

**K-Values in W/m<sup>2</sup>K:**  
air no movement: 3  
slight wind: 7  
strong wind: 15

**Clothing in winter: 4**  
**Clothing in summer**  
**(„light“): 12**

# MEN - an OPEN ENERGETIC SYSTEM

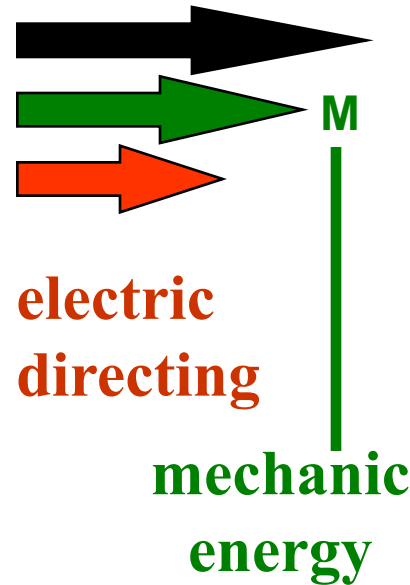
energetic transfer –  
energetic devaluation



formation of the system mass

energetic contents of nutrients

Caloric Energy

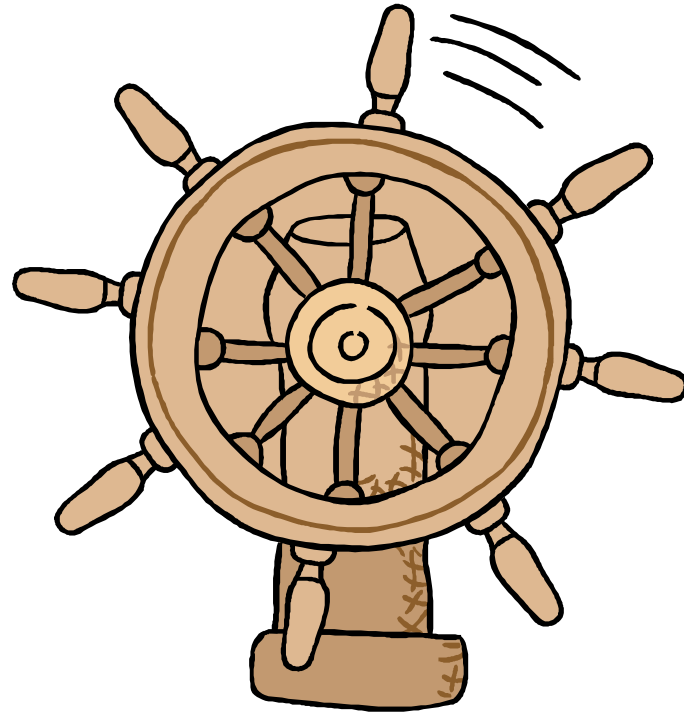


electric directing

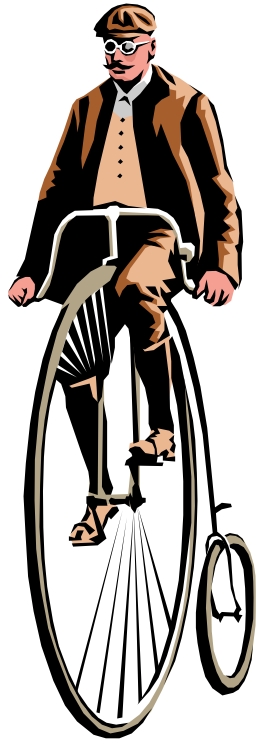
valid for maintainance of the system s temperature



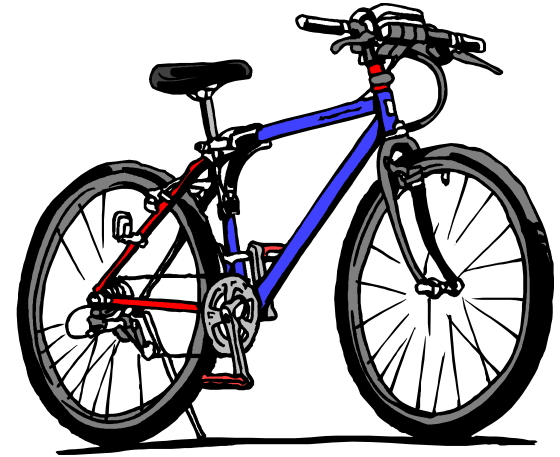
**Water Pump**  
**- Lever**



**Steering wheel**  
**- Rolls - Lever**

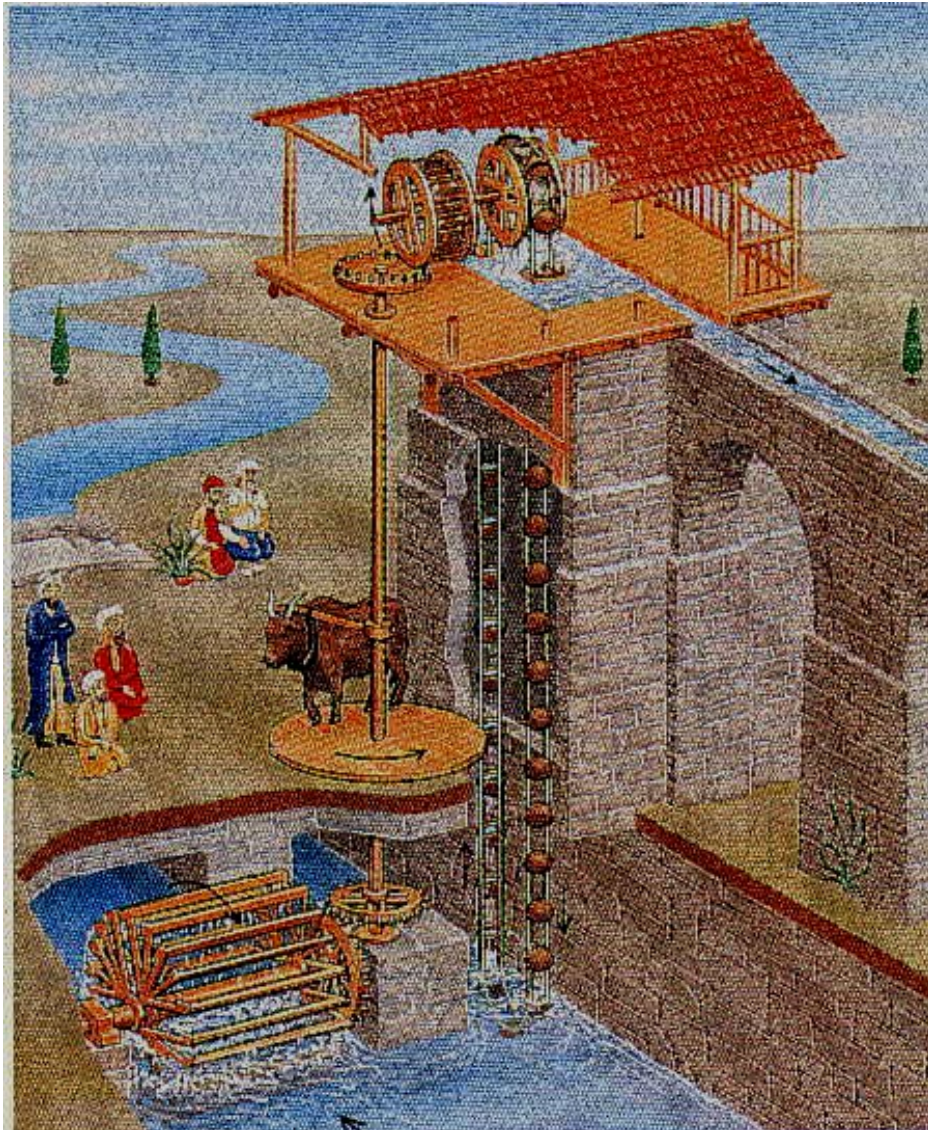


**remaining in  
modern times**





# Techniques of the Near East – Lever plus Muscles and Water, sometimes Wind



**Wooden Gear**

**„Bottled Chain“**

**Wooden Gear**

**Water Wheel**



In the wind is energy,  
the wind has got  
it from the sun.

This is, what they had...  
this is, what we shall  
use more intensively...

Water is the sister  
of the wind.



# Wind mills



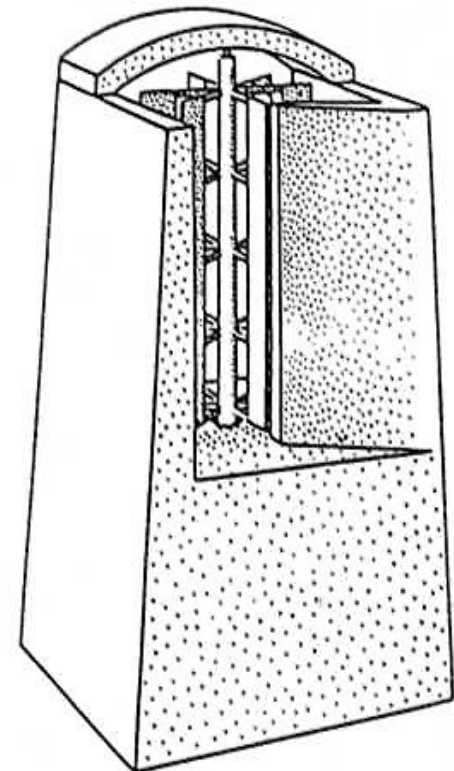
Bei frühen Formen der Windmühlen verwendete man Segel oder hölzerne Ruder, die auf vertikalen Achsen saßen. Schon im Mittelalter allerdings hatten sich Mühlen mit horizontaler Achse weitgehend durchgesetzt.

ZEICHNUNGEN: GEORGE RETSECK / QUELLE: U.S. NATIONAL WIND TECHNOLOGY CENTER

# Hurricane



Wind mill in Mesopotamia



**They had wind...**







**Deutsche (German)  
Bockwindmühle:  
Das gesamte Haus,  
gelagert auf dem Bock,  
wird mittels der Stange  
gedreht.**

**The whole house,  
mounted on an  
basement, is  
turned into the wind  
by a rod.**

**Grinding grains  
to flour.**



Rhodos



Holländische  
Windmühle:  
Windmill Netherland  
Der Turmkopf drehte mit  
den Flügeln  
selbstständig  
in den Wind  
The side wheel turns the  
Top of the tower into the  
wind - automatically





Retz

Eldest Austrian Windmill

- In function for demonstration







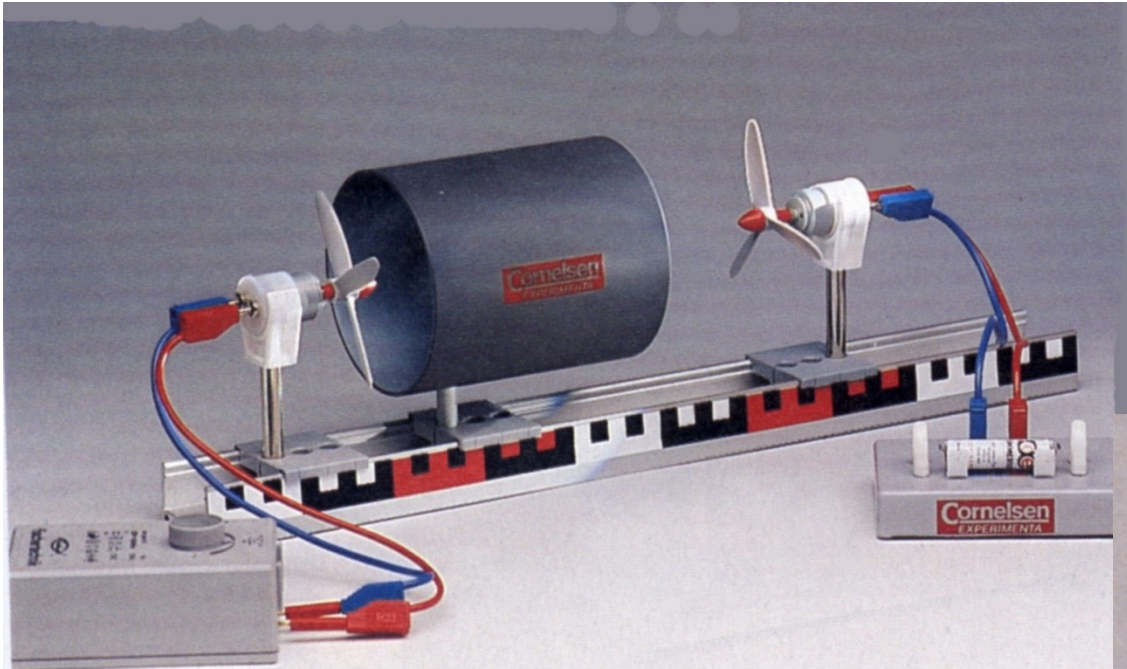




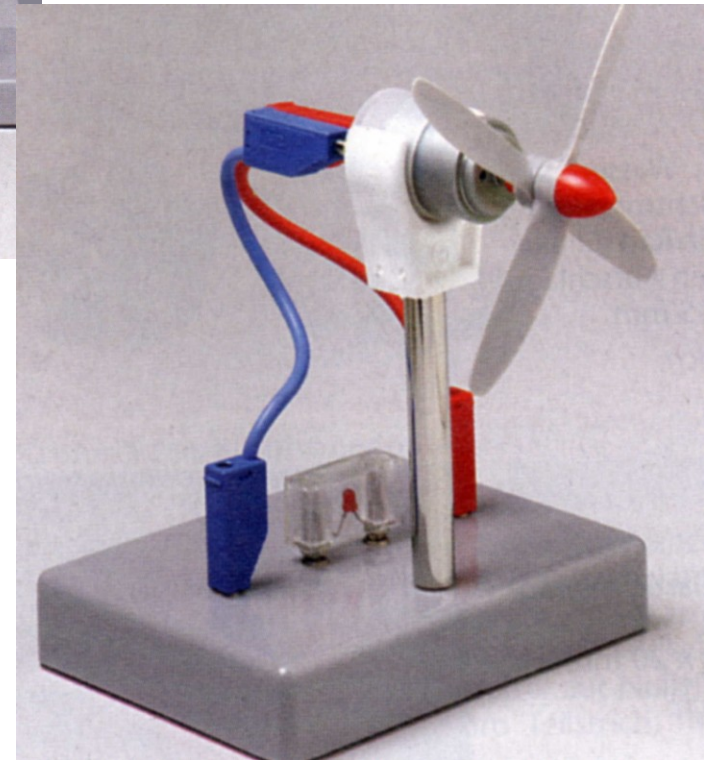


**Langsam, dafür hohes Drehmoment:  
Die amerikanische Windmühle.**





Experiments.....



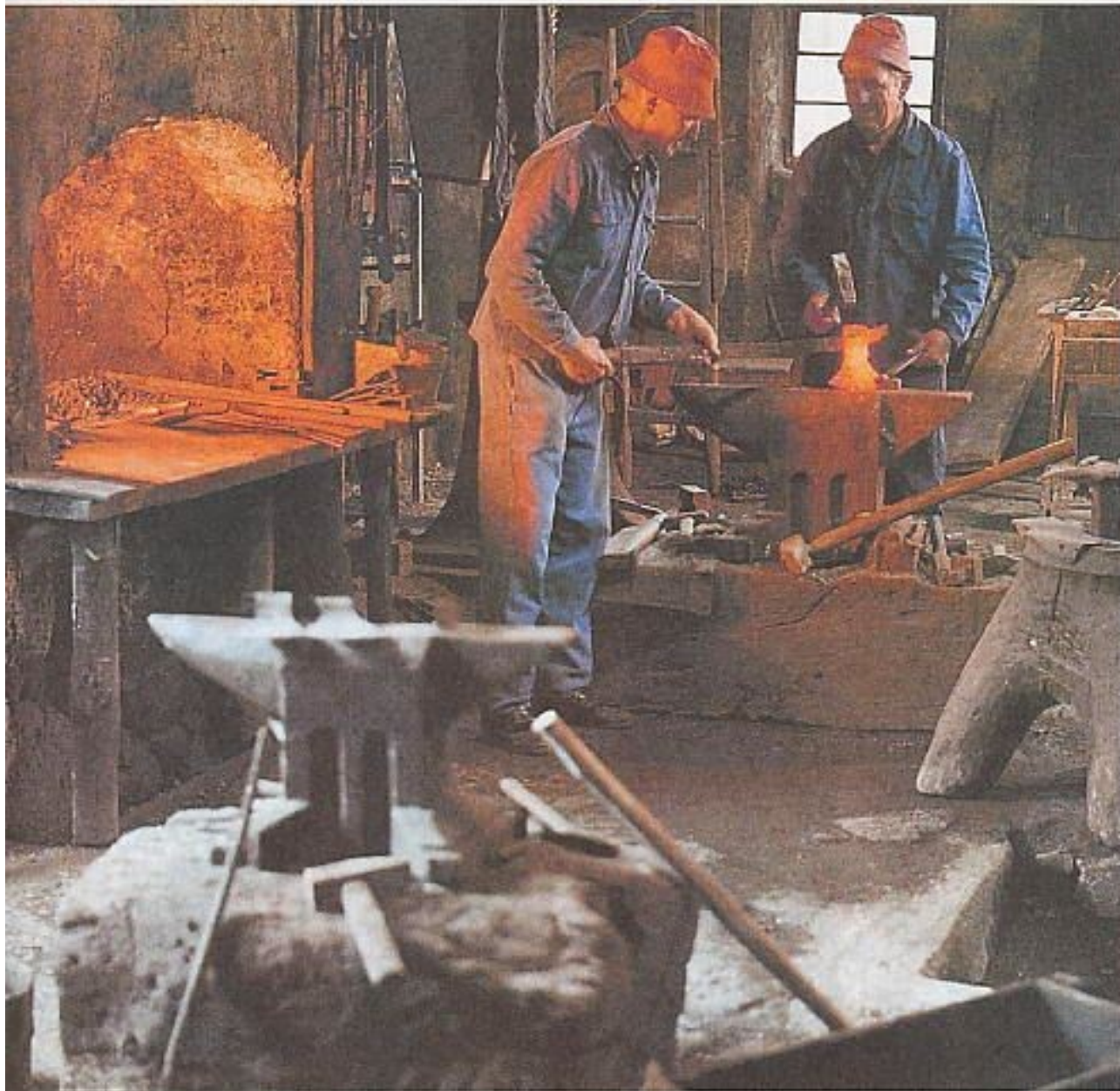
**An old Austrian tradition...**

**Iron**

**and**

**Water for water mills**









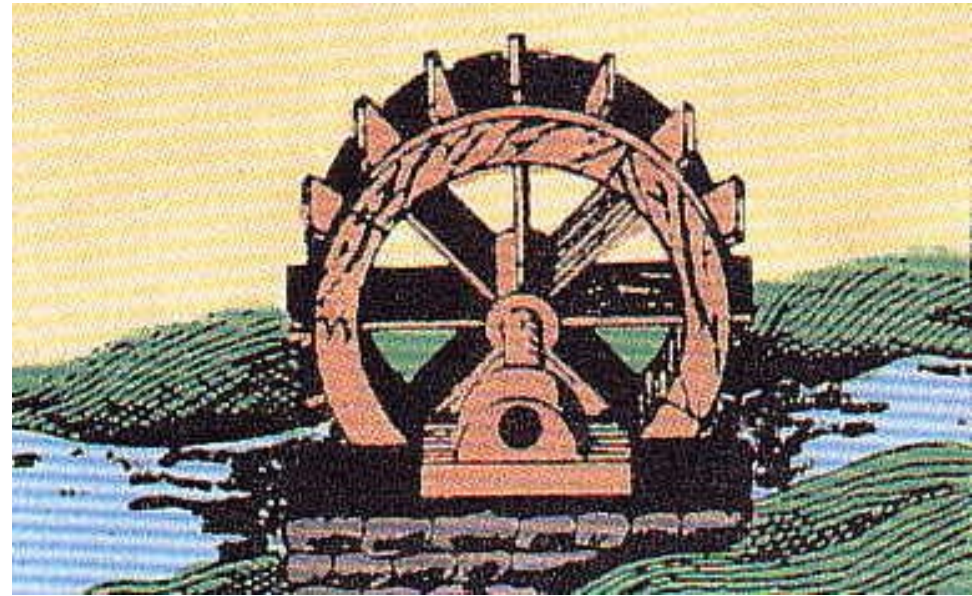
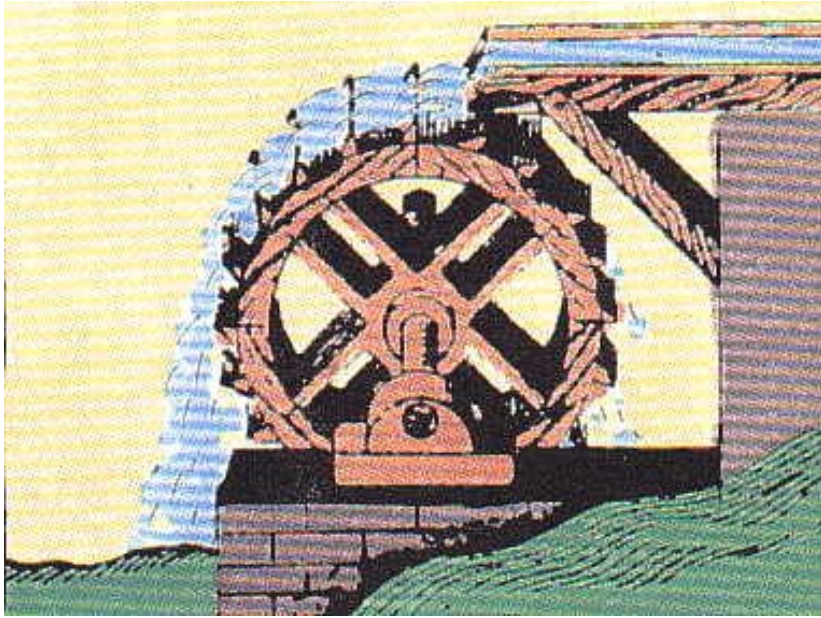
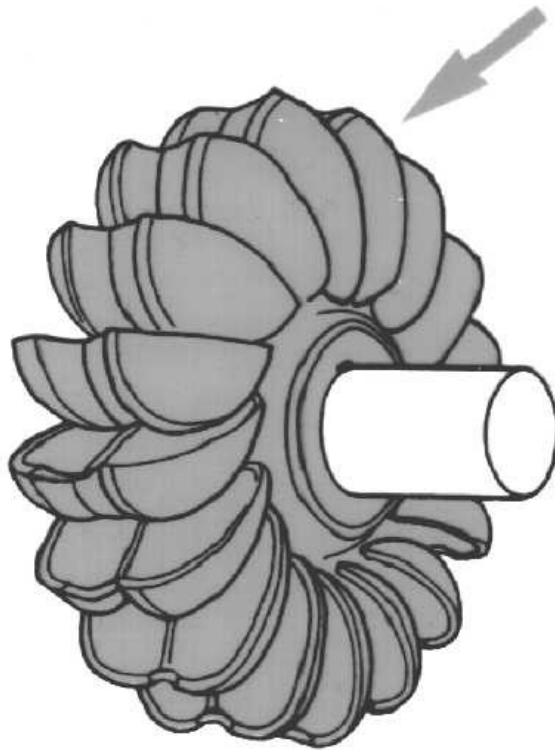


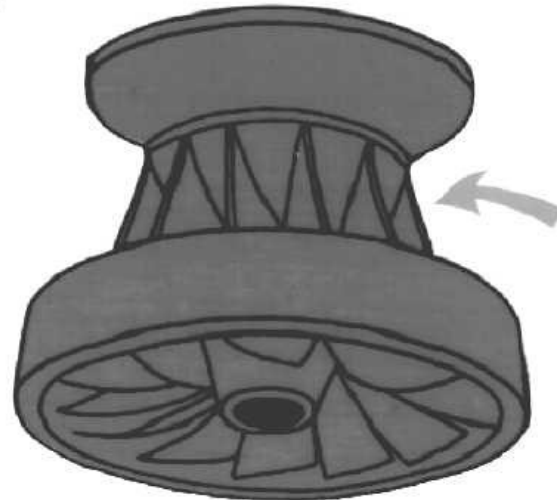


Foto: Coppenst-Werbung

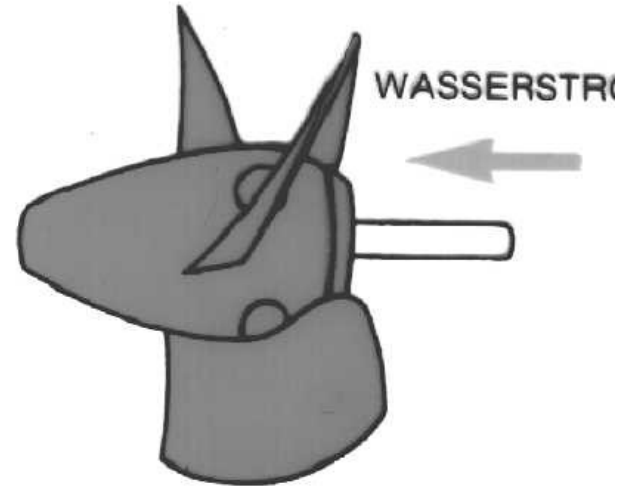
Bleiburg (Kärnten)



**PELTON**  
Tangentialturbine



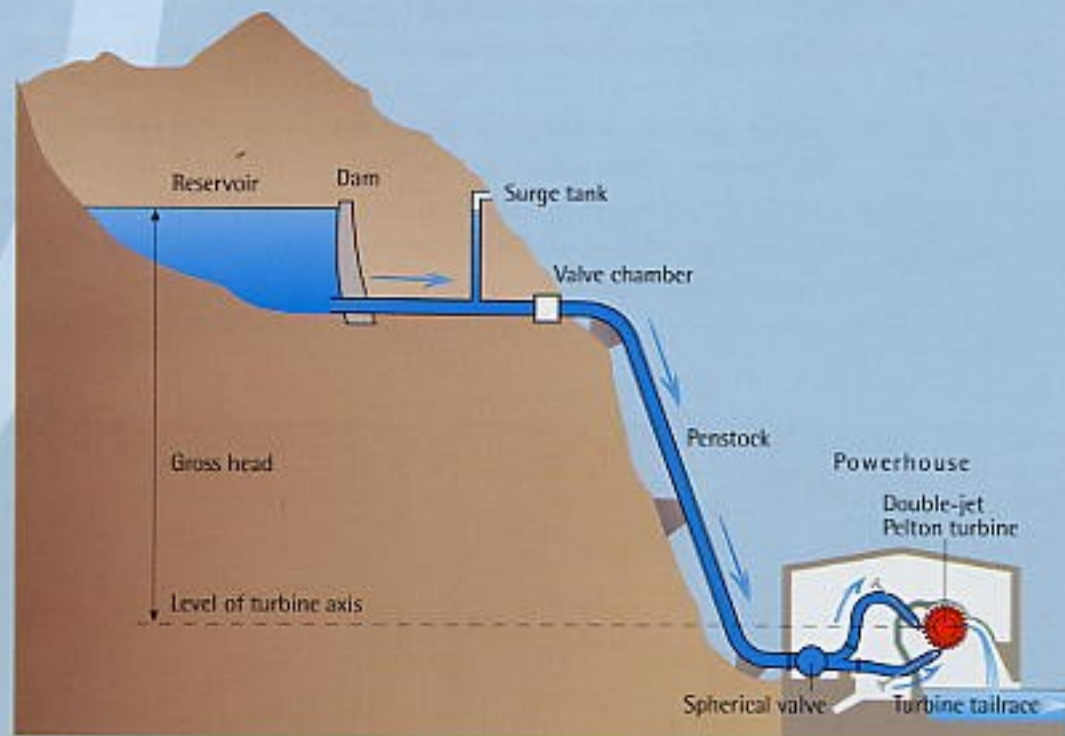
**FRANCIS**  
Radialturbine



**KAPLAN**  
Axialturbine

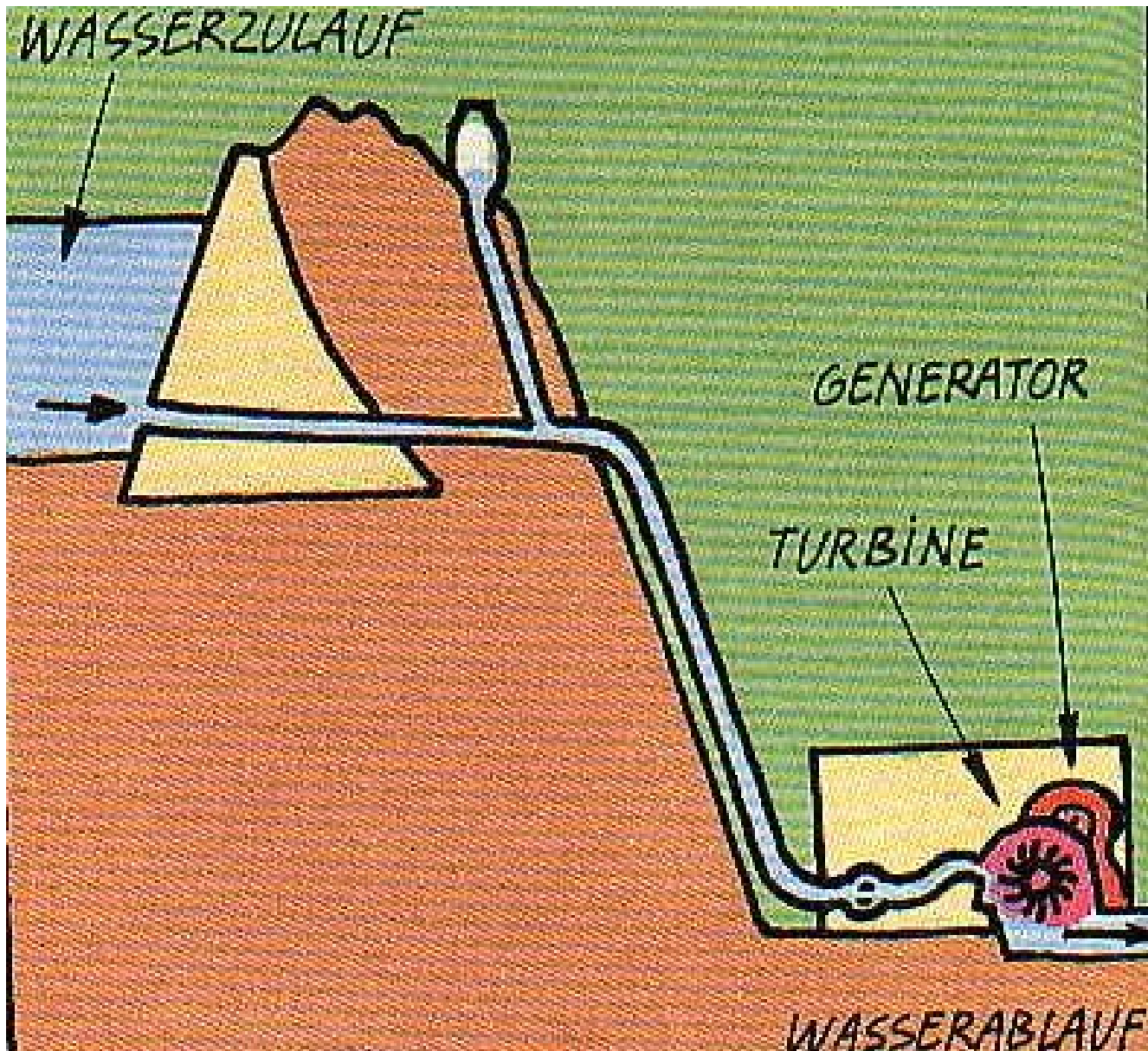
## Alpine Wonderland: Reservoir Lakes

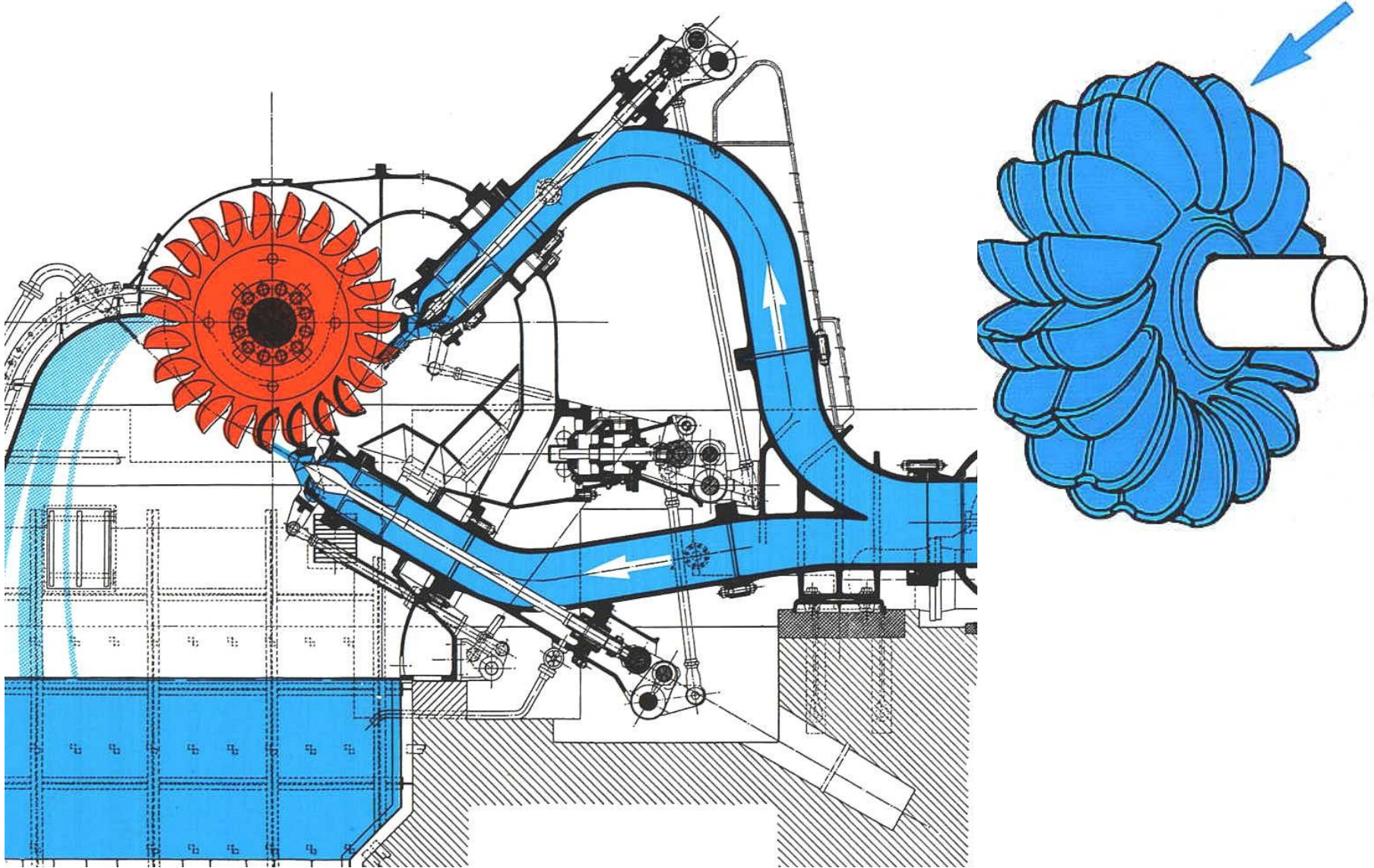
Hydro-electric power plants contribute greatly to flood control in the alpine valleys. In addition, access to alpine recreational areas has been opened up through their construction. More than half a million visitors every year enjoy the unique experience of the breath-taking alpine landscape during a visit to one of our facilities.



Storage power plant with Double-jet Pelton turbine

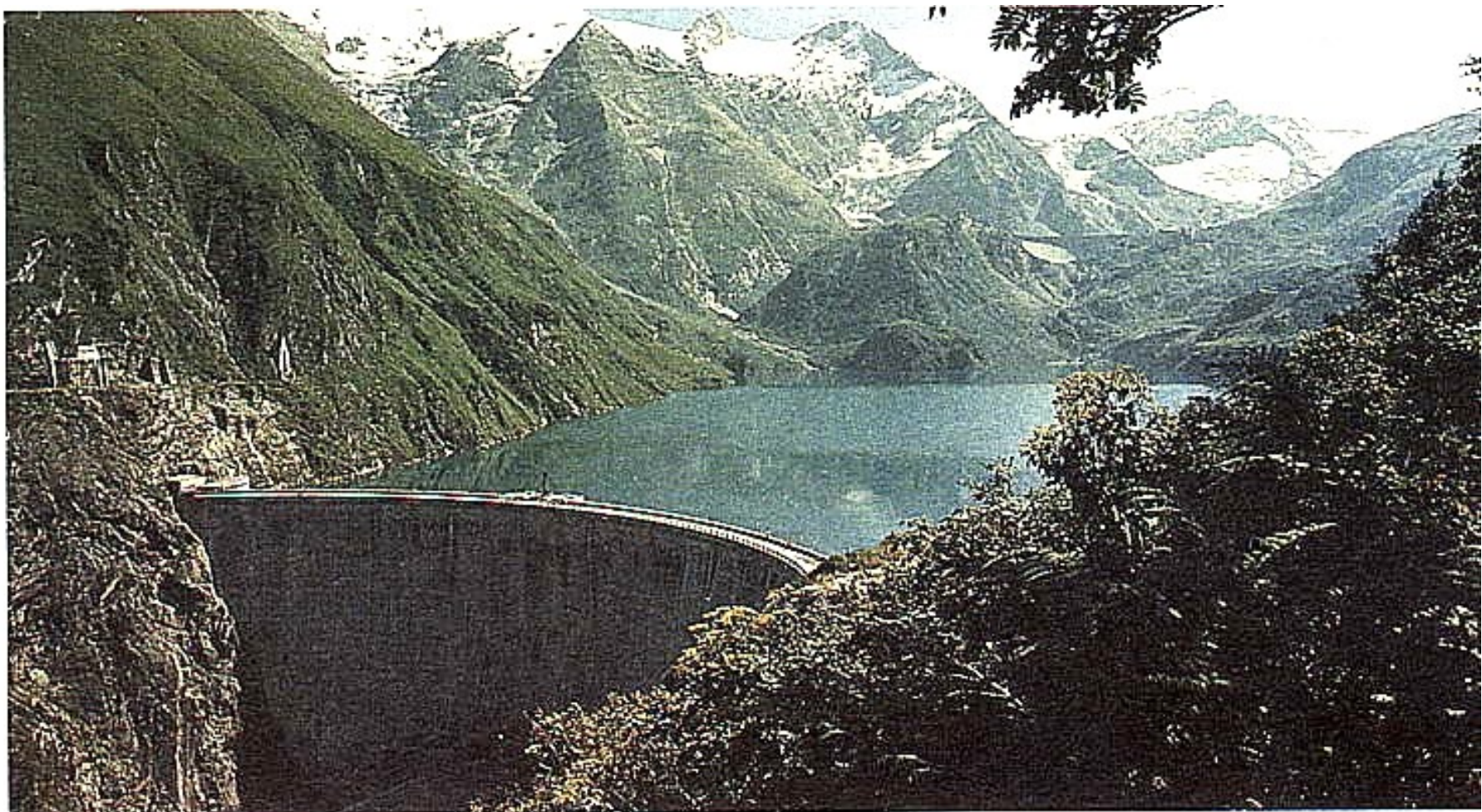






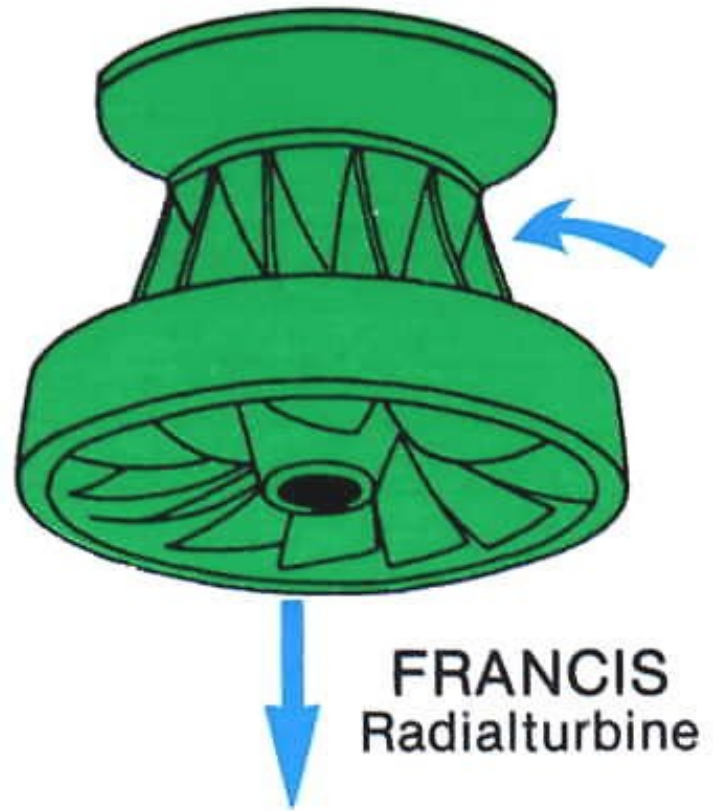
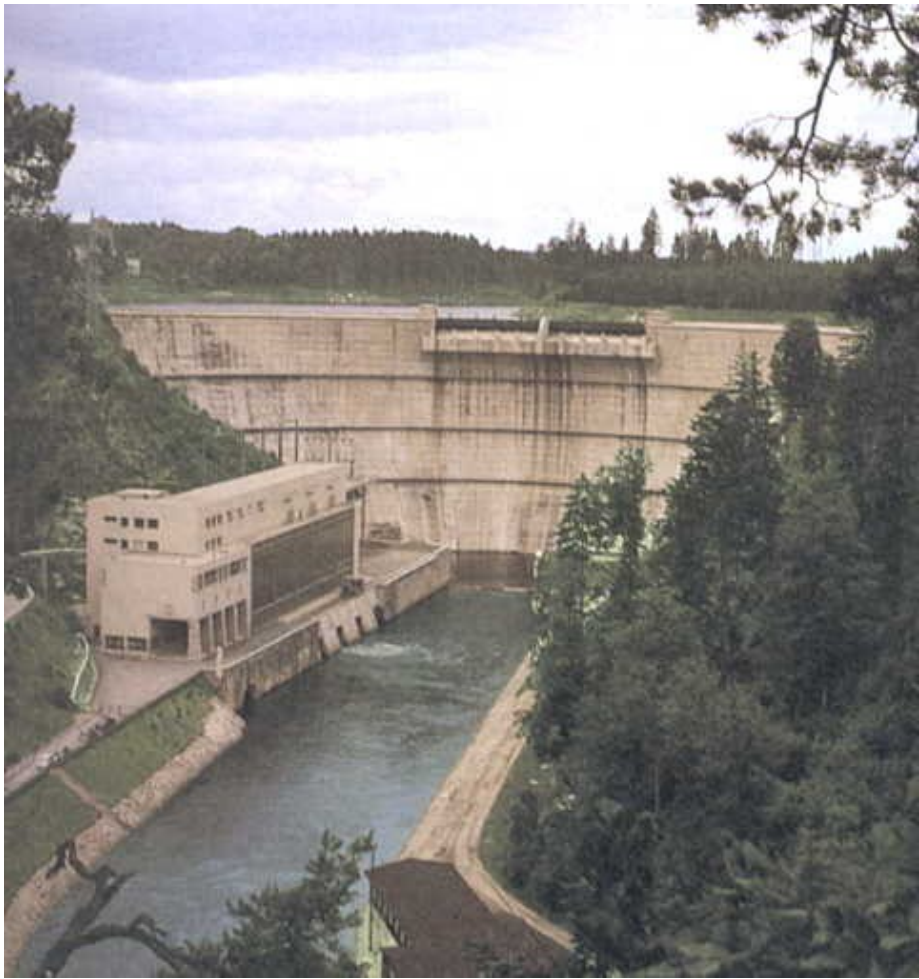
Pelton-Wheel





Speicherkraftwerk Kaprun: Stausee Wasserfallboden

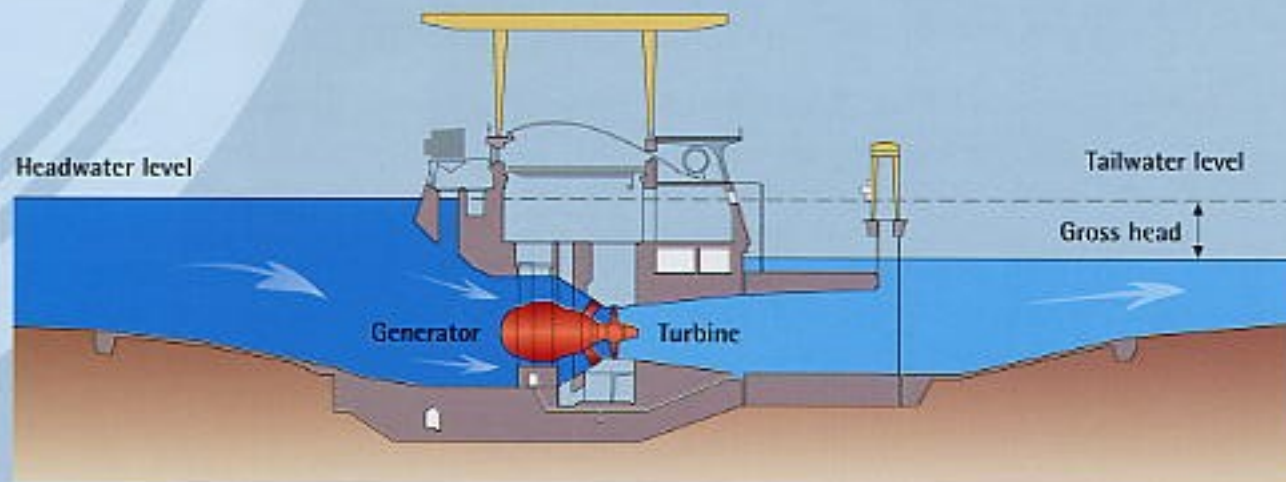




**FRANCIS**  
Radialturbine

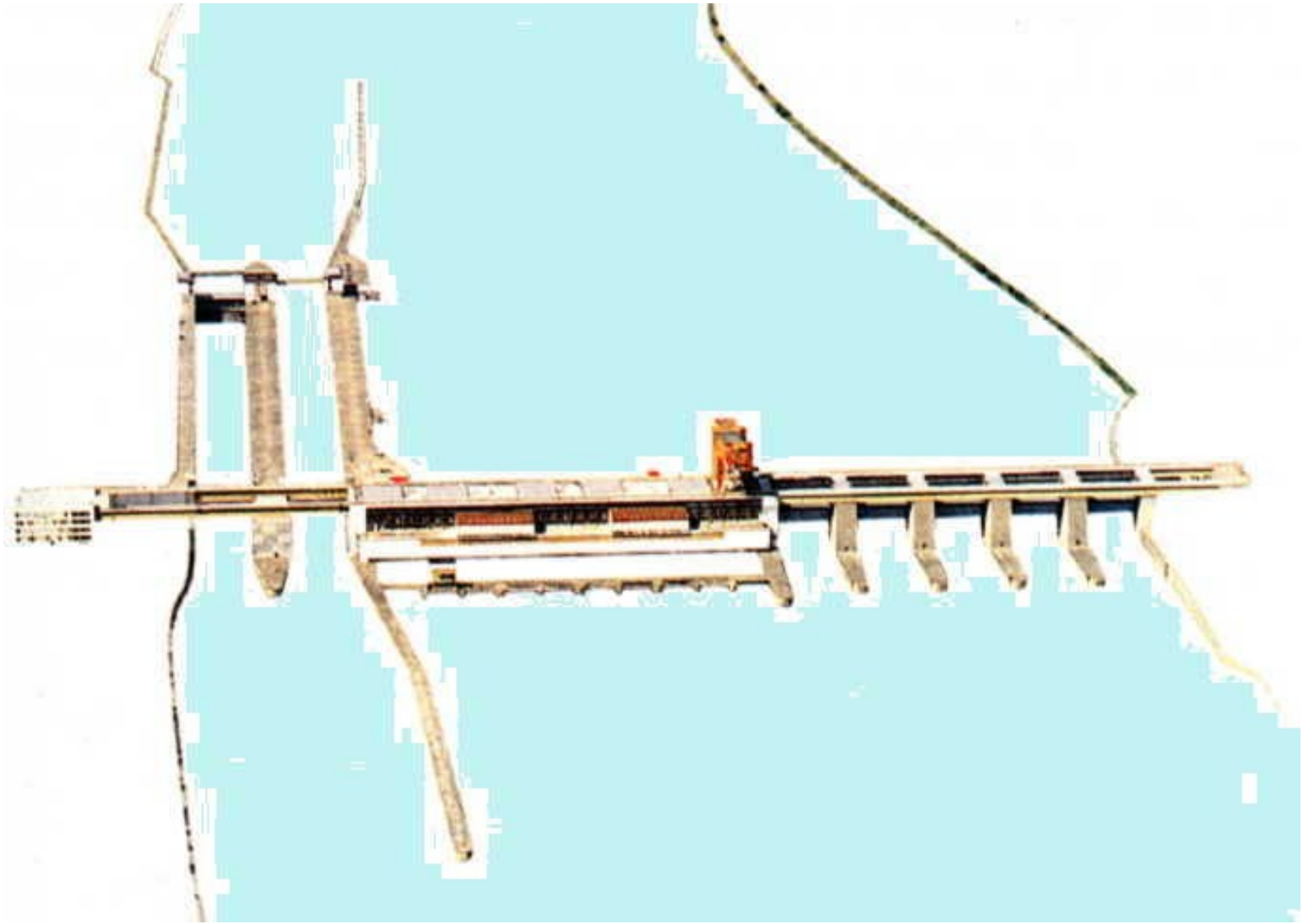
## Electrical Generating Facilities with Multiple Uses

The run-of-river plants have multiple other uses in addition to their primary purpose of generating electricity, as do all power plants planned and constructed by AHP. Flood control for certain stretches of river has been increased as a consequence of plant construction. The higher water levels on the Danube due to the dams have significant advantages for ship traffic, which would otherwise be hindered by currents and seasonal low water levels. Responsible construction methods have assisted decisively in the preservation of endangered natural habitats. A substantial contribution to the preservation of nearby wetlands and riparian areas has been achieved by means of an innovative groundwater conservation and management program. Additionally, many recreation areas have been created, which have received a favorable reception from nearby residents and visitors.



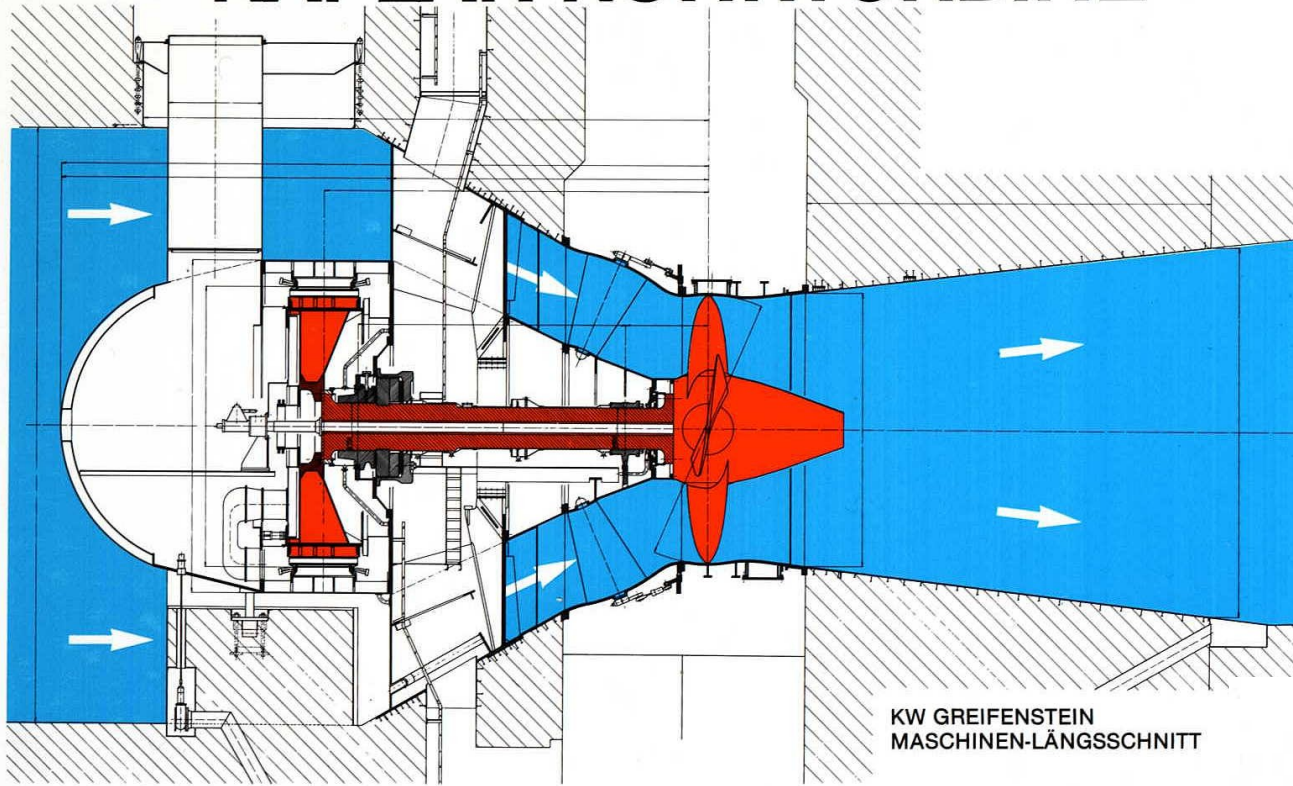
Konlon turbine with horizontal shaft



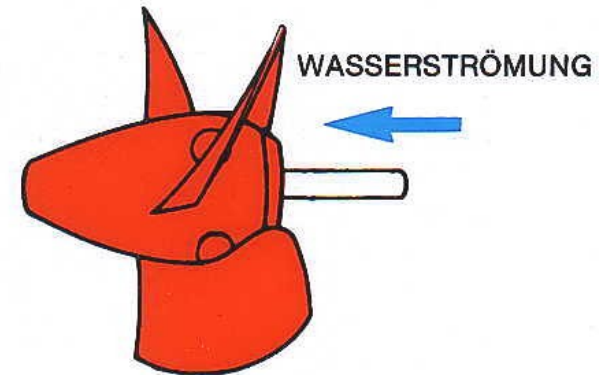




# KAPLAN-ROHRTURBINE



KW GREIFENSTEIN  
MASCHINEN-LÄNGSSCHNITT





Ancient Greece....

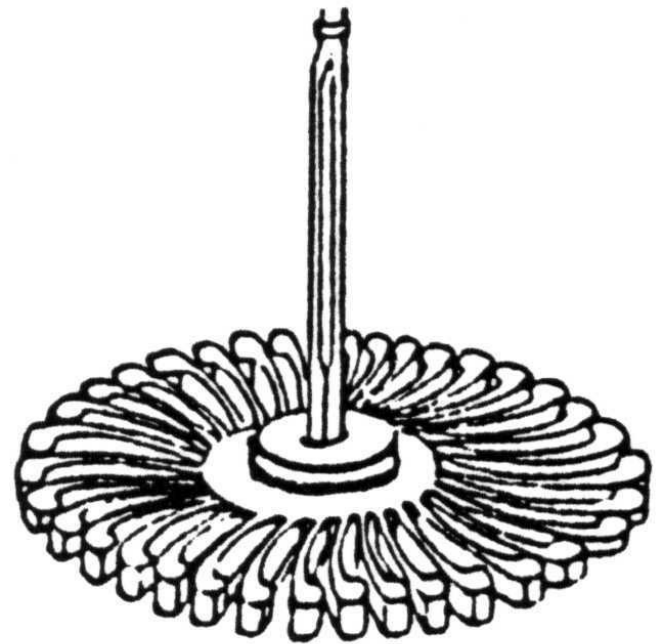
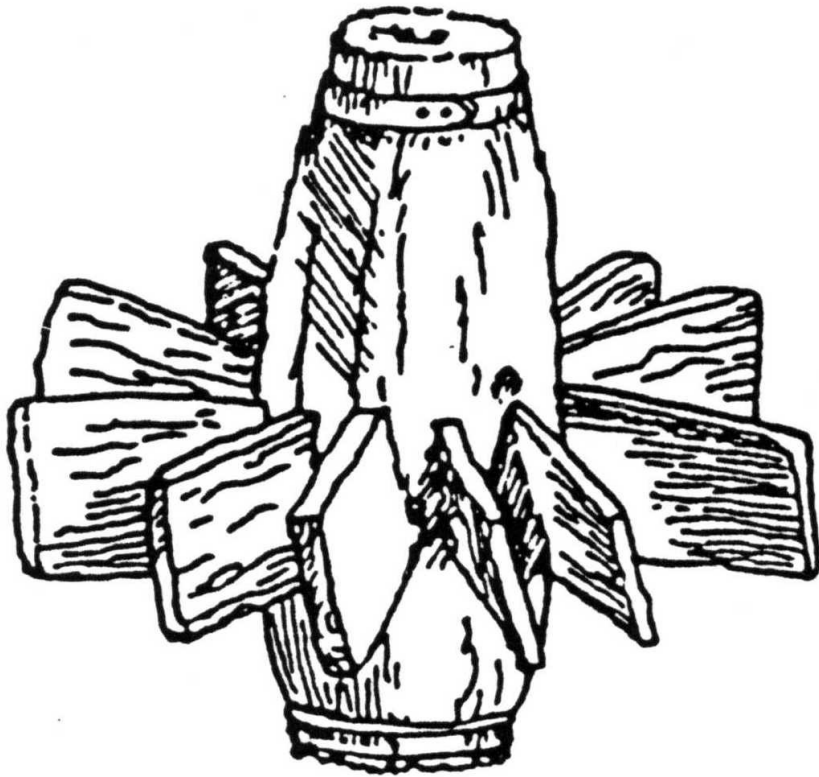
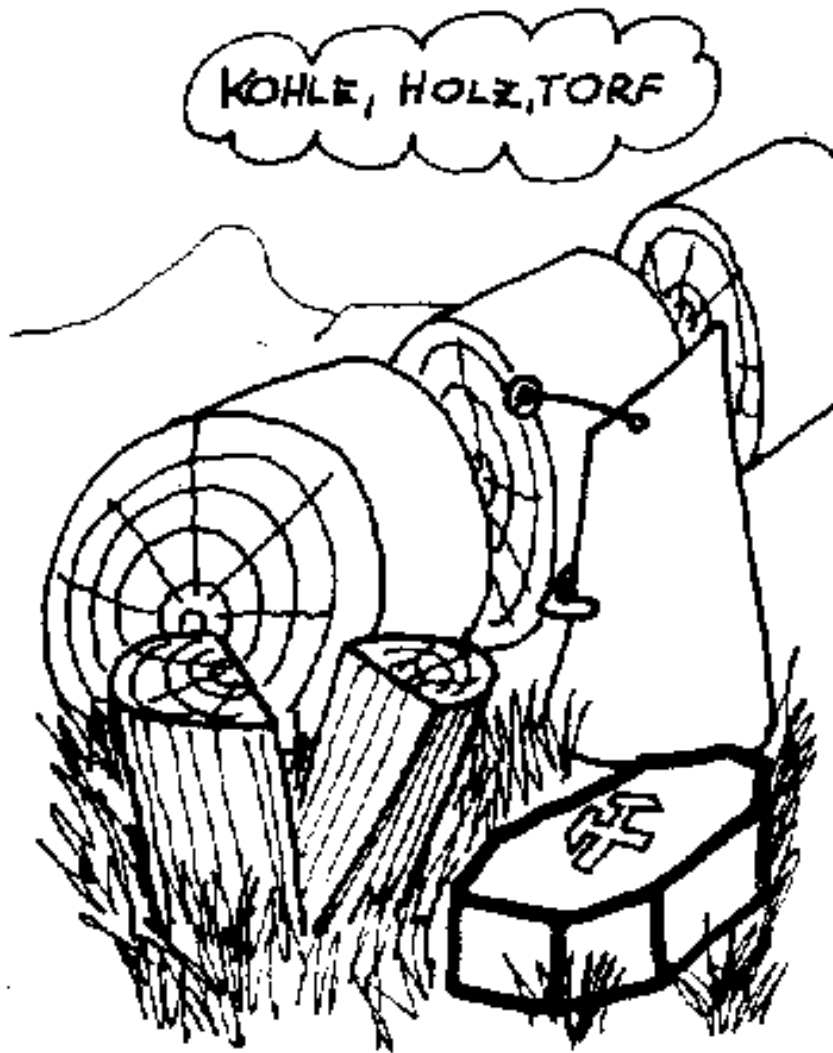




Abb. 2: Der bundesrepublikanische Pro-Kopf-Umsatz an elektrischer Energie (ca. 700W) entspricht einer Dauerbeschäftigung von 7 bis 10 „Sklaven“.

Picture: Praxis der Physik, 1998

We are accustomed to use 700 W electricity / person.  
Between 7 and 10 electric slaves always work for us.



Vapour at work.....  
High pressurized vapour –  
The steam engine

**1 cm<sup>3</sup> water →**

**1700 cm<sup>3</sup> vapour**

## The steam engine

1705...Newcomen - first engine

1784....James Watt – reverse steam engine

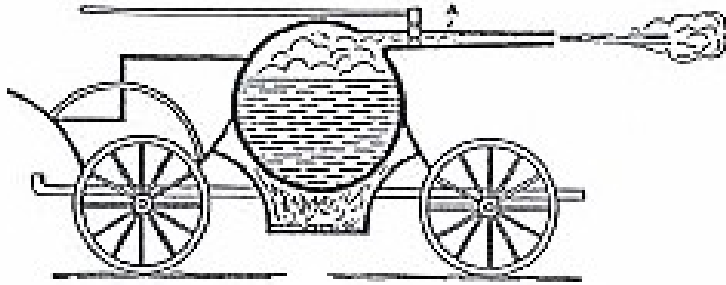
By far earlier: Heron of Alexandria:



Heron's aeolipile



„Actio est reactio“ by steam



Newton s steam car – explain the principle of it !



Vapour (steam) makes independent of Wind !



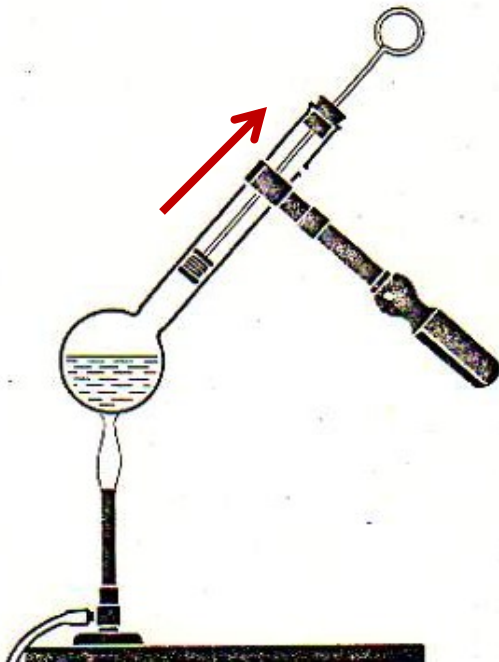
1862:  
Locomotive  
running on the  
street without  
railway.



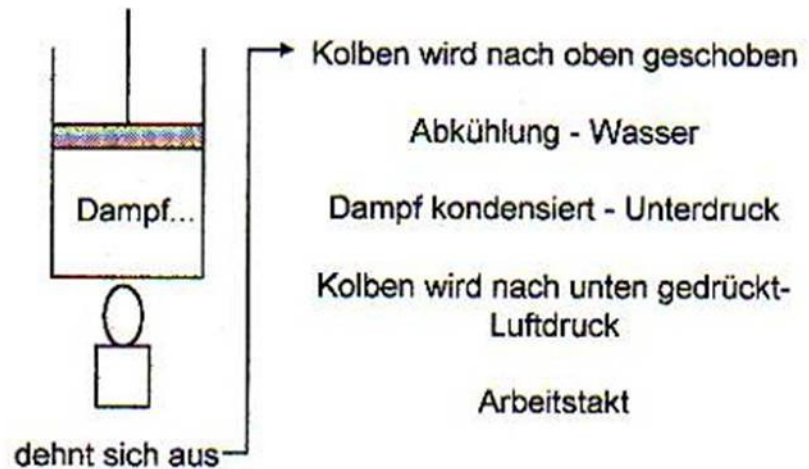
First Austrian Locomotive

Till about 1930 tractors are run by steam





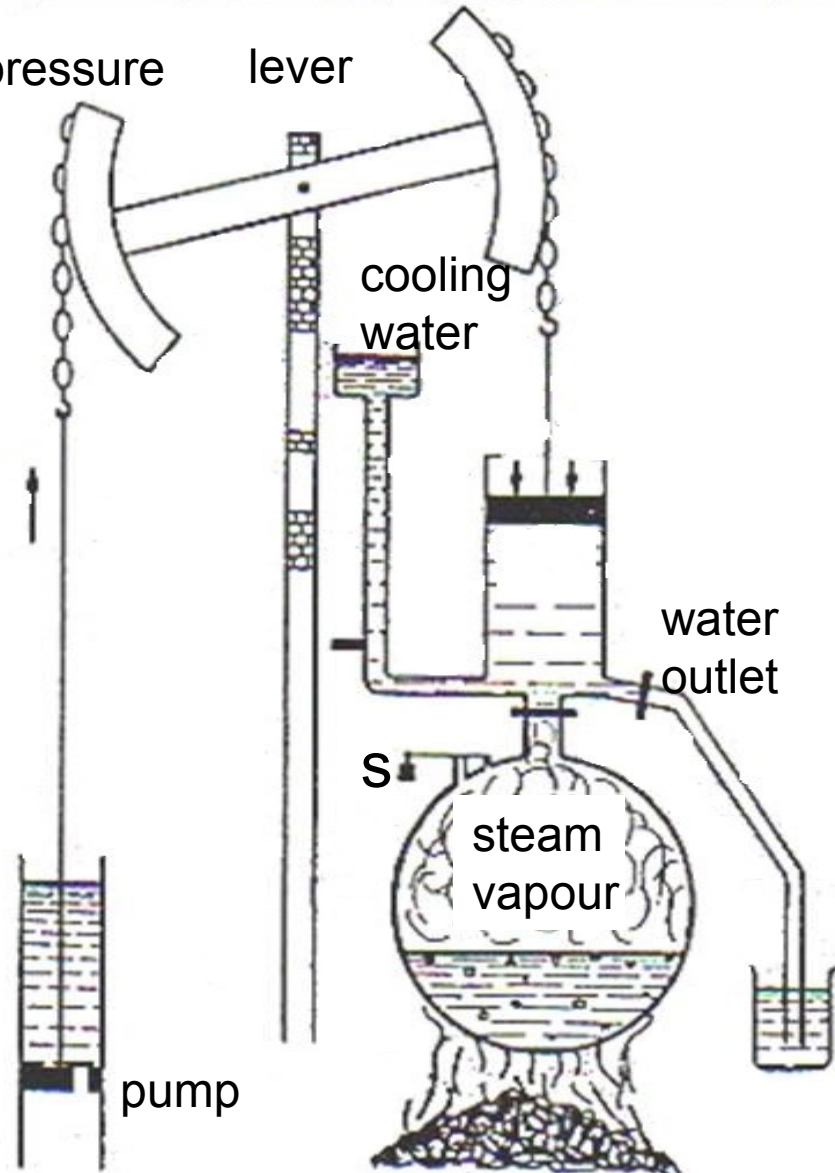
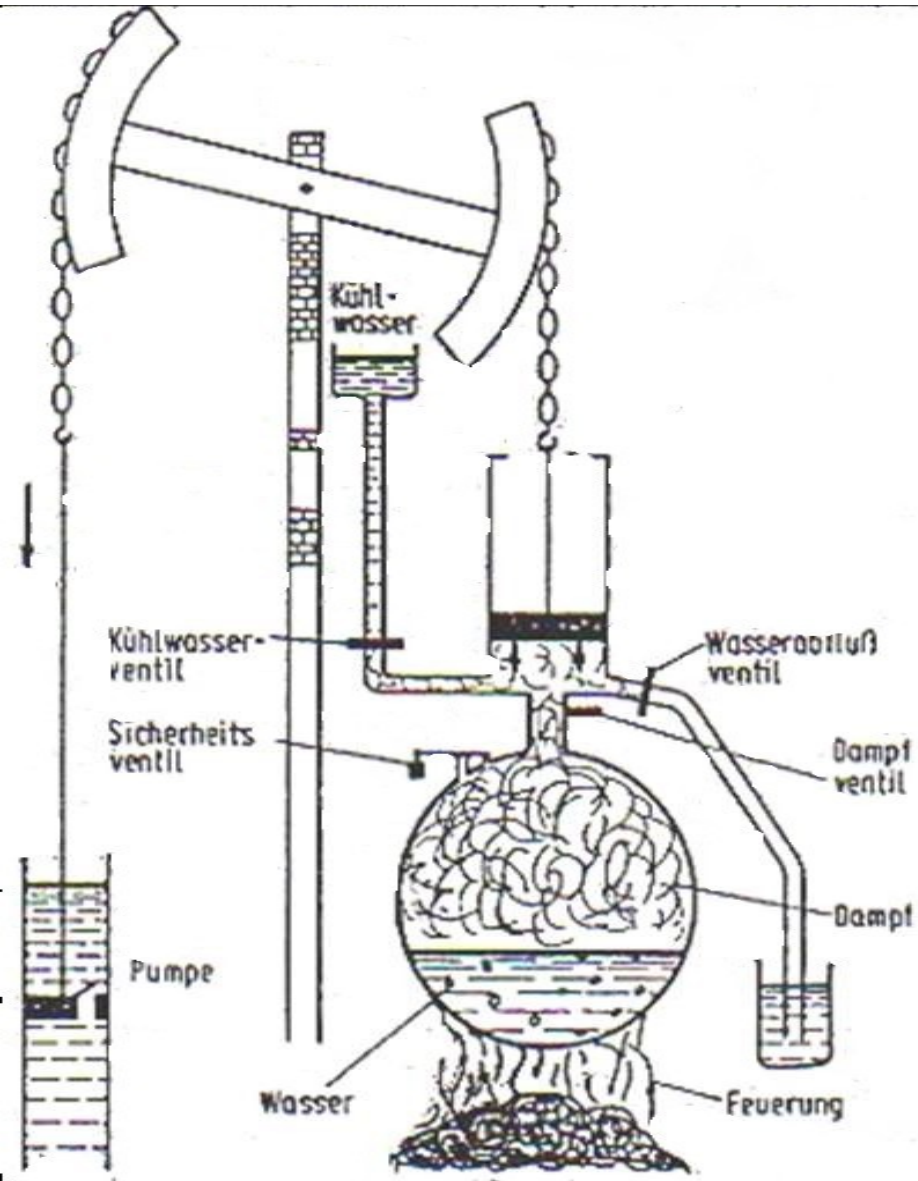
## ATMOSPHERISCHE DAMPFMASCHINE - NEWCOMEN



Water is boiling –  
the vapour pushes  
the piston upwards;  
by cooling the piston  
moves back

**This was Newcomen's steam engine –  
vapor expands – piston was pulled upwards  
water cooling – vapour condensates →  
subpressure – atmospheric air pressure  
depresses the piston.**

S...safety  
valve  
(overpressure lever  
)



Picture Source: NiUPC 1984

Newcomen ...how it works

The heavy balance pulls the piston in the cylinder upwards, the pump sinks down

The cylinder is filled with vapour

Cooling water is pumped into the cylinder, the vapour condensates, liquifies

Subpressure

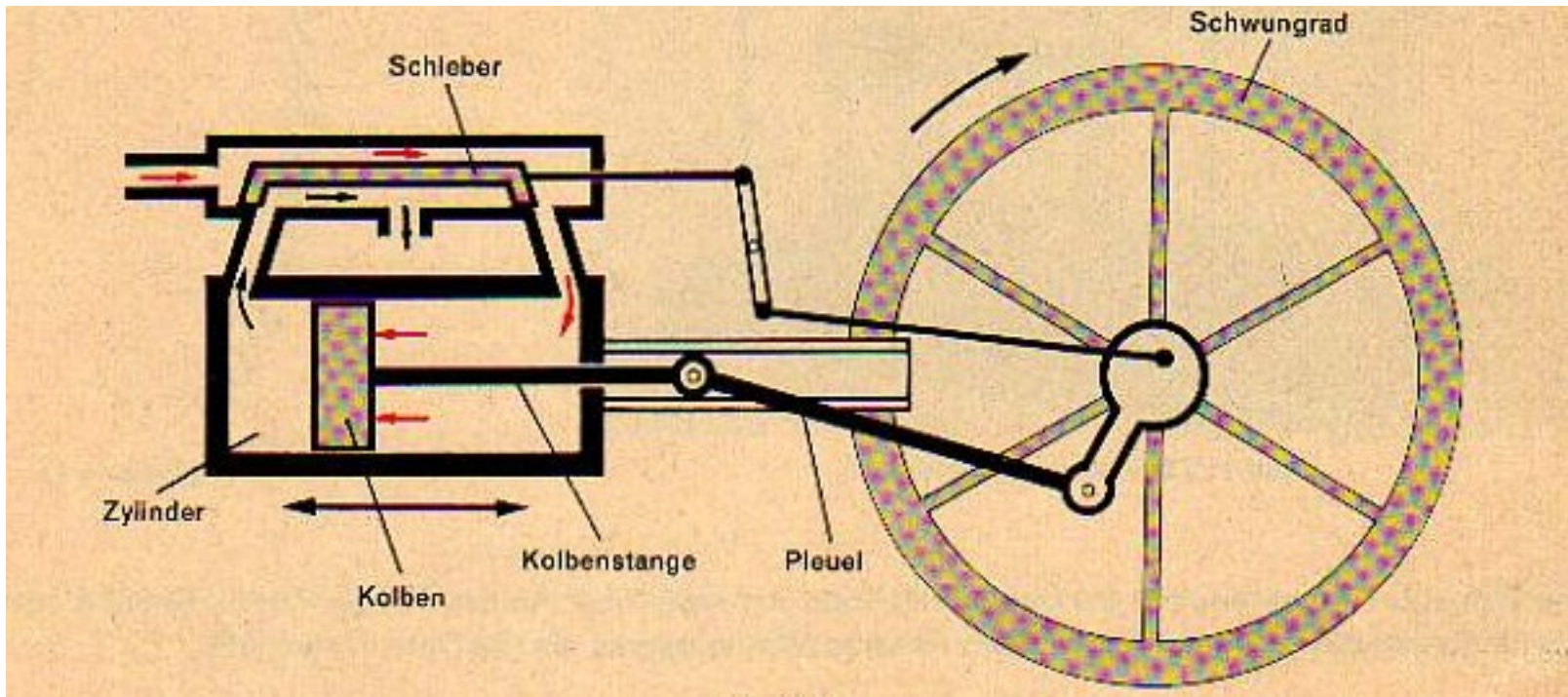
The piston in the cylinder is pushed down by the air pressure, because in the cylinder is subpressure

Cooling water leaves through the water outlet, new vapour equalizes the subpressure-

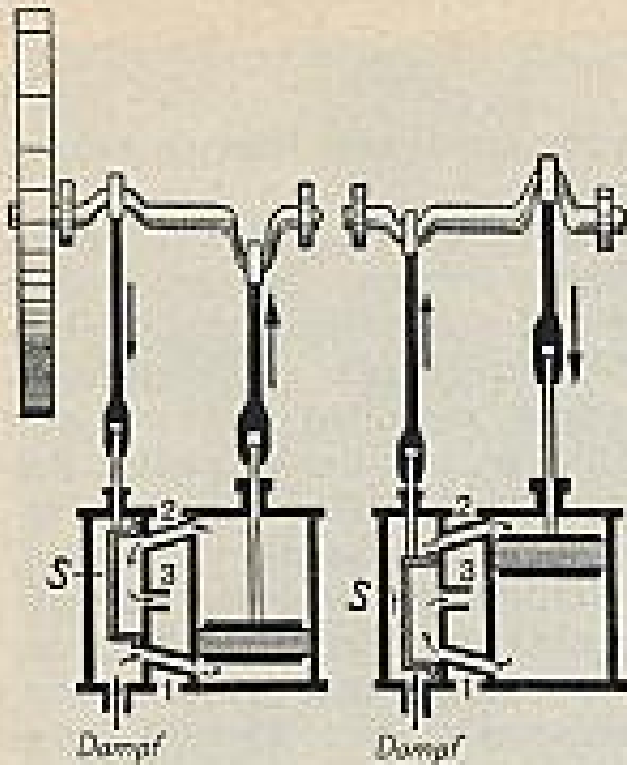
Next working stroke-----

No overpressure, therefore called atmospheric steam machine.....

## James Watt – The Steam Engine



This is the drawing of a steam engine dating from an old textbook. By this drawing you should be able to explain, how this engine works. This engine was used at steam locomotives.



Abt. 16.01. Dampfmaschine.

S = Schieber, 1, 2 = Verbindungsröhre, 3 = Auslaßkanal.

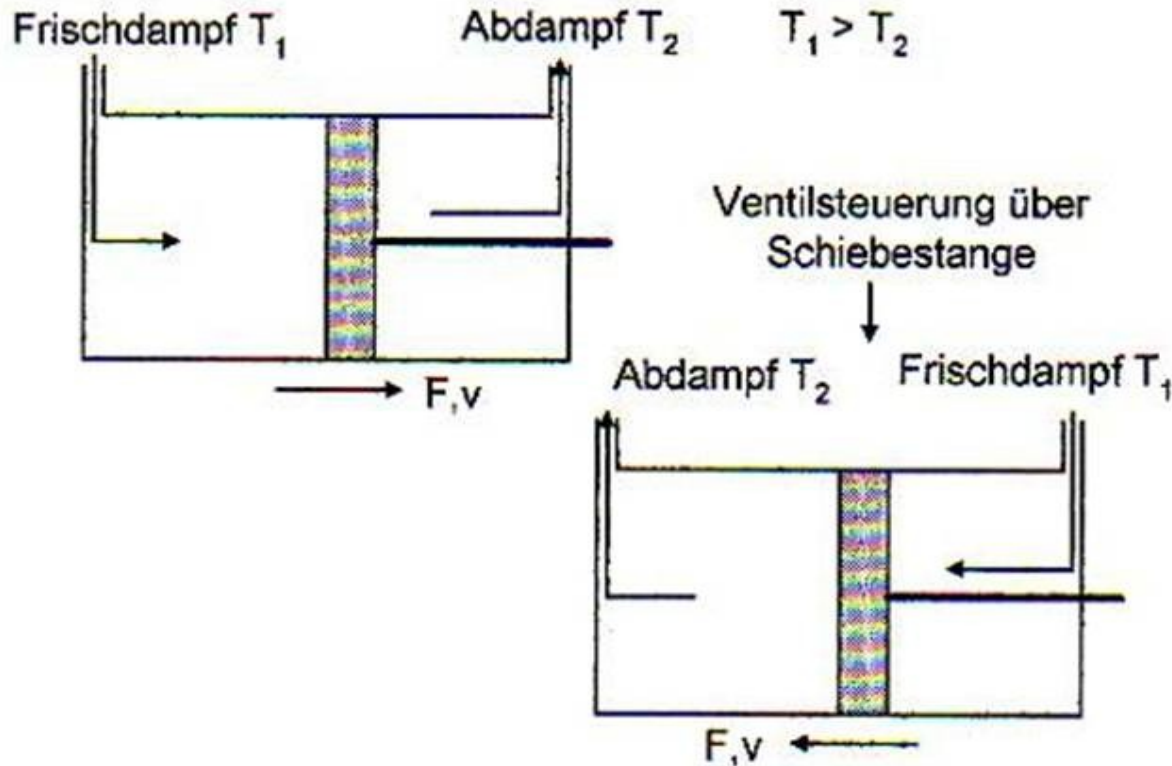
In old textbooks you find the schedule of a steam engine; try to explain it !

(assistance: on one side of the piston high pressurized – because overheated – steam comes into the cylinder; on the other side used steam, which has done his work, is pushed out – the stop valve is the regulator)

- S...gate valves or stop valves
- 1,2...connection tubes
- 3.....outlet or exhaust vapour



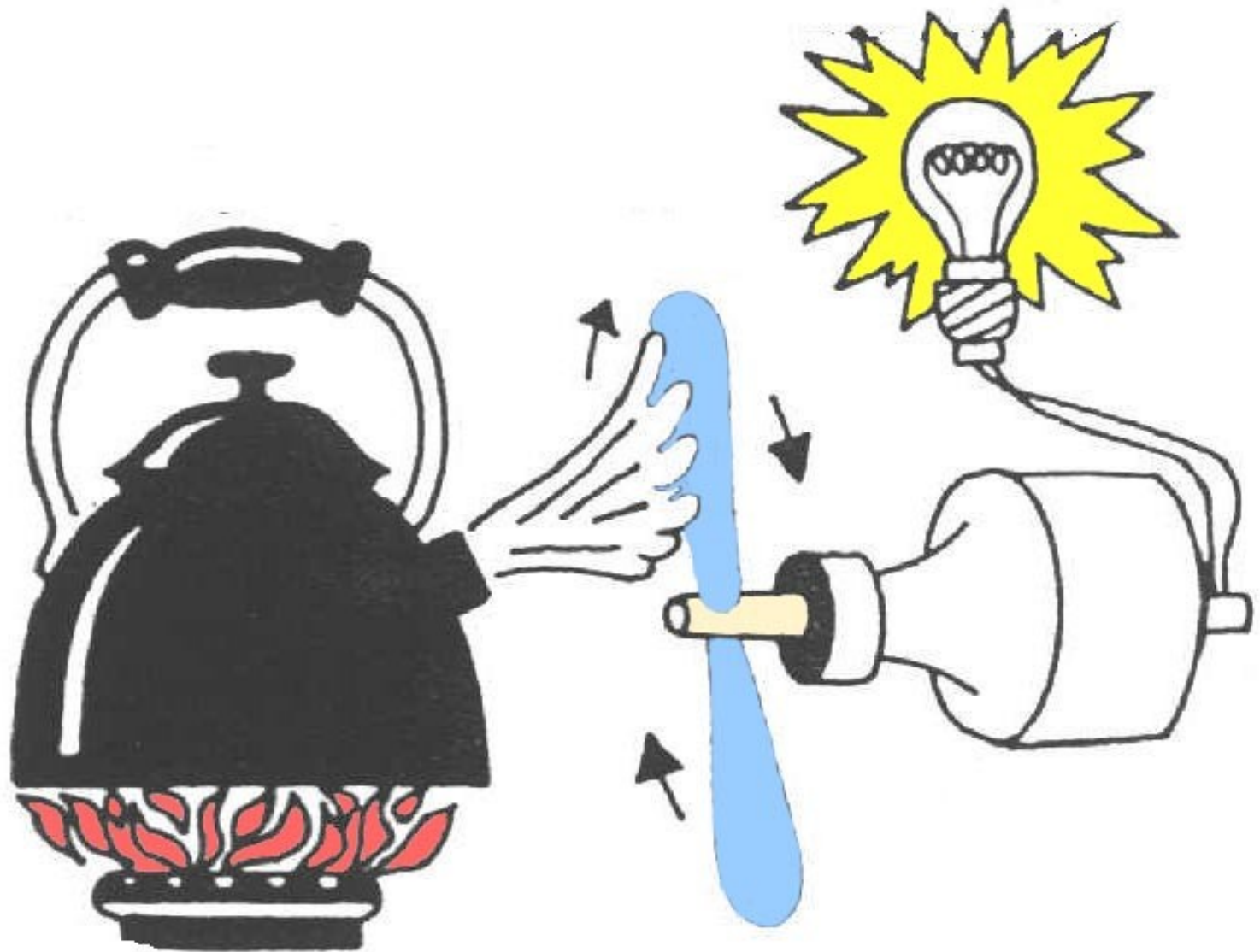
# GEGENDRUCKDAMPFMASCHINE - WATT:



$T_1$ ....fresh hot overpressured steam

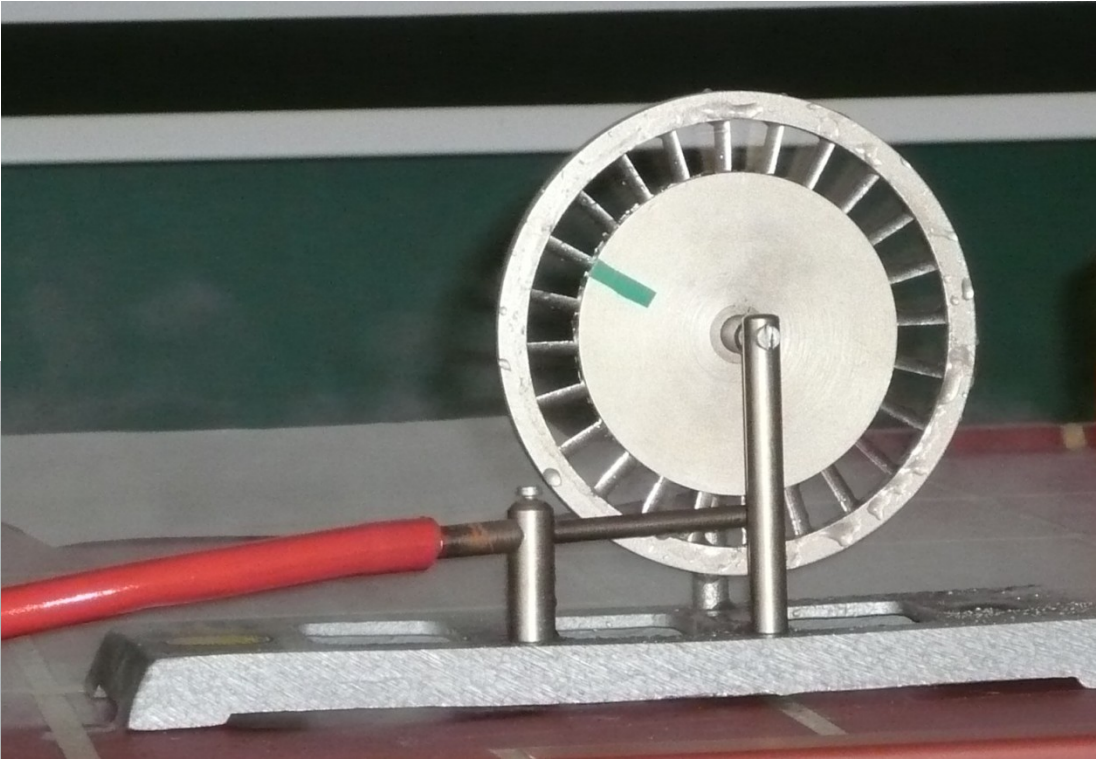
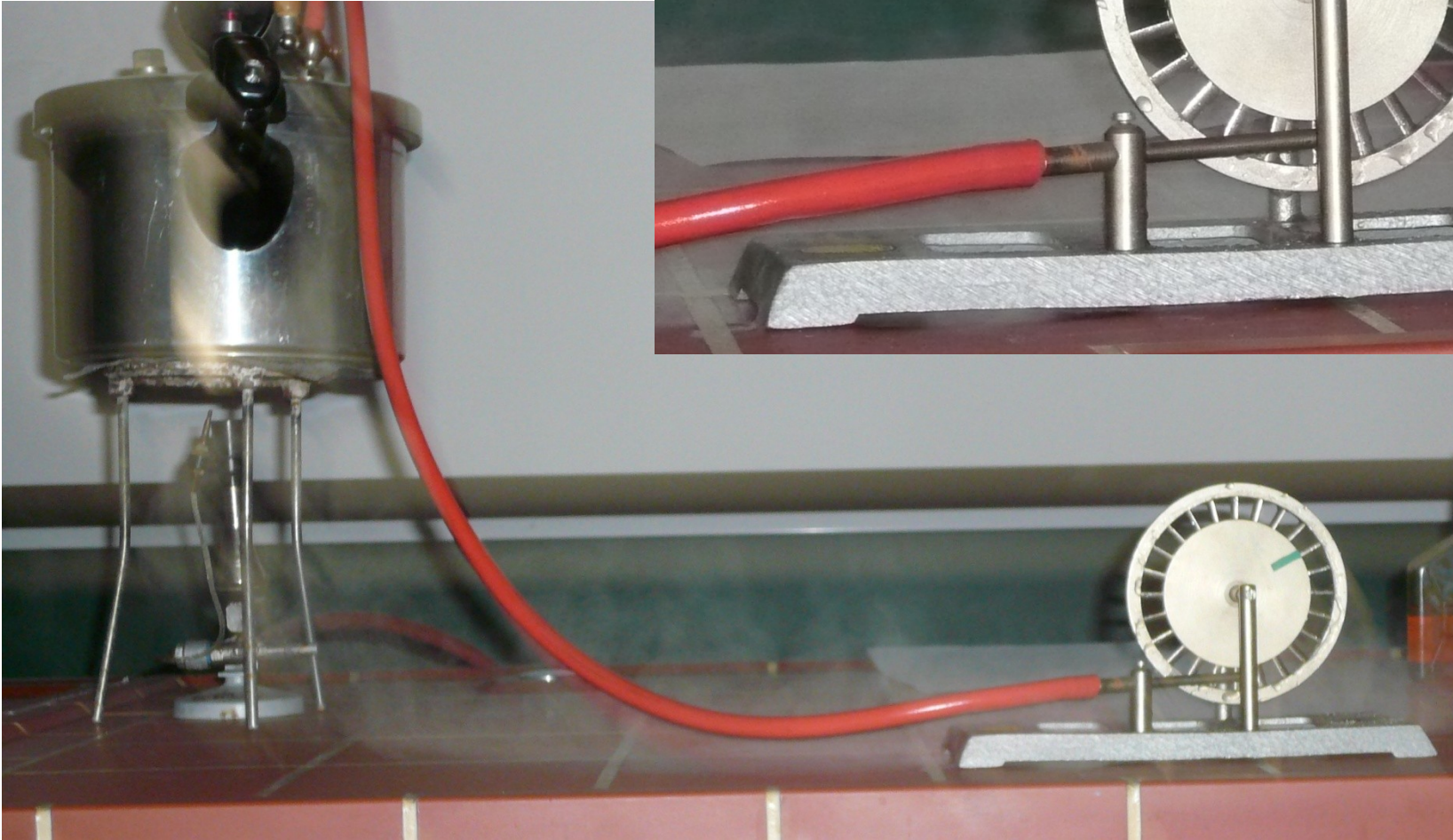
$T_2 < T_1$ .....used steam leaving through the exhaust pipe as vapour

The stop valve controls where fresh steam streams in



The steam turbine for youngsters

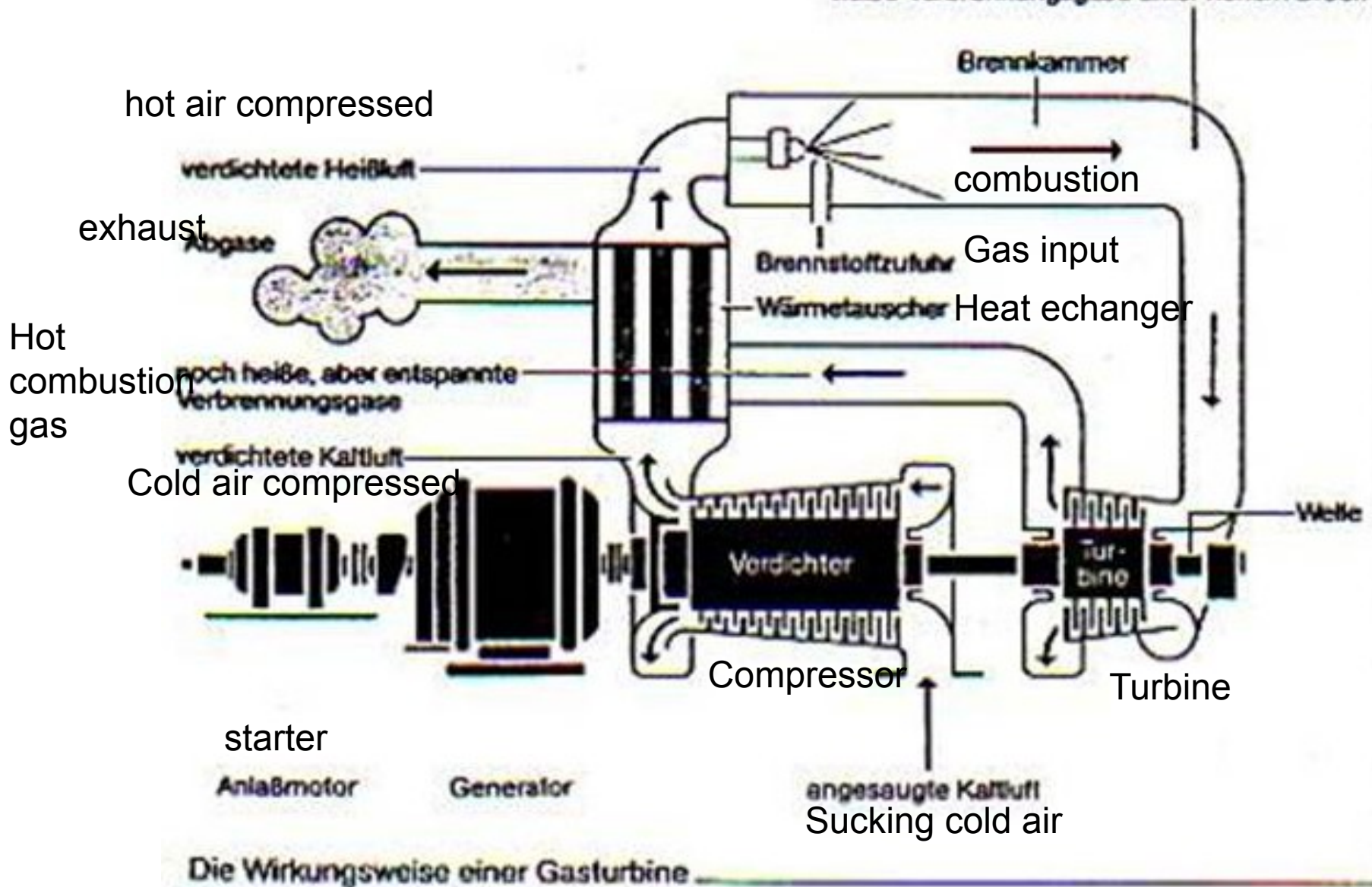
The steam turbine as experiment.





# Explain the function of a gas turbine !

Hot combustion gas, highly pressurized



Die Wirkungsweise einer Gasturbine

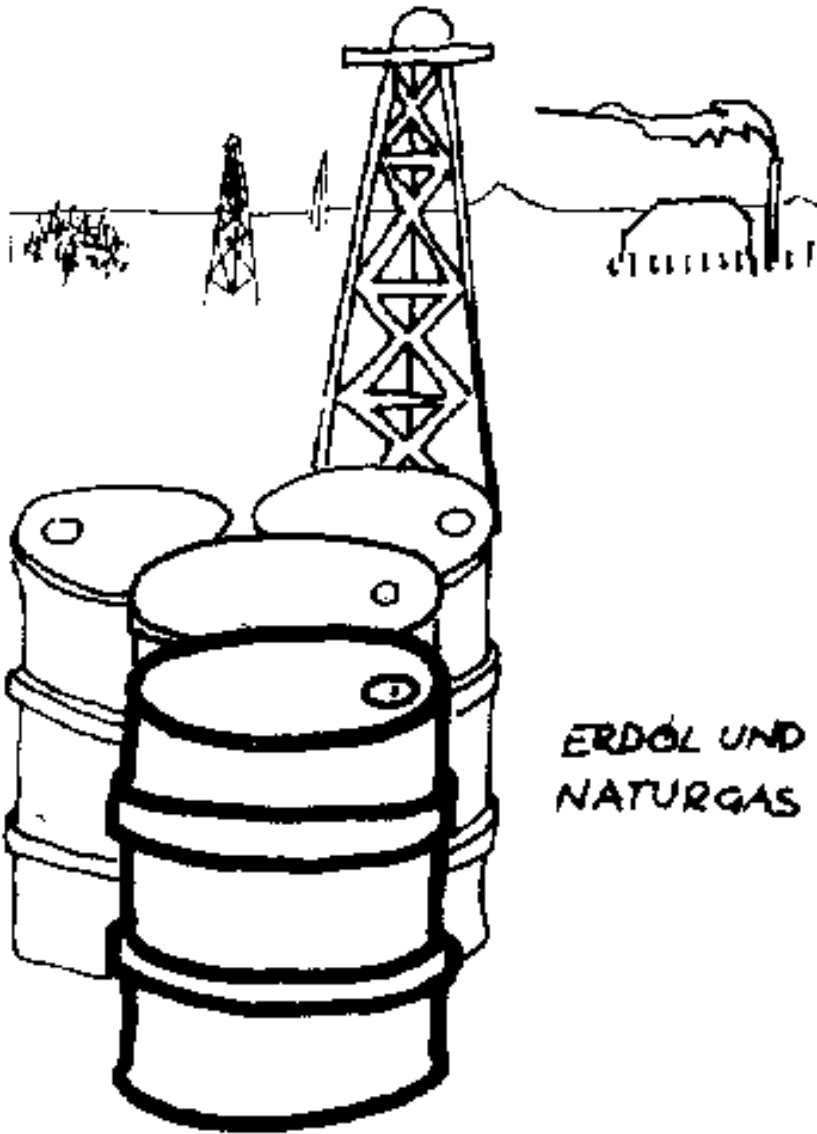
Burning waste.....

...using waste  
as energy !

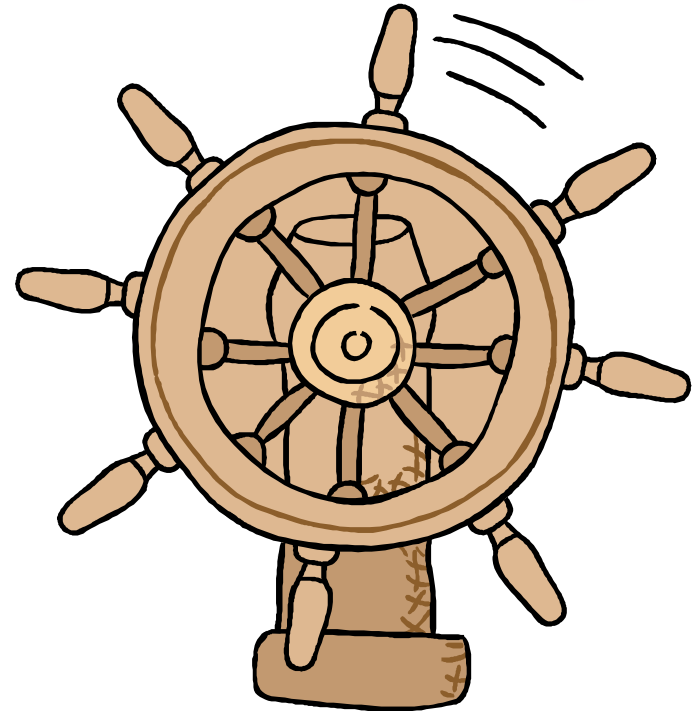




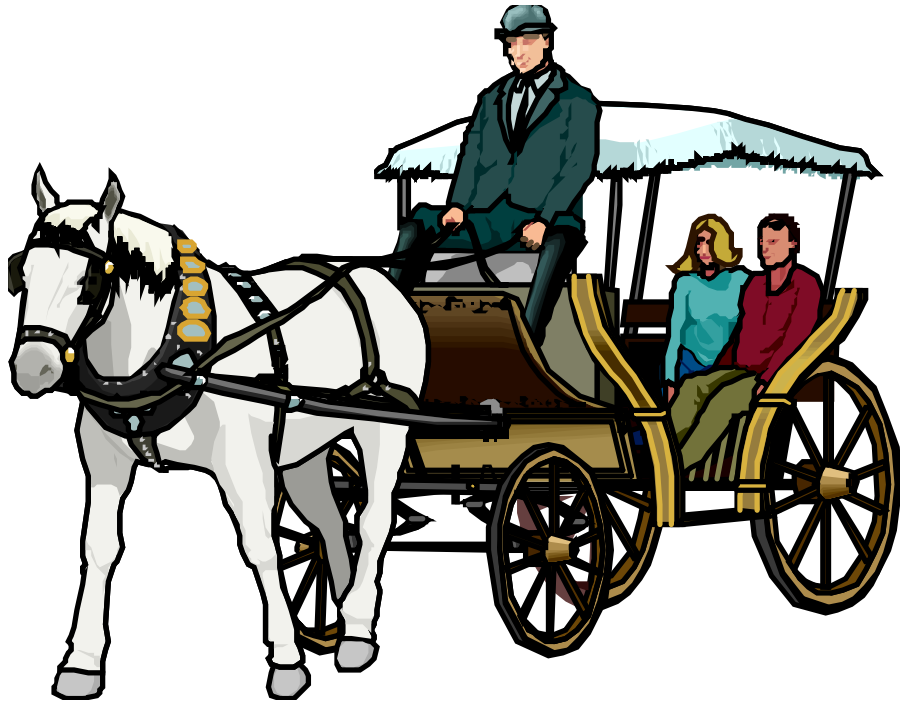




Oil, Gas, Gasoline,  
Diesel, Kerosine



Only Menpower.....



Animal power.....

The famous horse-train from  
Upper Austria to the czech Republic  
(today)



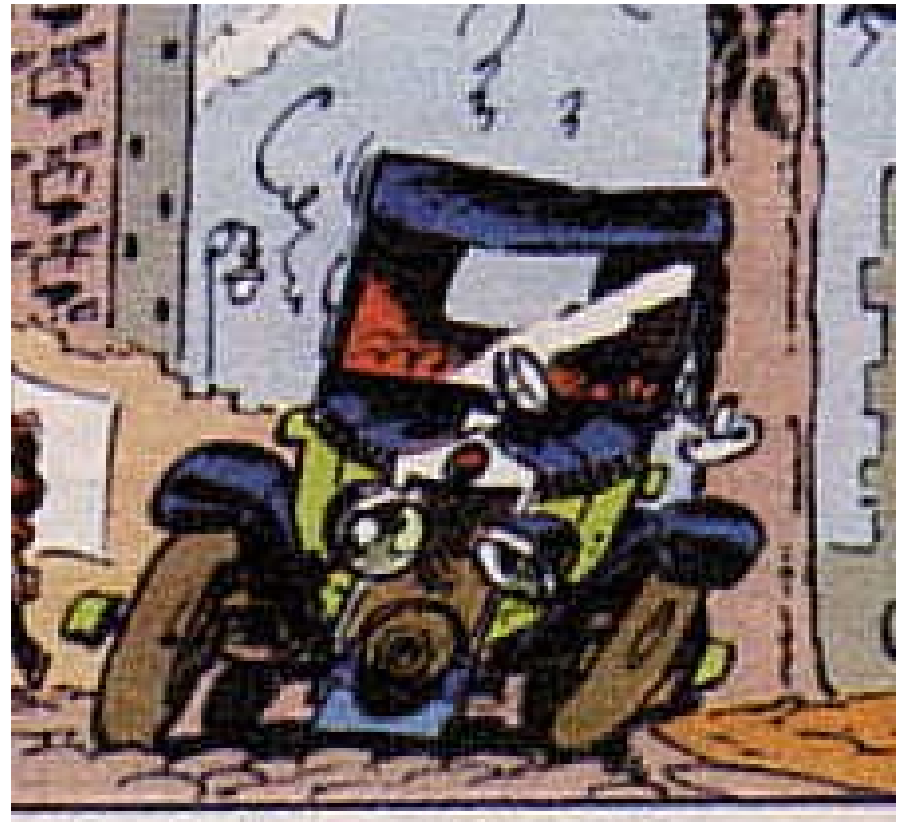


Natural Oil and Natural Gas will be exhausted.....

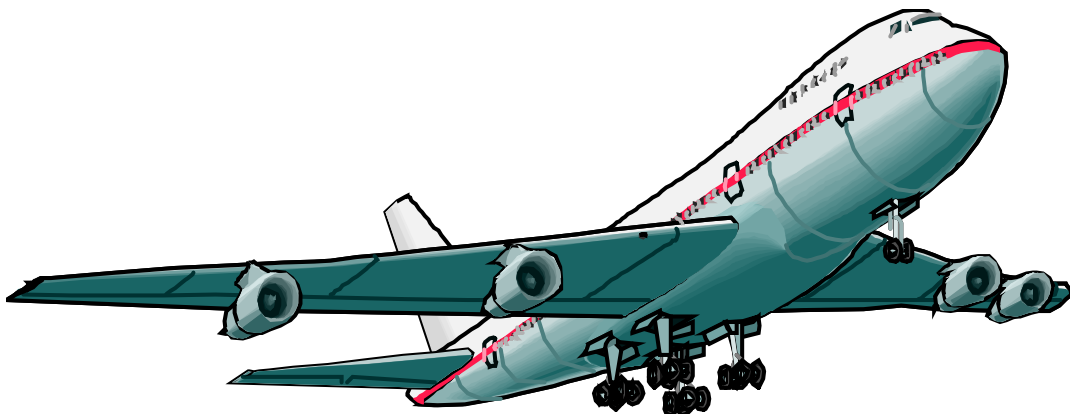
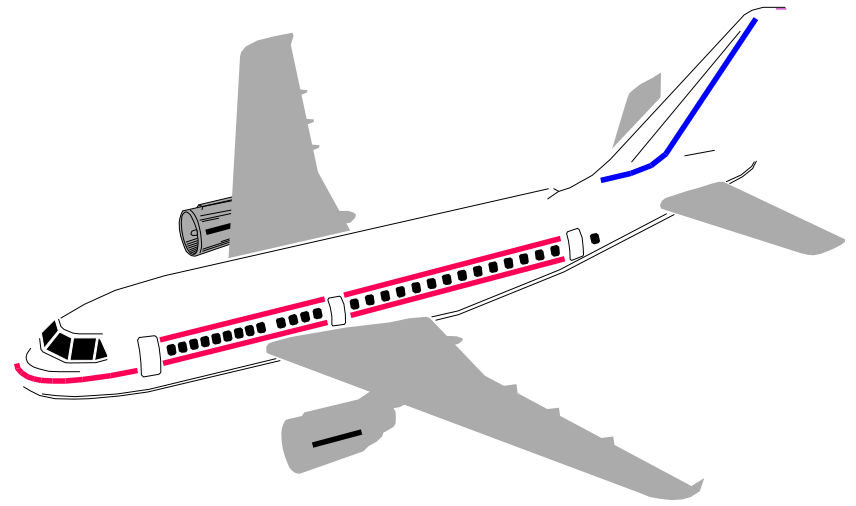
Nikolaus August Otto  
(1832-1891) – 1865

Rudolf Diesel (1858-1913)

Felix Wankel (1902 - ?)



Not flying with a steam engine....





Natural Oil is first....  
Its utilisation releases  
 $\text{CO}_2$  to the atmosphere  
enhancing the  
greenhouse effect.

A lot of substances are dating from natural oil, but they must be separated by fractional distilling and furthermore by cracking.

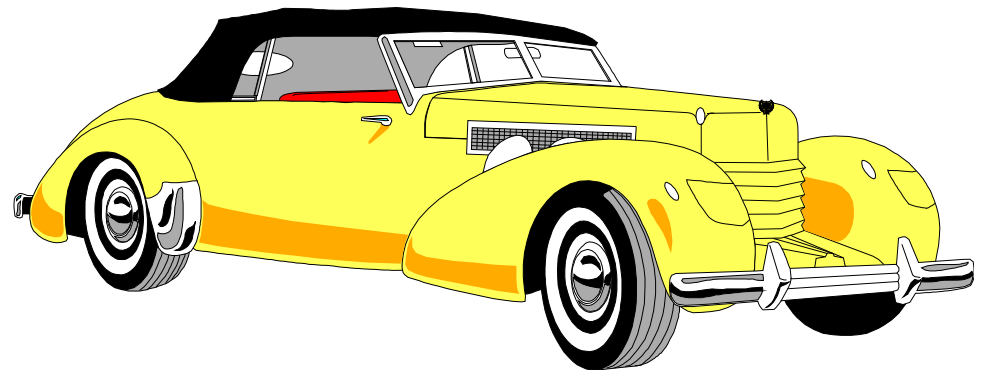
Cracking ... breaking complex compounds down to simple ones.



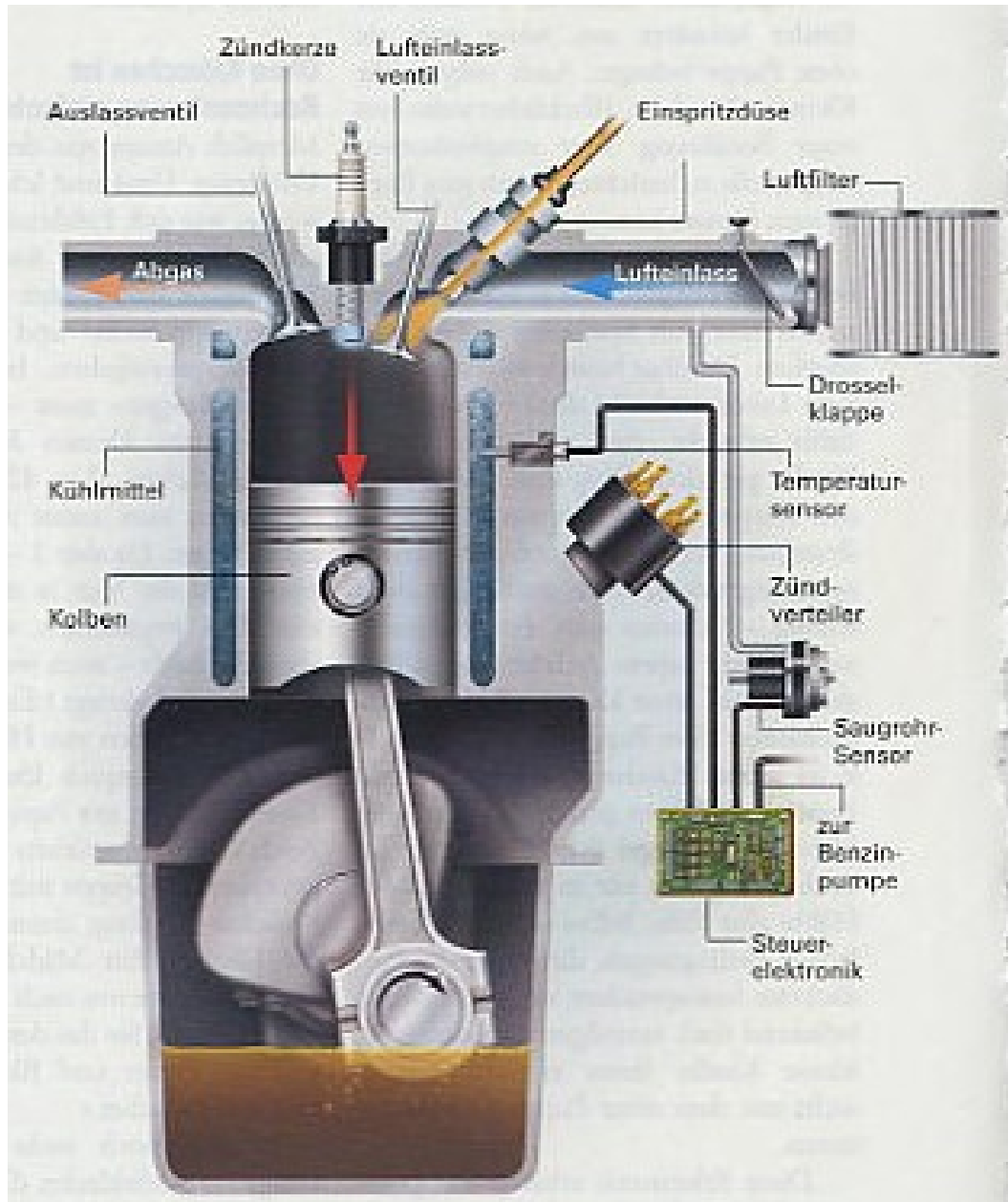


The first car in Austria, the Ottomobil from 1866. Gasoline was bought in the pharmacy.

An oldtimer needs by far more gasoline than a new car.



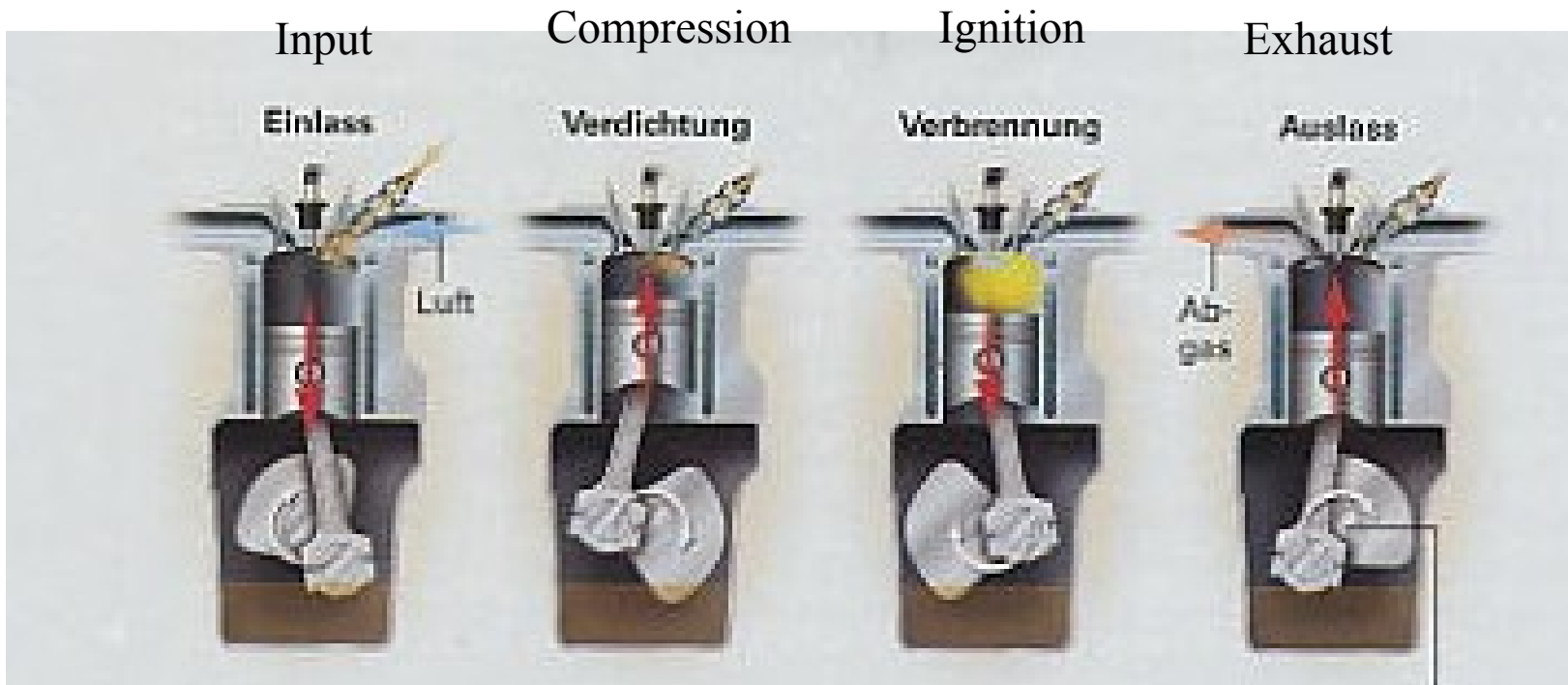




The four-stroke-engine,  
everybody can explain.

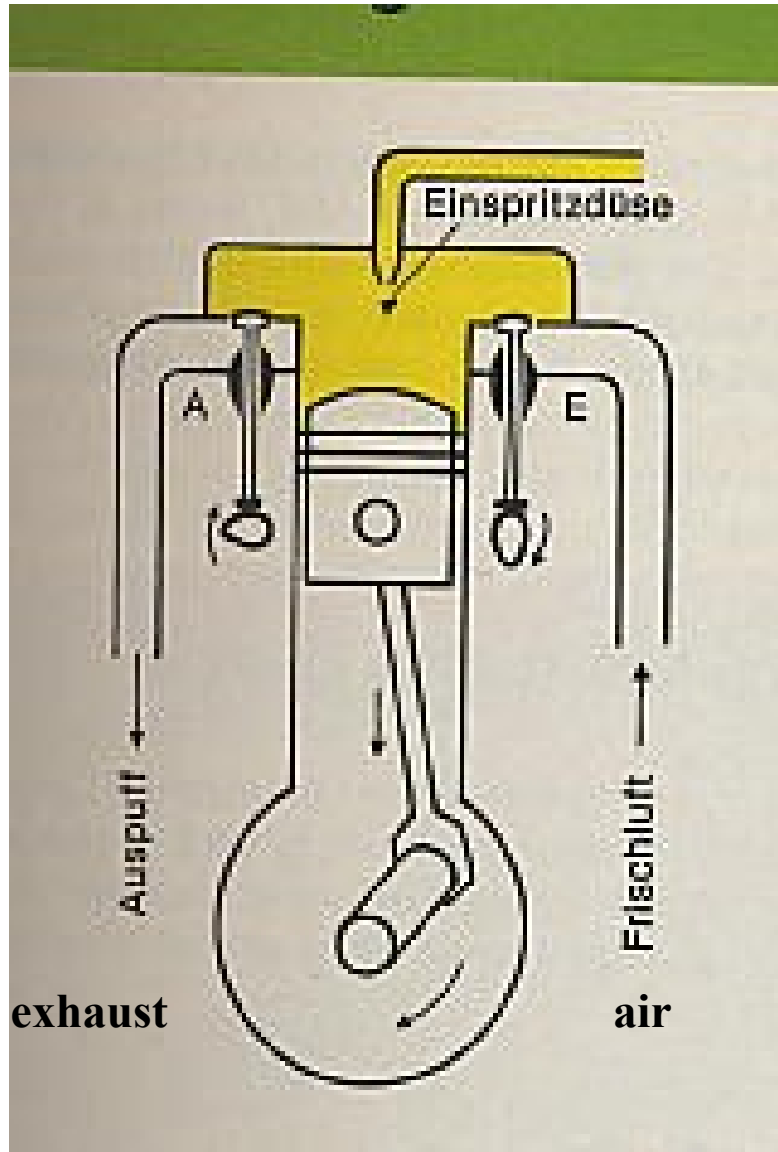
What was Wankels idea ?

Quelle: Spektrum der Wissenschaft



Sucking air  
Gasoline  
Injection

Source: Spektrum der Wissenschaft



Diesel engine:

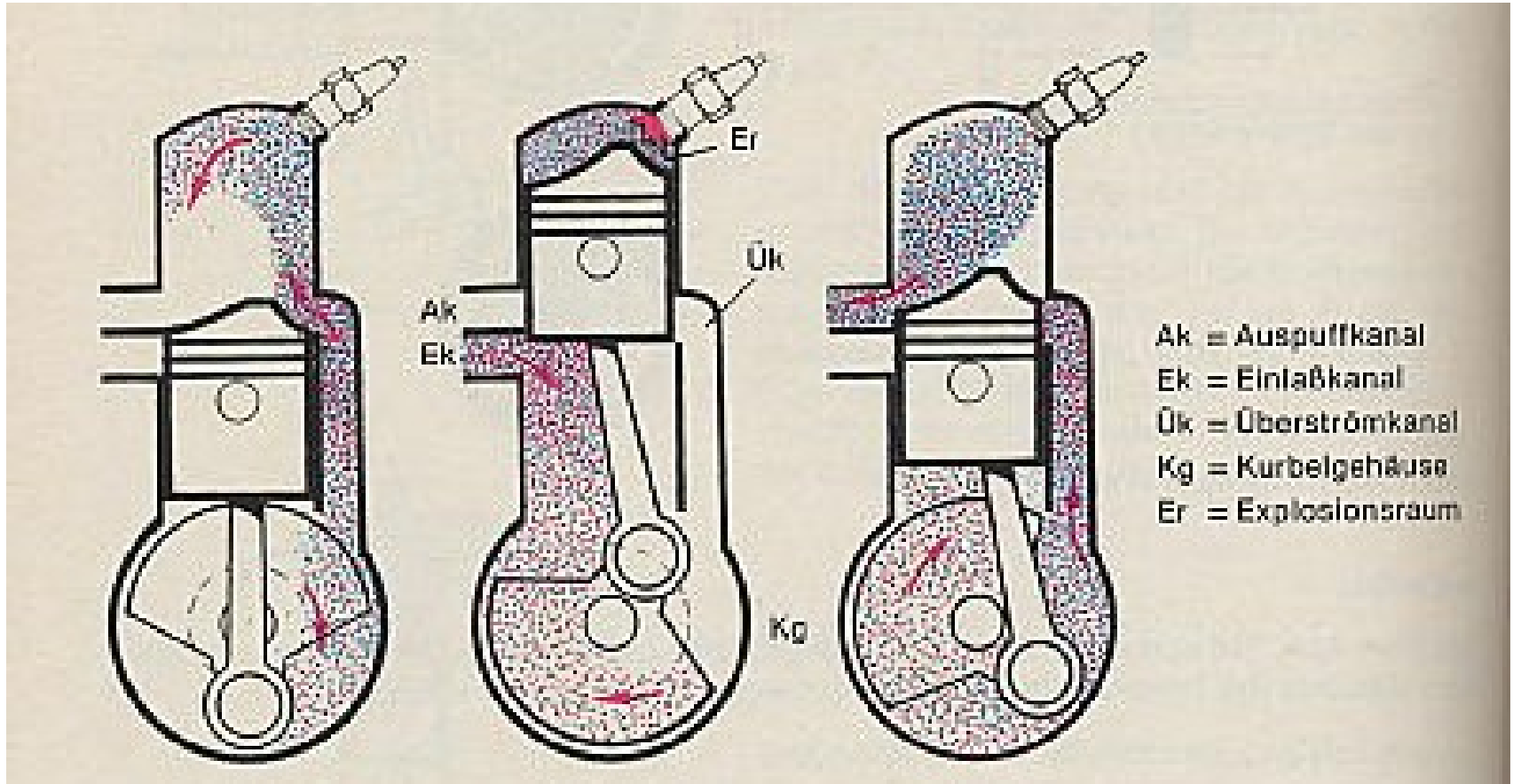
Only air is compressed,  
then Diesel is injected.

Self-ignition.

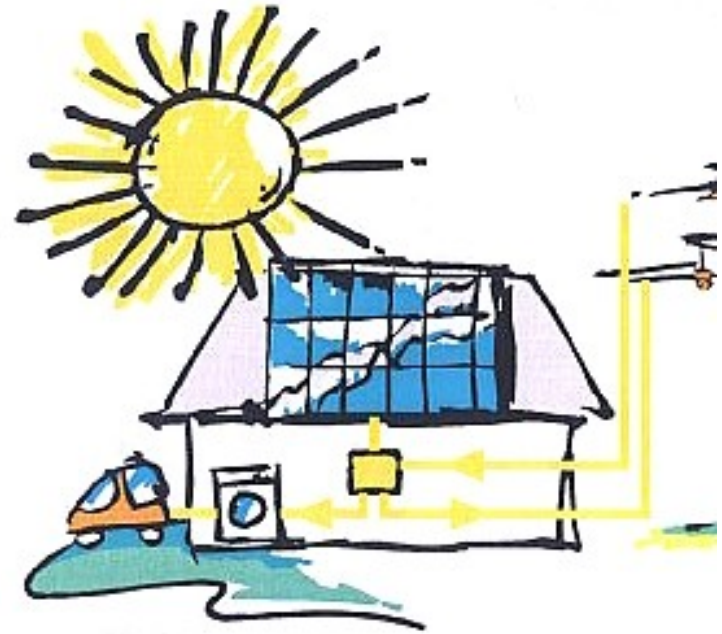
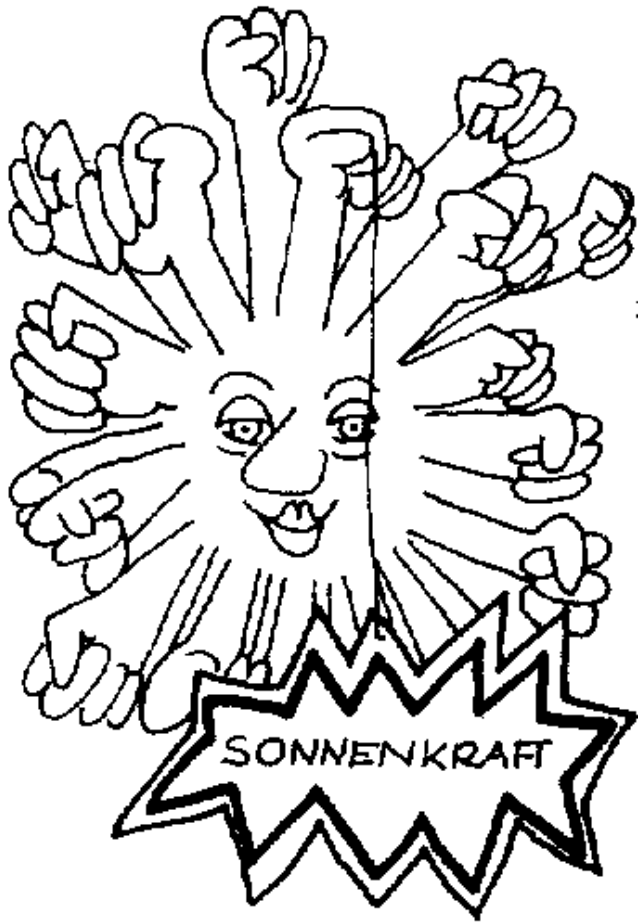
What is missing compared  
to a gasoline-engine ?

By which the Diesel-engine  
starts if it is rather cold ?

Two-stroke-engine – a very rare engine, a small engine  
The shape of the piston and one pipe for moving waste gas from the upper part of the cylinder to the lower part of it provides four strokes in a two stroke-machine.





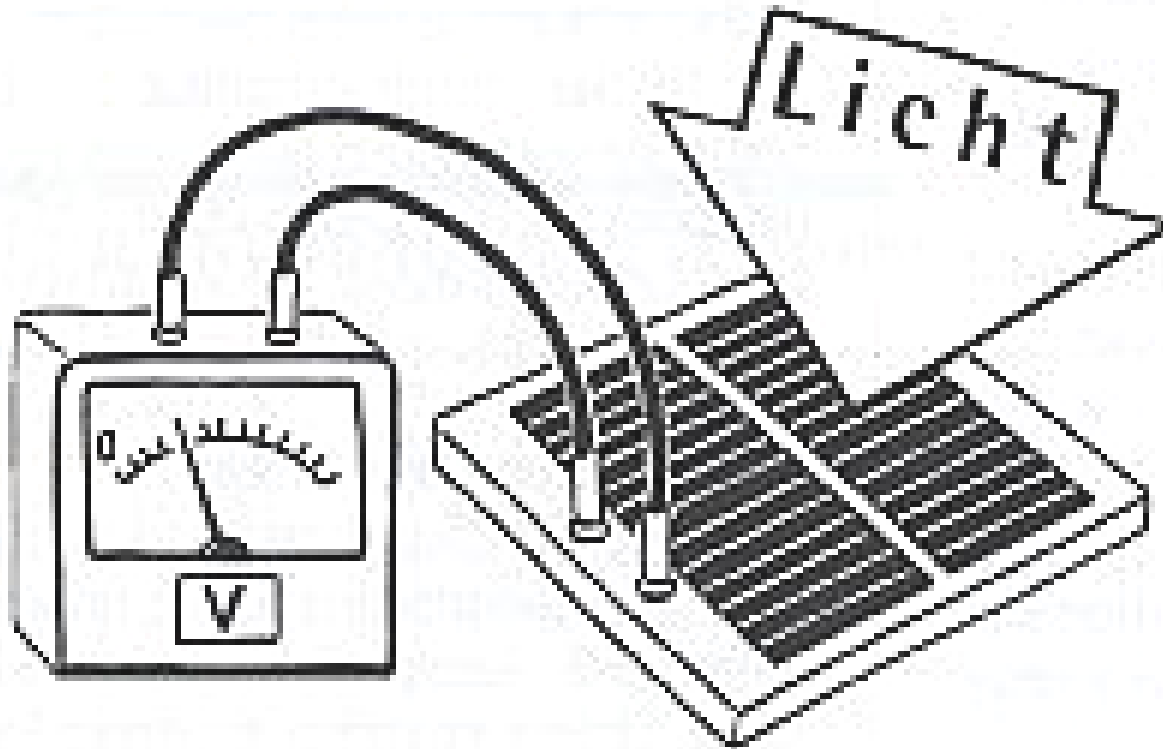


Is it...  
a flat panel..  
or a photovoltaic cell ?

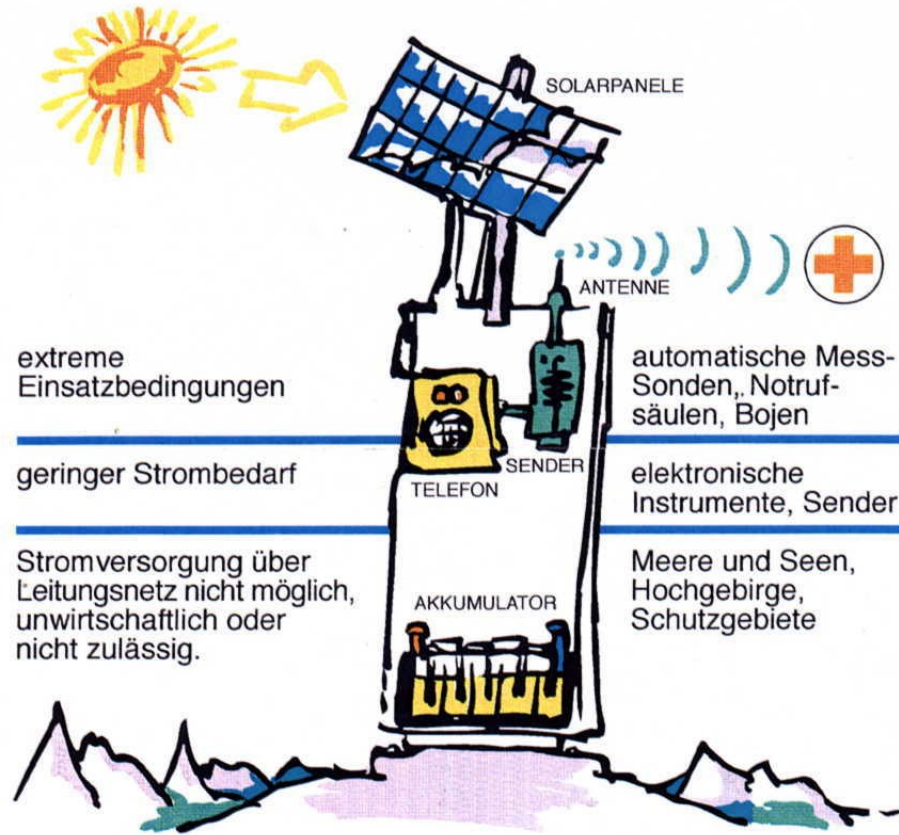
Use the Sun s Power directly !

# Photoelement

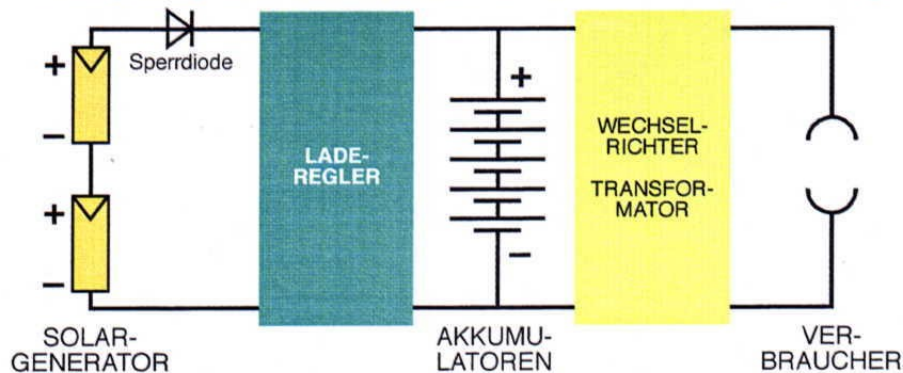
A. E. Becquerel 1839, Willoughby Smith 1873,  
R. E. Day/W. G. Adams 1875



Usual about 0,5 V per cell



Aufbauprinzip einer solartechnischen Stromversorgungsanlage

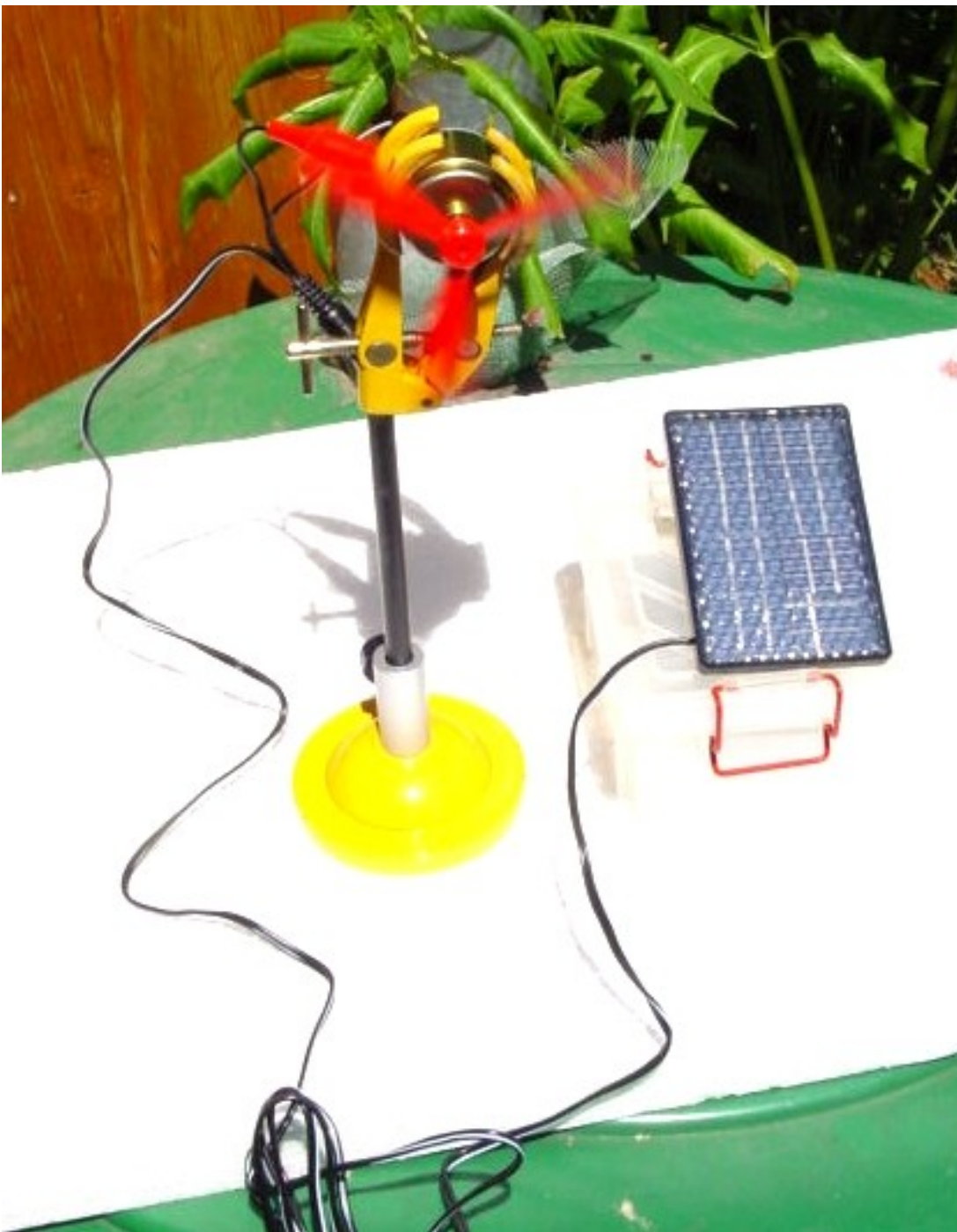


What s run by photovoltaic ?

Mostly where it is used ?

Under which conditions it is used ?

**The principle of photovoltaic supply !**



Solar Cell:

$U = 0,55 \text{ V}$  and

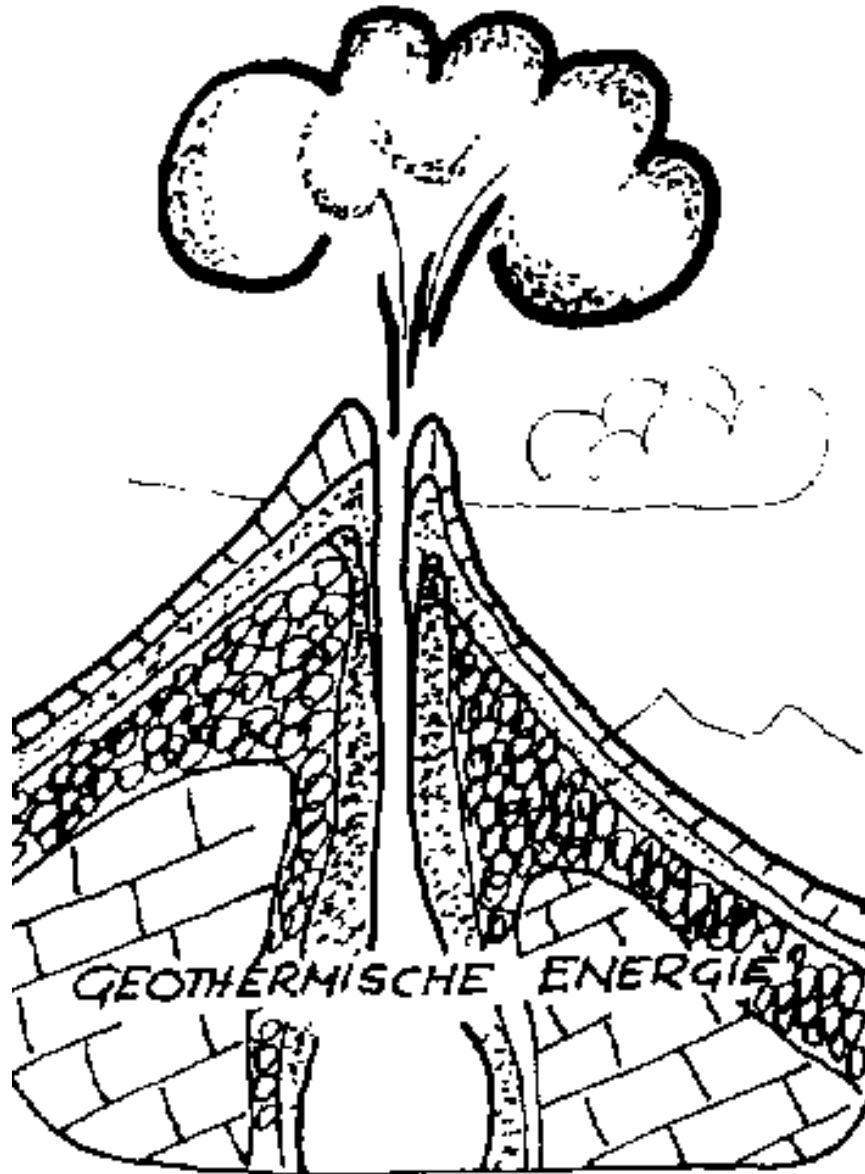
$I \sim 100 \text{ mA}$ .

Engine starts with

$U = 0,2 \text{ V}$  and

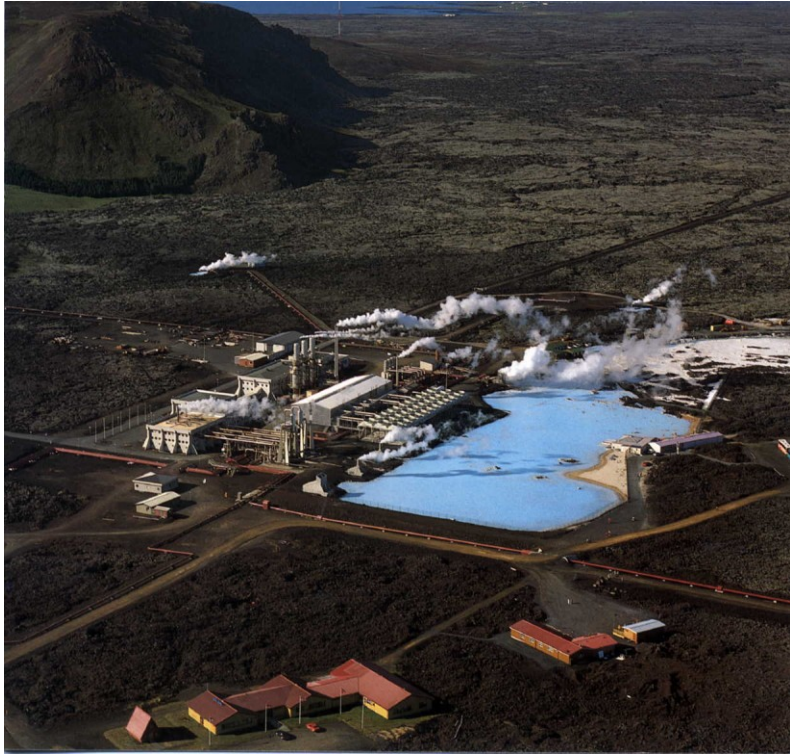
$P = 40 \text{ mW}$ .





The deeper the warmer.....  
Iceland has it s advantages.

Iceland s hot spots !  
In Austria:  
Heat pumps  
Hot dwells for bath !

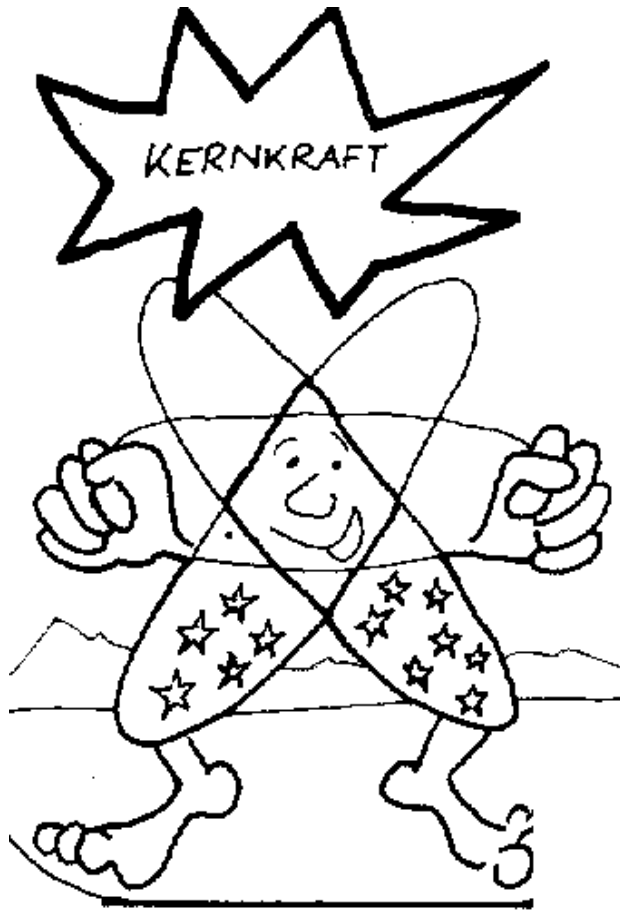


**Iceland**



**Hawai**





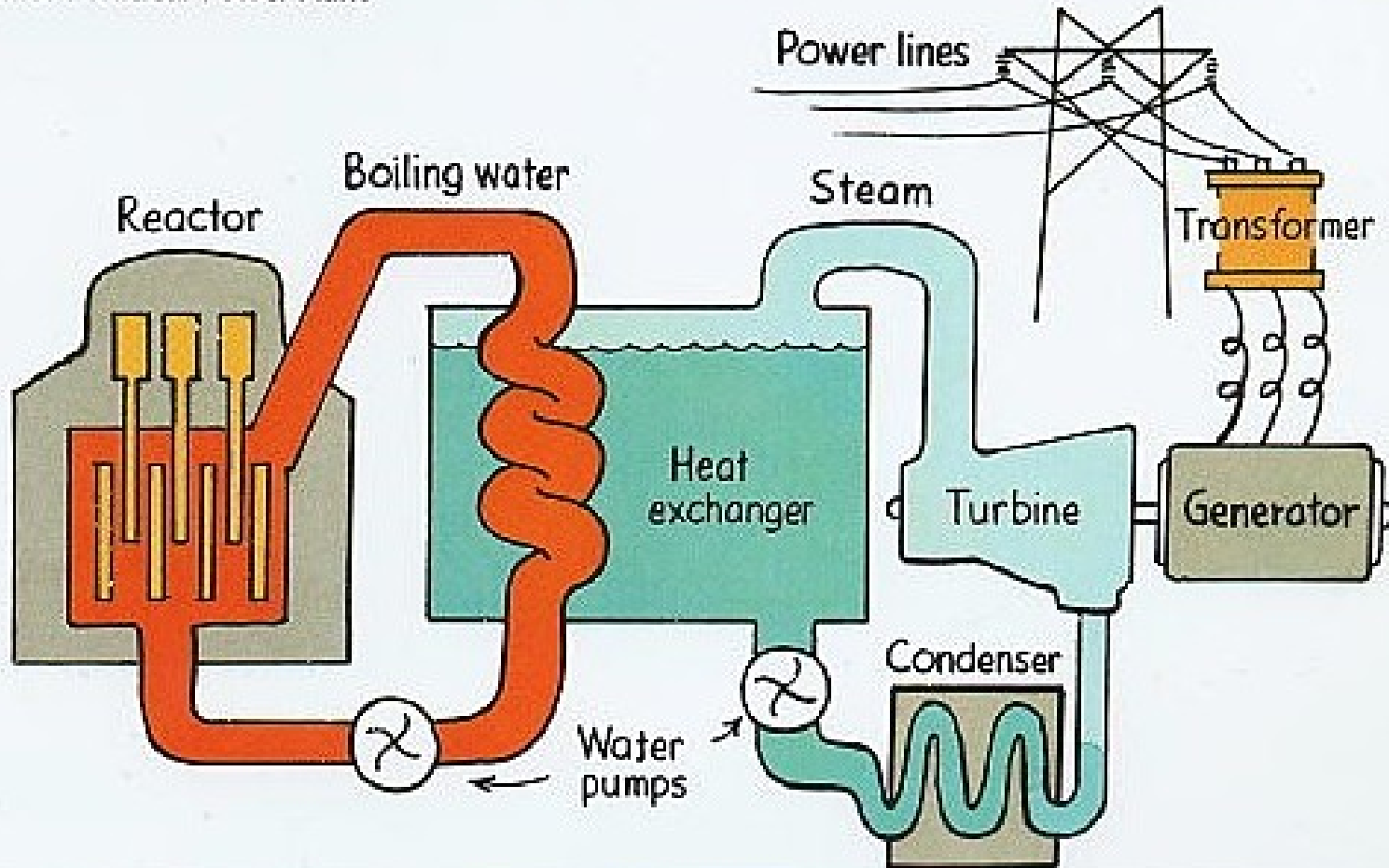
Much energetic density,  
Greenhouse-effect only during the  
Construction....and the Breakdown

Dangerous ?  
Radioactivity ?  
Radioactive waste ?

All clear ?

Then describe for pupils !

System of a Nuclear Power Plant



This is Petru Stiucas work (Suceava) !  
Explain to the children !

**This is by far not all !**

**This never can be complete !**

**But we wanted to tell a story !**

**All the best to you, Ingrid and Hans**