ترمودینامیک

Thermodynamics

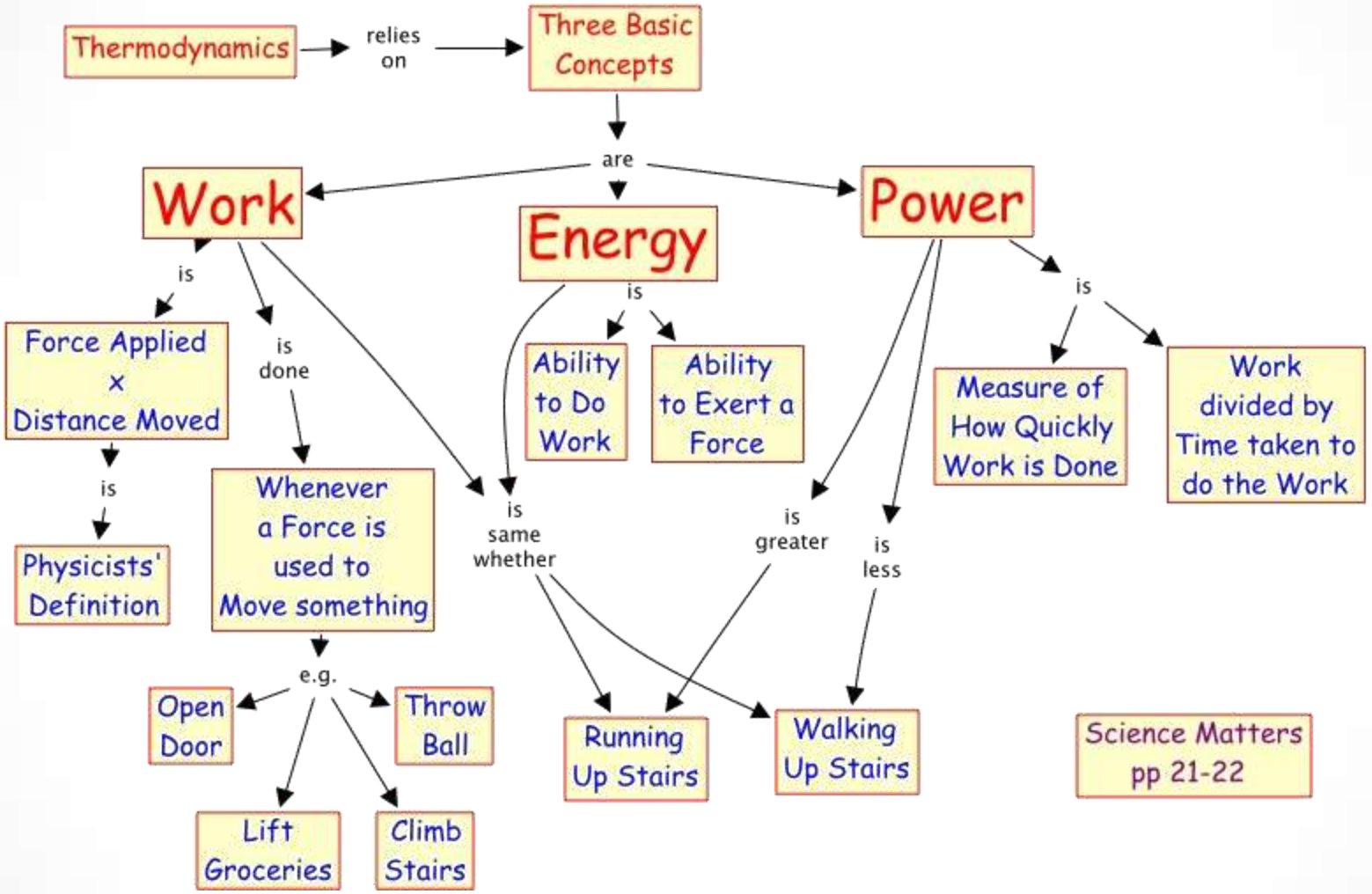
کاربردها

Applications

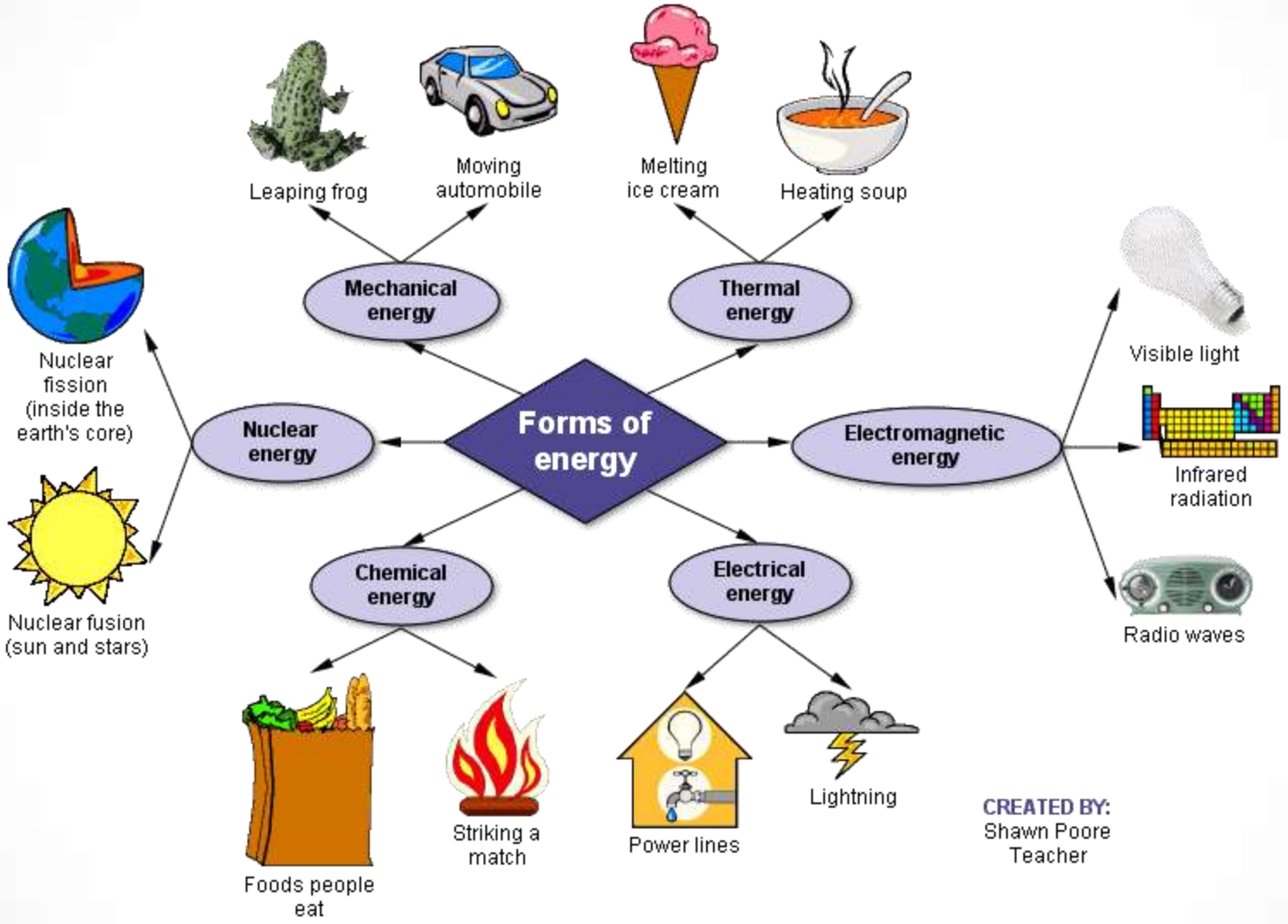
What is Thermodynamics?

- Thermodynamics is a branch of physics which deals with the energy and work of a system.
- It was born in the 19th century as scientists were first discovering how to build and operate steam engines.
- Thermodynamics deals only with the large scale response of a system which we can observe and measure in experiments.
- Small scale gas interactions are described by the kinetic theory of gases.
- The methods complement each other; some principles are more easily understood in terms of thermodynamics and some principles are more easily explained by kinetic theory.

Thermodynamics Concepts

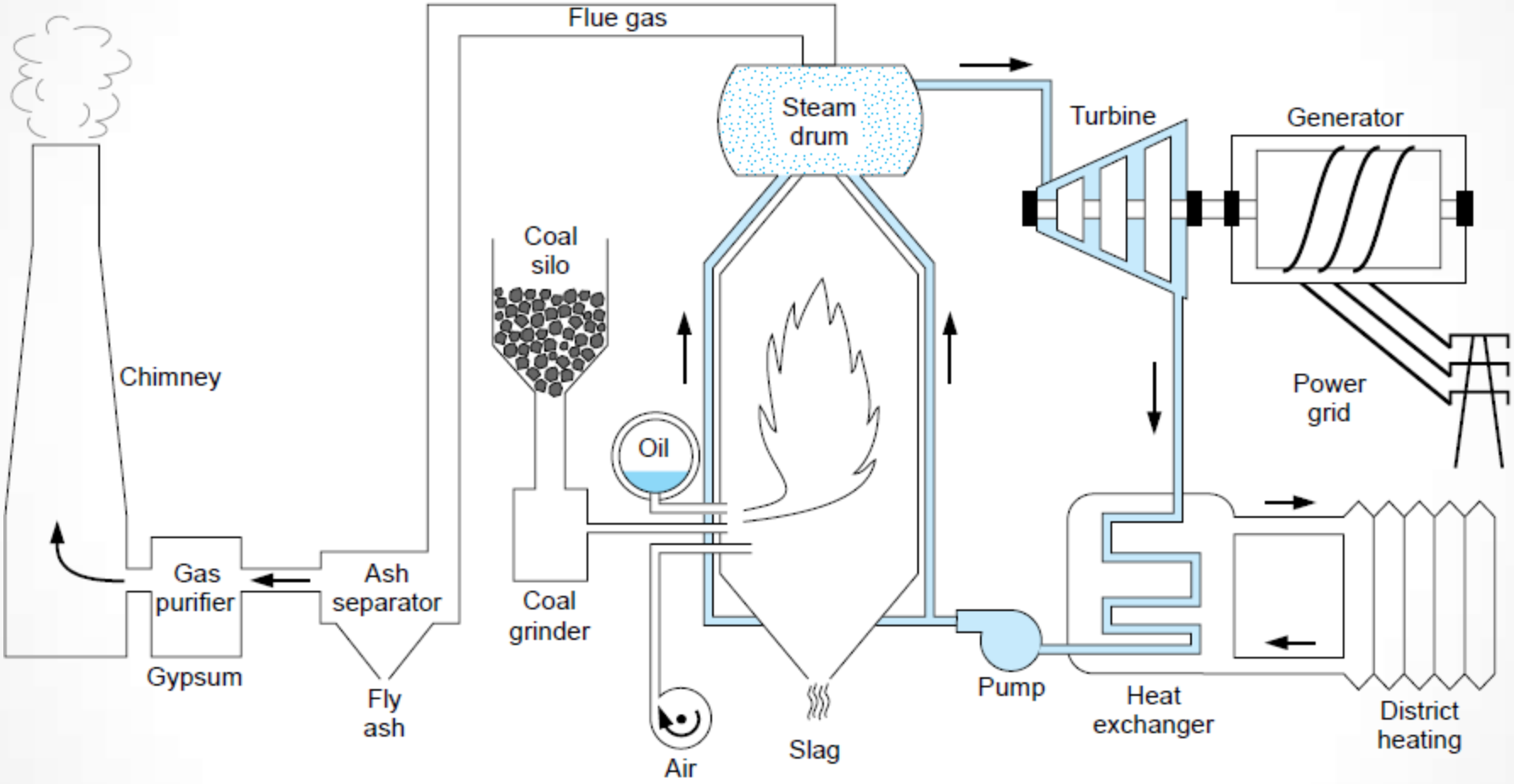


Thermodynamics Concepts



- **Work**- equal to the constant force exerted on an object in the direction of motion times the object's displacement
- **Energy**- the ability of an object to produce change in itself or the world around it
- **Kinetic energy**- equal to 1/2 times the mass of an object multiplied by the velocity of an object squared
- **Joule**- unit of energy equal to a Newton times a meter
- **Power**- equal to work done divided by the time it takes to do the work
- **Watt**- unit of power equal to 1 Joule/1 second
- **Rotational kinetic energy**- equal to 1/2 times the moment of inertia of the object times the rotational velocity squared
- **Gravitational potential energy**- equal to the product of its mass, the acceleration due to gravity, and the distance from the reference level
- **Reference level**- the position where potential energy is defined to be zero
- **Elastic potential energy**- stored energy is an object with tension or elastic qualities
- **Law of conservation of energy**- in a closed system, energy can not be created or destroyed
- **Mechanical energy**- sum of kinetic energy and gravitational potential energy of a system
- **Thermal energy**- heat energy
- **Elastic collision**- collision in which kinetic energy does not change
- **Inelastic collision**- collision in which kinetics energy increases

Applications

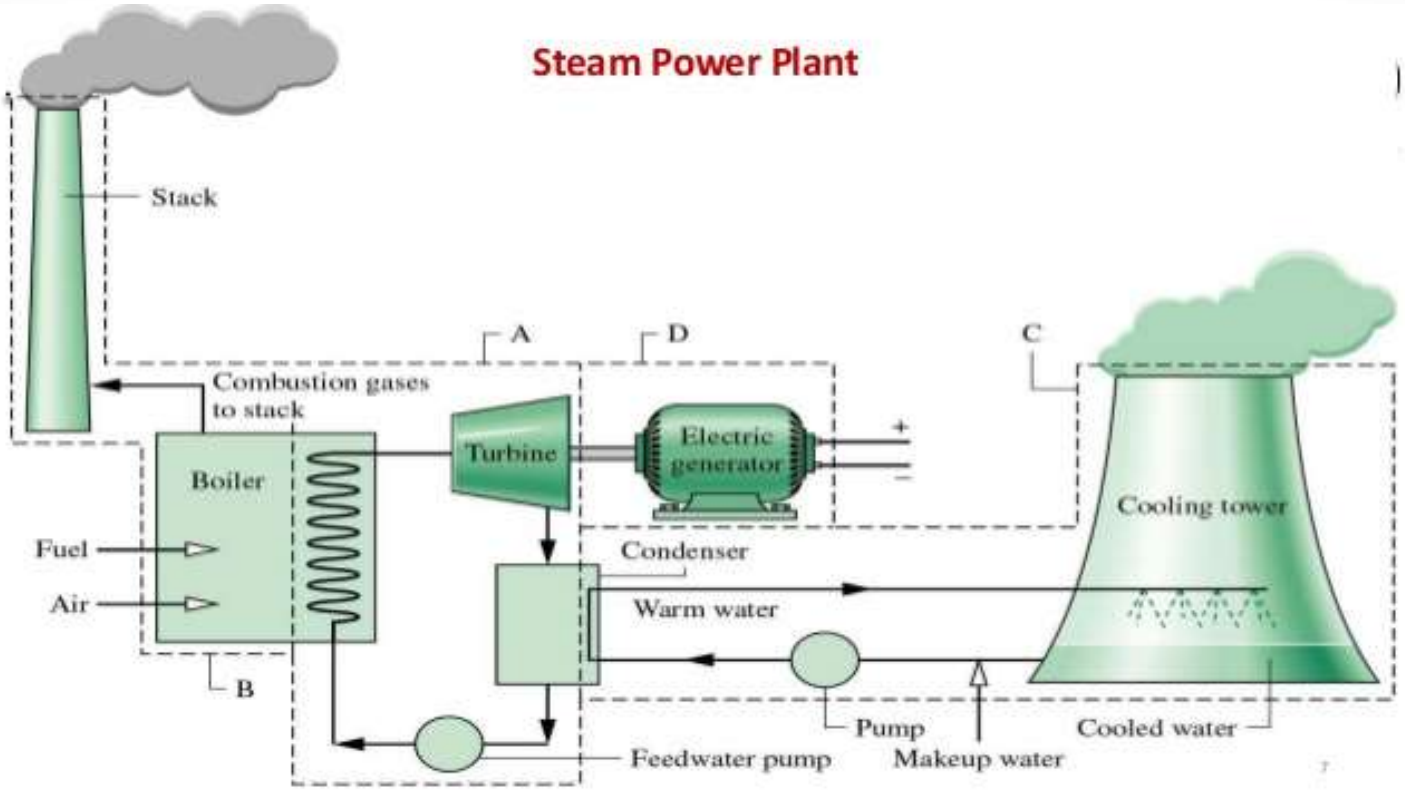


Schematic diagram of a steam power plant

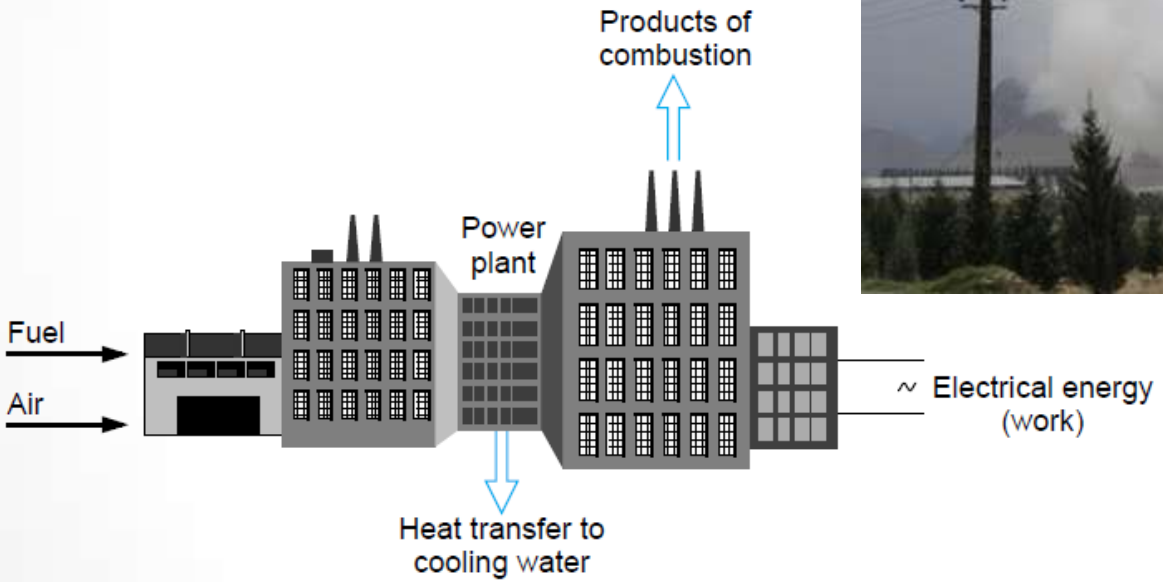
Applications

The Esbjerg, Denmark, power station

Applications

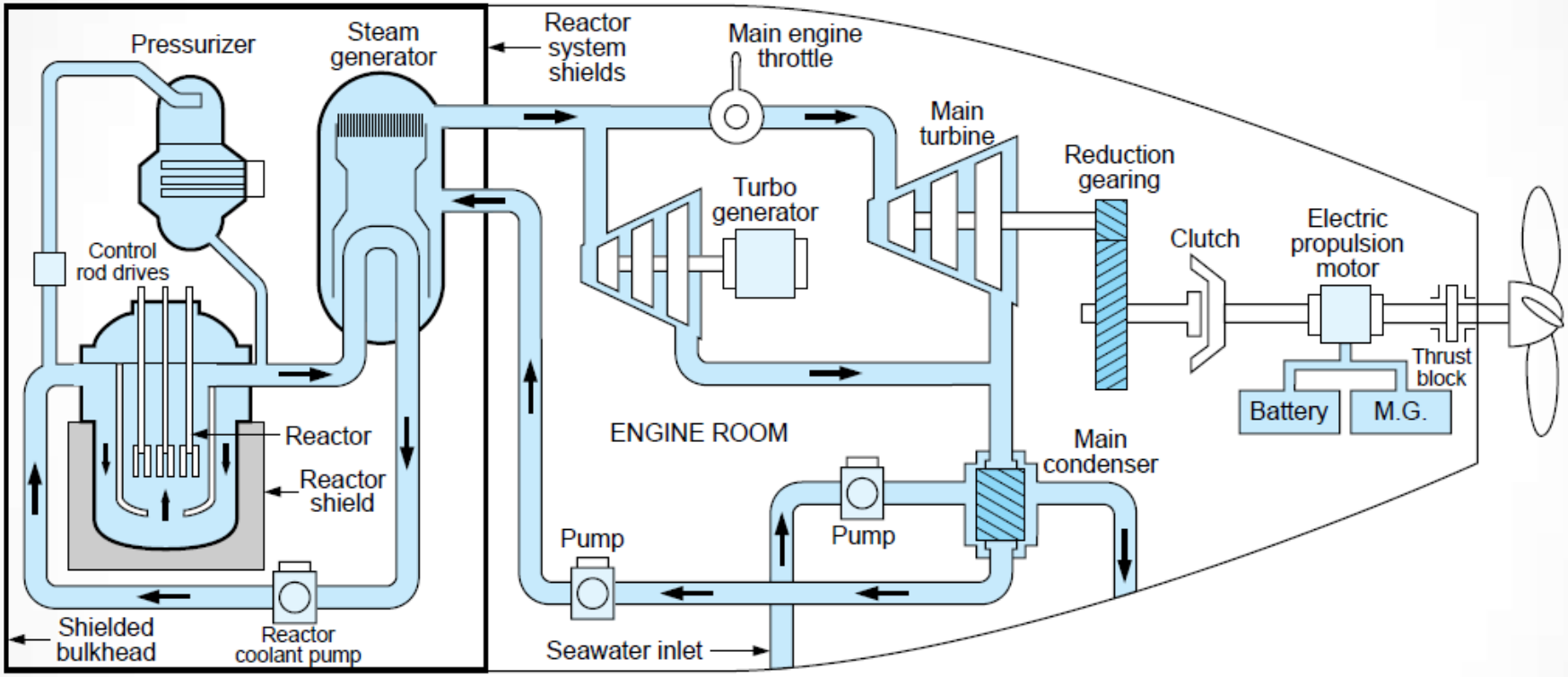


Applications



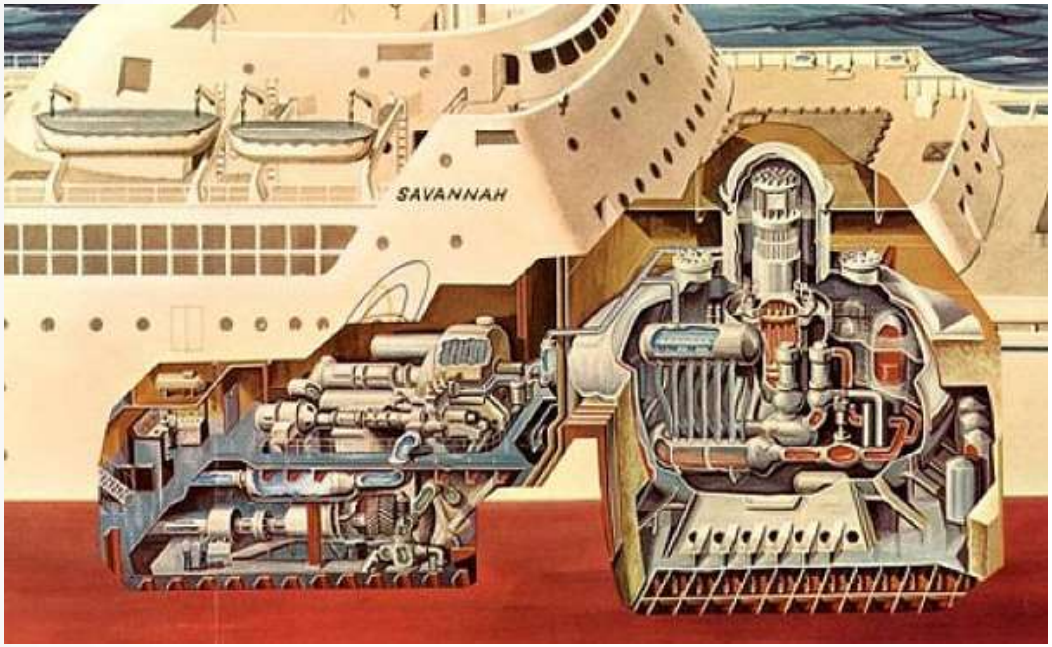
Schematic diagram of a power plant.

Applications



Schematic diagram of a shipboard nuclear propulsion system.

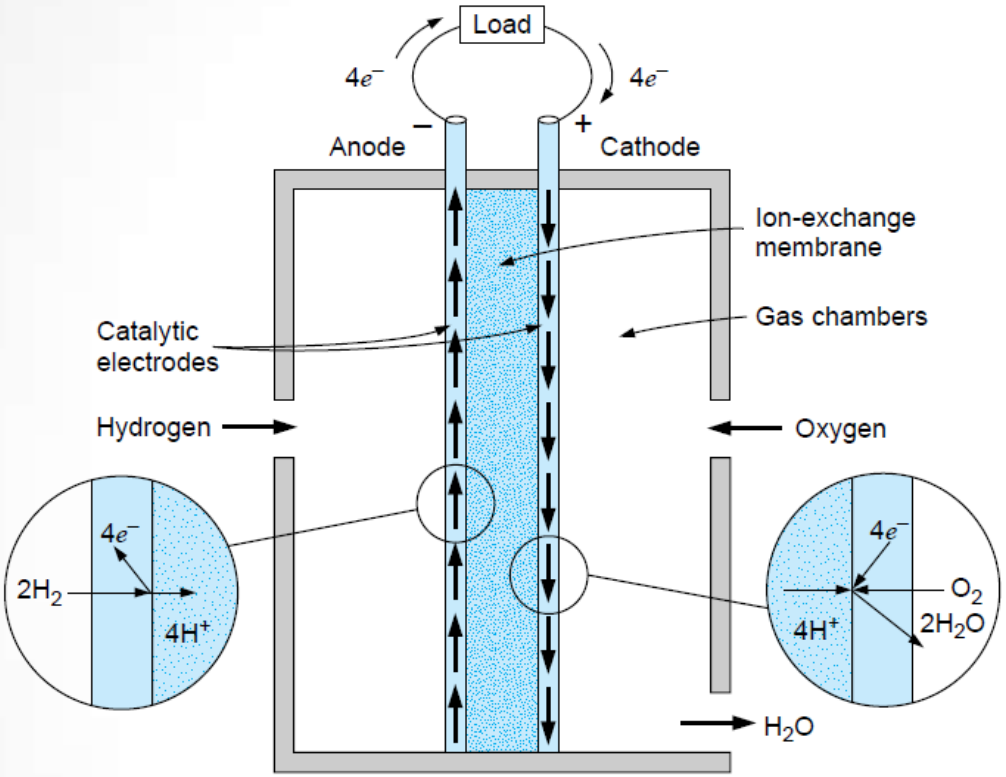
Applications



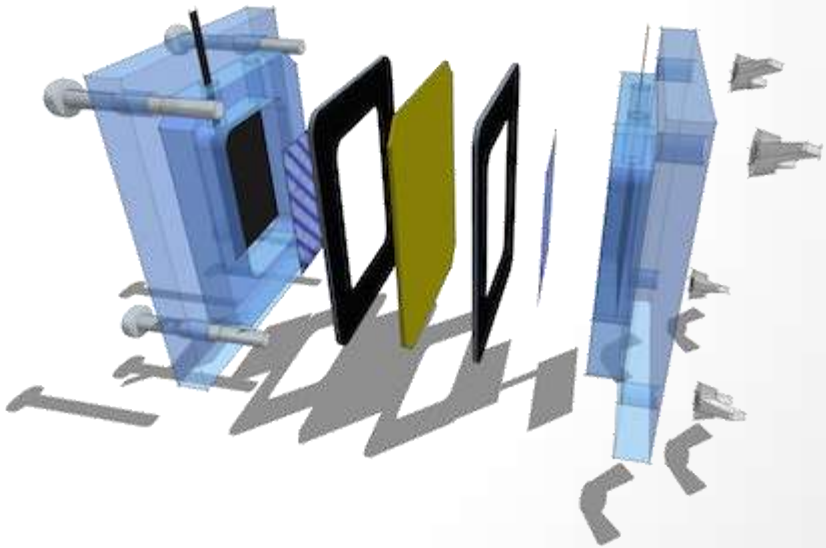
Nimitz-class supercarriers

USS Enterprise

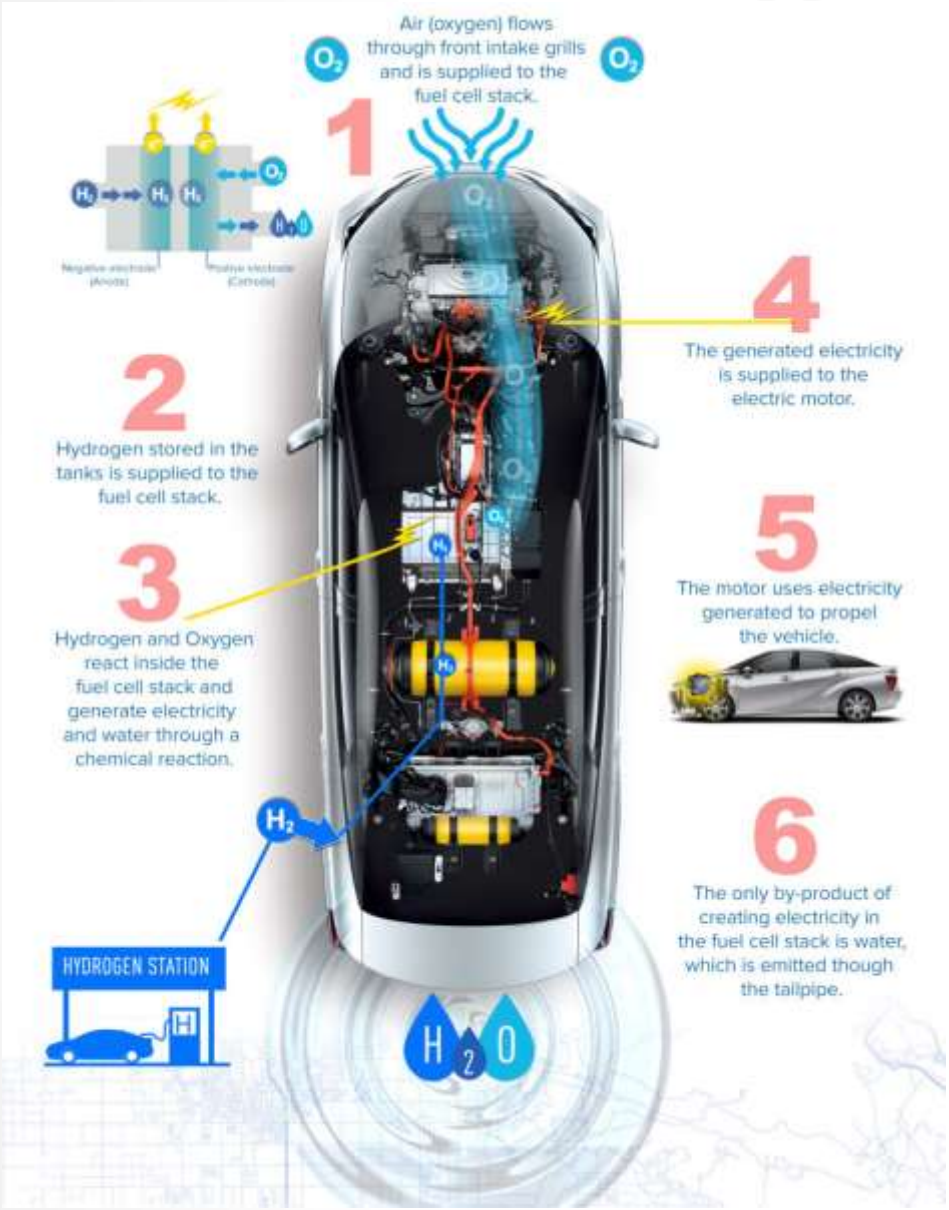
Applications



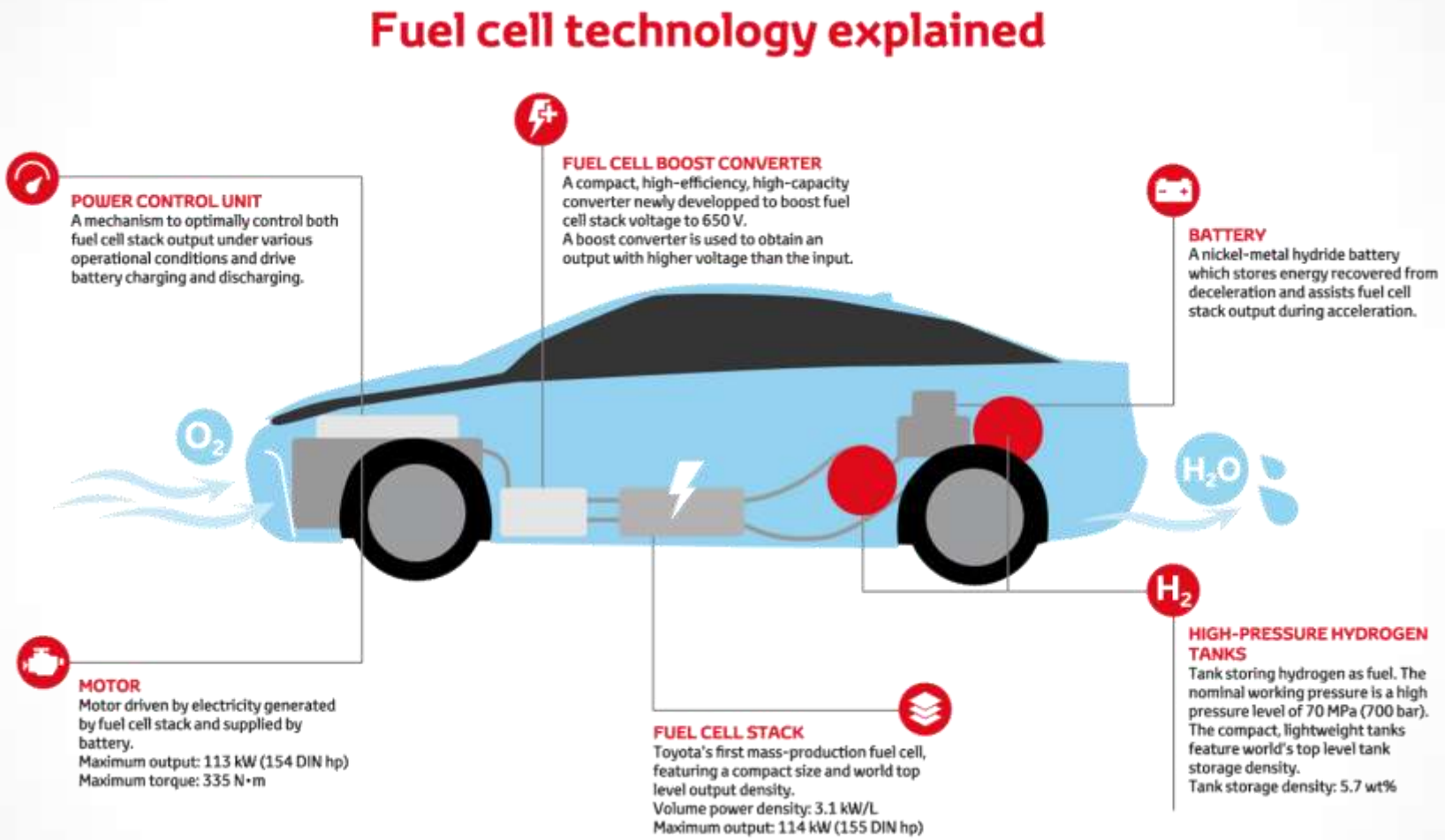
Schematic arrangement of an ion-exchange membrane type of fuel cell.



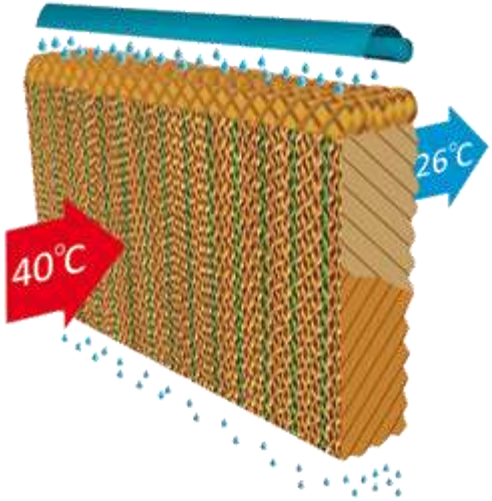
Applications



Applications



Applications



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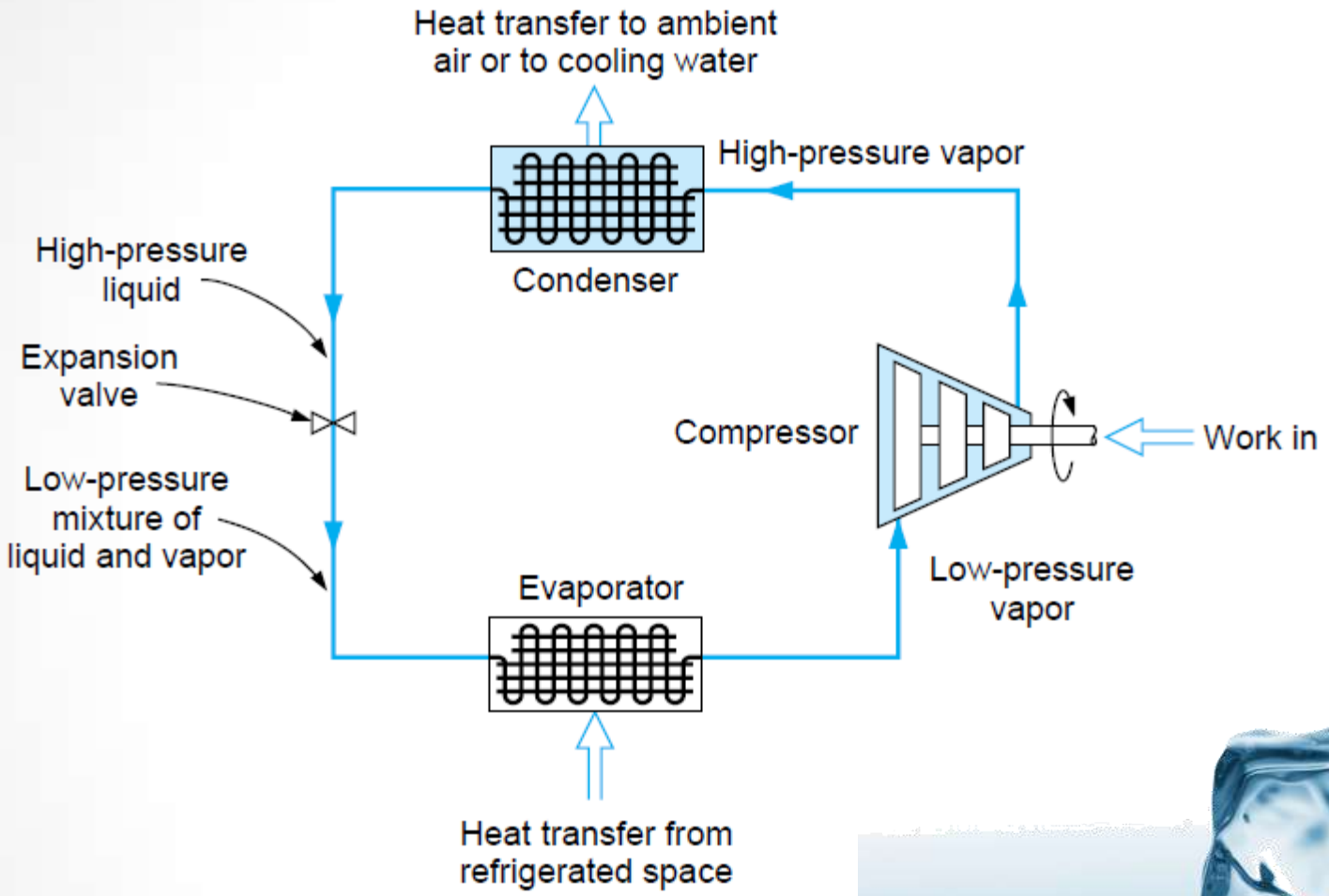
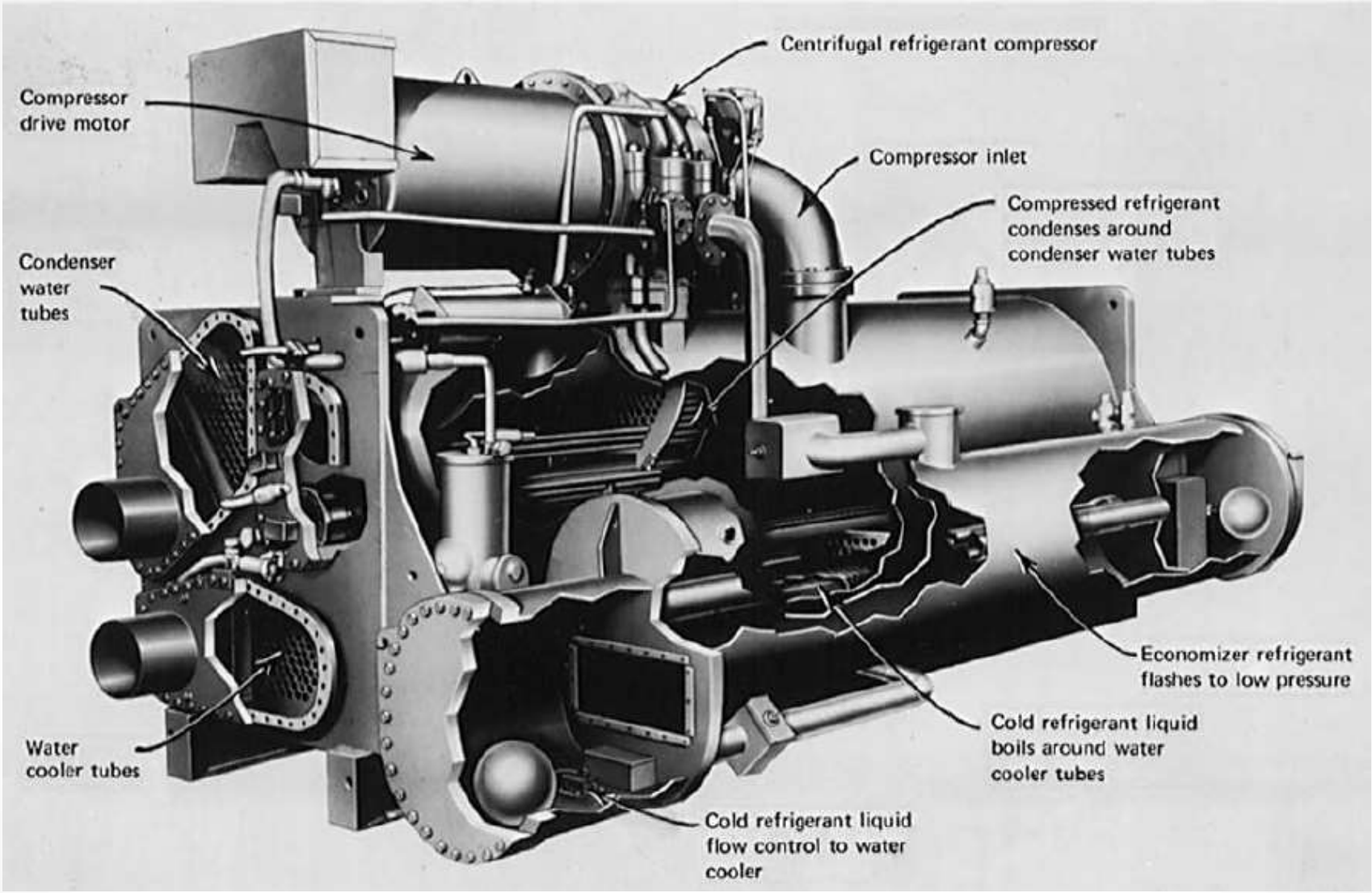


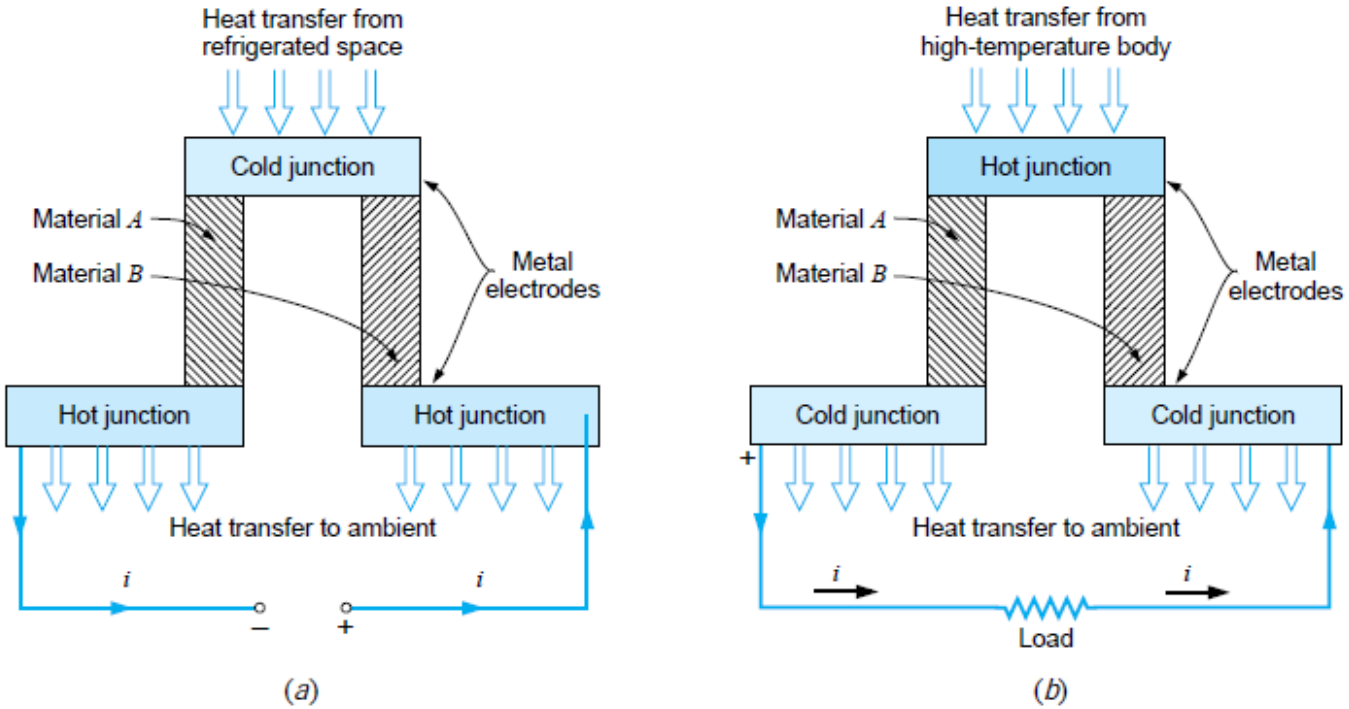
Schematic diagram of a simple refrigeration cycle.

Applications



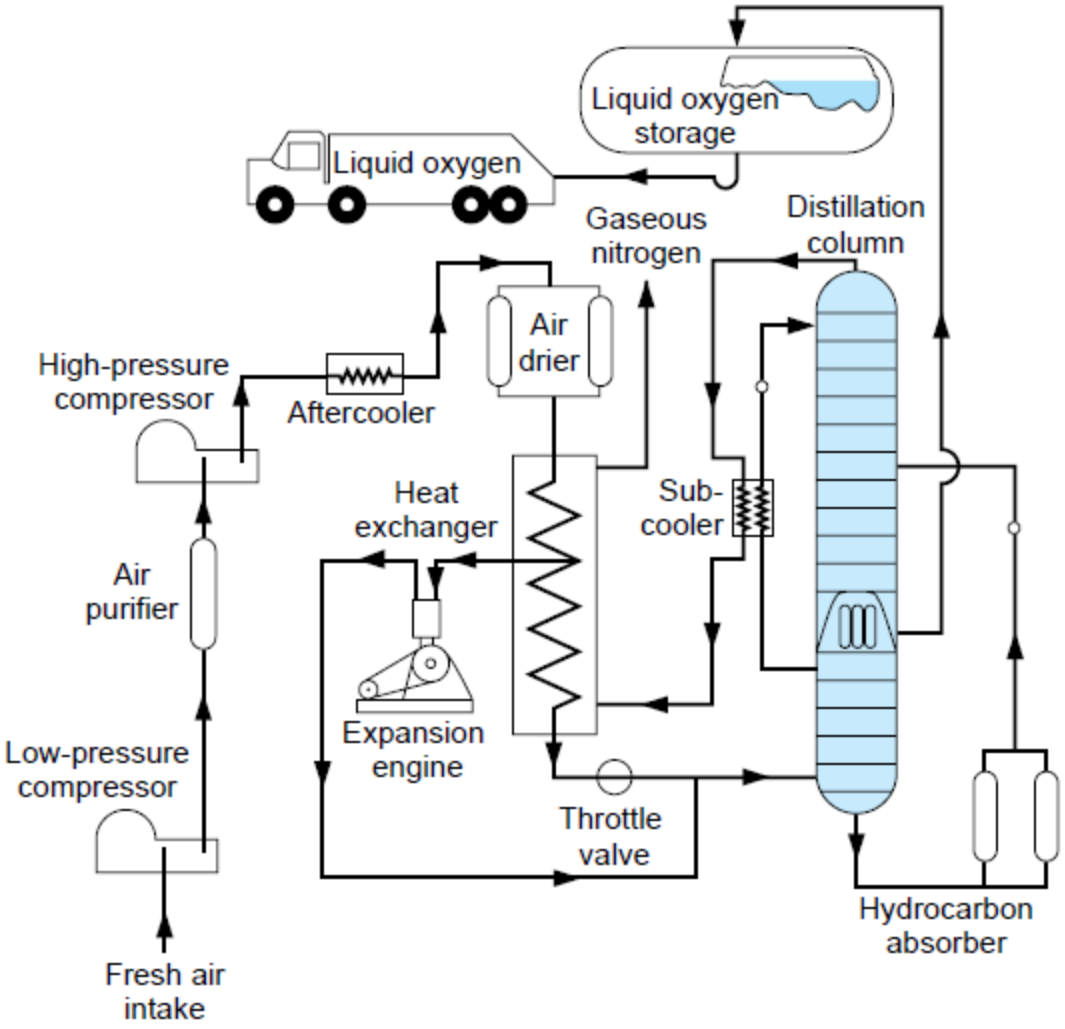
A refrigeration unit for an air-conditioning system.

Applications



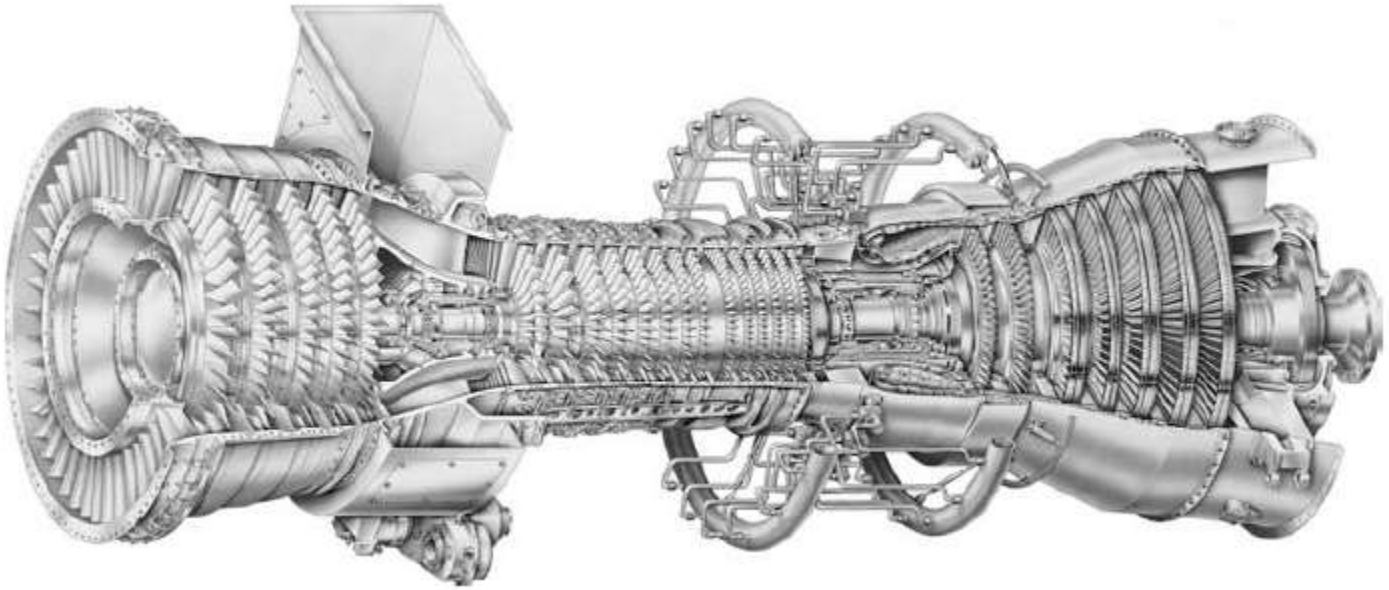
(*a*) A thermoelectric refrigerator. (*b*) A thermoelectric power generation device.

Applications



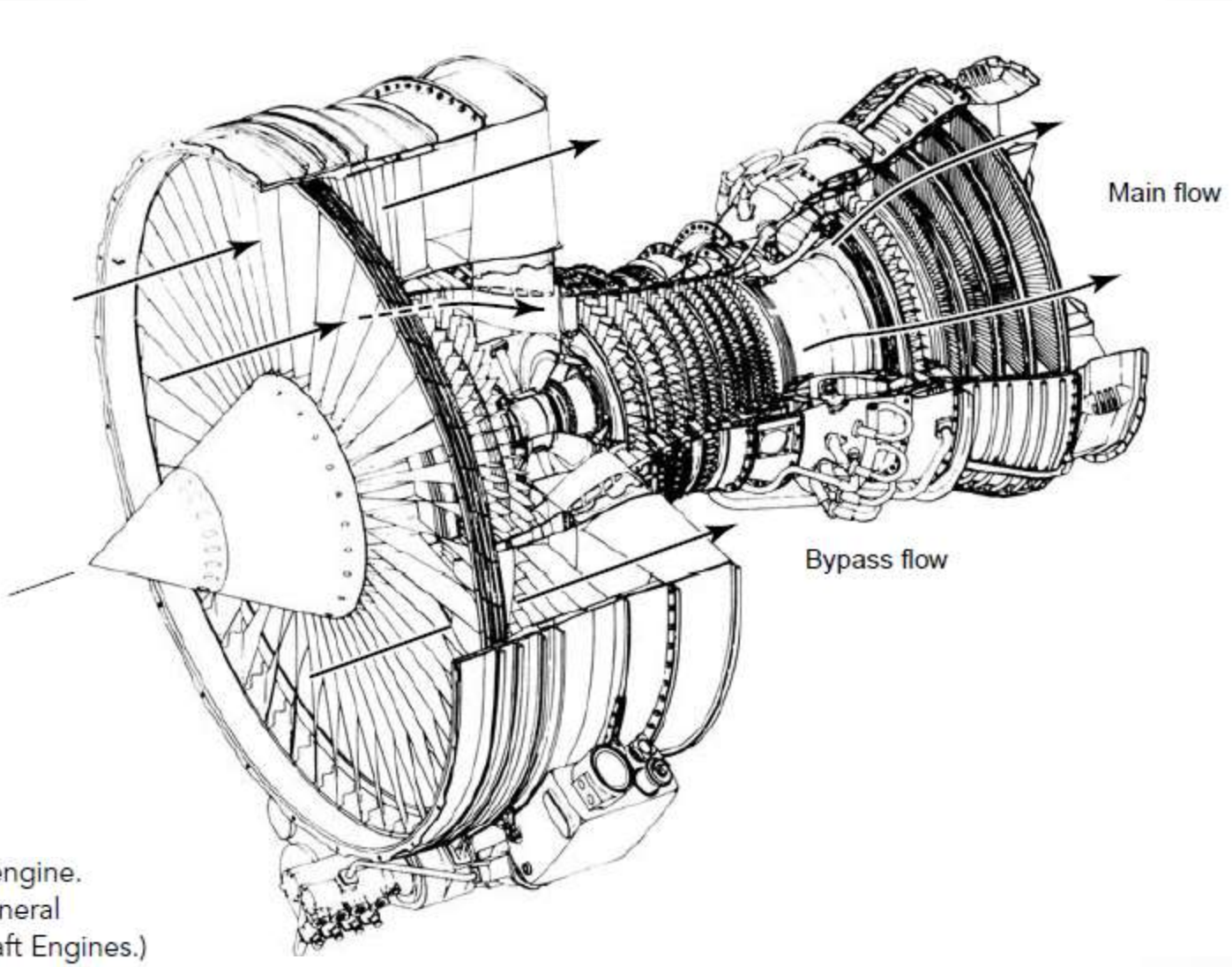
simplified diagram of a liquid oxygen plant.

Applications



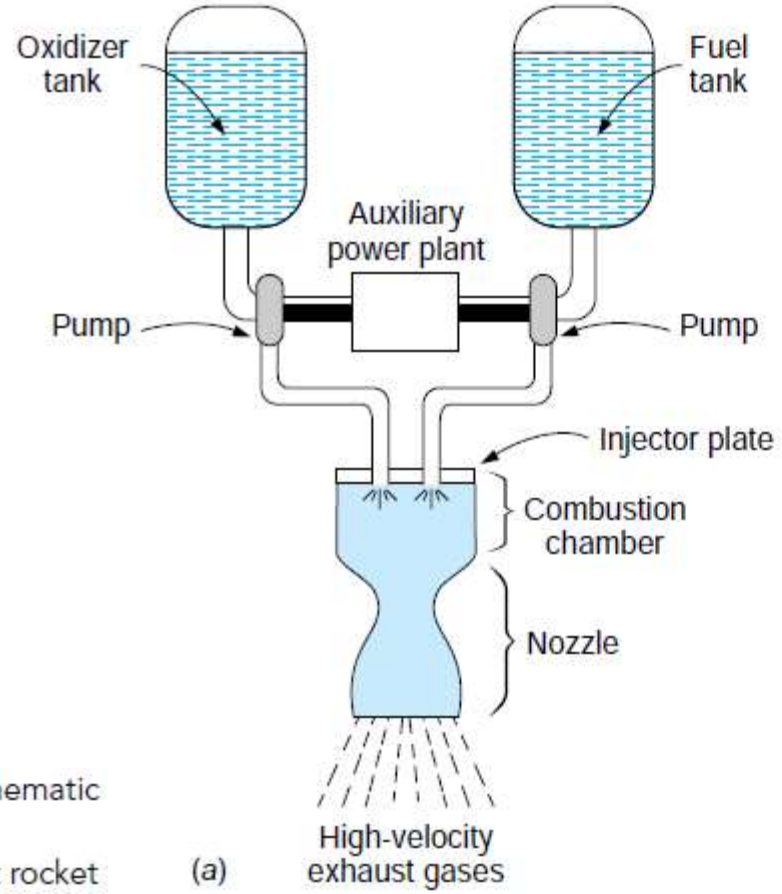
43 MW gas turbine.
(Courtesy General
Electric Corporation.)

Applications



turbofan jet engine.
(Courtesy General
Electric Aircraft Engines.)

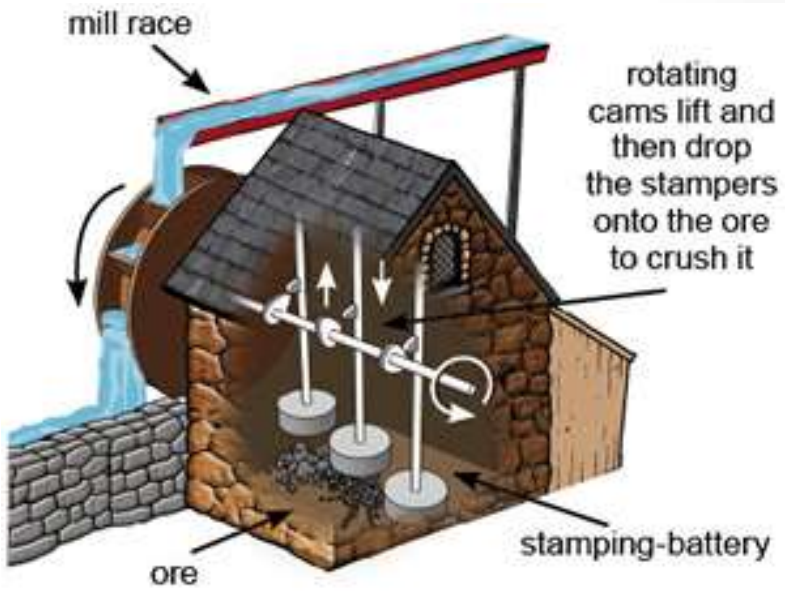
Applications



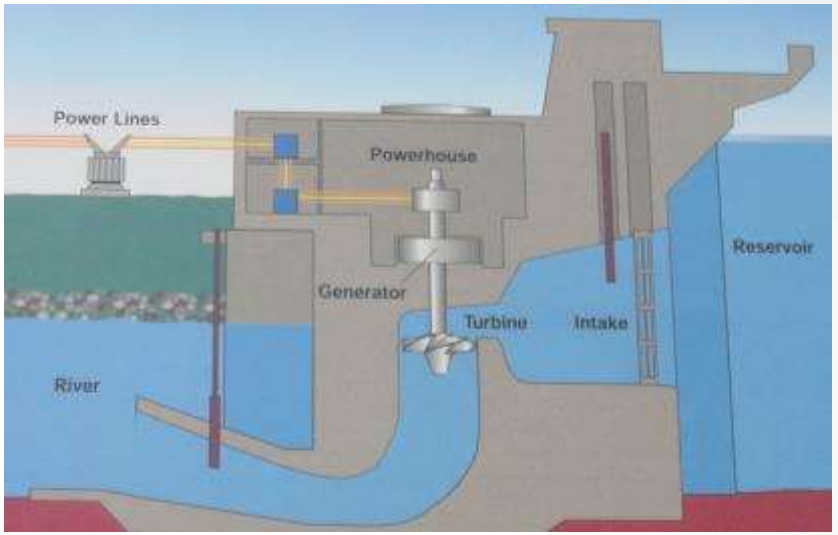

(b)

(a) Simplified schematic diagram of a liquid-propellant rocket engine. (b) Photo of the NASA space shuttle's main engine.

Water wheel

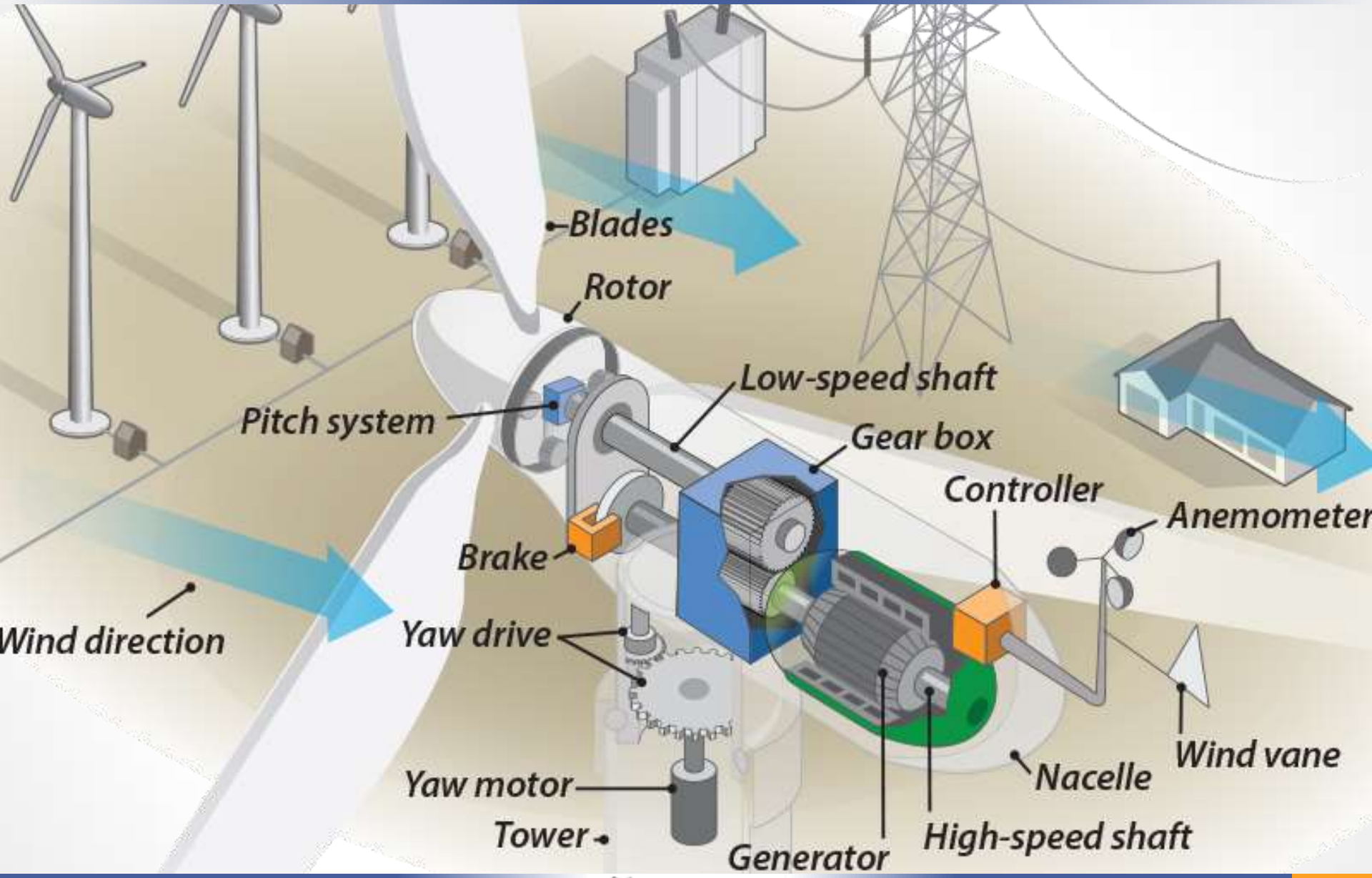

mill race
rotating cams lift and then drop the stampers onto the ore to crush it
stamping-battery
ore

Water turbine



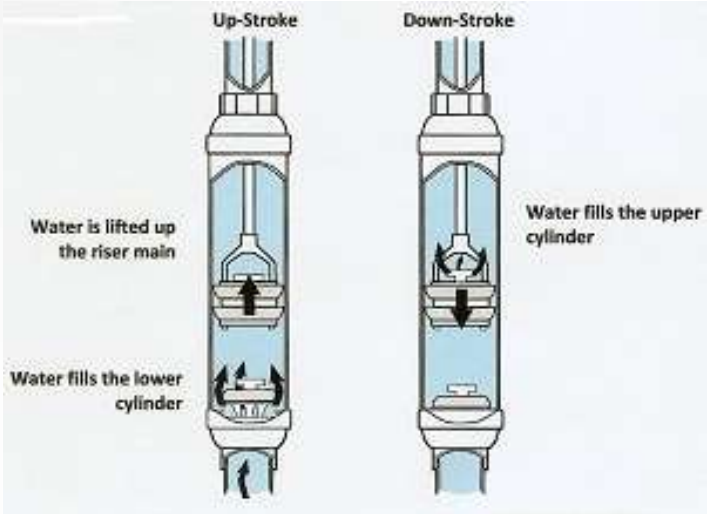
Windmill

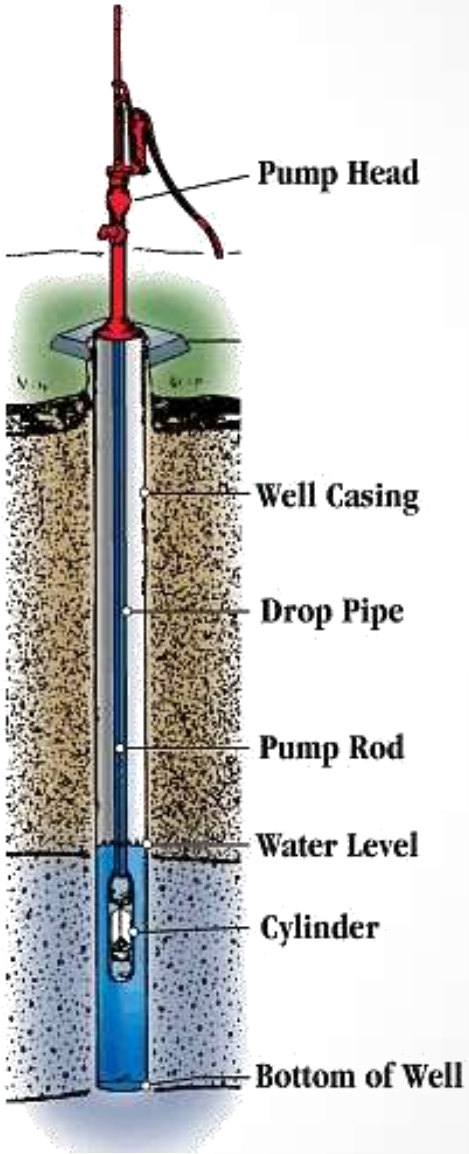
Wind turbine



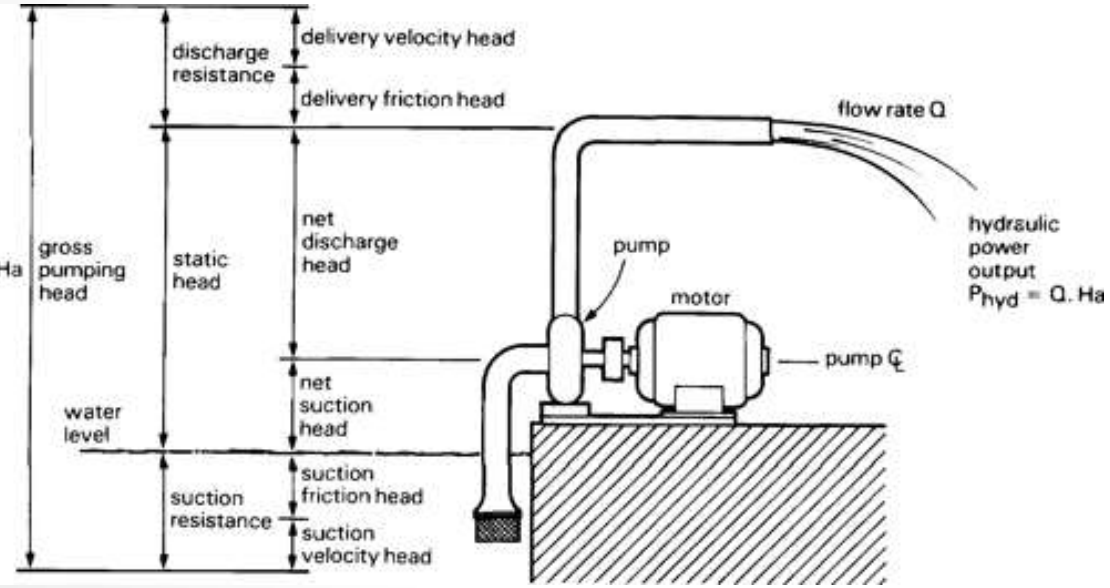
Wind energy

Hand pump


Up-Stroke
Down-Stroke
Water is lifted up the riser main
Water fills the upper cylinder
Water fills the lower cylinder

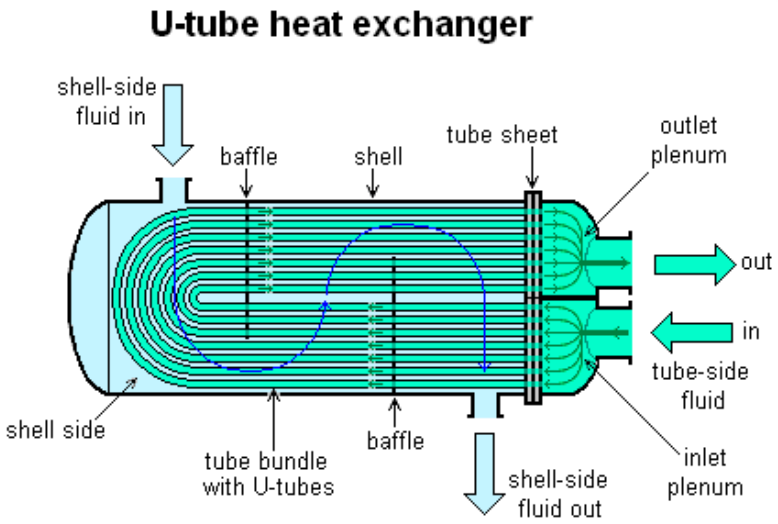

Pump Head
Well Casing
Drop Pipe
Pump Rod
Water Level
Cylinder
Bottom of Well

Motor pump


discharge resistance
delivery velocity head
delivery friction head
flow rate Q
hydraulic power output
$P_{hyd} = Q.Ha$
net discharge head
gross pumping head
Ha
static head
pump
motor
pump ℄
net suction head
water level
suction friction head
suction resistance
suction velocity head

Piping

Heat exchanging

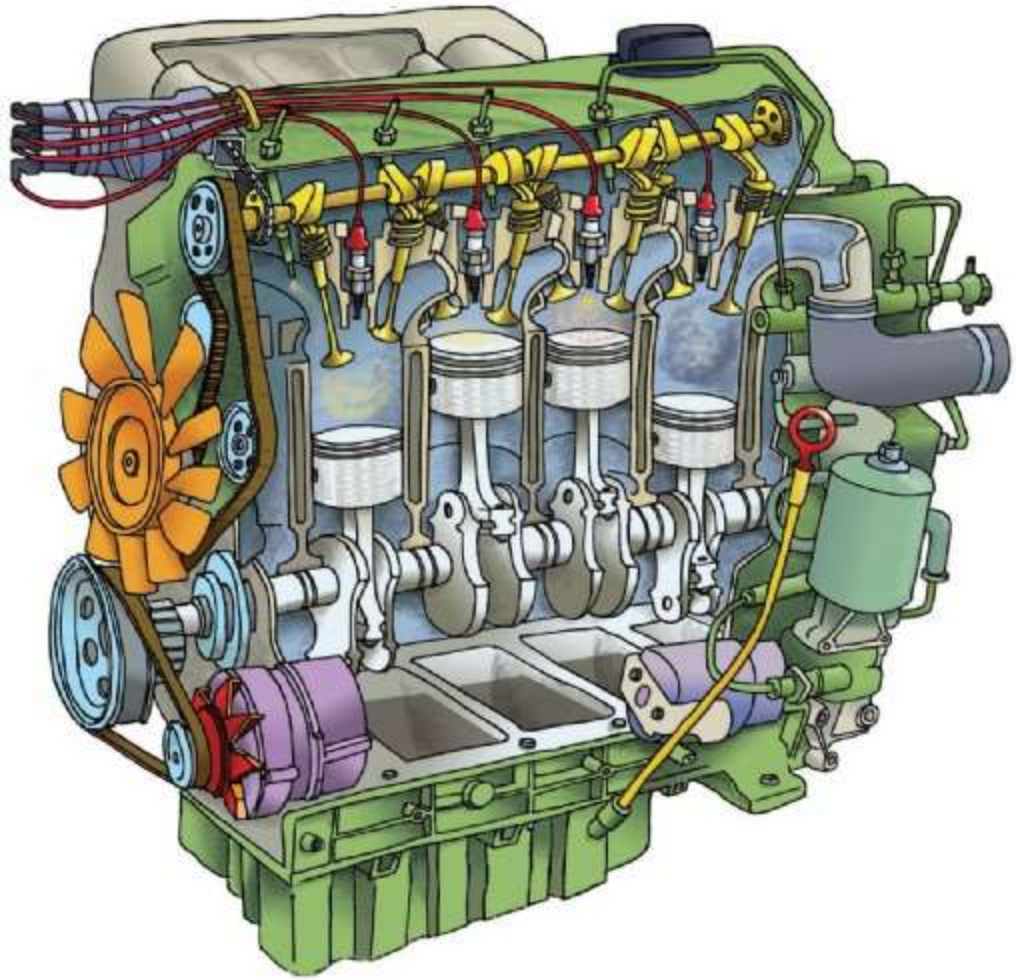


Internal view of liquid-to-liquid brazed plate heat exchanger

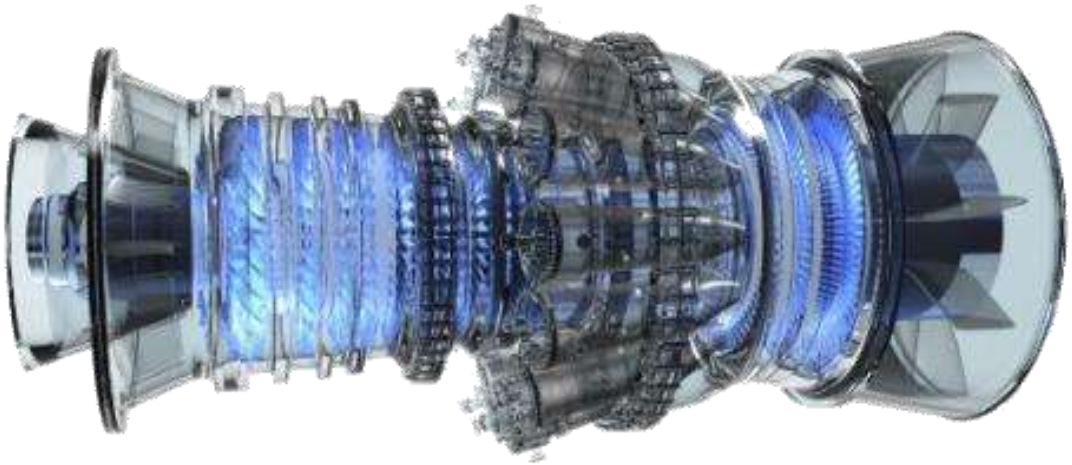
Heat, Ventilation and Air Conditioning (HVAC)

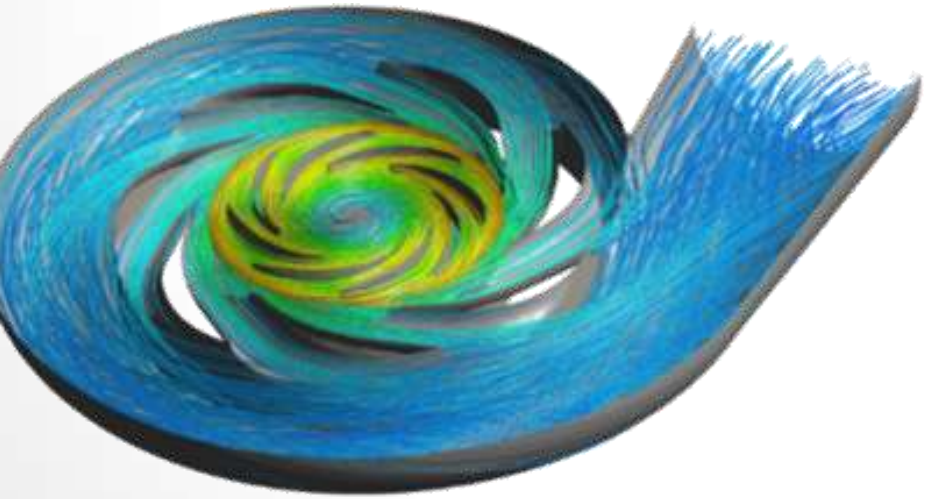
Thrust

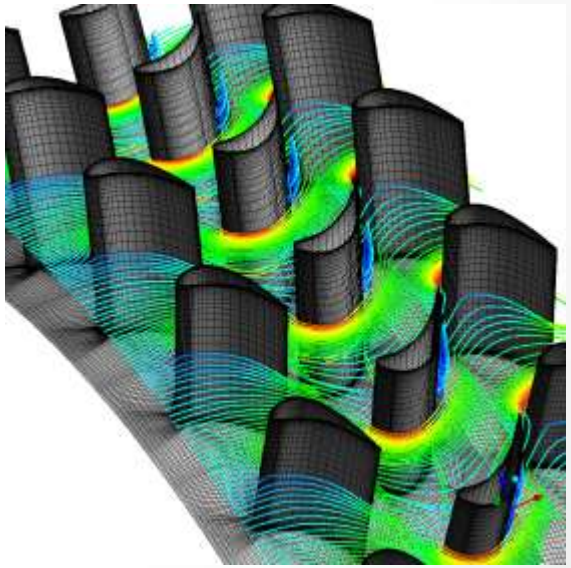
Internal combustion engines



Turbo machinery







A simple mistake: Mars Climate Orbiter

- On September 23, 1999, communication with the spacecraft was lost as the spacecraft went into orbital insertion, due to ground-based computer software which produced output in non-SI units of pound-seconds (lbf s) instead of the SI units of newton-seconds (N s) specified in the contract between NASA and Lockheed. The spacecraft encountered Mars on a trajectory that brought it too close to the planet, causing it to pass through the upper atmosphere and disintegrate.

Mars Climate Orbiter