

Welcome to the Wonderful World of Cryogenics

HITT student response system

I am a:

- A. Physics Major
- B. Physics Graduate Student
- C. Engineering Student (Grad or Undergrad)
- D. Otherwise engaged

Milestones in Civilization from the Cryogenic point of View Class of 2007

Antoine Laurent Lavoisier



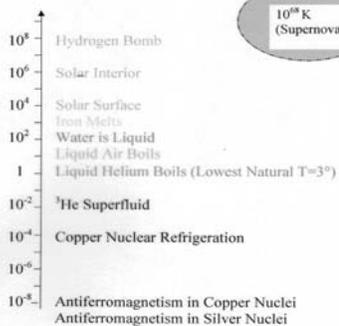
Antoine Laurent Lavoisier, 1743-1794, a portrait by David. (Photo: Roger Vadim)

1743-1794

Father of Low Temperature Physics

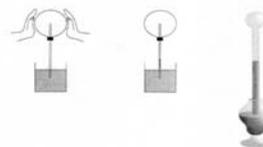


Temperature (K)



10^{10} K
(Supernova)

Galileo's Air Thermoscope



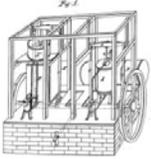
Galileo's Thermoscope. The thermoscope was first invented by Galileo. He put air in the flask and the liquid in the tube. The liquid in the tube rises or falls as the temperature of the air in the flask changes.

Push the tube into the stopper so that the tube extends about half way into the flask. The flask is then inverted into a beaker of colored water and heated by rubbing your hands together and then holding the flask. As the flask returns to room temperature, the liquid will rise in the tube.

What are the problems with this design?

Refrigeration

1850



Ferdinand Carre -developed successful Ice Business

Ice comes from....

From the Simpsons' featuring the cultivation of ice from the North Pole. When the ice deliveryman arrives at the Quik - E - Mart with his cargo, he says to Apu, "you've got to start charging more than a dollar a bag. We lost four more men on this expedition!" to which Apu replies, "If you can think of a better way to get ice I'd like to hear it."

"If the ice crop was poor, the price rose to the exorbitant rate of \$1.25 a pound." In today's dollar this price corresponds to over \$150 for a typical 3lb bag of ice (3).

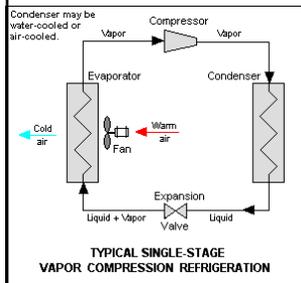
Then



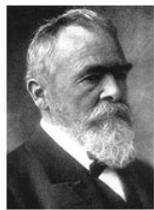
Now



Cold Beer



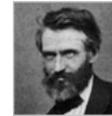
1873



Carl von Linde

dimethyl ether refrigerant--made Spatenbrau beer

LOX-1877

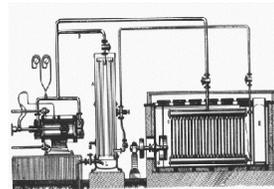


Louis Paul Cailletet (5)



Raoul Pictet (4)

French



Cailletet & Pictet's oxygen liquefaction process (5)



Space Shuttle Main Engine (1)



Fig. 3.1. Zygmunt Protowicz (1862-85) at the time of his studies in 1879.



Fig. 3.2. Karol Olszewski (1840-1912), self photograph.

Polish

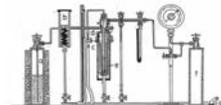


Fig. 3.3. Schematic apparatus by Protowicz and Olszewski (after ref. 10). A. bottle with liquid cylinder; B. condenser with Thomsen mixture; C. hydrogen (gold) thermometer; D. glass cylinder with liquid cylinder; E. thick-walled glass cylinder where oxygen is condensed; F. small cylinder with gaseous oxygen (= 40 atm).

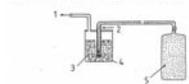


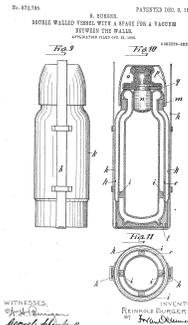
Fig. 3.4. Principle of operation of apparatus by Protowicz and Olszewski (after ref. 10). 1. condenser; 2. glass cylinder with condensed water; 3. hydrogen thermometer; 4. glass cylinder with liquid oxygen; 5. small high-pressure gaseous oxygen cylinder.

Dewar Flask

Jules Violle in 1882

Dewar's improvement in 1892?

Vacuum insulation and silvering



WITNESSES: [Signatures]



Father of Rocketry



Konstantin Tsiolkovsky 1903

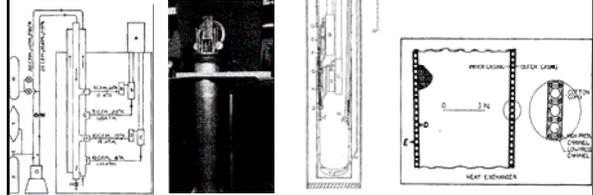
Identified LH_2 and LO_x as the respective fuel and oxidizer of choice, and also suggested use of multi-stage rockets

Liquefaction of helium - 1908

Kamerlingh Onne in Leiden

Joule-Thomson Effect

Samuel C. Collins - 1947



Gas Flow

Cryostat

cross-section

Heat exchanger

Blood Storage and Handling

In 1915, Dr. Richard Weil discovered that refrigeration in conjunction with citration (to prevent blood clotting) allowed for the storage of blood for several days. Until then, blood transfusions needed to be made directly from donor to recipient. Refrigerated "Precipitation" of blood also developed.

Cryogenics and Rocketry



Robert H. Goddard - 1926-41 feet



Wernher von Braun



V2 Rocket Herman Oberth



Freon Refrigerants

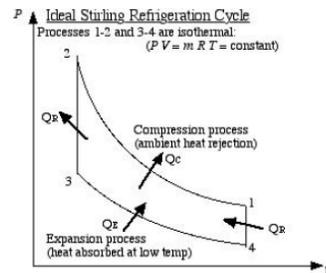
halogenated hydrocarbon

Formerly used toxic refrigerants included ammonia, butane, methyl chloride (or bromide), and sulfur dioxide

Charles Kettering and Thomas Middle invented the non-toxic freons in about 1935

Cryo-coolers

Based on Sterling engine, first introduced to cryogenics at 1956 Cryogenic Engineering Conference by J.W.L.Kohler



Satellites-1957



Cryonics

Basil Luyet published a work titled "Life and Death at Low Temperatures"

Cryogenics in Creating New Life

Cryo-preserve sperm, oocytes, and embryos



Maglev using Cryogenics

Meisner Effect

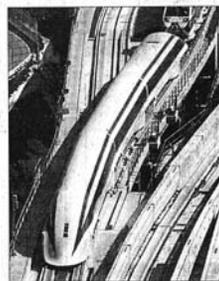


Mag-Lev 1997



World's fastest train reaches record speed
A Japanese magnetic levitation train has set a new world record for speed, reaching 560 kilometers per hour (348 miles per hour) during a test run in Tsukuba, Japan, on Monday. The train, known as the MLX01, is designed to run at a maximum speed of 550 kilometers per hour (341 miles per hour). The record was set during a test run on a 1.2-kilometer-long test track. The train's speed was measured by a laser Doppler velocimeter. The record is a significant milestone for the development of high-speed rail systems.

Gaining speed



A magnetic levitation train leaves its base yard for its first self-powered test run in Tsukuba, Yamaguchi Prefecture, west of Tokyo Monday. The "maglev" train is designed to run at a maximum speed of 550 kilometers per hour (341 mph).



'Maglev' train suffers cancellation blow