CHAPTER 3

Heat

Ques. What is heat?

Ans. A form of energy in bodies consisting of molecular vibration.

Ques. What governs the degree of molecular vibration?

Ans. The higher the temperature, the faster the molecules move; the lower the temperature, the slower they move.

Ques. What is temperature?

Ans. The condition of a body on which its power of communicating heat or receiving heat from other bodies depend.

Ques. When is a body at a higher temperature than another body?

Ans. When its molecules move faster than those of the other body.

Ques. How is temperature measured?

Ans. Ordinary temperature, by a *thermometer*. Very high temperatures in a combustion chamber, by a *pyrometer*.

Ques. How do thermometers work?

Ans. The basic principle is the expansion and contraction of substances due to the effect of heat.

Ques. What are the two fixed points on the Fahrenheit scale?

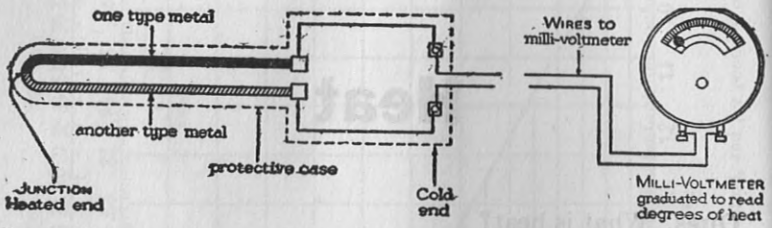


FIG. 1—Elementary thermo-couple thermometer used for measuring high temperatures. ***In principle*** when heat is applied to the junction of two dissimilar metals, a current of electricity begins to flow in proportion to the amount of heat applied. This current can be brought to a meter and translated into terms of heat.

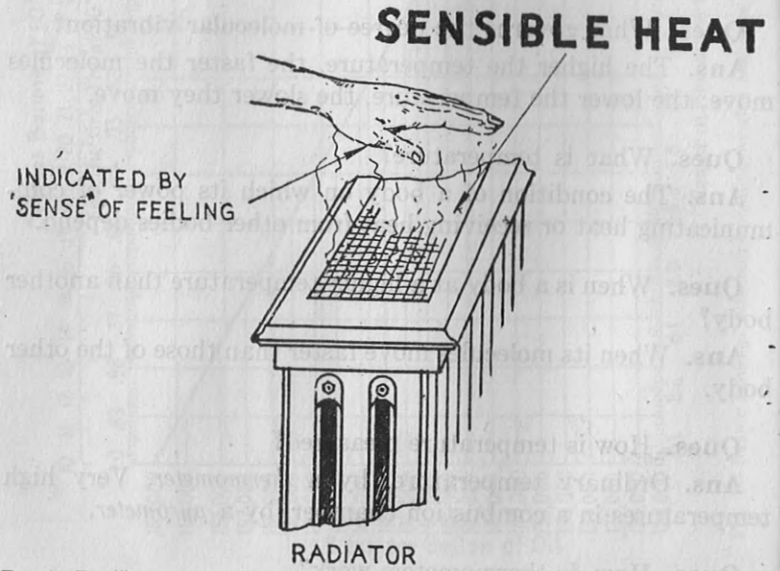
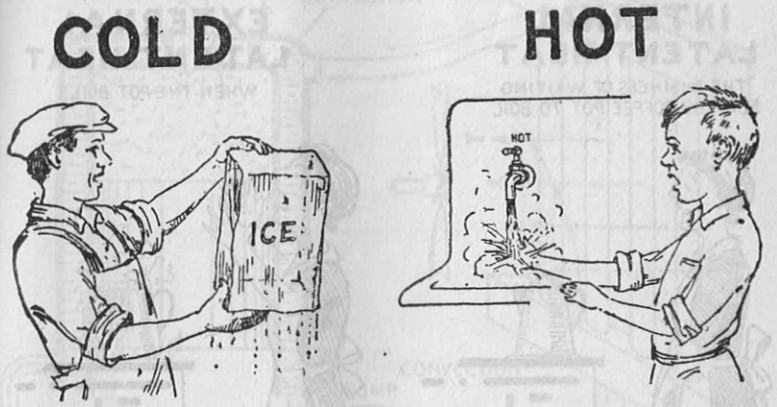


FIG. 2—Familiar example of sensible heat.

Ans. The freezing point is 32° above zero and the boiling point 212° above zero or 180° above the freezing point.

Ques. How do pyrometers work?

Ans. The basic principle for the various types are: 1, contraction of clay by heat; 2, relative expansion of two dissimilar metals; 3, thermo-electric couple, etc. The latter application is shown in fig. 1.



FIGS. 3 and 4—Two more examples of sensible heat.

Sensible and Latent Heat

Ques. What is sensible heat?

Ans. *That form of heat indicated by the "sense" of feeling,* as for instance in figs. 2 to 4. It is measured by the thermometer.

Ques. What is latent heat?

Ans. *The heat required to cause a change of state in a body,* as for instance converting water into steam, as in figs. 5 and 6.

Transfer of Heat

Ques. How is heat transferred from one body to another at a lower temperature?

Ans. By 1, radiation; 2, conduction; 3, convection.

Ques. Describe radiation, conduction and convection in boiler operation.

FIGS. 5 and 6—Domestic example of latent heat which consists of the *internal* and *external* latent heat. The internal latent heat is the heat necessary to raise the temperature of the water to the boiling point (212° at standard atmospheric pressure). The external latent heat is the additional amount of heat necessary to perform the work of pushing back the atmosphere to make room for the steam.

Ans. Heat from the burning fuel passes to the metal to be heated by radiation; through the metal by conduction, and is transferred to the water by convection (circulation, as in fig. 7).

Ques. What is specific heat?

Ans. The ratio of the quantity of heat required to raise the temperature of a given weight of any substance one degree Fahr.

to the quantity of heat required to raise the temperature of the same weight of water from 62° to 63° Fahr.

The capacity of any substance for receiving heat as compared with another which is taken as a standard, this being generally water. Thus, the same quantity of heat which will raise one pound of water 1° Fahr. will raise about 7.7 pounds of cast iron 1° Fahr. so, the specific heat of water being taken as 1.000 that of cast iron is .13*.

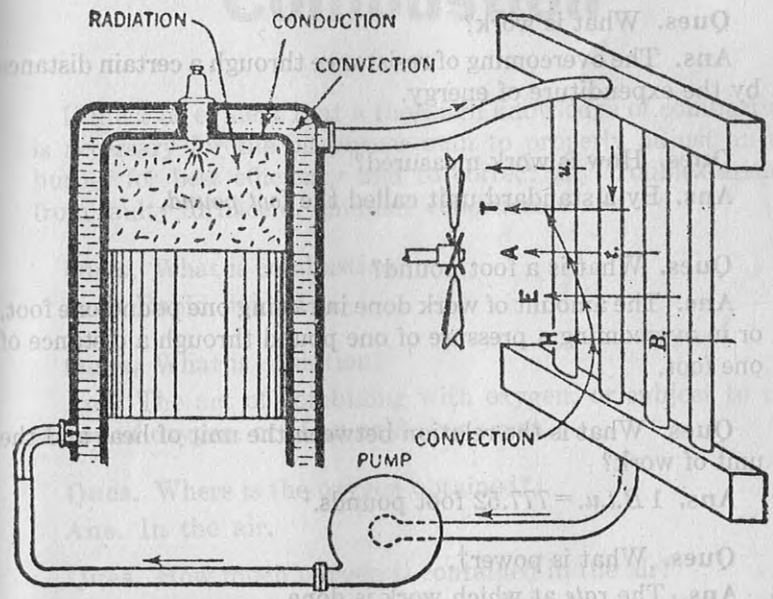


FIG. 7—Familiar example of *radiation*, *conduction* and *convection*. The term water cooled engine is a misnomer. *Why?*

Ques. What is the relation between heat and work?

Ans. Heat develops mechanical force and motion, hence it is convertible into mechanical work.

Ques. How is heat measured?

*NOTE—According to Machinery's Handbook.

Ans. By a standard unit called the *British* **thermal*** *unit.*

Ques. What is the (mean) B.t.u?

Ans. $\frac{1}{180}$ part of the heat required to raise the temperature of one pound of water from 32° to 212° Fahr.

Ques. What is work?

Ans. The overcoming of resistance through a certain distance by the expenditure of energy.

Ques. How is work measured?

Ans. By a standard unit called the *foot pound.*

Ques. What is a foot pound?

Ans. The amount of work done in raising one pound one foot, or in overcoming a pressure of one pound through a distance of one foot.

Ques. What is the relation between the unit of heat and the unit of work?

Ans. 1 *B.t.u.* = 777.52 foot pounds.‡

Ques. What is power†.

Ans. The *rate* at which work is done.

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*NOTE.—**Thermal**, not "**terminal**" as so called by some nondescripts.

†NOTE.—*Please* learn the difference between *work* and *power* — look it up then you will remember it.

NOTE.—**In steam making**, a considerable amount of the heat generated by the fuel is lost. Most of it goes up the chimney, especially in some cast iron house heating boilers — sometimes heating the stack red hot — a condition that should *not* be tolerated by even the *ignorantia* and will *not* be tolerated by the *intelligentia*:

‡NOTE—777.52 foot pounds is the value used by Marks and Davis in their steam tables. The value 778 is sufficiently accurate for ordinary calculations.