

CHAPTER 5

Steam

Quoting from the "Scope of Examination" for license to install oil burning equipment:

"The written test will investigate the applicant's familiarity with the law, rules and regulations established for the proper and legal installation of various methods and problems of installation with the principles and parts of all related equipment. . . ."

Since the boiler and its necessary attachments and accessories for its proper operation are "related equipment," the oil burner man must know something about steam and how a boiler makes steam.

1. Steam

Ques. What is steam?

Ans. The invisible vapor of water.

Ques. What is the "white cloud" seen issuing from a safety valve and ignorantly called steam by greenhorns and the lay?

Ans. It is not steam, but a fog of minute liquid particles formed by condensation, that is, *finely divided condensate*.

Ques. What is saturated steam?

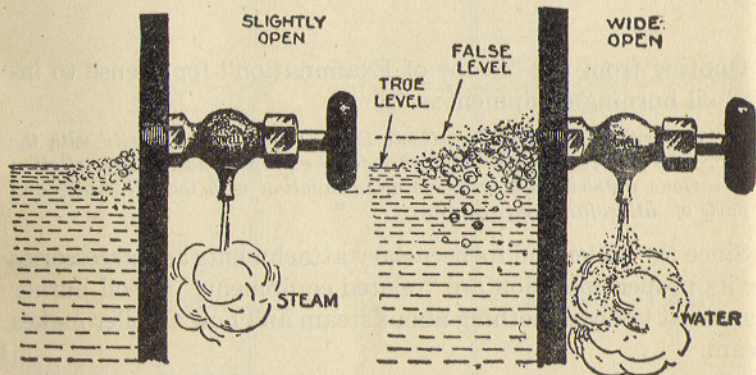
Ans. Steam of a temperature due to its pressure.

Ques. What causes steam to change into a white cloud?

Ans. Exposure to a temperature lower than that corresponding to its pressure.

Ques. Why is the definition of "saturated steam" important in an examination?

Ans. Because it specifies the only condition in which true steam can exist.



Figs. 1 and 2—Right and wrong way of testing water level with gauge cocks. If the cock be opened wide as in fig. 2, as invariably done by a *greenhorn*, the reduction of pressure inside and consequent violent ebullition to restore equilibrium causes a considerable disturbance of the water level near the cock in indicating a false level as shown.

Ques. What is so called wet steam?

Ans. Steam containing intermingled moisture, mist or spray.

Ques. Why is the "feel" of saturated steam and wet steam important in boiler operation?

Ans. Because the gauge cocks on a boiler indicate the approximate level of the water in the boiler by the dry or wet feel of the steam in testing.

Of course in testing, *greenhorns* will open the cock wide and render the test useless. See figs. 1 and 2.

Ques. What steam pressures are used on house heating boilers?

Ans. A few ounces for alleged vapor systems, and a few pounds for ordinary steam heating systems.

Ques. How much heat does it take to generate steam?

Ans. The sensible heat + the internal latent heat + the external latent heat.

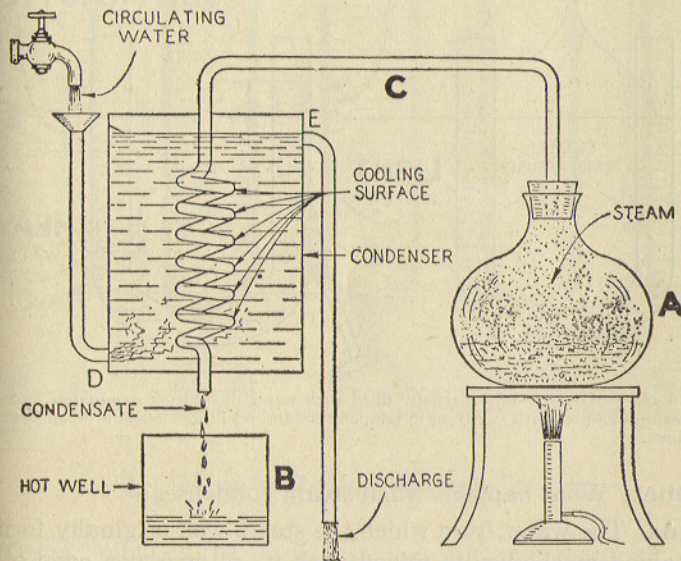


FIG. 3—The condensation of steam. Water boiling in flask A, passes through pipe C, to condenser coil and due to cooling water entering condenser D, and passing out at E, condensate leaves the coil and drains to hot well B.

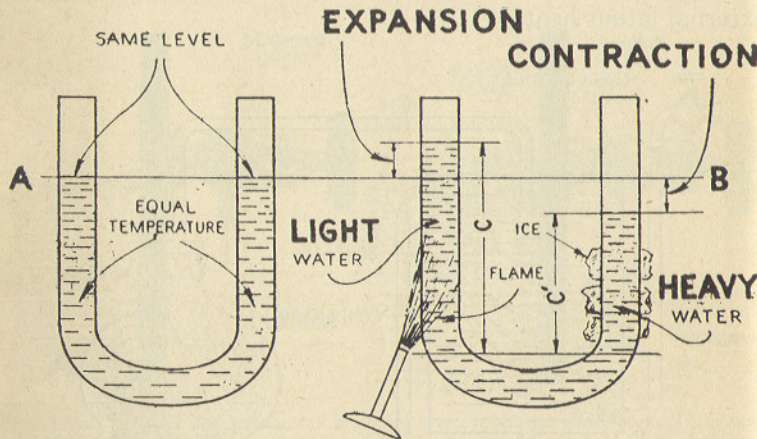
Ques. How many *B.t.u.'s* are required per pound of water starting at 32° Fahr.?

Ans. $180 + 897.51 + 72.89 = 1,150.4$.

The sum of these three items is known as the total heat above 32° F. In speaking of *B.t.u.* the speaker's knowledge should be of a higher order than that possessed by some individuals who call *British thermal units* *British terminal units*.

Ques. What is condensation?

Ans. The change of state of a substance from the gaseous to the liquid form as in fig. 3.



FIGS. 4 and 5—Glass U tube partially filled with water illustrating *expansion* and *contraction* of water with variation in temperature and resulting change in weight per unit volume.

Ques. What happens when steam condenses?

Ans. The water from which the steam was originally formed contained mechanically mixed with it $\frac{1}{20}$ or 5 per cent of its volume of air which is liberated and does not recombine with the water of condensation, but remains liberated in the pipes of a steam heating system.

Ques. What is the water of condensation called?

Ans. The condensate.

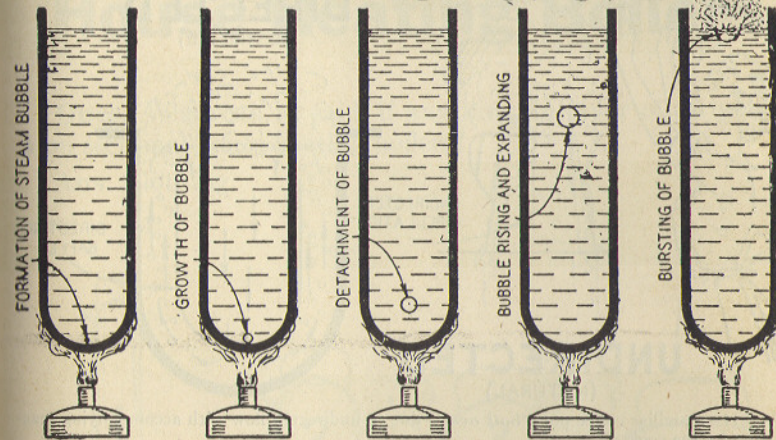
Ques. What is the boiling point?

Ans. The temperature at which steam will form for a given pressure.

Ques. How does the boiling point vary?

Ans. The higher the pressure, the higher the boiling point.

THE FORMATION OF STEAM



FIGS. 6 to 10—*Vaporization* or the formation of steam showing what happens during the process.

2. How a Boiler Makes Steam

Ques. What is the basic principle in steam making?

Ans. An *upset* of hydraulic thermal equilibrium, causing circulation, that is **convection currents**.

Ques. What causes convection currents?

Ans. A variation of temperature in different parts of a boiler, introducing a change of density. Figs. 4 and 5.

Ques. What is vaporization?

Ans. The formation or making of steam.

Ques. Describe the formation of steam.

Ans. A particle of water in contact with the metal is heated until it is changed into steam, first appearing as a small bubble which for a time clings to the metal as in fig. 6.

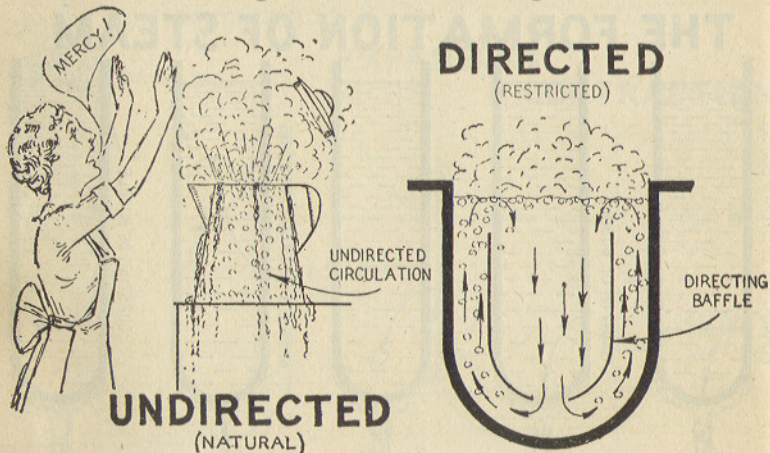


Fig. 11—Familiar coffee pot "boil over" due to undirected flow with accompanying reaction by the cook.

Fig. 12—Directed flow with cylindrical baffle or inner vessel—no boil over with this arrangement.

Its size gradually increases by the addition of more steam, formed from the surrounding water until it finally disengages itself from the metal as in fig. 8.

After disengagement, since the bubble is much lighter than the water, it quickly rises and bursts on reaching the surface, allowing the steam to escape into the atmosphere, as in figs. 8 to 10. Note expansion of the bubble during its ascent due to decreasing head.

Ques. Name two kinds of circulation.

Ans. Undirected, as in fig. 11, and directed, as in fig. 12.

NOTE.—In steam making, a *considerable* amount of the heat generated by the fuel, goes up the chimney instead of heating the water—especially in sectional cast iron alleged house heating boilers.