amount of heat required to maintain the common equivalent temperature is of the order of 7 percent.

Figs. 2 and 3 show results obtained in cold room tests in which the radiators were continuously filled with steam at 215 F. Under these conditions of operation, air temperature gradients are likely to be exaggerated as compared with those encountered with the intermittent operation usually obtained in actual practice.

The following statements applying to the use of radiators are based on experience and test results:[13]

1. The heating effect of a radiator cannot be judged solely by the amount of steam condensed within the radiator.

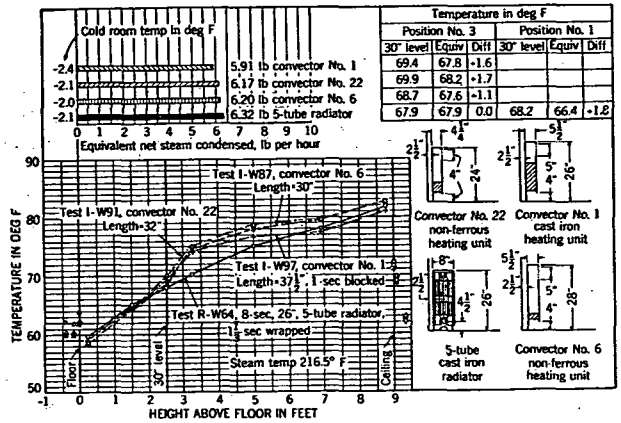

FIG. 3. TEMPERATURE GRADIENTS AND EQUIVALENT TEMPERATURES FOR RADIATOR AND CONVECTORS WITH COMMON EQUIVALENT TEMPERATURE

2. Smaller floor-to-ceiling temperature differentials can be maintained with long, low, thin, direct radiators, than can be maintained with high, direct radiators.

3. The larger portion of the floor-to-ceiling temperature differential in a room of average ceiling height heated with direct radiators occurs between the floor and the breathing level.

4. The comfort level (approximately 2 ft-6 in. above floor) is below the breathing line level (approximately 5 ft-0 in. above floor), and temperatures taken at the breathing line may not be indicative of the actual heating effect of a radiator in the room. The comfort-indicating temperature should be taken below the breathing line level.

5. High column radiators placed at the sides of window openings do not produce as comfortable heating effects as long, low, direct radiators placed beneath windows.

HEATING THE RADIATOR AND CONVECTOR

The maximum condensation occurs in a heating unit when the steam is first turned on. Tests[19] on an old-style column-type cast-iron radiator indicated that in the first 10 min the condensation rate reached a peak of 0.95 lb per sq ft of radiation per hour and 10 to 15 min later dropped to a rate of 0.24 lb. In one-pipe gravity systems the rate of steam supply to the heating unit, while heating up, is frequently retarded by controlled elimination of air through air valves or traps. In two-pipe systems automatic control valves may also retard the supply of steam. Vacuum types

of air venting valves may be used to reduce the length of the venting periods.

ENCLOSED RADIATORS

The general effect of an enclosure placed about a direct radiator is to restrict the air flow, diminish the radiation and, when properly designed, improve the heat distribution within the heated space.

Investigations[13] indicate that in the design of the enclosure three things should be considered:

1. There should be better distribution of the heat below the breathing line level to produce greater heating comfort and lowered ceiling temperatures.
2. The lessened steam consumption may not materially change the radiator heating performance.
3. The enclosed radiator may inadequately heat the space.

A comparison between a bare or exposed radiator (A) and the same radi-

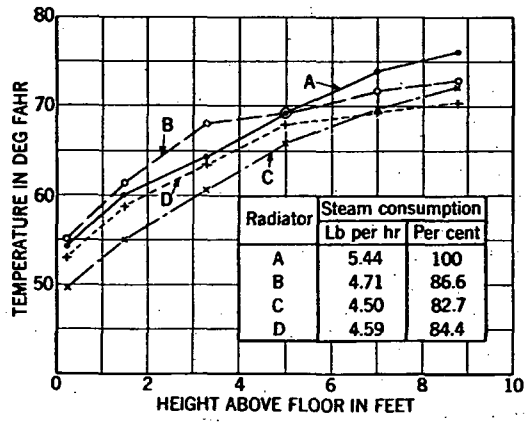

FIG. 4. STEAM CONSUMPTION OF EXPOSED AND CONCEALED RADIATORS

ator with a well-designed enclosure (B), with a poorly-designed enclosure (C), and with a cloth cover (D) will illustrate the relative heating characteristics. In Fig. 4 the curve (B) reveals that the enclosed radiator used less steam than the exposed radiator, but gave a satisfactory heating performance. A well-designed shield placed over a radiator gives about the same result. Curve (C) shows the unsatisfactory effects produced by improperly-designed enclosures. Curve (D) shows that the effect of a cloth cover extending downward 6 in. from the top of the radiator was to make the performance unsatisfactory and inadequate.

Some commercial enclosures and shields for use on direct radiators are equipped with water pans for the purpose of adding moisture to the air in the room. Tests[20] show that an average evaporative rate of about 0.235 lb per square foot of water surface per hour may be obtained from such pans, when a radiator is steam heated and the relative humidity in the room is between 25 and 40 percent. This source of supply of moisture alone is not adequate to maintain a relative humidity above 25 percent on a zero day.