temperature, by air having a normal velocity but a lower temperature, by excessive radiation to a cold surface, or any combination of these three effects."[34]

In view of these complex implications of the word *draft*, it is no wonder that great differences exist in the numerical values reported as the maximum tolerable air velocities in workplaces. In the case of a draft caused by air movement, the velocity of air that constitutes the draft depends on the season of the year, the physiological condition of the person, his activity, type of clothing, and the temperature difference between ambient and moving air.

Sedentary workers have complained of drafts when the air movement measured a few feet from the floor by a thermal anemometer is 30 to 40 l.f.m. (linear feet per minute) in the heating season, and 40 to 50 in the summer with cooled air. The objectionable air movement in summer with no air cooling is in the range of 100 to 200 l.f.m. for normal individuals.

Older persons are notably more sensitive to moderate air currents, and this fact should be considered when locating the workers in a large department that either cannot or should not be provided with uniform conditions. In fact, it must be recognized that workers are not standardized heat engines generating 400 or 600 B.t.u. per hour, and they have legitimate needs for an environment that can be modified somewhat according to metabolism and activity. This requires co-ordination of the work of the air-conditioning engineer, the plant medical department, and the supervisory personnel.

In summer near hot operations, air velocities as high as 500 l.f.m. have been observed without creating complaint or irritating draft. Such velocities, however, cannot be applied over a wide area, but instead are used as localized winds through which the individual may pass as often as he desires. Workers at fixed stations should not be subjected to constant or continuous air velocities above 200 l.f.m. If cooled or refrigerated air is passed over the working zone, the air velocity for comfort may be as high as 100 l.f.m. with small temperature differentials.

"Still air" in residential and commercial comfort air conditioning has for years been assumed to fall in the range of 15 to 25 l.f.m. These same values in a machine shop are denounced as "stagnant," and for many industrial environments 50 l.f.m. is properly rated as still air.

Somewhat akin to drafts are the high-temperature air blasts coming from heating systems with their discharge grilles located too near the occupied zone. So far, no generally accepted schedule of air movement combined with maximum permissible temperatures in the occupied zone has been produced.

K. ACCLIMATIZATION IN AIR CONDITIONING

Acclimatization is the term used to signify the gradual shift in the body's thermal response to its environment so that its heat balance can be maintained under a new combination of atmospheric conditions. Acclimatization accounts

[34] F. C. Houghten, C. Gutberlet, and E. Witkowski, *Trans. ASHVE*, *44*, 289 (1938).

for the difference between the winter and summer comfort lines shown on Figure 1, namely 66° and 71° effective temperature.

"According to the best information available from the Society's [ASHVE] Laboratory and other studies, acclimatization requires from one to two weeks. A longer period is indicated for acclimatization to cold than is required for acclimatization to heat. The Laboratory has found from seven to ten days required for acclimatization to heat, either as a result of change in summer weather or for men working in a hot environment."[35]

Carrier[36] cites an interesting example of the easily overlooked world-wide variations in acclimatization:

" . . . workers in tropical and semi-tropical countries such as India, for example, require temperatures above 80°. An illustration of this was found in the first air-conditioning plant installed in an Indian cotton mill. It was started up during the monsoon season when the outside temperature was 105° and the air was very dry. The mill temperatures to which the Indian workers were accustomed ran as high as 110° and 115°. The engineer in charge was greatly delighted when on a 105° day outside he maintained a temperature of 80° with 80 per cent relative humidity inside the mill, but the Indian operatives refused to work in so cold an atmosphere and he was obliged to provide a means for heating his spray water."

L. PSYCHOLOGY OF AIR CONDITIONING

Some of the plants built during World War II covered tremendous floor area between solid walls to conform with black-out design requirements. They were generally well air conditioned, but sometimes were provided with so nearly uniform distribution of air that the occupants did not believe there was any ventilation or air replenishment. This, coupled with the fact that no windows were available to establish visible communication between indoor and outdoor atmospheres, led to persistent complaints that inside air was stale, stagnant, stuffy, suffocating, or simply bad. Invariably the only permanent solutions to these complaints were based on a realistic knowledge of the layman's methods of appraising his atmospheric environment: (*1*) an audible (but not too noisy) and visible circulating fan; (*2*) ribbon streamers attached to air-supply grilles; (*3*) variable rather than smooth or uniform air currents; (*4*) clear glass windows or transparent glass blocks to display the weather; (*5*) ventilating ducts obviously piercing an outside wall; (*6*) moderately fluctuating rather than precisely constant temperature; and many other devices conceived to demonstrate to the occupant that something is really happening to his atmospheric environment to keep it constantly replenished. Some of these solutions are disappointing to the engineer whose goal is technical perfection in meeting a fixed combination of environmental conditions. But environmental engineering does not specify monotony as a desirable or even permissible objective.

M. AIR-CONDITIONING COMPLAINTS

A significant development of medical and physiological research is the increasing number of theoretical justifications or explanations for the complaints

[35] F. C. Houghten, *Trans. ASHVE*, *50*, 87 (1944).
[36] W. H. Carrier, *Ind. Med.*, *7*, 563 (1938).