fortable. Where the air is admitted through the ceiling, and the ceiling is high, the temperature difference may be slightly increased and, in some cases, the air quantity may be slightly decreased.

If a room is crowded in weather of 85 deg. outside temperature, with a relative humidity of 70 per cent, while giving each occupant 30 cu. ft. of air per minute, it may be assumed that there will be an increase of temperature of at least 5 deg. due to body heat and heat from equipment. The moisture increase, from the bodies of the occupants, may be assumed as 10 grains per minute, or 0.30 grains per cubic foot of air handled.

Under such a condition some method of air cooling will be needed to obtain satisfactory ventilation. A good air washer may reduce the temperature of the air passing through it about 70 per cent of the difference between the wet and the dry bulb temperatures. Its operation would hardly be worth while without a water supply having a temperature of 50 deg. or cooler because of increasing relative humidity with a decreasing temperature. The beneficial effect of an air washer will increase in proportion to the dryness of the outside air.

It should be understood that the example cited is an extreme case of temperature and humidity. Experience, however, shows that a supply of air which proves to be adequate for maintaining a desirable effective temperature in winter will prove inadequate for the same purpose in hot weather. While an increased volume of air supply is often of material benefit, the use of refrigeration brings the final hot-weather solution, not so much in actual temperature drop as in reduction of humidity.

When using an upward system of air supply, as through floor mushrooms, drafts will be felt often with the introduction of air at temperatures of more than 5 deg. cooler than the average room temperature. For this reason, and for the additional reasons of sanitation and control, the downward system of ventilation is more efficacious in large and densely occupied places of assemblage. The air should be brought in at a point high enough to permit of its being diffused before coming into contact with the occupants. It is always desirable, if not imperative, to prevent cool-air currents from striking the occupants from behind them.

RECIRCULATION

Where recirculation of air in ventilation work is utilized care should be taken that the recirculated air shall be suitable. Usually the air must be reconditioned by cleaning, dehumidifying and deodorizing. The saving in operating costs obtainable by recirculation of the air in ventilation systems, while very considerable, must not be obtained at the expense of quality.

The percentage of recirculated air may be varied to suit the seasonal changes so as to conserve heat in winter and refrigeration in summer.

Toilets and similar rooms and all kitchens in buildings using recirculation, should be separately, mechanically ventilated, with the exhaust in excess of the supply, in order to prevent objectionable odors from diffusing into other parts of the building. This air removal may in many cases be sufficient to insure a sufficient replacement of new air to the general recirculating system.

PSYCHOLOGICAL AND PHYSIOLOGICAL REACTIONS

The factors which may affect a person's health, comfort, or well being are: (1) temperature; (2) humidity; (3) motion of the air; (4) dustiness; (5) bacteria content; (6) odors present; (7) other injurious substances.

Temperature, humidity and motion taken together, determine the feeling of warmth and influence the elimination of body heat. They are the three most important factors in the physiological effects of the surrounding atmosphere upon the body.

Dust, bacteria, and odors may be of secondary importance when compared with the combined effect of temperature, humidity, and air motion, but they are nevertheless important factors, and must be given consideration.

The engineer who disregards the psychological factor in ventilation is, indeed, short-sighted. As in most human contacts and activities, the effect of air conditions on the mind is profound.

Consideration must always be given to the elimination of objectionable noise from machinery and to air-friction noises. It is usually helpful if the occupants of a ventilated room may visualize some indication that air is moving. It helps if they may, when they wish, place their bodies or portions thereof, in sensible air currents, to demonstrate that ventilation is in effect. Periodical or occasional temperature reductions, or increases in air movement, possibly accompanied by muscular exercises, are of great value, psychologically as well as physically.

It is a familiar fact that a room may be comfortable at one dry-bulb temperature and yet decidedly uncomfortable at another time at the same dry-bulb temperature. This fact may be due either to a change of relative humidity or to a change in air motion. A room may feel equally comfortable with different dry-bulb temperatures provided the relative humidity or air motion is varied to produce this effect. Other factors enter into this problem, such as changes of clothing (seasonal or otherwise), acclimatization, degree of activity, etc.

HOW TEMPERATURE, HUMIDITY, AND AIR MOTION AFFECT HUMAN COMFORT

The temperature sensations of the human body depend not only on the temperature of the surrounding air as registered by a dry-bulb thermometer, but also they depend upon the temperature indicated by a wet-bulb thermometer. Dry air at a relatively high temperature may feel cooler than air of considerably lower temperature with a high moisture content.

Air motion makes any moderate condition feel cooler.

Human comfort or discomfort, as regards feeling of warmth, depends largely upon the body temperature, and, therefore, upon the relation between the rate of production and dissipation of heat. By the process of metabolism heat is constantly generated within the body, which heat must be eliminated from the surface of the body and from the respiratory tract by radiation, convection and evaporation. To maintain a constant body temperature the heat loss must equal the heat produced. It is, therefore, apparent that any reduction in the elimination of heat from the body must result in a rise in temperature and a feeling of discomfort.