should be free from dents, fins and projections of all kinds on which refuse material might catch.

All permanent circular joints should be lap-jointed, riveted and soldered, and all longitudinal joints either grooved and locked or riveted and soldered. Circular laps should be in the direction of the flow, and piping installed out-of-doors should not have the longitudinal laps at the bottom. Every change in pipe size should be made with an eccentric taper flat on the bottom, the taper to be at least 5 in. long for each inch change in diameter.

All pipes passing through roofs should be equipped with collars so arranged as to prevent water leaking into the building.

The main trunks and branch pipes should be as short and straight as possible, strongly supported, and with the dead ends capped to permit inspection and cleaning. All branch pipes should join the main at an acute angle, the junction being at the side or top and never at the bottom of the main. Branch pipes should not join the main pipes at points such that the material from one branch tends to enter the branch on the opposite side of the main.

Cleanout openings having suitable covers should be placed in the main and branch pipes so that every part of the system can be easily reached in case the system clogs. Either a large cleanout door should be placed in the main suction pipe near the fan inlet, or a detachable section of pipe, held in place by lug bands, may be provided.

Elbows should be made at least two gages heavier than straight pipe of the same diameter, the better to enable them to withstand the additional wear caused by changing the direction of flow. They should preferably have a throat radius of at least one and one-half times the diameter of the pipe.

Every pipe should be kept open and unobstructed throughout its entire length, and no fixed screen should be placed in it, although the use of a trap at the junction of the hood and branch pipe is permissible, provided it is not allowed to fill up completely.

The passing of pipes through fire-walls should be avoided wherever possible, and sweep-up connections should be so arranged that foreign material cannot be easily introduced into them.

MAINTENANCE OF SYSTEM

Because of its simplicity the exhaust system usually receives but little attention once it is installed; however, to obtain the best results, it should be inspected at suitable intervals and necessary adjustments made.

The exhaust fan should be given proper attention the same as any other high-speed machine. It should be kept in proper alignment and tightly bolted to its foundation.

Suction hoods, which have been removed to adjust the machines, should be replaced as soon as the adjustments are completed.

Never start a machine with the blast gate closed, as the slight air leakage past the blast gate may draw material into the pipe and clog it.

Disconnect furnace feeders from the furnaces when not in operation, and do not overload the system by ill-advised additions.

Chapter 26

VENTILATION STANDARDS

Necessity for Ventilation and Its Value; Quantity of Air Required for Ventilation; Entering Air Temperature; Recirculation; Humidity; Wet and Dry-Bulb Temperatures; Atmospheric Conditions Affecting Comfort and Health; Metabolism and Temperature Equilibrium of Human Body; Effective Temperature; the Comfort Line and the Comfort Zone; Air Cooling; Heat Dissipated to the Atmosphere from the Human Body; Synthetic Air Chart; Testing Methods and Instruments.

VENTILATION, as defined in most dictionaries, means to cause outside or so-called *fresh* air to circulate through a room or other enclosure so as to replace foul air. As applied to spaces occupied by human beings, ventilation means more than merely the displacement of the vitiated air by air taken wholly or in part from out-of-doors, and consists in maintaining air conditions in the space which will insure the health and comfort of the occupants.

The development of knowledge concerning the factors entering into good ventilation has necessitated the cooperation of the engineer, the physiologist and the physician. The studies made at the A.S.H.V.E. Research Laboratory and at other institutions, have contributed materially to this art. Almost any desired atmospheric condition can now be produced within a given enclosure.

NECESSITY FOR VENTILATION AND ITS VALUE

Wherever human beings are present in closed quarters the products of respiration from the lungs, together with the heat and water vapor from the skin are given off directly into the surrounding air. So far as is known today, the exhaled products of respiration from healthy individuals are non-toxic and harmless in themselves. Unless the space per occupant is very limited, their presence in the air of the room is of little consequence, so long as the temperature, relative humidity and motion of the air of the room are maintained within certain rather definite limits.

In a crowded place of assemblage the heat given off by the occupants, together with that given off by the lighting and power equipment, may be, and frequently is, more than the normal heat loss through the structure to the outside air, even in winter under cold climatic conditions. This means that in order to preserve an equilibrium of effective temperature the entering air must be cooler than the leaving air, so that the problem in such enclosures is usually one of cooling and ventilating, rather than one of heating and ventilating.

A typical case for winter might show about 300 B.t.u. of body heat,