which obstruct air currents, it is desirable to extend the ventilators above the buildings by mounting them on stacks.

Example.—A foundry building is 40 ft. wide, 200 ft. long, with an average height of 40 ft.; the ventilators are to be mounted at the ridge of the roof, at a height of 55 ft. above the floor. What number and size of ventilators are required?

Answer.—In this case, ventilation is especially necessary in summer. The air in the building should not be over 10 deg. fahr. warmer than the outside air. The wind velocity may be as low as 4 miles per hour. Spacing the ventilators, tentatively, 25 ft. apart, 8 ventilators would be required. Under average conditions, 10 air renewals per hour are sufficient. If the foundry is small and cramped, and pouring takes place over a large section of the floor space, 15 or more air renewals per hour may be needed. On the basis of 10 renewals per hour, the capacity of each ventilator must be:

$$Q = \frac{10 \times (200 \text{ ft.} \times 40 \text{ ft.} \times 40 \text{ ft.})}{8} = 400{,}000 \text{ cu. ft. per hour}$$

The discharge per square inch of throat area under these conditions is;

$$\left[\frac{36 \times \sqrt{55 \times 10 \text{ deg.}}}{6 + 4 \text{ mi./hr.}} + 20 \times 4 \text{ mi./hr.}\right] = 165 \text{ cu. ft. of air per hour.}$$

The required throat area per ventilator is

$$\frac{400{,}000}{165} = 2420 \text{ sq. in.}$$

if there is no resistance and no wind pressure.

The diameter is $\sqrt{\frac{2420}{0.7854}} = 55.5$ in. Standard sizes are 54 in. and 60 in. Either eight—54 in. or else seven—60 in. ventilators could be used, spaced respectively 25 ft. or 28 ft. apart.

The foregoing is based on the use of high class ventilators. If ventilators of lower efficiency are used, or if the air flow into the building is restricted (as in winter) larger ventilators may be required.

CONTINUOUS TYPE OF ROOF VENTILATOR

The continuous type of roof ventilator is illustrated in Fig. 11. It furnishes a continuous opening in the roof throughout the length of the building, and is in effect a ridge louvre or monitor. It is stated that the high temperature of the air immediately beneath the sheathing, resulting from exposure of the roof to the sun's rays, induces a powerful convective effect along the pitched roof toward the opening which offers a direct avenue of escape, whereas in the unit type of ventilator, the free egress of the air is confined to definite points along the roof, and the natural upward flow is diverted with some loss, to a longitudinal movement. These ventilators are expected to function by the force of temperature difference alone, and have no external features designed to generate a suction by the action of the wind. The absence of a conspicuous external structure makes this type of ventilator particularly suitable for certain types of buildings.

DAIRY STABLE VENTILATION

Natural ventilation has an important application in dairy stables and other buildings housing live stock. A paper by F. L. Fairbanks, A. S. H.

& V. E. JOURNAL, February, 1928, offers valuable information on this subject. Some of the most important facts are stated below. Although they have been derived from a study of dairy stables, it will be found that some of them are general in their application:

1. For good ventilation, there should be provided about 3500 cu. ft. of fresh air per hour per 1000 lb. of live stock weight.

2. A strong convective circulation is generated by the heat from the bodies of the stock causing an upward movement toward the ceiling, about them, and a consequent downward movement at the walls.

3. Intake openings should be located in the walls near the ceiling so that incoming cold air, falling toward the floor, will accentuate the convective action induced by the heat within.

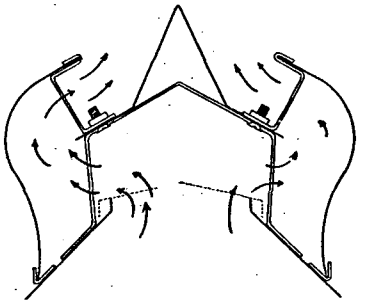


FIG. 11. CONTINUOUS TYPE ROOF VENTILATOR

4. Outlet openings seem to function merely as exhaust ports, to relieve the interior pressure, and appear to have little influence on the direction of air currents. Hence, the spacing or distribution of outlet openings is rather immaterial, so long as the required aggregate area is provided. Area of outlet openings should be about one-third greater than intake.

5. It is better to take the air out at the floor than at the ceiling since by the former there appears to be a larger volume of warm air held in the stable, which contributes to better temperature control.

6. The active circulation resulting from the down flowing cold air entering at openings in the walls near the ceiling, cooperating with the convective action induced by the heat of the animals, effectually prevents condensation and keeps the air fresh and odorless.

Fig. 12 illustrates a dairy stable ventilation system embodying the principles stated.

CONTROL OF VENTILATION

Control of natural ventilation depends upon hand regulation, which may be applied in two ways, *First*, by the selection of appropriate localities about the building at which to make openings, with regard to direction of the wind, and *Second*, by regulation of the amount of opening, which is accomplished by window operative devices, dampers, or louvres. Control may be effected by the regulation of either inlet or outlet openings, or both and for satisfactory results needs careful study and close attention.