

among buildings, are a series which, in their application to school-houses, must be condemned in the most unequivocal manner. Of the most deleterious, or dangerous, and the most carefully to be avoided, are those which may be classified under four general heads, as follows, viz. :—

- "1. All warming by means of ordinary stoves, not provided with a flue for the escape of smoke or the products of combustion.
- "2. Any method which merely warms the same air again and again.
- "3. Any system by which the air is liable to be vitiated by direct contact with overheated metal surfaces.
- "4. All methods in which warmth is obtained by water pipes heated at high pressure.

"The first of these requires no comment, their objectionable nature being now pretty well understood and condemned by experienced school promoters and managers.

"The second refers to methods which have been, and still are, almost universal in their application to churches, public halls, &c., and which are unfortunately not unknown to schools. One of these consists of a coil of hot-water pipes placed in a corner, or of lines of pipes carried round the walls, without any provision for a renewed supply of air. The coil, or line of pipes, heats the particles of air with which it is in contact, and thus transmits warmth: but the principle is merely to heat and re-heat the air which happens to be in the room, and which is being breathed by the children again and again, with the certainty of becoming more impure at each respira-

tion. Another system, although having its apparatus of heating surfaces placed in the basement, yet frequently draws its supply of professedly fresh air from the *interior* of the room or building, and is even worse. The heated air rises to the ceiling, and, as it descends by cooling, is again drawn down to the basement to be re-heated, and to perform the same process as before. The heat is certainly economized, and the process may, by some, be ranked as 'cheap,' but the principle is eminently vicious, and the effects on health disastrous in degree according to the length of time during which the air is breathed.

"Another method, the result of over-zeal for economy, usually aggravates its evil by obtaining heat from metal stoves. The radiation of heat from iron plates in contact with the air (almost always fired violently when warmth is quickly required), is also cheap, but most dangerous to health. The air is deteriorated, and numerous instances could be given, from actual observation, of the bad effects produced.

"Generally, all methods are objectionable which deteriorate or render too dry the air, which in any way tend to prevent a copious supply of oxygen, and which are not capable of simple and easy management.

"It is much easier to point out the various systems which are bad in principle or in practice, and to determine what we ought not to do, than to draw final conclusions as to the course best for adoption in each case. The subject of warming and ventilation is perhaps the most difficult among all those questions which arise in connection with School Architecture. The conditions of the problem may easily be stated. The building requires not warmth only, or ventilation only, but the two in combination, each efficient, thorough and ample. The air for respiration must be perfectly fresh, comfortably warm, yet never too warm, always in movement so imperceptible as never to be productive of draughts. The system should be so entirely under control that, when the temperature of the external air changes suddenly, that of the internal air may be regulated accordingly, and on no account allowed to become stagnant or unwholesome. The apparatus should be capable of warming the building within a short time of the lighting of the fires, so that when the children first arrive the effects may already be at their maximum. These desired results may be attained in any one of several different ways, according to the building to be treated; but, whatever the course pursued, there is one great principle applicable alike to every system possible to be devised, which we must strongly insist upon at the outset, viz., that of *demand and supply*. The removal (or attended removal) of heated or vitiated air from a room by means of an aperture or flue is often supposed to be ventilation. It is only a part—a necessary part—of ventilation. To be of use, indeed to act at all in the manner intended, such a flue or aperture requires that fresh air of at least equal volume shall, by some other source placed at a lower level, be admitted to the room at the same time. The *demand*, set up by the outlet flue, requires the *supply* which can only be met by the provision of an inlet flue." In all those systems which attempt to warm the air of a room without allowing any of the warmth to escape, ventilation is entirely lost sight of. None can be really good which do not contemplate a continual removal of foul and supply of fresh air to the room. The amount of fresh air to be *continuously* admitted requires some consideration, for on it depends the amount of warming-power to be provided, whether by open fires, hot water or other means. Calculating the movement through the inlets to be at the rate of 150 feet per minute, *from 15 to 20 cubic feet of air per child per minute* is required to pass into the school-room in a ceaseless stream. To provide such an amount of heating power as will admit of a constant movement and renewal of the air, the warm fresh supply being admitted at one place and the vitiated air being carried out of the building at another, involves sometimes a cost so considerable that sound hygiene forgotten in a mistaken zeal for defending the purse-strings. *A large outlay at first cannot be avoided if we would have thorough warming and thorough ventilation effectually combined*, for, if the foul air be continuously extracted, and fresh air continuously admitted, the arrangements for warming the latter must be of great power, and for removing the former of great extent. True economy dictates that only such methods as are sound in principle, healthful in practice, easy of management, and therefore suitable for a school-house, should be considered.

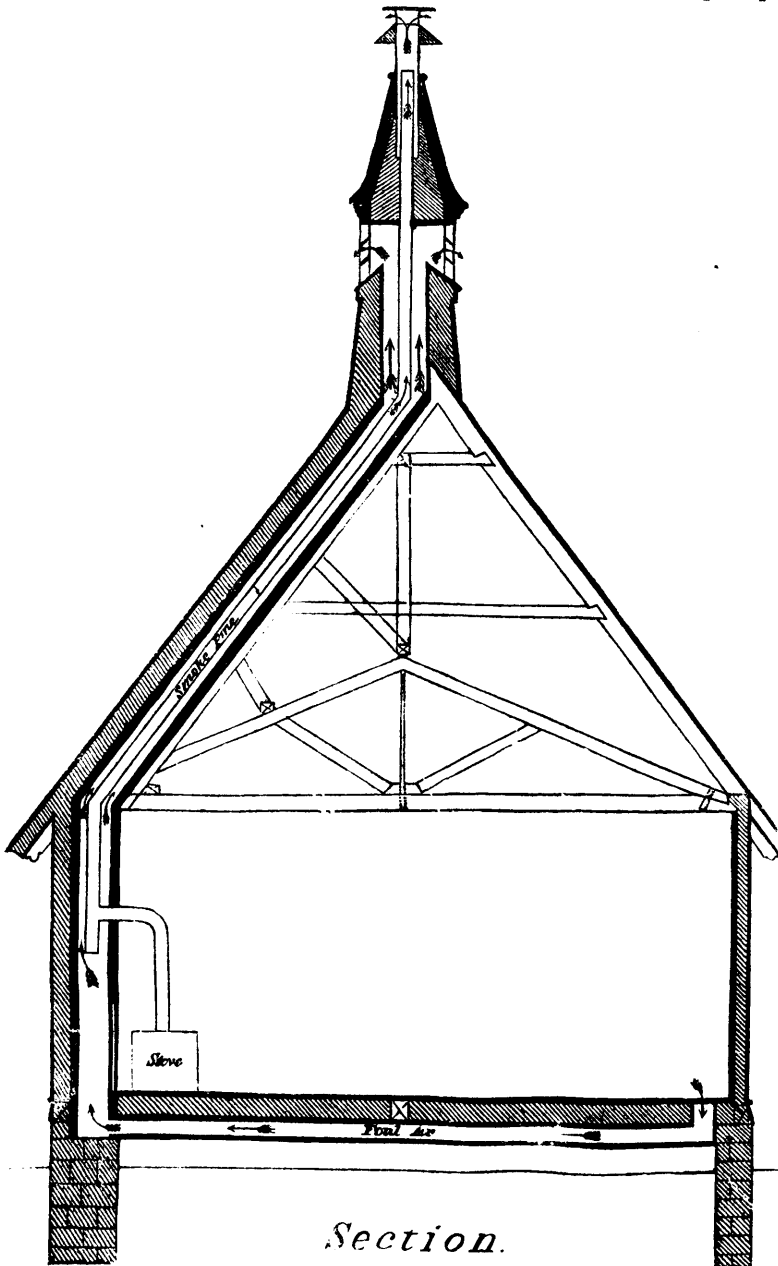


Fig. 1.—SHOWING ARRANGEMENT OF HEATING AND VENTILATION.