settled the average amount of air space, the next question to be put is, Are there appliances for changing the air in it the requisite number of times to give a product of 3,000 feet, or something near that amount? If not, what is the result? It has been found as the result of actual analysis and experiment that air containing eight or nine parts in 10,000 of carbonic acid produces nausea, loss of appetite, headache, irritability, and other symptoms. Are your little scholars ever peevish and fretful? I must not ask whether children of an older growth ever become so—no wonder if they do. It is hard to get exact statistics of mortality in connection with various degrees of vitiation of air by respiration, as other unsanitary conditions are often associated, but the above results were proved to be solely attributable to the vitiation of air by respiration in the several degrees named. Of course, mortality statistics associated with an indefinite amount of air vitiation are to be had. We now come to the consideration of the

MEANS FOR CHANGING THE AIR

in the school-room—the means for getting in this "1 kormodity," and we shall find that there are two more little modifications in the "frame" which I would not make for fear of spoiling its vigor by too much matter of fact, but to which we must when we come to the matter-of-fact subject of ways and means allude. Whilst the air "doesn't cost nothink" "out-dores," it costs as little (not much in proportion to its worth) to get it into the right place, and "git it warm;" and whilst "it ain't much trouble to make a hoal," it requires much thought and time and trouble (and this all means money) to get the "hoals" in the right places for different seasons and under varying circumstances. And it is this question of money combined with a want of proper understanding of the consequences, and of the whole subject indeed, that stays the hands of those who have not yet appreciated the fact that the question at issue is of the value of children's and teachers' brains and bodies *versus* the cost of a few ventilating tubes and the ingenuity required to devise and prepare them—*plus* the cost of fuel and enlarged school-rooms.

First, then, what should be the size of the "hoal" or holes—for it wants some to let the bad air out as well as to let the good air in. This will depend upon the rapidity of currents of air that may be borne, and then again upon whether the air is warmed when introduced; but as a rule about five feet per second may be borne. There are 3,600 seconds in an hour, and we want 3,000 feet of air in that time, *i.e.*, $\frac{5}{6}$ of a foot per second for each individual: this with a current of five feet per second will require one hole per individual to be $\frac{1}{6}$ of a square foot, or 24 square inches; and the same to let out the air. If heated it will have to flow more rapidly, and it may more safely be allowed to do so. Whilst I am speaking of heating, let me dispose of a popular fallacy. I think it is generally supposed that in winter people can more safely crowd together and do with smaller air space than in summer. Unless hot air is heated before it is introduced the reverse of this is true; the air has to "git warm," as one poem has it, and consequently cannot be changed so frequently unless we are to be chilled by it.

The next point in connection with the ventilation of the school-room is the relative position of the inlets and outlets. These relative positions will vary much according to varying circumstances, amongst which may be mentioned the shape and size of the room, the season of the year, the mode of heating. And let me here say that the ventilation and heating of any room must always be considered together. I shall not be able, in the compass of this general paper, to consider minutely all the varying circumstances alluded to. For a fuller description of details of some of the plans to be resorted to I shall refer you to one or two papers within your reach. Some others we may consider somewhat in detail, and there are certain general principles which, if strictly remembered and carried out, will help us much in the consideration of details in each special case. There are four of these general principles that must never be lost sight of:—1. The air brought in must be distributed throughout the whole of the breathing space. 2. It must be of a suitable temperature when it comes in contact with the inmates, and of a suitable degree of humidity. 3. It must be pure. 4. Hot air is lighter than cold. It is of great importance to bear in mind these few principles; it will be found that every defect in ventilation is due to a violation of some one of them.

In many of our school-rooms the feet are in Greenland, whilst the head approaches the torrid zone. The light hot air is at the top of the room, the colder strata below. The air may thus be in a stagnant condition, or an attempt may be made to let the heated and supposedly impure air out by ventilators at the top. And now what happens: in rooms heated by stoves just as soon the air gets enjoyably warm it flies off and away, the lower part of the room being always uncomfortably cold. Following out the principles which I have expressed above, sanitarians in various places seem to have simultaneously hit upon a modification of the Ruttan method, which may be expressed thus:—Cold pure air is conducted so as to impinge upon the stove for heating surface; here it becomes heated and ascends. Meanwhile at the sides of the room and close to the floor are outlets, sometimes funnel-shaped, taking off air from the floor line by means of pipes passing up through the room and connecting with the stovepipe (of which I here show a sample), with the chimney, or with the outside air. The air heated by the stove rises to the ceiling; cooling, it gives way to that which, expanding beneath it, rises to take its place, falls over in fountain form, gradually settling down till it is drawn down and out by the outlet shafts. This plan is illustrated and described in a paper by Dr. Cassidy, to be found at pages 150-1 of the First Annual Report of the Provincial Board of Health, to which any person in this audience can readily refer. You will see that a constant circulation of air is thus carried on. I now proceed to show you a series of diagrams which came to my hand most opportunely whilst preparing this paper. They illustrate a series of experiments by an architect, Mr. Warren R. Briggs, and are published by the State Board of Health of Connecticut. They show how much more a feature than is generally supposed are differences in the relative position of inlets and outlets in providing for the distribution of fresh warm air to all parts of a room. (See reprint in New Hampshire Report, pages 162-167.) I regret that I have not time to enter into other methods of winter ventilation, and modes of introducing and distributing heated air.

I must now turn to methods of ventilating in summer. Even in summer in Canada the air is not often of as high a temperature as our bodies, 98½° F. It is generally much cooler, and becomes heated by contact with us. Hence, put outlets in the top and it will rise to them and away. Then "make a hoal, and all the air will come in of itself." But the "hoal," if not of a particular kind may sometimes allow the air to blow too directly on the teacher's neck, especially if it is already blowing hard out of doors. Hence, the teacher may not despise a few hints as to various devices for breaking up a current of air or directing it above his head, especially if the devices be of such a nature that he can at once introduce them himself.

1. One such may be adopted by raising the bottom sash of the window and filling up the opening with a piece of board. You will not see much gain from this until you remember that a broad air duct has been thus constructed, opening upwards between the two sashes, and directing the current of air upwards.