

size cut out of the lower edge of the back of the rim. This is No. 3; and I have an opening No. 4, running vertically from the middle of No. 1; the size is three inches by five eighths. You observe I keep these numerous entrances closed by slides when not in use. I now suspend in the hive a two quart tin pail of hot water, the pail being coated with blacking on the outside to make the heat radiate more readily. To make the currents of air from the hive easily seen I shall mix the air in the hive with smoke. I open entrances No. 1 and 3, and you see quite a volume of smoke escaping from No. 1; I close No. 3 and open No. 2, and the volume of smoke continues to come from No. 1. By means of a strip of smoking cotton velvet it can be shown that a strong current of air sets into the hive through No. 2. After a little I again close No. 2 and open No. 3, and we still get a dense smoke from No. 1; I suddenly close No. 3, and No. 1 ceases to act, open it again and away goes the smoke. This is like the case of the candle going out in the jar with the reduced opening. No. 3 being still closed I insert a piece of tin into No. 1, dividing it horizontally, just as we inserted the cardboard into the mouth of the jar, and just as occurred in that case, the current sets outwards above the partition and inwards below it. This is more clearly shown when I open the vertical opening No. 4, all the other openings being closed. You now see the smoke pouring out of the upper part of No. 4, while at the same time a strong current is rushing in at the lower part. This is plainly seen when we test the current with the smoking velvet. Open No. 3 and the whole of No. 4 is filled with outgoing smoke; close it again and at once the outgoing smoke is confined to the upper part of the opening.

In ventilating buildings it is found, that in order to get a quantity of air into an apartment, it is necessary to get an equal quantity out, and vice versa. Our experiments teach us that the same rule holds good in regard to the ventilation of hives.

If we had a covered passage from No. 2 to near the back of the hive, like the trench in the tunnel, the air thus introduced would sweep the hive from back to front on its way to the place of exit at No. 1.

But the same object is much more easily obtained by keeping No. 3 open.

I assume that no argument is necessary to show the advantage of having a rim to raise the combs above the bottom board. If it is placed between the hive and the bottom board, the Vaudsen clamps do away with the objection to loose bottom-boards, and the cost per hive is less than six cents. Having a rim we learn from

these experiments that good lower ventilation is most easily obtained by leaving the ordinary fly-hole open above the rim, while at the same time we have an opening in the lower edge of the rim at the back of the hive.

The greatest obstacle to free ventilation of hives by a single opening is the friction of the currents around the edges of the opening, and the friction between the outgoing and the incoming currents. In our experiments we have seen that the friction between the currents themselves is much greater than it is between the currents and a partition separating them.

Since the currents are retarded in proportion to the length of the lines by which they are bounded, the best form for a single opening is that which has the shortest border for a given area, and at the same time the shortest horizontal section, because, as we have seen, the friction between the currents is along a horizontal line. A horizontal fly hole the full width of a Langstrath hive, say 12 inches long and half an inch deep gives an opening six square inches in area with a border 25 inches in length and a line of friction between the currents 12 inches long. A square opening of the same capacity has less than 2½ inches for friction between the currents. A circular opening of the same area has less than 8½ inches for friction about its circumference, and about 2½ inches for friction between the currents, and a vertical opening of the same capacity, say 6 inches high and one inch wide, has 14 inches for border friction, and only one inch for friction between the currents, on account of its height and the small amount of friction between the currents. This form of opening is more efficient for ventilation than any of the others. Leaving dead bees and the debris of the hive entirely out of question, the worst possible form of single opening for lower ventilation is the one which is most convenient as an entrance for the bees, viz: A narrow horizontal entrance at the level of the bottom board. Some of the most intelligent and observing bee-keepers have found this to be the case, and are now making their entrances deeper. A few years ago Dr. Tinker made his entrances half an inch deep, the hives being sealed at the top. Now he finds that to secure the best results in outside wintering, he must have the entrance 1½ inches deep by 8½ inches long.

But all are not agreed that it is the best way to have hives hermetically sealed at the top and ventilated below only. Probably a large majority of bee-keepers either favor direct upward ventilation, that is air admitted at the entrance and passed out at an opening for the purpose somewhere in the top, or more slowly passed off through what are often improperly called absorb-