still in operation, and which infringe the most simple natural laws, that is to say, a veritable collection of the monstrosities of furnace design.

The Subdivision of a Current of Hot Gas.—Assume that the current of hot flowing gas Q, which is giving off heat or cooling, is to be divided between two vertical ascending channels, q_1 and q_2, this division to be effected in the manner shown in Fig. 45. The veins of gas q_1 and q_2 are at temperatures t_1 and t_2 and $q_1 = q_2$ and $t_1 = t_2$. Assume that during the operation of this system the amount of heat lost from the branch q_1 is a little greater than the amount of heat lost from the branch q_2 and that, accordingly, the temperature t_1 becomes slightly less than t_2. When $t_2 > t_1$, the

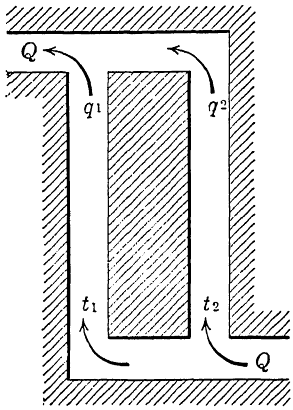

FIG. 45.

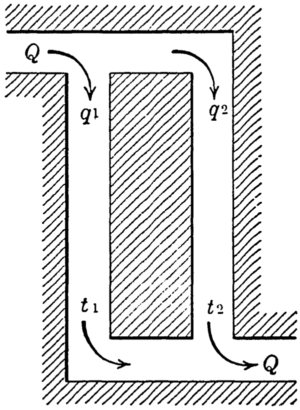

FIG. 46.

weight of the column of gas q_1 becomes greater than that of the column of gas q_2, and accordingly the velocity of the current q_1 will become less than that of the current q_2. The decrease of the velocity of the current of gas q_1 results in a further lowering of its temperature t_1; in other words, the velocity of the current of gas q_1 will continue to diminish, and its temperature t_1 will continue to decrease. During this time the velocity of the current of gas q_2 will, on the contrary, be increased, and its temperature will become higher. The current of gas q_1 will finally cease to flow and the entire volume of the current of gas Q will then pass through the branch q_2. But there will still be a loss of heat from the channel q_1 and after the velocity of this current has decreased to zero it will reverse and travel in the opposite direction, as is indicated in Fig. 47. From the preceding, it may be readily seen that *a current of hot gas which is giving off heat or cooling cannot be subdivided into equal ascending currents.*

When, however, the attempt is made to subdivide the current of gas Q into two equal *descending currents* (Fig. 46), it will be completely successful.

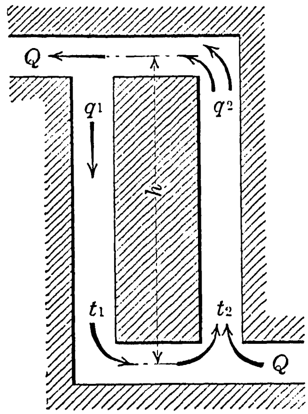

FIG. 47.

Assuming, for example, that the temperature of one of these currents, q_1, should become less than the temperature of the current q_2. In this case the weight of the column of gas q_1 will be increased, and the velocity of its descending motion will be increased. The current of gas q_1 will become stronger than q_2, its temperature will gradually increase and it will finally become equal to q_2. It can be concluded from this that the problem of subdividing a current of gas which is cooling or giving off heat into equal descending channels may be solved in a very simple manner, owing to the fact that there is always a tendency for the temperatures of these descending streams to remain uniform.

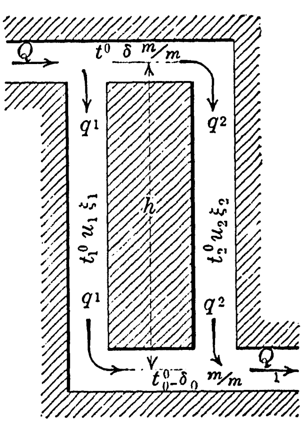

FIG. 48*a*.

Therefore, *if it is desired to subdivide a current of hot gas which is cooling or giving off heat, into equal streams, it is necessary to give these streams a downward or descending direction of flow; or, in other words, a current which is cooling may be subdivided into uniform descending streams.*(1)

(1) Accordingly, it is possible to approximate the frictional resistance in the two channels between which the current is divided, when one branch has a higher resistance or a higher heat loss than the other, because the stream of gas divides itself accordingly.

In Fig. 48*a*, such a case is shown. The stream of gas Q is divided into two descending streams q_1 and q_2, the average temperatures of which are different, being denoted by t_1 and t_2. The average

It is frequently necessary to subdivide a current of cold air or gas which is being heated, as in the hot-blast stove or in furnace regenerators. This problem may be solved as follows: Figs. 48 and 49 show a current of a cold gas circulating through a channel, having walls heated to incandescence. Assume that the stream of cold gas being heated has been equally divided between two

velocities of these two streams are denoted by u_1 and u_2 and the friction in the two branches in millimeters of water is ξ_1 and ξ_2.

The condition necessary for the maintenance of equilibrium, in this case, is that the increase of the hydrostatic pressure in the two branches q_1 and q_2 shall be equal. If there were no loss of hydrostatic pressure in impressing the velocities u_1 and u_2 upon the two branches and in overcoming the frictional resistance ξ_1 and ξ_2 of the two channels to the passage of the gas, the hydrostatic pressure in millimeters of water in the channel q_1 of a height h would be, taking 1.29 kg as the weight of a cubic meter of the furnace gas at 0°

$$1.29h\left[1-\frac{1}{1+\alpha t_1}\right]=1.29\cdot h\cdot\frac{\alpha t_1}{1+\alpha t_1}.$$

For the branch q_2, the hydrostatic pressure would be

$$1.29\cdot h\cdot\frac{\alpha t_2}{1+\alpha t_2}.$$

A part of these increases in the hydrostatic pressure will be expended in overcoming the frictional resistances ξ_1 and ξ_2, and in impressing the velocities u_1 and u_2 upon the columns of gas. These last losses, in millimeters of water, may be expressed in the following manner:

$$\frac{u_1^2}{2g}\times\frac{1.29}{1+\alpha t_1} \quad\text{and}\quad \frac{u_2^2}{2g}\times\frac{1.29}{1+\alpha t_2},$$

and the condition for the equality of the increases in hydrostatic pressure in the two branches is given by the following equation:

$$1.29h\cdot\frac{\alpha t_1}{1+\alpha t_1}-\xi_1-\frac{u_1^2}{2g}\cdot\frac{1.29}{1+\alpha t_1}=1.29h\cdot\frac{\alpha t_2}{1+\alpha t_2}-\xi_2-\frac{u_2^2}{2g}\cdot\frac{1.29}{1+\alpha t_2}.$$

In this equation there are six variables; five of these must be known in order to fix the value of the sixth.

For example, the checker openings around the outside of the checker-work of a Cowper hot-blast stove lose a great deal more heat by radiation and by the cooling effect of the outside of the stove than the central passes. By reason of this they have a much greater cooling effect upon the current of hot gases, and therefore the current of gases flowing downward through these openings is reinforced, since if $t_2<t_1$, $u_2>u_1$. By measuring t_2 and t_1, it is not difficult to find $\frac{u_1}{u_2}$.