A problem of theoretical and practical importance is to determine the air-flow direction in a ventilation drift. Most methods of analyzing ventilation networks are based on the assumption that the direction of motion of the air is given, or can be found by preliminary analysis. Analysis of a ventilation system therefore generally begins with determining the directions of the air currents.

For determining the directions of the air currents, a number of methods have been suggested, and are widely used in analyzing ventilation networks [1-3]. However, as I shall show, these methods sometimes give incorrect results which invalidate the subsequent calculations.

I shall demonstrate the incorrectness of present methods by taking as an example a two-diagonal junction.

Let us consider one of the most widely-used methods, suggested by A. S. Popov [1], for analyzing a complicated diagonal junction. It reduces essentially to determining the air-flow direction in the diagonal workings from the ratios of the resistances of the adjacent workings.

For the two-diagonal system shown in Fig. 1, there are four possible combinations of the ratios of these resistances:

\[
\frac{R_1}{R_2} > \frac{R_3}{R_4} > \frac{R_5}{R_6} \quad (1)
\]

\[
\frac{R_1}{R_2} < \frac{R_3}{R_4} > \frac{R_5}{R_6} \quad (2)
\]

\[
\frac{R_1}{R_2} > \frac{R_3}{R_4} > \frac{R_5}{R_6} \quad (3)
\]

\[
\frac{R_1}{R_2} < \frac{R_3}{R_4} < \frac{R_5}{R_6} \quad (4)
\]

It is characteristic that these expressions do not occur in the resistances of the diagonal branches. If we assume that the air-flow directions in the diagonals are opposite, Popov shows that the resistance ratio must obey (1) or (2). If, on the other hand, the air-flow directions in the diagonals are the same, we are forced to agree with the author's conclusion that this can occur only if (3) or (4) holds.

Thus Popov establishes necessary conditions for differently directed air flow in the diagonals, (1), (2), and sufficient conditions for identically-directed flow, (3), (4). However, (1)-(4) can be used to determine the direction

![Fig. 1. Two-diagonal junction of ventilation drifts.](image)
of air flow in a diagonal network only if we can show that all the conditions are sufficient. In fact, the fact that (1) or (2) is obeyed when the air flows in the diagonals are differently directed does not lead to the conclusion that the converse is true: it does not follow that, if the resistance ratio of the ventilation network obeys (1) or (2), there will be one of the corresponding cases of differently-directed motion. It is therefore of interest to find sufficient conditions to determine the directions of the air currents in the diagonal branches.

For convenience, let us use the symbol a to denote the cases when current $q_7$ flows from intersection 2 to intersection 1, and b to denote the cases when it flows from intersection 1 to intersection 2; similarly, indices c and d will correspond to flow of $q_8$ from 3 to 4 and from 4 to 3, respectively.

1. Consider case ad. Here

\[
\begin{align*}
    h_1 &= h_7 - h_2 = 0; \\
    h_7 + h_3 &= h_5 - h_4 = 0; \\
    h_6 + h_5 &= h_8 = 0,
\end{align*}
\]

where $h_i$ is the depression in the $i$-th branch. For the given air-flow directions in the diagonals $h_7 > 0, h_5 > 0$. Consequently $h_1 > h_2$ and $h_5 > h_6$.

The ratio of depressions $h_3$ and $h_4$ is indeterminate: we may have either $h_7 > h_5$, or $h_5 \leq h_7$.

Thus the ratios of the depressions in all the branches of the system are determined by the following systems of inequalities:

<table>
<thead>
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<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$R_1 &gt; R_3 &gt; R_5$</td>
<td></td>
<td>ad</td>
</tr>
<tr>
<td>2</td>
<td>$R_1 &lt; R_3 &lt; R_5$</td>
<td></td>
<td>bc</td>
</tr>
<tr>
<td>3</td>
<td>$R_1 &gt; R_3 &gt; R_5$</td>
<td>$R_3 &lt; R_1 &gt; R_3 + R_5$</td>
<td>$R_3 &lt; R_6 &gt; R_1 + R_6$</td>
</tr>
<tr>
<td>4</td>
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<td>$R_3 &lt; R_6 &lt; R_1 + R_6$</td>
<td>a?</td>
</tr>
<tr>
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<td>$R_3 &lt; R_6 &gt; R_1 + R_6$</td>
<td>?c</td>
</tr>
<tr>
<td>6</td>
<td>$R_3 &gt; R_1 &lt; R_3 + R_5$</td>
<td>$R_3 &lt; R_6 &lt; R_1 + R_6$</td>
<td>bd</td>
</tr>
<tr>
<td>7</td>
<td>$R_3 &gt; R_1 &gt; R_3 + R_5$</td>
<td>$R_3 &lt; R_6 &gt; R_1 + R_6$</td>
<td>b?</td>
</tr>
<tr>
<td>8</td>
<td>$R_3 &gt; R_1 &gt; R_3 + R_5$</td>
<td>$R_3 &gt; R_6 &lt; R_1 + R_6$</td>
<td>?d</td>
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