Platinum resistance thermometers provide the most accurate temperature indication, but the accuracy is not always as high as is needed, in spite of use of the best instruments. The components of the error must be established before the error can be reduced. The error includes the following: 1) error of the thermometer itself; 2) effects from the leads; 3) error of the secondary instrument. The second of these is zero if the resistance is measured with a potentiometric device. If a bridge method is used, suitable choice of the bridge elements can often reduce this error to a level where the results are virtually unaffected. The error from the secondary instrument can have a relatively large effect, but this can be reduced by use of a more accurate instrument and by reducing the range of the measurements. The error \( \delta_{\text{res}} \) introduced by the resistance transducer itself is

\[
\delta_{\text{res}} = \delta_{R_0} + \delta_{R_1} + \delta_{\text{heat}},
\]

in which \( \delta_{R_0} \) arises because \( R_0 \) (resistance at 0°C) differs from the nominal value, \( \delta_{R_1} \) is due to deviation of \( R_{100}/R_0 \) from its nominal value, and \( \delta_{\text{heat}} \) is due to the heating by the measuring current.

The errors of (1) have been examined in detail [1], and formulas have been given for \( \delta_{R_0} \) and \( \delta_{R_1} \) in terms of the deviations of \( R_0 \) and \( R_{100}/R_0 \) from their nominal values. Also, suggestions are made as to the choice of measuring current, which produces a rise of \( \Delta T \)°C in a given temperature range. The \( \delta_{\text{res}} \) for 0-25°C for grade II thermometers is then 2.2% (when the thermometer receives the 10 mW permitted by the State Standard). The range 0-25°C is the minimal one for standard automatic instruments, but often the range 0-10°C or less has to be covered, and the error due to \( \delta_{\text{res}} \) correspondingly increases as the range is narrowed.

It is not realistic to propose to reduce \( \delta_{R_0} \) and \( \delta_{R_1} \) by more accurate manufacture, so thermometers should be calibrated and limits set for the deviation of \( R_{100}/R_0 \) from nominal for class II, but \( R_0 \) and \( R_{100}/R_0 \) should be measured with an accuracy higher by at least an order of magnitude, while the secondary instrument should make allowance for inaccurate calibration and for the deviation of \( R_{100}/R_0 \) from nominal. Here this problem is considered in relation to an unbalanced bridge system whose output voltage is measured by a null method.

The following expression describes the temperature dependence of the resistance of a platinum thermometer for nominal values \( A, B, \) and \( R_0 \) of the parameters:

\[
R_t = R_0 (1 + At + Bt^2).
\]

In practice we have \( R_0 \) and \( R_{100}/R_0 \). A parabola whose axis is vertical is defined by three points, whereas measurements gives us only the two quantities \( R_0 \) and \( (R_{100}/R_0)_a \), so it is desirable (especially for narrow ranges of measurement) to assume that \( B \) does not alter, since it has little effect on the shape of the curve. Then we can put

\[
R_t = R_0 (1 + At + Bt^2),
\]

for a device with maker's data, in which \( R_0 = R_0 - \Delta R_0 \) is the actual value of \( R_0 \) and \( A = A_N - \Delta A \) is the actual value of \( A \).

We can determine \( \Delta A \) from

\[
\frac{R_t}{R_0} = 1 + At + Bt^2 - \Delta At,
\]
\[ \Delta A = \frac{1}{t} + A + Bt - \frac{1}{t} \left( \frac{R_t}{R_0} \right). \]  

Substitution for \( A, B, \) and \( t = 100\,^\circ C \) gives

\[ \Delta A = 0.01 \left[ \left( \frac{R_{100}}{R_0} \right) \frac{N}{\left( \frac{R_{100}}{R_0} \right) a} \right] \deg^{-1}. \]  

The thermometer's parameters are allowed for by correcting the measuring circuit at \( t_1 \) and \( t_2 \) (start and end of the measurement range). The error due to \( \delta_{res} \) can be reduced further by correction at points some way from the start and end. In Fig. 1, correction at the start is provided by adjustment of the resistance of one arm, while correction at the end is provided by adjusting the supply voltage. The correcting device \( r_{kl} \) is designed to adjust the resistance \( R_3 \) of the arm in accordance with the actual resistance of the transducer at \( t_1 \). The correcting elements \( r_1, r_2 \), and \( r_{kl} \) are chosen such that the slider in the corrector should be in the middle position for a transducer whose maker's calibration values do not differ from the nominal ones. If \( R_3 \) is relatively high, \( r_1 = \infty \) is possible (series correction). The end readings on the scale correspond to the minimum and maximum possible values of the resistance at \( t_1 \). For instance, a class \( \Pi \) instrument with \( R_0 = 100 \Omega \) would have end readings representing 99.90 and 100.10 \( \Omega \) at \( t_1 = 0\,^\circ C \) and 109.72 and 109.99 \( \Omega \) at \( t_2 = 25\,^\circ C \). Resistance \( r_2 \) in series with \( r_{kl} \) reduces the effects of variations in contact resistance in the slider and enables one to give the correcter an almost linear scale. In a similar way we calibrate the scale of corrector \( r_{kl} \), which adjusts the output voltage \( U \) to its nominal value at \( t_2 \).

To derive \( r_1, r_2, r_3, \) and \( r_4 \) for given \( r_{kl} = r_{kl} \) we need to know what \( R_0 \) and \( R_3 \) should be when \( \Delta R_0 \) and \( \Delta A \) take their maximal values. We can determine \( R_{3\text{max}} \) from the balance condition:

\[ R_{3\text{max}} = \frac{R_0 R_4}{(R_0 - \Delta R_0) \left( 1 + A \frac{t_1^2}{1 + Bt_1^2 - \Delta A} \right)}. \]  

Also, \( r_1 \) and \( r_2 \) are given by

\[ \frac{r_1 (r_3 + 0.5r_k)}{r_1 + r_2 + 0.5r_k} = R_3, \]  

\[ \frac{r_1 (r_2 + r_k)}{r_1 + r_2 + r_k} = R_{3\text{max}}, \]  

so

\[ r_2 = -0.75r_k \pm \sqrt{0.5r_k \left( 0.125r_k + \frac{R_{3\text{max}} R_3}{R_{3\text{max}} - R_3} \right)}. \]