6. Various Correction Circuits

A conceptual diagram of load cell circuit was shown in Figure 2.12. However, a diagram of an actual load cell would be more similar to the load cell circuit shown in Figure 2.13 below.

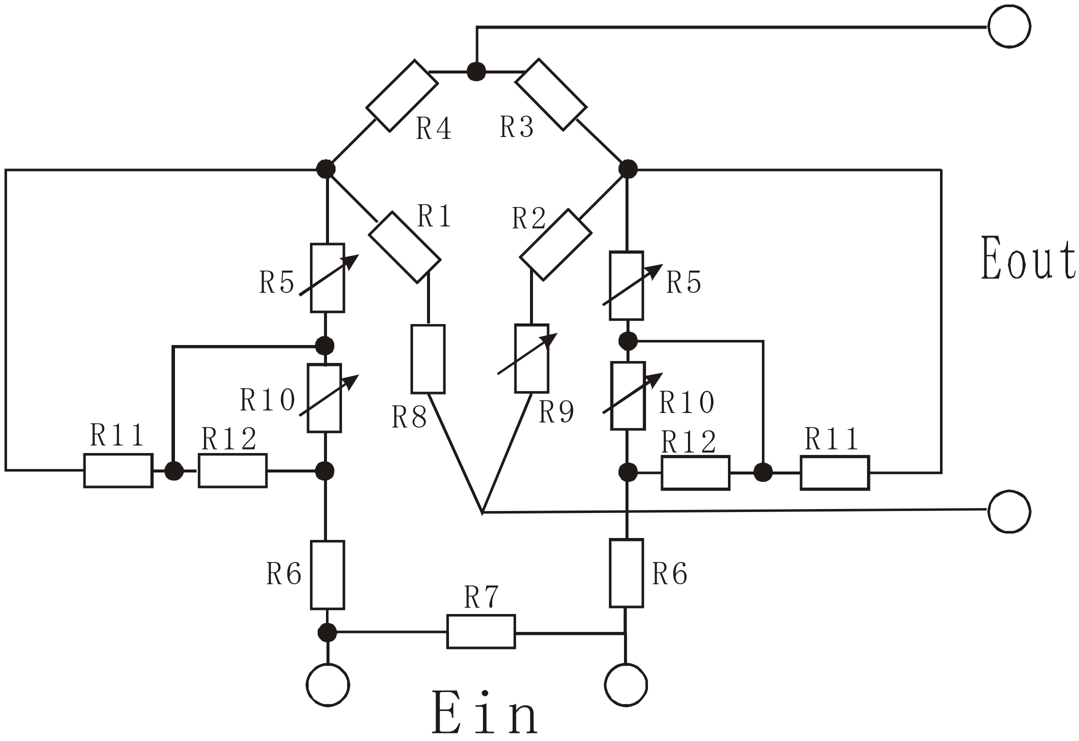

Figure 2.13. Load cell circuit

Various resistors are attached in order to adjust the output sensitivity, the temperature, etc. in order for the load cell to satisfy its specifications. Let's examine the purpose and type of each resistor.

R_1 ~ R_4 are strain gauges and **R_5** and **R_{11}** are resistors that compensate for temperature changes that influence the output voltage. The factors that have the most significant effect on the output voltage relating to temperature are temperature changes in the elastic coefficient of the spring material (approx. -0.003%/˚C for irons, approx. -0.07%/˚C for aluminum alloys) and temperature changes of the gauge factor of the spring gauge.

In order to compensate for errors caused by temperature in the output voltage of the load cell, an element whose resistance value varies with changes in temperature is connected to R_5. The amount of current—which corresponds to changes in output caused by the special temperature characteristics of the gauge factor of the strain gauges and the Young modulus of the spring material—is adjusted.

Materials that have a large, positive temperature resistance coefficient, such as pure nickel or copper, are normally used for resistance temperature detectors. R_{11} is a fixed resistor and used to adjust the linearity of R_5, etc.

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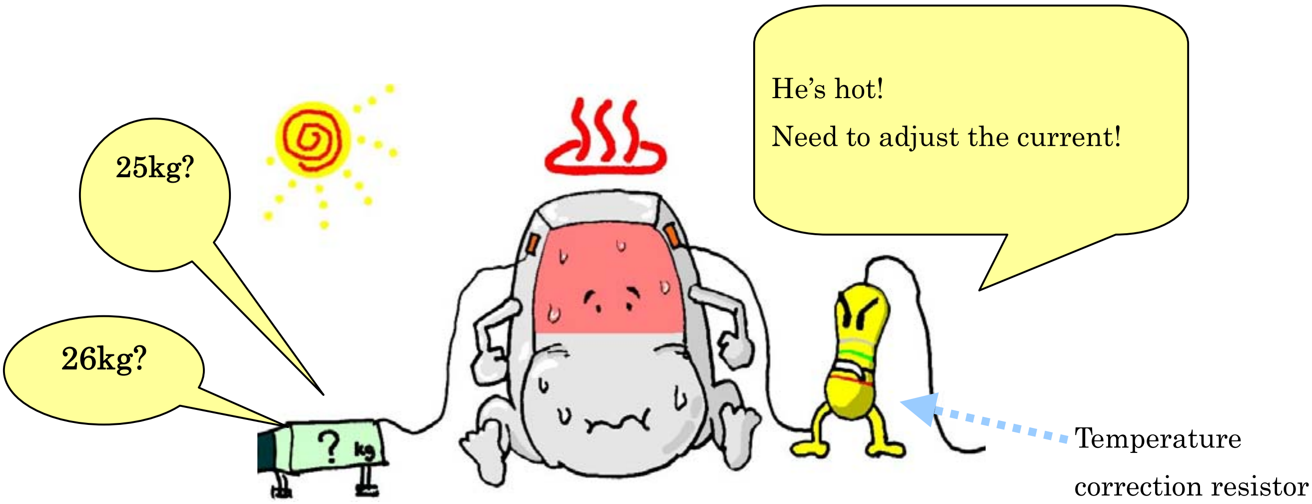
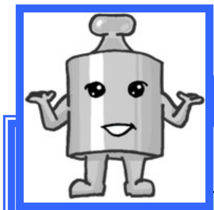


R_{10} and R_{12} are resistors for correcting the non-linearity of the output voltage. Column load cells are often used for weighing systems with a large capacity. However, since the cross-sectional area of the spring material changes when a force is applied, a linearity error will occur. Thus, in addition to strain gauges, other elements that can detect the stress of the spring material are also attached. As such, the linearity of the output voltage of the load cell can be corrected by automatically adjusting the current that runs through the bridge circuit. For R_{10}, semiconductor gauges are often used. R_{12} is a fixed resistor and used to adjust the linearization of R_{10}, etc.

R_8 is a resistor that is used to adjust the zero balance. When $R_1 = R_2 = R_3 = R_4$, the output voltage should theoretically be zero, but in actuality there is a variation of approximately ±0.5Ω between $R_1 = R_2 = R_3 = R_4$. Therefore the zero-point output is uneven. Thus, the zero balance will be kept at a fixed value by placing some form of fixed resistance in the bridge.

R_9 is a resistor used to adjust a zero-point change due to temperature. The zero-point change of load cells can be attributed to the heat expansion or compression of the spring material. To prevent this error, self-temperature compensation gauges are used. These gauges reduce errors even though the ambient temperature changes. A resistor with a large temperature coefficient is used for this correcting resistor.

R_6 are fixed resistors for adjusting the output sensitivity, and **R_7** for adjusting the input resistance.



A load cell engineer says

A&D is capable of performing various types of corrections using software to reduce costs while simultaneously improving accuracy (such as creep correction). This is possible only because A&D is an integrated manufacturer of display circuits, strain gauges, and load cells.

Mr. K