1. Safety instructions

- Do not exceed a maximum permissible voltage of 8 V.
- Do not exceed a maximum permissible current of 1.5 A.

2. Description

The resistance bridge is used in determining the resistance in bridge circuits as well as in investigating the voltage drop along a wire. The device consists of a rail with scale mounted on two bases with a resistance wire. A slide contact, is attached on top of the resistance wire. This defines the resistances $R_1$ and $R_2$ (see Fig. 1).

3. Technical data

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
<td>approx. 1300x100x90 mm³</td>
</tr>
<tr>
<td>Rail</td>
<td>approx. 30x30 mm²</td>
</tr>
<tr>
<td>Scale</td>
<td>0 – 1000 mm</td>
</tr>
<tr>
<td>Scale divisions</td>
<td>mm</td>
</tr>
<tr>
<td>Resistance wire</td>
<td>1 m, 0.5 mm diam.</td>
</tr>
<tr>
<td>Material</td>
<td>NiCr</td>
</tr>
<tr>
<td>Resistance</td>
<td>5.3 Ω</td>
</tr>
<tr>
<td>Connection</td>
<td>4 mm safety jacks</td>
</tr>
<tr>
<td>Maximum voltage</td>
<td>8 V</td>
</tr>
<tr>
<td>Maximum current</td>
<td>1.5 A</td>
</tr>
</tbody>
</table>

4. Operating principle

In order to determine a resistance a Wheatstone bridge circuit is set up (see Fig. 1).

To do this a resistance wire of length $l = l_1 + l_2$ and with specific resistivity $\rho$ (Ωm) is connected into a circuit consisting of the resistor $R_X$ to be measured and a known resistor $R_0$. A DC volt-
age $U$ is applied to this circuit. The ammeter is used to measure the current flowing between the point D and the moveable tapping point C located on the resistance wire.

The partial resistances of the wire $R_1$ and $R_2$ can be varied using the slide contact on the resistance wire.

Now it is important to calibrate the measurement bridge, i.e. to adjust the slide contact so that there is no voltage between points C and D and thus a current no longer flows. The partial resistances are:

$$R_1 = \rho \frac{l_1}{F} \quad \text{and} \quad R_2 = \rho \frac{l_2}{F}$$

whereby $F$ is the cross-sectional area of the wire.

For the resistance ratios the following then holds true:

$$\frac{R_X}{R_0} = \frac{R_1}{R_2} = \frac{l_1}{l_2}$$

From this we can deductively compute the unknown resistance:

$$R_X = R_0 \cdot \frac{l_1}{l_2}$$

The resistor $R_0$ should be selected so that upon calibration of the bridge $l_1$ and $l_2$ are approximately equal, in order to keep the error to a minimum.

5. Sample experiments

5.1 Determining resistance in a Wheatstone bridge circuit

Additionally required:
1 AC/DC Power Supply 12 V, 3 A (230 V, 50/60 Hz) 1002776
or 1 AC/DC Power Supply 12 V, 3 A (115 V, 50/60 Hz) 1002775
1 Zero Galvanometer CA 403 1002726
1 Resistance Decade 1 Ω 1002730
or 1 Resistance Decade 10 Ω 1002731
or 1 Resistance Decade 100 Ω 1002732
1 Incandescent lamp with socket
8 Experiment cables (500 mm)
1 Switch (optional)

- Connect up the experiment setup as illustrated (see Fig. 1).
- An incandescent lamp is used as the unknown resistance.
- A voltage of 4 to 6 V is applied.
- Close switch K and slowly move the slide contact from A to B to A again.
- At the same time observe the deflection of the ammeter. When the pointer deflection in the proximity of point A is zero, this means that the value of $R_0$ is very high and that it must be reduced. If the zero value is in the proximity of point B, then the value of $R_0$ is too low and must be increased.
- Select the $R_0$ value so that when the power is switched on again the pointer of the ammeter does not deflect when the slide contact is in the middle of the wire, i.e. the measurement bridge is calibrated.
- If there is no appropriate resistance available, use a resistor $R_0$, for which the pointer's deflection is smallest and then carry out the calibration.
- Obtain readings of partial lengths of the resistance wire.
- Repeat the experiment with varied voltage levels, enter your findings in a table and compute the resistance $R_X$.

5.2 Determine the specific resistivity $\rho$ of a wire

- Experiment set-up according to Fig. 1, but this time use a resistance wire with a length from 1 to 3 m instead of the incandescent lamp.
- Measure the length \( l \) and diameter \( d \) of the wire used and from this compute the cross-sectional area \( F \).
- Determine the resistance \( R_x \) as described under 5.1.
- For computed resistance \( R_x \) the following is true:

\[
R_x = \rho \cdot \frac{l}{F}
\]

Whereby \( \rho \) is the specific resistivity, \( l \) is the length of the wire in m and \( F \) is its cross-sectional area in m\(^2\).

- The following is true for its specific resistance:

\[
\rho = R_x \cdot \frac{F}{l}
\]

- Repeat the experiment with various voltages and wires of varying lengths, enter the data into a table and work out the mean value.

Fig. 2 Determining resistance in a Wheatstone bridge circuit