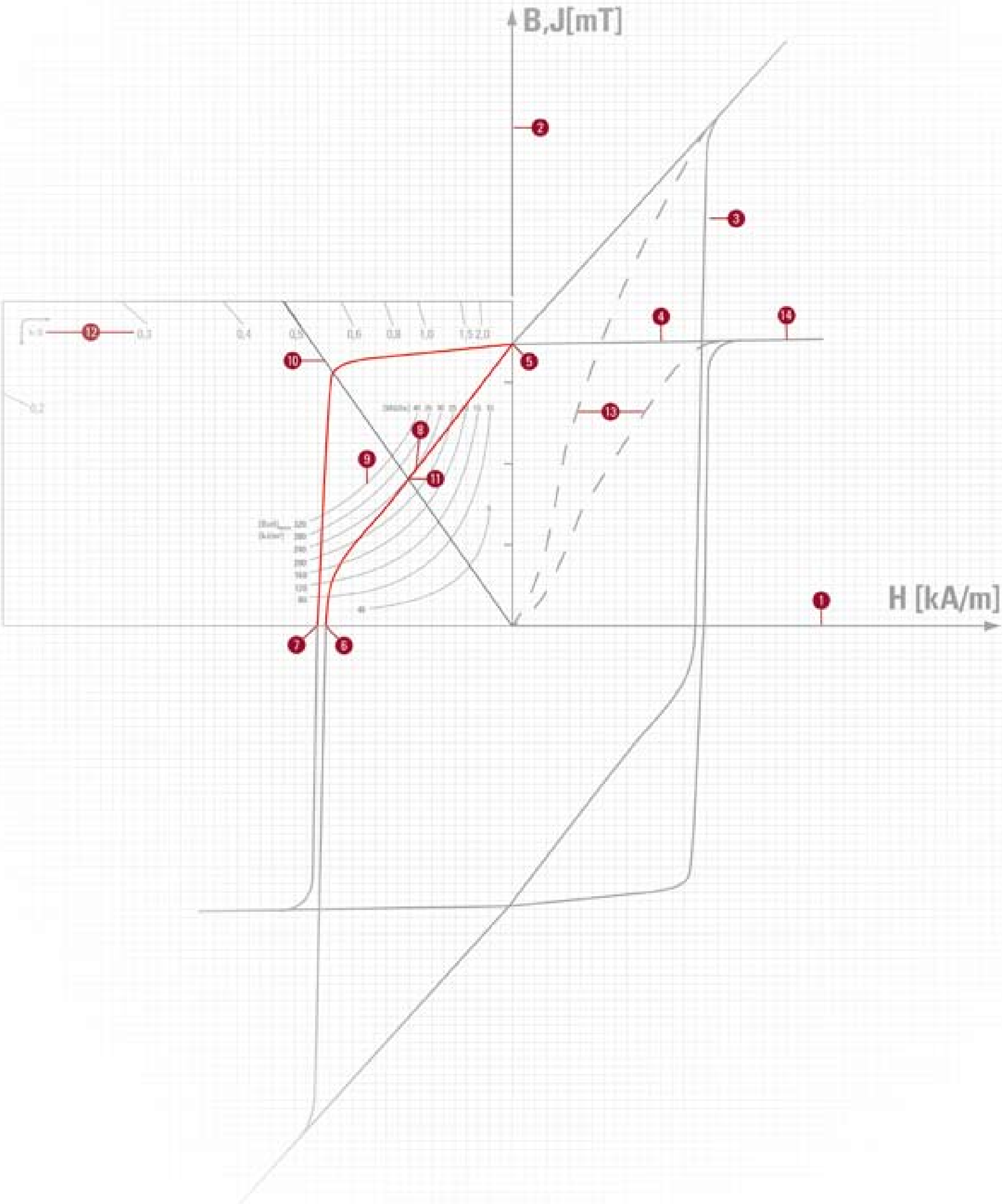

A hysteresis loop is a plot of magnetic induction B and magnetic polarisation J as a function of the magnetic field strength H.

The first quadrant shows the behaviour of the material when it is being magnetised. When an external magnetic field of strength H is applied, the magnetic moments are oriented parallel to this field. When all magnetic moments are oriented, the magnetisation is said to be saturated.

The second quadrant of the hysteresis loop is the demagnetisation curve. The shape of the demagnetisation curve and its initial and final points, giving remanence B_r and coercivity H_c, represent the most important magnetic properties of a permanent magnet. All curves in the figures of this brochure show average values of quantities.

The B and J curves in the third and fourth quadrant are the same as in the first two quadrants, reflected through the origin. Here the magnetisation is rotated by 180 °C (in the opposite direction).

1 **X axis: Magnetic field strength H [kA/m]**
The x axis gives values of the external magnetic field strength H.

2 **Y axis: Magnetic flux density B/Magnetic polarisation J [mT]**
The y axis gives values of the magnetic flux density B in the magnet and the magnetic polarisation J.

3 **B curve: Magnetic flux density (magnetic induction) B [mT]**
The B curve shows the magnetic flux density B in the magnet, depending on the externally applied magnetic field strength.

4 **J curve: Magnetic polarisation J [mT]**
The J curve shows the contribution of the magnet material to the magnetic flux density, depending on the externally applied magnetic field strength ($J = B - \mu_0 \cdot H$).

5 **Remanence B_r [mT]**
The remanence B_r is the remaining magnetisation in a magnetic material at field strength H = 0 kA/m, after it has been magnetised to saturation in a closed path.

6 **Coercivity H_{cB} [kA/m]**
The coercivity H_{cB} is the magnetic field strength required to bring the magnetic flux density back to 0 in a ferromagnetic material which has been magnetised to saturation.

7 **Coercivity H_{cJ} [kA/m]**
The coercivity H_{cJ} is the magnetic field strength required to bring the polarisation back to 0 in a ferromagnetic material which has been magnetised to saturation.

8 **Energy product $(B \cdot H)_{max.}$ [kJ/m³]**
The figure shows hyperbolas 9, whereby all points on any hyperbola have the same energy product B · H (product remains constant). The hyperbola tangent to the B curve has the maximum energy density $(B \cdot H)_{max.}$.

10 **Operating load line**
The operating load line describes the properties of the magnetic loop. Its angle depends on the magnet geometry and the magnetically soft pole pieces used. If a permanent magnet has no surrounding iron, the angle of the operating load line depends only on the magnet geometry. In systems with magnetically soft pole pieces, the angle of the operating load line depends on the relationship of the air gap to the magnet's length. When an external magnetic field ($H \neq 0$) is applied, the new operating load line is displaced parallel to the former one.

11 **Operating point**
The operating point is defined as the intersection of the operating load line and the B curve. It is the point on the demagnetisation curve whose coordinates are the magnet's magnetic flux density and the magnetic field strength in an operating state. The operating point of a permanent magnet must always be in the linear region of the demagnetisation curve, taking the effects of temperature (temperature coefficients of B_r and H_{cJ}) and external opposing fields into account. If the operating point comes into the nonlinear region near the knee, the magnet will become partially demagnetised (irreversible losses).

12 **Length-to-diameter ratio h : D**
In our figures, there are auxiliary lines for determining the operating load line of a disc magnet without surrounding iron. To construct the operating load line, connect the origin of the graph with the factor h : D. The factor h : D describes the ratio of the height to the diameter of the magnet. Note that the angle of the operating load line varies within a magnet; our figures show average values. For a very small h : D ratio (< 0.3) one should take into account that the operating point in the centre of the magnet is much lower than the average value.

13 **Initial curve**
An initial curve shows the magnetic flux density (or the magnetic polarisation), as a function of the externally applied magnetic field strength, for the initial magnetisation of a magnet.

14 **Saturation polarisation**
When a magnet is fully magnetised, the polarisation does not continue to increase with increasing field strength.