

#### 4.4.2 Cunife-Magnets

Alnico is a very hard and brittle material, which can be machined only with considerable effort. Cutting a screw thread is not possible with ordinary tools. However, this was exactly what Leo Fender wanted when the former Gibson developer Seth Lover built the Fender humbuckers for him: The cylinder magnets had to be adjustable in height by a thread. Cunife, a copper-alloy with an addition of Fe and Ni, which was developed 1937 by Neumann, Buechner and Reinboth in Germany was employed as an alternative to Alnico. The alloy constituents are melted, rapidly cooled and cold-formed. Optimum magnetic parameters are achieved with cold-formed 5 mm diameter wire; this is by chance exactly what is needed as the diameter for pickups with single magnets. The cold-forming yields a heavily anisotropic material with maximum field efficiency in the longitudinal direction. The magnetic parameters are similar to that of Alnico-III.

Cunife (also called **Cunife-1**) consists of 60% Cu, 20% Ni and 20% Fe. The remanence obtained is 5.4 – 5.7 kG, the coercivity 500 – 590 Oe (40 – 47 kA/m) and the maximum energy density 1.3 – 1.85 MGOe (10 – 15 kJ/m<sup>3</sup>), which is somewhat higher than for Alnico-III. In addition there is also a **Cunife-2**-alloy with a small amount of cobalt: 50% Cu, 20% Ni, 27,5% Fe, 2,5% Co. This alloy should not be mixed up with Cunico, which has a much higher Co content. Cunife-2 will give higher remanence values at lower coercive field strengths and is, thus, rather unsuitable for pickups.

The big advantage of Cunife is its low **hardness**: The specification sheets in [22, 23] state a Rockwell hardness of B200. However, the B-Rockwell hardness is only specified up to a maximum of 100, so maybe Brinell hardness is meant, instead of the designation ‘Rockwell hardness’. The Brinell hardness measurement can only be used for measurements of soft and medium-hard substances and 200HB is characteristic for the lower end of non-hardened steels. The Rockwell Hardness employs a diamond cone (C = cone) and is adequate for harder materials. 45 HRC characterizes the upper end of non-hardened steels, 60 HRC is characteristic for hardened steels. Threads cannot be cut into hardened steel but they are possible in non-hardened steel.

Cunife-magnets have not been widely used. The most famous protagonist is built into Fenders Custom and Thinline Telecasters. It was developed by Seth Lover after he moved from Gibson to Fender in 1967.

Spec. resistance of Cunife-1: 0.185 Ωmm<sup>2</sup>/m; Alnico has a 3 – 4 times higher resistance.

Density of Cunife-1: 7.8 g/cm<sup>3</sup>, comparable to Alnico.

The relative reversible permeability of Cunife-1 is close to 1, i.e. smaller than for Alnico.

The magnetic properties of Cunife are strongly dependent on the individual production process (cold drawing, annealing), Fig. 4.11 shows approximate values for the *B/H*-curve.