

## Chapter 10

# Machine Shop Steel Metallurgy

*Success is simply a matter of luck.  
Ask any failure.*

—Earl Wilson

### Introduction

The hardening and softening of metals using heat is essential to making the tools and products of the modern world, from kitchen knives to jet engine blades. Because steel is the most common material heat-treated, as well as the most often used metal in the machine shop, this chapter focuses on steel.

Metallurgy and heat-treatment is a complex subject. Metallurgists, physicists, and heat-treat specialists often spend a lifetime in its study, so it is not possible to completely cover the subject in this chapter. For critical or complex applications, professional guidance and equipment are essential. However, there are several important heat-treating tasks that can be done in the machine shop with limited equipment, and we will cover these tasks.

This chapter looks at the crystalline structure of metals and explains why steel can be hardened using heat. It reviews practical aspects of heating, quenching, tempering, and annealing steel. The equipment needed to perform these processes, and their advantages and limitations are explained, as are common heat-treatment problems and their solutions. Several types of tool steels, which the machinist can readily heat-treat, are detailed. In addition, the uses and differences between drill rod, drill blanks, and reamer stock are discussed, along with their common alloys.

There are other uses for heat in the shop too: annealing work-hardened copper and brass, softening metals to bend them, soldering and brazing, and expanding parts prior to slipping them over other parts. These operations are easily done and offer practical solutions and alternatives to the machinist.

There is also an explanation of metal fatigue and the steps to avoid it.