

CHAPTER IV.

ON THE PRINCIPLES OF THE ACTION OF CUTTING TOOLS.

476. **General Explanations.**—In making the bearing and working surfaces of the parts of a machine, it is only a rough approximation to the required figure that can be obtained by casting, by forging, or by pressure. The precision of form which is essential to smooth motion and efficient working is given by means of cutting tools. The object of the present chapter is to give a brief statement of the principles upon which the action of such tools depends. For detailed information respecting them, reference may be made to the second volume of Holtzapffel's *Treatise on Mechanical Manipulation*, extending from page 457 to page 1025, and to Mr. Northcott's *Treatise on Lathes and Turning*; and for a very clear summary account of their nature and use, to an Essay by Mr. James Nasmyth, published at the end of the later editions of Buchanan's *Treatise on Millwork*.

The appendix to Holtzapffel's volume contains two essays of much value on the general principles of cutting tools—one by Mr. Babbage, and the other by Professor Willis.

477. **Characteristics of Cutting Tools in General.**—The usual material for cutting tools is steel, of a degree of hardness suited to that of the material to be cut. Every cutting tool has at least one cutting edge; and sometimes three or more edges meet and form a point, two or more of those edges being cutting edges; so that the form of the cutting part of a tool is that of a wedge, or of a pyramid, as the case may be. A cutting edge is formed by the meeting of two surfaces, generally plane, and sometimes curved. When a surface forming a cutting edge is oblique to the original surfaces of the bar out of which the tool is made, that surface is called a *chamfer* or *bevel*. The angle at which those surfaces meet may be called the *cutting angle*. It ranges from about 15° to 135° , according to the nature of the material to be cut, and the way in which the tool is to act upon it. Examples of cutting angles of tools for different purposes will be mentioned further on. A narrow cutting edge at the end of a bar-shaped tool is often called the *point* of the tool; the body of the tool is called the *shaft* or the *blade*; the term *shaft* being usually applied to tools with a cutting point or narrow edge at one end, and *blade* to those which have a longitudinal cutting edge; but *blade* is often applied to

both kinds of tools. A bar-shaped shaft is sometimes called a *stem*. The blade or shaft of a tool is sometimes made of iron, and edged or pointed with steel. A larger piece, to which the blade is fixed, is called the *stock*; and in the case of hand-tools, that part of the stock which is grasped by the hand is called the *handle*. The stocks and handles of hand-tools are usually of wood of some strong and tough kind. Where steady pressure is to be exerted, stiff woods are to be chosen, such as beech and mahogany; where blows are to be given, flexible woods, such as ash. Machine-tools are held in *tool-holders* of different sorts, made of cast and wrought iron. A *rest* is a fixed or moveable support for a cutting tool, in machine tools, the rest carries the tool-holder.

The term *machine-tool* is often applied, not merely to the cutting implement itself, but to the whole machine of which it forms part.

The piece of material which is being cut by a tool is commonly called the *work*. A given relative motion of the work and cutting tool may be obtained either by keeping the work fixed and moving the tool, or by keeping the tool fixed and moving the work, or by a combination of both those motions.

478. **Classification of Cutting Tools.**—The following classification is that of Holtzapffel. Cutting tools, according to their mode of action on the bodies to which they are applied, are divided into *Shearing*, *Paring*, and *Scraping* tools; the following being the characters by which those tools are distinguished from each other.

I. A *Shearing Tool* acts by dividing a plate or bar of the material operated on into two parts by shearing; that is to say, by making these two parts separate from each other by sliding at the surface of separation.

II. A *Paring Tool* cuts a thin layer or strip, called a *shaving*, from the surface of the work; thus producing a new surface.

III. A *Scraping Tool* scrapes away small particles from the surface of the work; thus correcting the small irregularities which may have been left by a paring tool.

479. **Shearing and Punching Tools.**—A pair of shears for cutting iron usually consists of two blades; the lower fixed, and the upper moveable in a vertical direction. The inner faces of the blades are plane, and are so fitted as to slide past each other very closely, but without appreciable friction. The ordinary angle for the cutting edges is from 75° to 80° . In shears for cutting plates, the edge of the lower blade is horizontal; that of the upper blade has an inclination of from 3° to 6° , in order that the shearing may begin at one edge of the plate, and go on gradually towards the other edge. Fig. 282 represents a cross-section of the blades of a pair of shears, with their cutting

