hospitable board. His conversational powers rivalled those of Dr Johnson; and, if more of his sayings have not been chronicled for the benefit of posterity, the defect is due to the absence of a Boswell. Through the liberality of his friends, his last days were freed from the pressure of poverty, and he was enabled to place his illegitimate son ín a position which soon brought him wealth, and to leave a competency to his two illegitimate daughters. Illness seized him early in 1810, and for the next two years his sufferings were acute. He died in his house at Wimbledon on the 18th of March 1812, and his body was buried with that of his mother at Ealing, the tomb which he had prepared in the garden attached to his house at Wimbledon being found unsuitable for the interment. An altar-tomb still stands to his memory in Ealing churchyard. A catalogue of his library was printed in 1813.

The *Life of Horne Tooke,* by Alexander Stephens, is written in an unattractive style and was the work of an admirer only, admitted to his acquaintance at the dose of his days. The notice in the *Quarterly Review,* June 1812, of W. Hamilton Reid’s compilation, is by J. W. Ward, Lord Dudley. The main facts of his life are set out by Mr J. E. Thorold Rogers, in his *Historical Gleanings,* 2nd series. Many of Horne Tooke’s wittiest sayings are preserved in the *Table Talk* of Samuel Rogers and S. T. Coleridge. (W. P. C.)

**TOOKE, THOMAS** (1774-1858), English economist, was born at St Petersburg on the 29th of February 1774. Entering a large Russian house in London at an early age, he acquired sound practical experience of commercial matters and became a recognized authority on finance and banking. He was one of the earliest advocates of free trade and drew up the *Merchants' Petition* presented to the House of Commons by Alexander Baring, afterwards Lord Ashburton. He gave evidence before several parliamentary committees, notably the committee of 1821, on foreign trade, and those of 1832, 1840 and 1848 on the Bank Acts. He was elected a fellow of the Royal Society in 1821. He died in London on the 26th of February 1858.

Tooke was the author of *Thoughts and Details on the High and Low Prices of the last Thirty Years* (1823), *Considerations on the State of the Currency* (1826), in both of which he showed his hostility to the poIicy afterwards carried out in the Bank Act of 1844, but he is best known for his *History of Prices and of the State of the Circulation during the Years 1703-1856* (6 vols., 1838-1857). In the first four volumes he treats (*a)* of the prices of corn, and the circumstances affecting prices; (*b*) the prices of produce other than corn; and (*c*) the state of the circulation. The two final volumes, written in conjunction with W. Newmarch (*q.v*.), deal with railways, free trade, hanking in Europe and the effects of new discoveries of gold.

**TOOL** (O. Eng. *tól,* generally referred to a root seen in the Goth, *taujan,* to make, or in the English word “ taw,” to work or dress leather), an implement or appliance used by a worker in the treatment of the substances used in his handicraft, whether in the preliminary operations of setting out and measuring the materials, in reducing his work to the required form by cutting or otherwise, in gauging it and testing its accuracy, or in duly securing it while thus being treated.

For the tools of prehistoric man see such articles as Archaeology ; Flint Implements; and Egypt, *§ Art and Archaeology.*

In beginning a survey of tools it is necessary to draw the distinction between hand and machine tools. The former class includes any tool which is held and operated by the unaided hands, as a chisel, plane or saw. Attach one of these to some piece of operating mechanism, and it, with the environment of which it is the central essential object, becomes a machine tool. A very simple example is the common power-driven hack saw for metal, or the small high-speed drill, or the wood-boring auger held in a frame and turned by a winch handle and bevel-gears. The difference between these and a big frame-saw cutting down a dozen boards simultaneously, or the immense machine boring the cylinders of an ocean liner, or the great gun lathe, or the hydraulic press, is so vast that the relationship is hardly apparent. Often the tool itself is absolutely dwarfed by the machine, of which nevertheless it is the central object and around which the machine is designed and built. A milling machine weighing several tons will often be seen rotating a tool of but two or three dozen pounds’ weight. Yet the machine is fitted with elaborate slides and self-acting movements, and provision for taking up wear, and is worth some hundreds of pounds sterling, while the tool may not be worth two pounds. Such apparent anomalies are in constant evidence. We propose, therefore, first to take a survey of the principles that underlie the forms of tools, and then pursue the subject of their embodiment in machine tools.

Hand Tools

The most casual observation reveals the fact that tools admit of certain broad classifications. It is apparent that by far the larger number owe their value to their capacity for cutting or removing portions of material by an incisive or wedge-like action, leaving a smooth surface behind. An analysis of the essential methods of operation gives a broad grouping as follows :—

|  |
| --- |
| I. The chisel group . . Typified by the chisel of the woodworker. |
| II. The shearing group . . „ „ scissors. |
| III. The scrapers ... „ „ cabinet-maker’s scrape. |
| IV. The percussive and destructive group . „ „ hammer and the punch. |
| V. The moulding group . „ „ trowel. |

The first three are generally all regarded as cutting tools, notwithstanding that those in II. and III. do not operate as wedges, and therefore are not true chisels. But many occupy a border-line where the results obtained are practically those due to cutting, as in some of the shears, saws, milling cutters, files and grinding wheels, where, if the action is not directly wedge-like, it is certainly more or less incisive in character.

*Cutting Tools.*—The cutting edge of a tool is the practical outcome of several conditions. Keenness of edge, equivalent to a small degree of angle between the tool faces, would appear at first sight to be the prime element in cutting, as indeed it is in the case of a razor, or in that of a chisel for soft wood. But that is not the prime condition in a tool for cutting iron or steel. Strength is of far greater importance, and to it some keenness of edge must be sacri­ficed. All cutting tools are wedges; but a razor or a chiseI edge, included between angles of 15° or 20°, would be turned over at once if presented to iron or steel, for which angles of from 60° to 75° are required. Further, much greater rigidity in the latter, to resist spring and fracture, is necessary than in the former, because the resistance to cutting is much greater. A workman can operate a turning tool by hand, even on heavy pieces of metal-work. Formerly all turning, no matter how large, was done by hand-operated tools, and after great muscular exertion a few pounds of metal might be removed in an hour. But coerce a similarly formed tool in a rigid guide or rest, and drive it by the power of ten or twenty men, and it becomes possible to remove say a hundredweight of chips in an hour. Or, increase the size of the tool and its capacity for endurance, and drive by the power of 40 or 60 horses, and half a ton of chips may be removed in an hour.

All machine tools of which the chisel is the type operate by cutting; that is, they act on the same principle and by the same essential method as the knife, razor or chisel, and not by that of the grind­stone. A single tool, however, may act as a cutting instrument at one time and as a scrape at another. The butcher’s knife will afford a familiar illustration. It is used as a cutting tool when severing a steak, but it becomes a scrape when used to clean the block. The difference is not therefore due to the form of the knife, but to the method of its application, a distinction which holds good in reference to the tools used by engineers. There is a very old hand tool once much used in the engineer’s turnery, termed a “ graver.” This was empIoyed for cutting and for scraping indiscriminately, simply by varying the angle of its presentation. At that time the question of the best cutting angles was seldom raised or discussed, because the manipulative instinct of the turner settled it as the work pro- cecded, and as the material operated on varied in texture and degree of hardness. But since the use of the slide rest holding tools rigidly fixed has become general, the question of the most suitable tool formation has been the subject of much experiment and discussion. The almost unconscious experimenting which goes on every day in every workshop in the world proves that there may be a difference of several degrees of angle in tools doing similar work, without having any appreciable effect upon results. So long as certain broad principles and reasonable limits are observed, that is sufficient for practical purposes.

Clearly, in order that a tool shall cut, it must possess an incisive form. In fig. 1, *A* might be thrust over the surface of the plate of metal, but no cutting action could take place. It would simply grind and polish the surface. If it were formed like *B,* the grinding action would give place to scraping, by which some material would be removed. Many tools are formed thus, but there is still no incisive or knife-like action, and the tool is simply a scrape and not a cutting tool. But *C* is a cutting tool, possessing penetrative. capacity. If now *B* were tilted backwards as at *D,* it would at