

MODERN GEAR PRODUCTION

The cover features two large, interlocking gears. The top gear is a solid dark orange color, while the bottom gear is a lighter, semi-transparent orange. In the center, where the gears would mesh, is a white gear-like shape with eight teeth. This central shape contains the author's name and credentials. The title 'MODERN GEAR PRODUCTION' is arched over the top gear in a dark blue, serif font.

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Introduction

A PAPER with the same title presented to the Institution of Production Engineers originated this book. Interest in the subject prompted a wider, somewhat more comprehensive treatment of gear manufacture, but no work of this type can give more than an introduction to such a vast industrial activity of great complexity. Its main purpose is to provide information on possible methods of gear making that will be useful in technical academic establishments while at the same time supplying some knowledge on processes that is not always readily available to those engaged in industry. Most of the processes considered have a literature of their own and each machine has individual operating instructions that are available to those deeply involved in gear-manufacturing techniques, but these are outside the scope of this publication.

Based on the author's lengthy experience in the gear-making industry with the David Brown company, who have such a wide interest in all aspects of gear production, it is a survey of current manufacturing methods. Many of the techniques and processes now in general use seem to have been developed within his cognizance and have provided the broad foundation for the work. But many other sources of information have also contributed to the general content and the author acknowledges with gratitude the comments and thoughts expressed by colleagues and widely dispersed friends during many interesting discussions on gears.

Ever since toothed gears were first invented countless different methods of making them have been used. At any specific time some of these were considered to be modern and at the moment there is no valid reason to regard the present as the final period in an evolutionary process of gear manufacture. Techniques and design criteria not yet conceived may confidently be expected to emerge in the future. In that respect the present review is contemporary in part only, despite its title.

Where possible, British Standards have been referred to in the text since they supply much information on the kind of product that the gear industry can provide.

References to processes that may be the subject of patents does not in any way affect the protective rights incorporated in the patent.

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Brief History of Gear Making

TOOTHED gearing is one of the most widely used mechanisms of the modern world and our daily life depends for much of its activity upon the rotation of shafts connected by toothed gears. It is a product of engineering that demands attention, not only from specialists but from mechanical engineers collectively. Knowledge on gears and gear-making methods is continuously expanding in spite of the extensive amount of information already published on the subject.

In its basic form much of the technique of gear production is widely known but this continuous introduction of new methods influences the whole process of gear making either directly or indirectly. Many types of gear are in use and the application for which each is most suited influences, to some extent, the method and process employed to make it, as well as usually having decisive control over the tooth form.

When the quality of gears or the methods of manufacture are reviewed over a sufficiently long period of time it is possible to see that a change has taken place. During the past half century the change, when viewed in retrospect, seems to have been quite spectacular and even over the past decade progress has been extensive, but in fact, it has been gradual and therefore, more likely to have a firm foundation.

Changes have been made in quality and manufacturing methods ever since toothed gears were first conceived but for centuries progress was extremely slow. The classical origin of worm gearing, for instance, was the study of the screw and this was made by Archimedes (287–212 B.C.), but early references to the Archimedian spiral being used for rotating an engaging toothed wheel have been lost. However, reference to its utilization for exerting pressure and producing forward motion may be found in Greek and Roman literature.

For suitable applications, toothed gearing was made during the Middle Ages and some of these gears survive to this day in the clocks found in cathedrals and other ecclesiastical buildings where they have been preserved. Salisbury Cathedral, for example, claims to possess the oldest clock in England, made towards the end of the fourteenth century in about 1386. The mechanism

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of Wells Cathedral clock, made in 1392 and removed from its original home during the nineteenth century, may be seen in operation in the Science Museum, South Kensington. All the gears were made of iron and though some are worn, the clock movement still keeps good time. Leonardo da Vinci knew and appreciated the use of toothed gearing; some of his amazing machines were gear driven and engravings made by the great German artist Albrecht Dürer show a vehicle designed for the Emperor Maximilian I, at about the end of the fifteenth century, that was driven by worm gears on all four wheels (Fig. 1.1).



FIG. 1.1. Albrecht Dürer's engraving of a worm-driven vehicle.

These engravings suggest that the principle of the worm and wheel must have been known earlier and that Dürer had probably seen examples of their application. Dürer, however, is credited with having discovered the epicycloidal curve so he may not have been ignorant of gear geometry. Actually, the cycloidal curve produced when a point on the circumference of a circle that rolls along a straight line had been discovered and examined earlier in the fifteenth century, and it seems probable that these curves were used for gear tooth shapes. It is well established, however, that toothed gears became increasingly employed during the centuries preceding the Industrial Revolution in England in the eighteenth century, largely for clocks, irrigation devices,