Volume 1

Rudolf Och

SPLINES
QUALITY ASSURANCE

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The author

Graduate Engineer (Dipl. Ing., FH) Rudolf Och was born in Bamberg, Germany in 1951. After graduating in mechanical engineering he founded FRENCO GmbH in Nuremberg, Germany in 1978. In the beginning, the company only engaged in the development and manufacture of spline gauges. Over the years, however, the business was extended to include the full spectrum of gear and spline metrology. This development is supported by numerous inventions.

The author was a member of the American Standards Institute for Splines ANSI and has been Chairman of the German standards committee AA 2.1 since 1993. During the chairmanship, the German term for spline (Passverzahnung) was officially introduced and all relevant German standards were revised. The international standard ISO 4156 was also completely revised under German leadership by the responsible standards committee ISO/TC 14.

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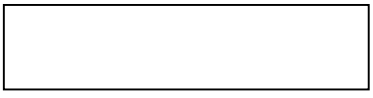

Preface

Splines are a difficult technical “marginal area” within drive technology. They are neither addressed during vocational training nor in degree courses. Experts in the matter are accordingly few and far between. Quality assurance of splines requires an additional field of knowledge, which further complicates the subject matter. We have used many pictures to support the explanations in order to ensure the topic is as easy to understand as possible.

This book is a compilation of individual documentations, which were compiled over a period of 30 years from the author’s experiences. It was revised as a whole before print and reflects the status quo of standardisation.

No responsibility is accepted for the accuracy of the information in this book. It must be noted that technical developments are a continuous process and knowledge, standards and rules are subject to constant changes.

June 2008, Rudolf Och

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1. Spline Basics (formerly OFL 01)

Many different types of gears and splines are required in engineering applications. It is difficult to replace toothed components even though their manufacture is expensive and they are subject to wear. Transmissions with gears are required for two very simple reasons:

a) Motors have an unfavourable ratio between torque and speed.

b) Installation conditions cannot be changed constructively at will.

The increasing number of motor-driven motions does not lead to a decrease in the number of splines used, but rather to an increase.

In principle, there are two common types of gearing: gears and splines.

1.1. The function of Gears

Gears always transmit torque from one axis to another. This is achieved by means of direct or indirect contact via chains or drive belts and is usually combined with a speed change. Examples are spur gears, bevel gears, worm wheels, chain wheels and timing belt pulleys.

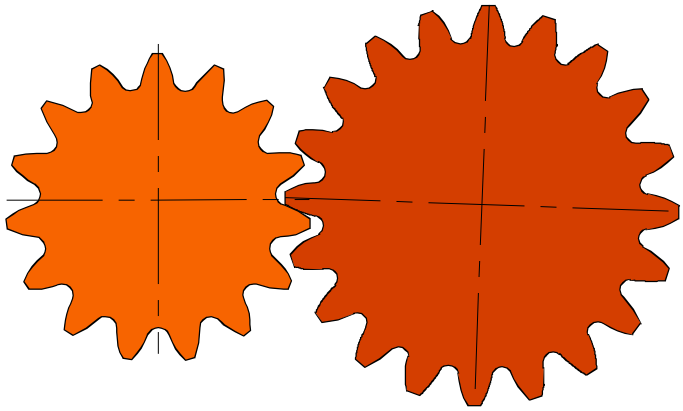

Fig 1: Spur gear pair

There are standards, literature, lectures at universities, seminars, software packages and specialists for all the different types of gears.

There is, however, very little information available on splines. This book therefore concentrates on splines in particular.

1.2. The function of Splines

Unlike gears, splines are exclusively used to transmit torque on the same axis. As with gearboxes there are, in principle, only two reasons why splines are required:

a) The driven component must have the ability to slide on the driving component.

b) Torque transmission components must be separated due to their manufacture or installation.

Manual transmissions and clutches are examples of a).

Drives and steering mechanisms are examples of b).

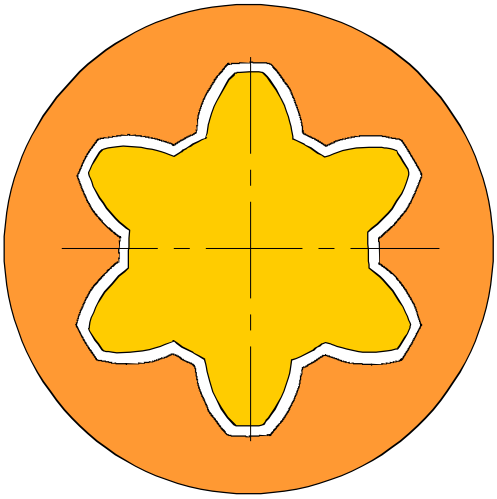

Fig 2: Spline pair

The main requirement of splines is to safely transmit torque. Little backlash, good centering, low noise, little wear and usually small axial forces are also desired. A combination of these requirements is very demanding and usually leads to a geometric over-determination.

Requirement and design specification depend on the individual type of application, which is why there are many names for these form-fitting connections:

- Plug-in toothing
- Clutch spline
- Straight-sided splines
- Splined shafts and splined hubs
- Sliding profiles
- Short gearing
- Serrated shafts and hubs

“Spline” is the generic term for all interlocking profile types mentioned above. Face gearing, which in some respects has similar functions, is excluded from this and must be kept separate from splines. It also transmits torque on one axis; however it cannot be slid on and requires an additional axial force of pressure.

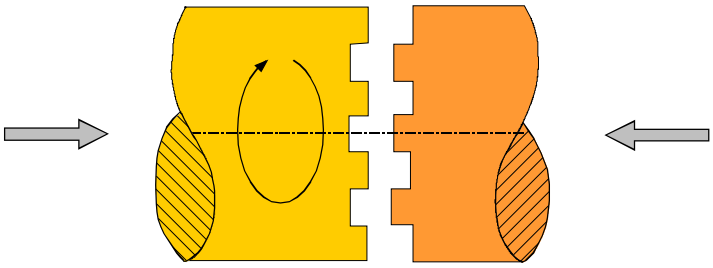

Fig 3: Face gear pair