

## Axial freedom and other liberties

### *A view on Cylkro® face gears from different angles*

*When designing and developing new gear sets and transmissions, even ASSAG engineers are sometimes amazed at the possibilities of the Cylkro® face gear. The features of an angular face gear transmission are very specific, both on their own as well as in combination, and offer solutions based on engineering liberties and application possibilities. Compared to traditional angular transmissions such as bevel gears or worm gear sets, face gear transmissions encompass easy mounting, space saving opportunities and free combinations for differentials and multiple outputs. The number of applications in which these face gear sets are now being used is steadily growing and new solutions are being developed on a daily basis.*

#### **Axial freedom**

A basic spur Cylkro® face gear set consists of a cylindrical pinion and an angular Cylkro® face gear, mostly at a 90° axis angle (picture 1). The cylindrical pinion can be moved freely in the axial direction, without affecting the contact pattern, thus saving time and cost while mounting the gear set.



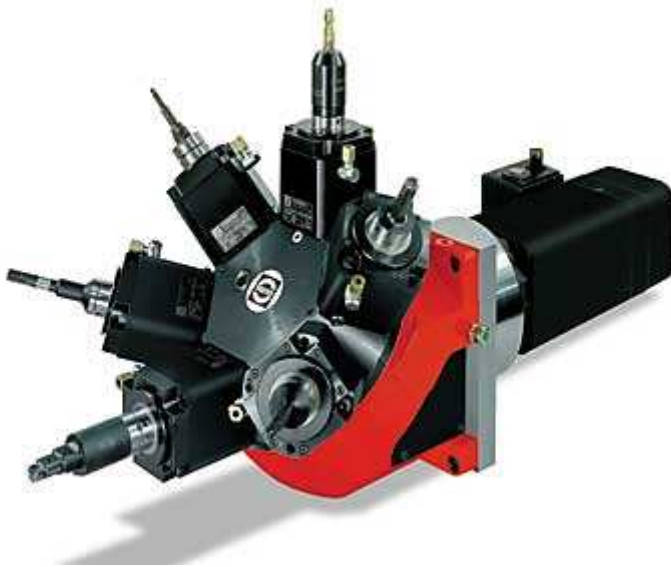
**Figure 1:** Examples of Cylkro® face gear sets

The axial freedom can also be used to its advantage, as for instance the starter gear of the Porsche Carrera GT shows. In this limited edition of an exclusive 1200 pieces, the pinion is axially pushed into the Cylkro starter gear at the moment of starting the engine. Another example is the Geringhoff corn header. Solely by exchanging one face gear for another face gear with a different number of teeth, while maintaining the same pinion, the rotational speed of the gear box can be adapted to all different types of harvesting conditions.

#### **Free choice of axis angle**

Sometimes transmissions require an axis angle other than 90°. With Cylkro® face gears it is possible to realize any axis angle between 0° and 135°. Small axis angles, such as 17°, are used in mixing equipment. A large axis angle is for instance used in a German manufactured machine tool, in which

the pinions are aligned along the Cylkro® teeth at a 135° angle. Sauter Feinmechanik from Germany uses, among others, 45° face gear transmissions in their multiple driven tools (picture 2).



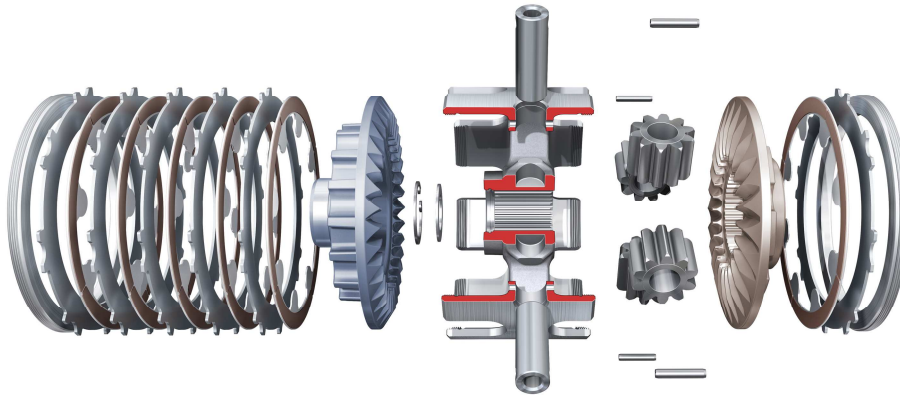
**Figure 2:** Sauter Feinmechanik driven tool using 45° face gear transmission

### **Saving space**

Together with German based Benz Tools, ASSAG developed the face gear transmissions for the Benz X-line angular gear head program for the wood working industry. Using face gears and spur pinions makes it possible to realise higher rotational speeds as well as higher torque. The components have become more compact, thus allowing longer tool lengths. Increased system rigidity means longer time between maintenance and less wear of parts.

### **Multiple drives**

Another space saver success combined with the possibility of multiple drives is the recently launched new Audi quattro with self-locking crown gear differential. Two Cylkro® face gears with different tooth geometries, resulting in a 40:60 % torque split, are built into this lightweight differential (4.8 kg). Using the Cylkro face gear technology, Audi could realize a weight reduction of 2 kg compared to the conventional differential.

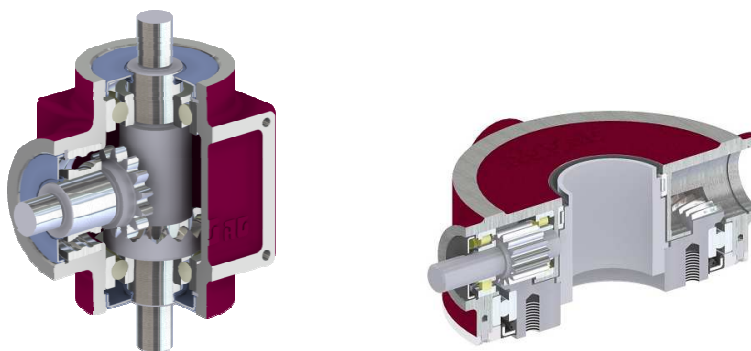


**Figure 3:** Exploded view of Audi Quattro self-locking crown gear differential

The Cylkro face gear with the largest number of teeth (picture 3, left side) is connected with the cardan shaft to the rear axle. The second face gear takes care of the power take-off to the front axle. In between the face gears, four pinions are equally spaced at 90° in a planet carrier that is driven by the outgoing axis of the S-tronic 7-speed gearbox with double clutch. If one of the axles starts to spin, for example, while it is on ice or snow, the self-locking face gear centre differential will immediately engage. By a package of plates it can widely vary the torque distribution between the front and rear axles. Up to 70% of the drive force can be fed to the front, and as much as 85% toward the tail-end.

**Evolvere® Drives**

With all the experience and know-how gathered over the years, ASSAG developed its Evolvere® (Latin for “to evolve”) concept. This is, a complete angular gearbox with flexibility to give the best solution with engineering support, utilising considering cost-effective components and easy mounting and maintenance.

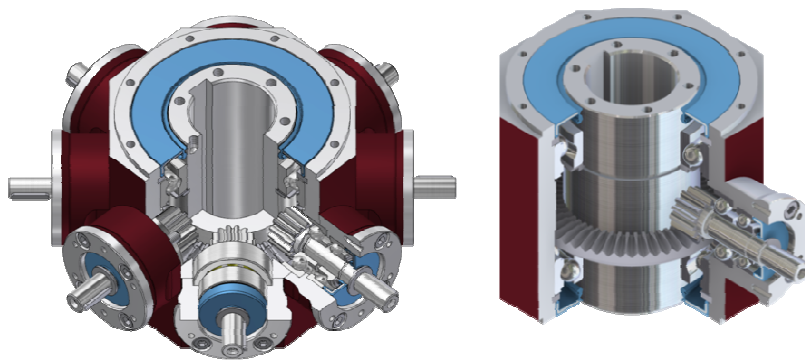


**Figure 4:** Block shaped 1:1 and flat 1:5 versions of the EVOLVERE angular gearbox family

ASSAG provides three types of standard Evolvere gearboxes:

- Block-shaped gearboxes for 90° transmission ratios 1:1 to 1:4 (picture 4)
- Compact, flat gearboxes for 90° transmission with ratios 1:5 to 1:10 (picture 4)
- Octagonal gearboxes (Octodrive) for different angles and multiple inputs/outputs with ratios 1:3 and higher (picture 5)

Evolvere gearboxes can for instance be found in Storz Medical applications for kidney stone therapy. The Evolvere drive allows the patient's body to be placed in such a position that the shock wave therapy has maximum result in crushing the stones with minimum side effects for the patient.



**Figure 5:** OCTODRIVE gear box (sectional view) in different configurations

**Octodrive – freedom of choice**

ASSAG's angular gearbox program allows customers the freedom of choosing the number of inputs, outputs, angles, ratios and other options. Octodrive face gear drives are delivered with output torques from 29 to 225 Nm and modules 0.7 to 3.5 with ratios 1:3 up to 1:10. Additional dimensions are produced according to customer requirements. Friction-minimized angular ball bearings and optimized geometry and topology of the teeth result in an efficiency factor of the gear transmission >95%. Based on its octagonal form and self-centering of standard flanges, the gearbox fits practically anywhere and can be adapted to customer requirements in a short time. Applications can be found in the fields of lifting units, as part of packaging lines and as tool exchangers.

**Summary and outlook**

Cylkro® face gears offer practically limitless transmission solutions. Customer requirements, as in torque, design and application, can be met either in customer specific gear set solutions, complete Evolvere transmissions or in standard gear boxes. While designing new transmissions ASSAG engineers strive for continuous innovation in every respect, being technologically, economically and ecologically. High quality and durability at a competitive price is what ASSAG and Cylkro face gears are all about.

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