MOUNTING INSTRUCTIONS

DATES OF PROJECT

CLIENT	:	ORDER NUMBER CLIENT	:
PROJECTNUMBER	:	ARTICLE NUMBER CLIENT	:
DATE	:	REFERENCE CLIENT	:

TECHNICAL DATES

DRAWING NUMBER PINION:	MOUNTING DIMENSION [mm]:	C_1:	C_2:	
	FLANK BACKLASH [mm] :	j_n:		
DRAWING NUMBER GEAR:	FORCES ON PINION [kN] :	F_t:	F_{rad}:	F_{AX}:
	FORCES ON GEAR [kN] :	F_t:	F_{rad}:	F_{AX}:

Mounting instructions of Cylkro®-Gears

1 Implementations of Cylkro®-gear designs

Cylkro®-gear designs exist as Cylkro®-gear-rings to be mounted on a hub, as Cylkro®-gears to be mounted directly on a shaft and as shaft gears. Different examples of the design possibilities are shown in figures 1 through 7.

2 Mounting of Cylkro®-gears to hubs and shafts

2.1 Cylkro®-gear-rings to hub

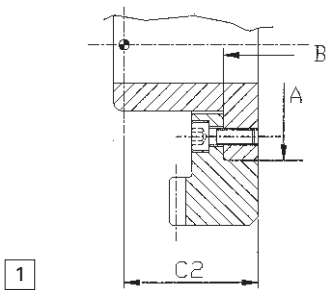
The positioning accuracy of the Cylkro®-gear-ring to the hub is of utmost importance. This is accomplished with the help of two planes, used during the manufacturing process of the Cylkro®-gear-ring, i.e. a radial plane used for centre alignment during teeth cutting and an axial plane used for fixing alignment. Both planes are indicated as A and B in figures 1 through 7. Position, form and dimensional correlation between the two planes and their adjacent hub planes must be machined to a perfect fit.

The most common method for the Cylkro®-gear-ring to transmit the torque is to bolt the ring to the hub. Different kinds of constructions are possible depending on the magnitude of the torque to be transmitted and on the manufacturing form of the Cylkro®-gear-ring and hub. The bolts must be tightened using a calibrated torque wrench as specified on the drawings and then the nuts must be locked. Taper pins or taper bolts are to be used, when bolts are insufficient to transmit the required torque.

2.2 Hub to shaft

This joint requires precise tolerances for the shaft diameter and the hub's bore hole. A common tolerance for the hole diameter is metric H7. The tolerance to be applied to the corresponding shaft depends on the way the torque is transmitted and on the load characteristics (smooth, vibrating or sharp variations). The most common joints are key and shrink fit joints. A satisfactory modern joint for many applications is the glued joint.

Remark:
Design and manufacturing responsibility of the Cylkro®-gear to hub and/or hub to shaft joint characteristic lies with the gear assembly manufacturer who uses Cylkro®-gears in its assembly. Crown Gear is available for any advice requested by the manufacturer/ assembler.



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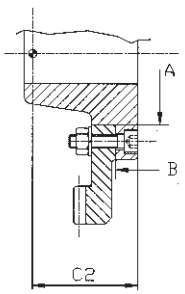

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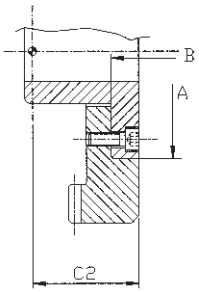

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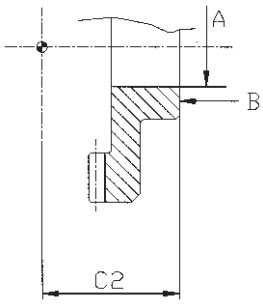

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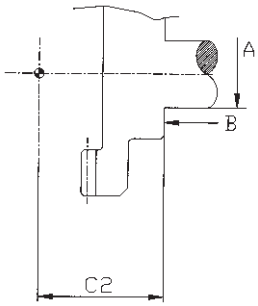

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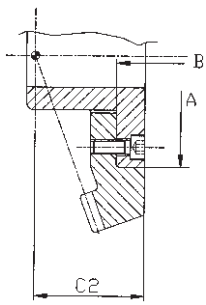

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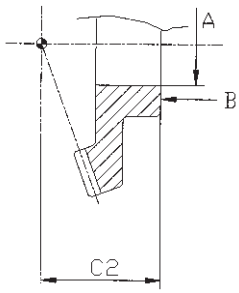

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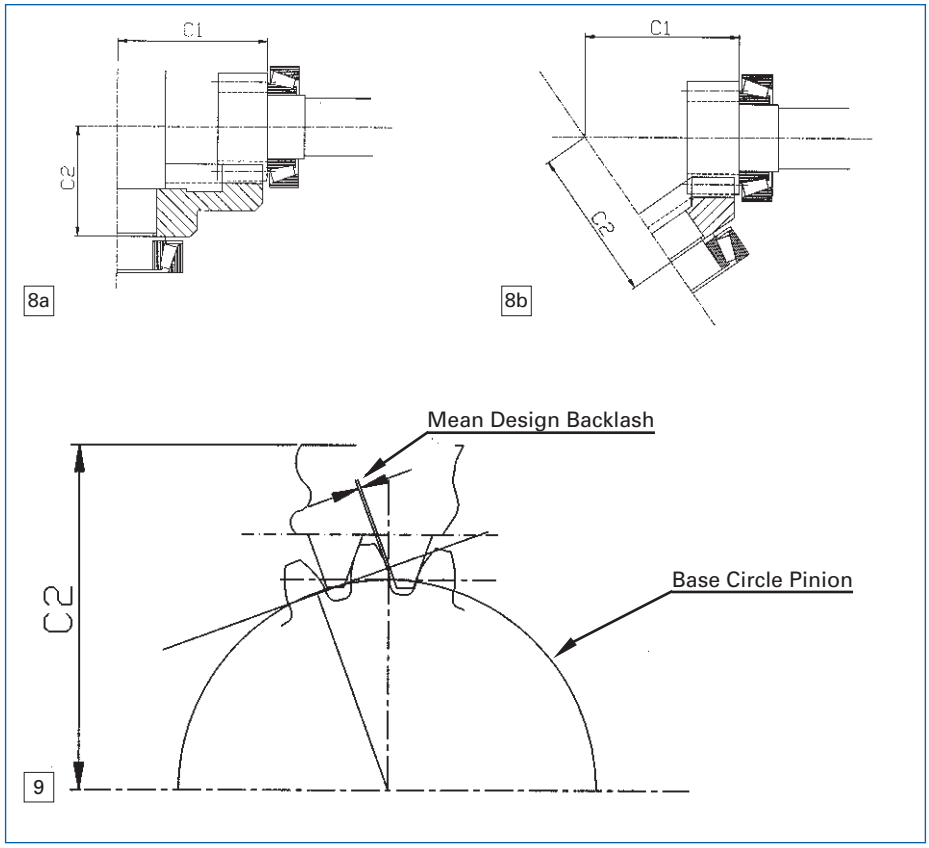
3 Mounting dimensions

In figure 8a and 8b the mounting dimensions for the pinion and Cylkro®-gear are represented by C1 and C2.

In Cylkro®-gear pairs, the mounting dimension C2 of the Cylkro®-gear corresponds to the distance between the (mounting) locating face and the centre line of the pinion shaft assuming theoretical normal backlash. C2 is used as the reference dimension for all tooth cutter tooling during the manufacturing process of the Cylkro®-gear.
C1 and C2, on the drawings, are nominal (standard) dimensions.



4 Flank backlash

Gear transmissions function only when a given backlash exists between the teeth. This concerns backlash measured between non driving flanks. The shortest distance between non driving (adjacent) teeth flank is defined as “normal backlash”. The word backlash, when used in the context of these mounting instructions, always refers to: “normal backlash”.

The average backlash value in the design stage is defined, firstly by the thickness of the pinion teeth and by the thickness of the Cylkro®-gear-teeth along with the mounting distance of the locating face (See Figure 9). Generally the real backlash will differ from the designed in backlash and usually it will be smaller due to tolerance deviations, variances in shape and operational circumstances.

Changes in backlash occur for reasons such as:

- Temperature changes of the housing.
- Temperature changes of the pinion and Cylkro®-gear.
- Elastic deformations of the housing, the shafts, the bearings and the gears.
- Dimensional, shape and location tolerances of the housing, gears and shafts.

The backlash value at design is determined by Crown Gear and where required in agreement with the designer of the complete gear assembly. Compelling factors influencing the design values for the backlash are the tooth’s dimensions (module m) and the application.

5 Mounting

No special skills are required to mount Cylkro®-gears. The pinion shaft may be shifted along its axis. This implies that only one dimension requires precise adjustment.
To keep it easy, this is accomplished best in two phases:

1. Coarse adjustment.
2. Fine adjustment plus control of the tooth contact pattern.

Sometimes a second adjustment may be necessary after the “control of the tooth contact pattern” process has taken place.

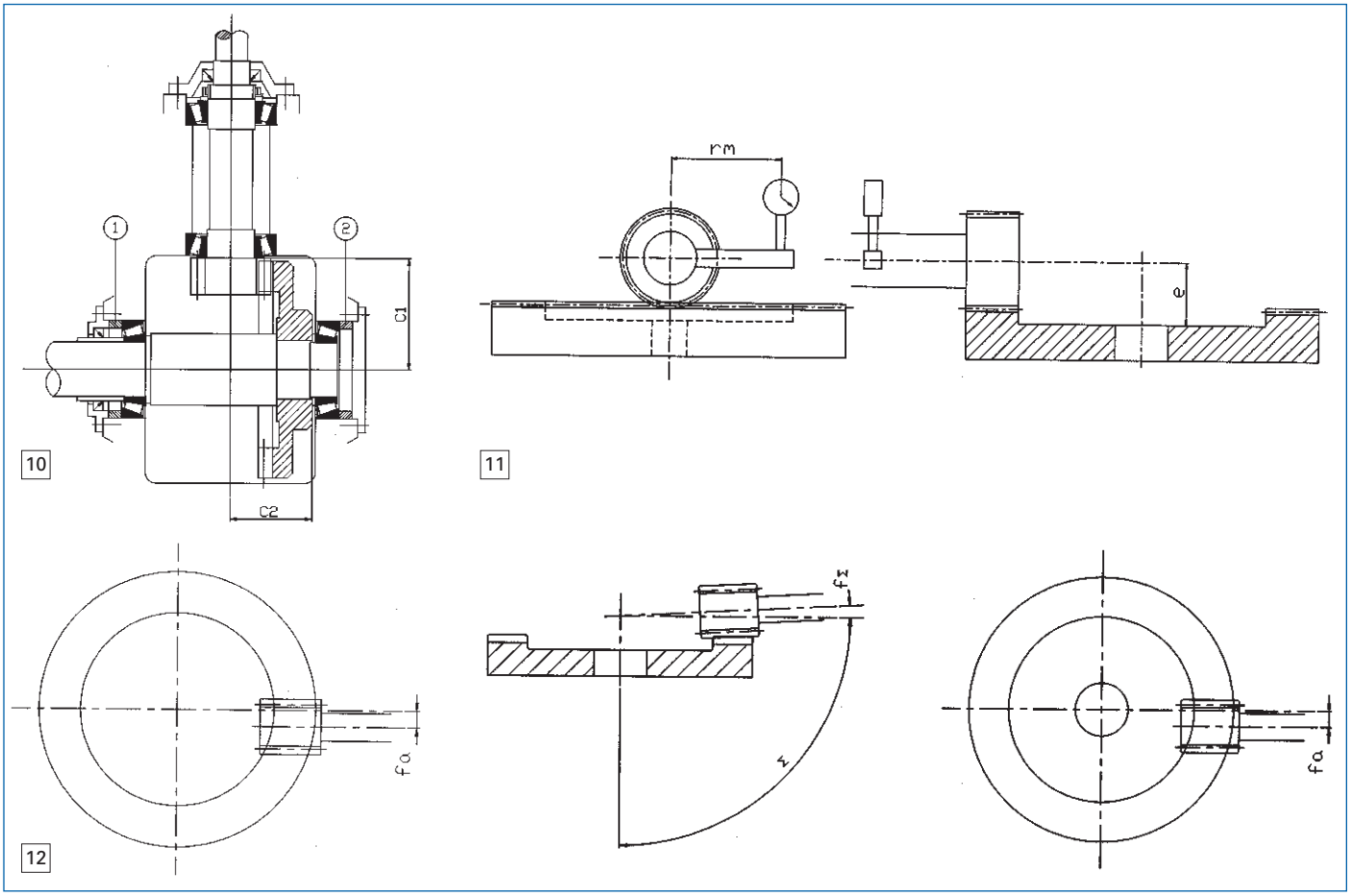
5.1 Coarse adjustment

The pinion shaft and the Cylkro®-gear shaft are mounted, together with their bearings, in the gearbox. Special care must be taken to adjust the wheel shaft as precisely as possible to conform with the C2 mounting dimension. When mounting the Cylkro®-gear-pair one should take into account the real shaft positions, i.e. the actual positions taken during operation. The actual shaft positions are determined much more by the orientation of the load on the teeth than by the value of this load (See also Chapter “6. Load distribution”).

5.2 Fine adjustment and control of the tooth contact pattern

Fine adjustment occurs after checking the backlash. This control measurement must occur when the pinion and wheel shafts take up their positions under load conditions.

The backlash may be measured by means of feeler gauges. This method for checking and adjusting the backlash on Cylkro® gears is appropriate and sufficient for “go” or “no go” determination. The method determines only if the assembly is within tolerance or not and naturally it does not give any absolute values of actual measurements’ results. In many instances the areas for checking the backlash (planes of action) are difficult to get to or they are not accessible at all for feeler gauges. In those instances another measurement method must be applied.



A simple yet accurate measurement method to check the backlash is described as follows:
"Rotate the pinion shaft keeping the Cylkro®-gear still and measure the shaft's rotational movement (on an arbitrary radius)".

If:

- r_m radius on which the pinions shaft's rotational movement is measured
- f rotational movement of the pinion shaft (distance)
- r_b base radius of the pinion
- j_n backlash
- ß tooth angle of the pinion

Then:

$$j_n = f \frac{r_b}{r_m} \cos ß$$

Figure 11 shows a possible measurement set up for the above method.
The backlash must be measured on a certain number of backlash positions (for example 6) which should be spread evenly over the Cylkro®-gears circumference.

Note:
A wide variance of the checked values may point towards an inaccurate position of the hub to shaft joint.

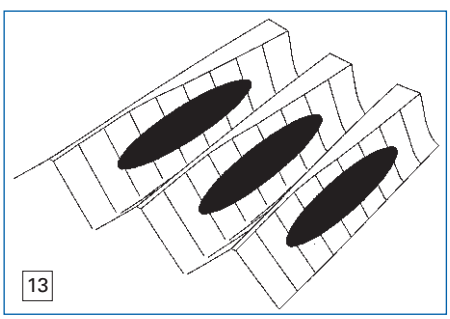
If the average value of the backlash measurements deviates from the standard value as outlined, then the shaft must be shifted towards the correct position, using gauge rings (Figure 10) or another method to lock the shaft in the axial direction. Finally the right bearing tolerances are set by means of gauge rings 1 and 2.

5.3 Tooth contact pattern during mounting

When a Cylkro®-gear-pair is mounted in the way described, the teeth contact patterns (Tooth contact pattern: contact surface on the teeth flanks when the gear pair is operating under load conditions) ideally should correspond with the design objectives. Important deviations exist regarding the active flanks in dimension, shape and/or position, if this pattern is incorrect. Together with these tolerance requirements for the Cylkro®-gear-ring to the hub and the hub to the shaft joints (See Chapter 2) there is also a requirement that the bore holes for the pinion and the gear must be precisely positioned.

The allowable tolerances on shaft angles and bore hole "off-centre" deviations are defined in the DIN standard number 3965, part 4 (See Figure 12). Usually class 6 to 7 offers a sufficient degree of precision for standard industry applications for Cylkro®-gears. Under some circumstances higher tolerance levels are required, i.e. applications with high rotational speed and a demand for precise contiguous motion transfer.

Once a gear set is mounted the tooth contact pattern can be checked. To do so a contact paste is applied to one of the two mating gears, preferably to the pinion. The layer thickness of the



contact paste does not exceed 0.005 millimetres (± 0.2 mils).
Turning the pinion shaft under low load conditions will transfer the contact paste onto the teeth's flanks of the mating Cylkro®-gear. The position, the size and the variance of the successive contact pictures on each tooth flank are the basis for determining the mating quality of the Cylkro®-gear-pairs, thus mounted.
Under low load conditions each tooth flank should show a contact pattern agreeing with the one shown in figure 13.
Other contact patterns can appear as the result of variances. Two situations are to be distinguished:

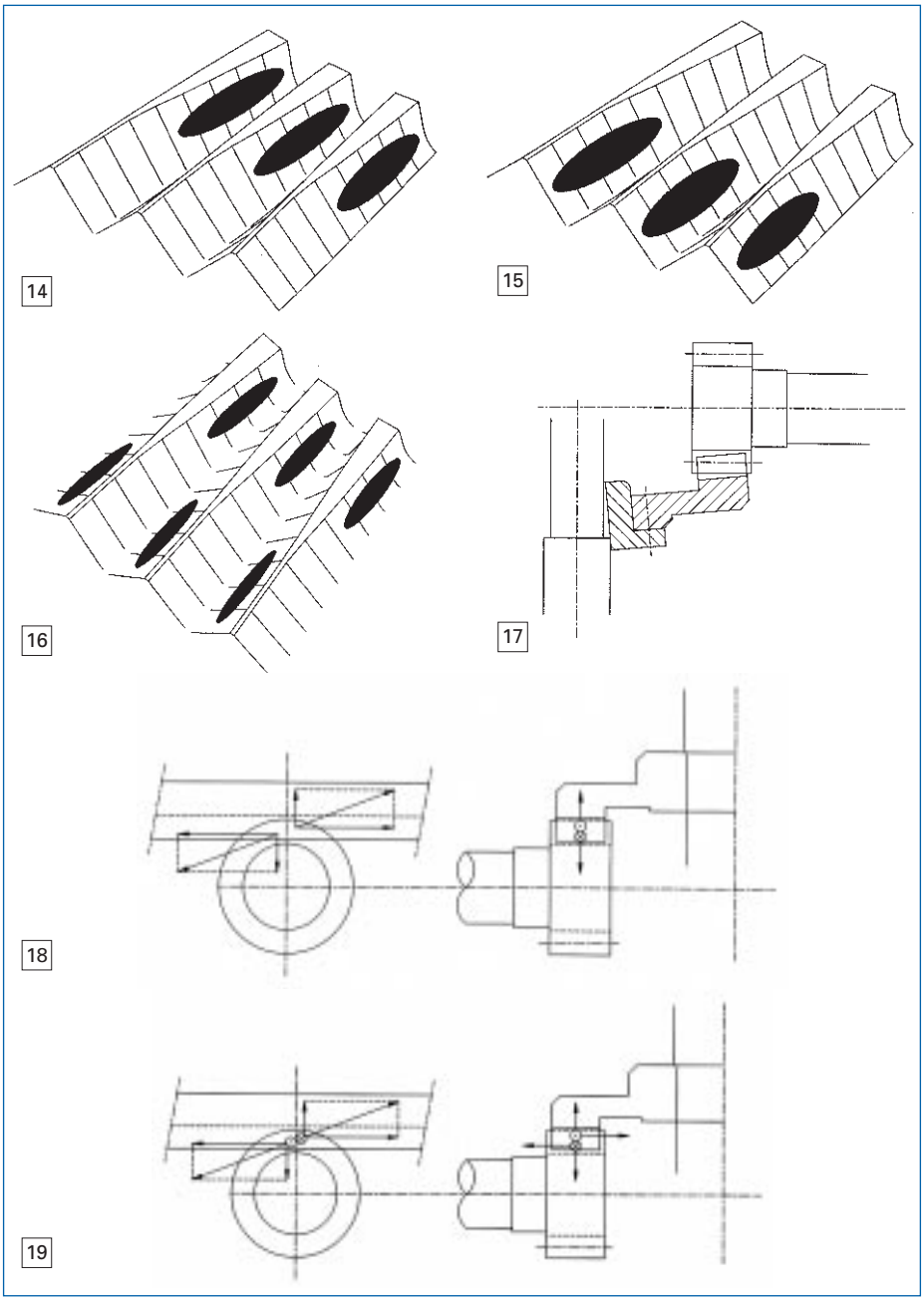
1. All teeth show the same contact pattern however the pattern is not positioned as described (Figures 14 and 15). Axial shift of the Cylkro®-gear will correct this error. Axial shifts decreasing the backlash result in a pattern shift towards the outside perimeter of the gear.

Note:
A change in backlash does not affect the efficiency of the Cylkro®-gear in any negative way.

2. The contact pattern on successive flanks as shown in picture 17 is the result of axial run out. This can be caused by an incorrectly seated hub on the shaft as shown in figure 17.

Important differences in tooth to tooth contact patterns are not acceptable. The cause of the problem must be detected and corrective action must be taken.

The mounting instructions described above are generally applicable for most situations. With most small batches and mass production runs the experience gained during the initial and sometimes lengthy mounting process with the first gear pair provides sufficient experience to ensure the quality of the gear box and the ability to determine tooth contact patterns. As a result, mounting successive gear pairs becomes routine and can usually be accomplished in a single step.



5.4 Tooth contact pattern in operation

It is normal to verify tooth contact patterns during operation, in particular with large gear diameters and heavy load duty cycles. This is accomplished with the help of an oil resistant lacquer (blue or red) which is preferably applied to some flanks of the Cylkro®-gear at equally spaced distances. The lacquer has a layer thickness of among 0.001 to 0.002 millimetres (0.04 and 0.08 mils). The lacquer layer disappears when the contact loads are applied. The result is a dynamic duty contact pattern for the teeth in the way they are marked. This method shows a synthesis of all possible deviations on each tooth flank.

6 Load distribution

To support the Cylkro®-gear shafts correctly, the magnitudes and directions of the generated tooth loads exercised must be known. The bearings on the pinion shaft of a Cylkro®-gear with spur teeth are determined only by radial forces. The bearings on the Cylkro®-gear-shaft are determined by both axial and radial forces (See Figure 18). The bearings of the helical pinion shaft are also loaded in axial direction (See Figure 19).

The magnitude and direction of the tooth loads of Cylkro®-gears are provided by Crown Gear at time of delivery.

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