Conveyor systems with freewheels

New generation of freewheels and backstops makes torque increase possible

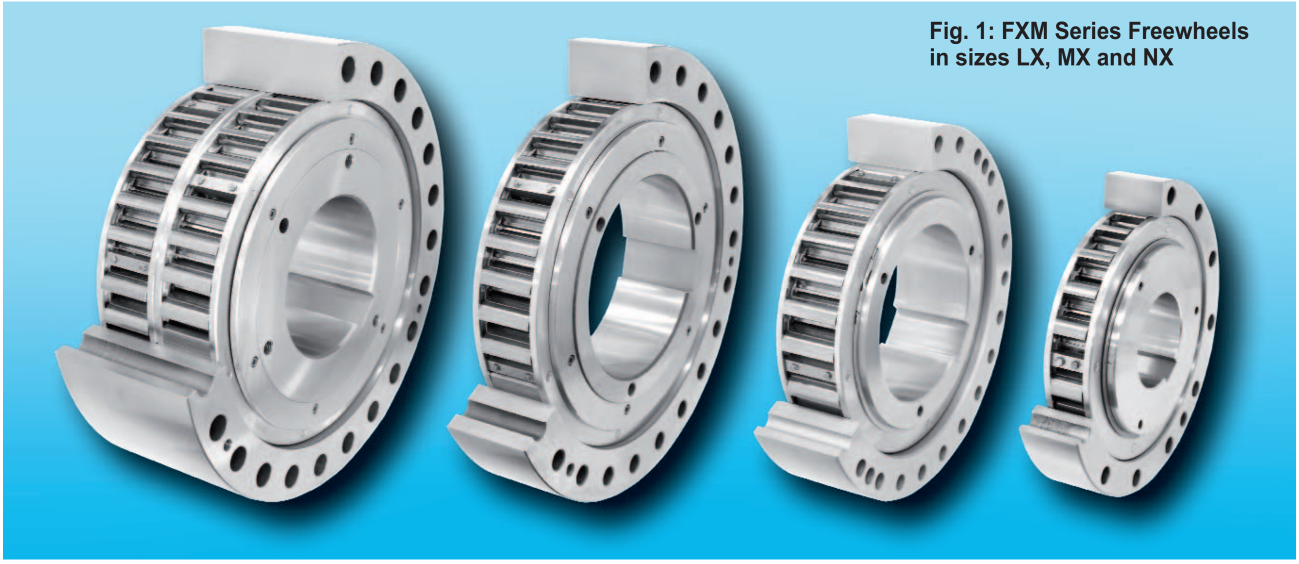

Fig. 1: FXM Series Freewheels in sizes LX, MX and NX

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Freewheels with sprag lift-off are frequently used as backstops in conveyor systems. A new freewheel cage design enables users to realize a robust, reliable, maintenance-free low-cost backstop without complicated structural modifications.

A freewheel is a mechanical coupling activated by rotation which switches automatically from the freewheeling operation (no torque transmission) to driving operation (torque transmission) when the direction of rotation changes [1]. Freewheels are used as backstops, overrunning clutches and indexing freewheels. Freewheels play a significant role as backstops in conveyor systems, and their use in these applications is the focus of this article.

Conveyor systems, such as conveyor belts, bucket elevators and pumps are in common use worldwide for conveying bulk goods.

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Automatic mechanical freewheels are ordinarily used as backstops in ascending conveyor systems. They prevent undesirable reverse movement of the conveyed material when the system stops. Freewheels with sprag lift-off are used for applications of this [1]. RINGSPANN freewheels with X sprag lift-off (Fig. 1) are ideally suited for wear-free operation in combination with rapidly rotating machine shafts. The following requirements must be met in order to ensure effective use of backstops:

- High torque capacity
- Long service life
- Robust construction
- Effective function even when used with oil containing friction-reducing additives
- High concentric run deviation tolerance
- High temperature resistance

Because of the sprag lift-off function, the freewheel is not exposed to wear in the freewheeling operation. The rotation speed of the inner ring is higher than the rotation speed at which the freewheel sprags lift off. This effect can ordinarily be achieved when the freewheel is mounted on a high-speed shaft (the engine shaft or the first or second transmission shaft). The advantage is that torque is low at this mounting position and thus allows for a relatively small freewheel size.

Freewheel structure

As shown in Fig. 2 as well as [2] and [1], an inner ring (2) with a freewheel cage (3) is mounted on the shaft end (1) in freewheels with X sprag lift-off. The outer ring (4) is bolted directly or with a connection

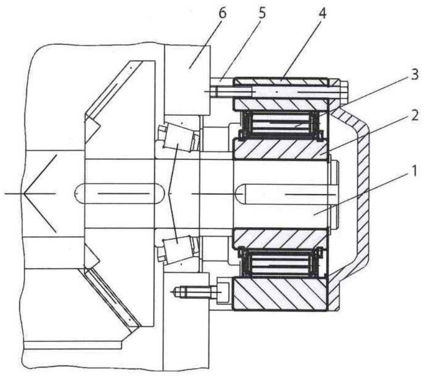

Fig. 2: Helical bevel gear with integrated freewheel as backstop

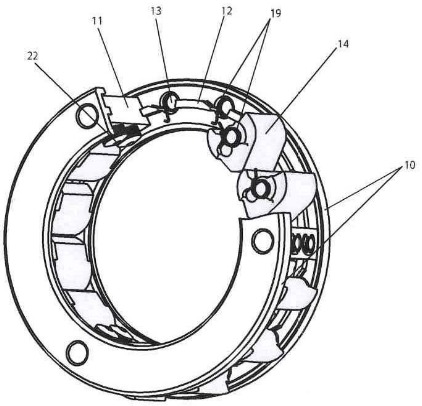

Fig. 3: Perspective view of the freewheel cage

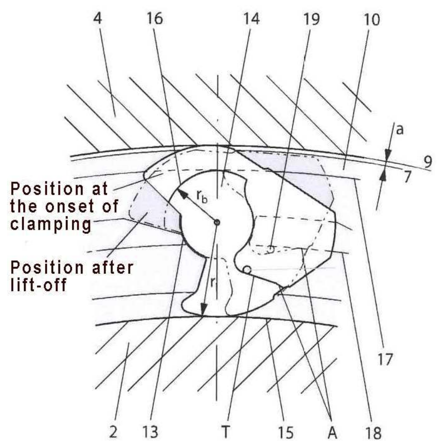

Fig. 4: Sprag in a cage of the new generation for sprag lift-off X

flange (5) to the motor or gearbox housing (6). In the freewheeling operation, i.e. when the shaft is rotating at operating speed, the sprags lift off in response to the centrifugal force in such a way that they rotate wear-free in the outer ring (4) above lift-off speed.

Gap a (Fig. 4) is created between the outer enveloping circle cylinder (7) of the sprags (14) (Fig. 3 and 4) in the lifted position and the outer ring track (9). This ensures virtually unlimited service life.

In order to fulfil the requirements of robustness and temperature resistance, components must be made primarily of metal, and components which transmit force must be made of hardened steel. The freewheel cage (3) – the heart of the freewheel – is described in detail below.

Circumferential sprag guidance

As shown in Figs. 3 and 4, the freewheel cage (3) consists of the two stable cage rings (10) with E-shaped cross-sections, which are fastened together with connecting bolts (11). Located at approximately the midpoint of the radial width of the cage rings (10) is a circular collar (12) with milled cut-outs (13), which serve to position and guide the sprags along the circumference. This allows for a tight arrangement of sprags. In addition, length of the sprags (14) in contact with the inner track (15) is extended. The increased number of sprags and the longer sprag lengths provide for higher torque that that achieved in the previous model.

The milled cut-outs (13) ensure that the sprags are aligned parallel to the axis at the beginning of the blocking operation and thus guarantee full torque transmission. During sprag-lift off, the sprag guidance system ensures that the sprags are aligned without force in the correct lift-off position.

Radial sprag support

The contour (16) at both sprag ends is an important role in sprag lift-off from the outer track (9). This contour has a radius of r_b in the area of contact with the inner cylindrical surface (17) of the cage ring. Radius r_b is concentric to the inner clamping radius r_i. The contour (16) transmits the centrifugal force applied to the sprag (14) to the cage ring (10) and permits the sprag to twist. This twisting movement is limited by stop A, which is located farther along the aforementioned contour and also rests against the inner edge (18) of the collar (12). Cut-out T ensures that the hook on the sprag spring (19) has space between the sprag (14) and the inner edge (18) of the collar (12) of the cage ring (19).

As shown in Fig. 4, the sprag (14) is configured in such a way that there is a relatively large distance between the centre of rotation and the centre of gravity. Under the influence of centrifugal force, this distance results in a high torque on the sprag when the cage freewheel rotates at high speed. This torque causes the sprags to twist in the freewheel mode and thus to lift-off from the outer track. The torque is opposed by relatively high spring pressure. This provides for both high engagement assurance of the freewheel and a relatively low lift-off speed.

Advantages of the new generation of freewheels.

Three sprag heights are used in the new generation of freewheels (Fig. 1): 12 (Freewheel Cage NX), 20 (Freewheel Cage MX) and 35 mm (Freewheel Cage LX). Fig. 1 provides an overview of the freewheels of this new generation. Due to engineering advances, the new generation of freewheels offers the following advantages:

- 12% to 25% (depending on size) increase in torque capacity due to longer sprags and a larger number of sprags
- Transmissible torques of 100 to 369 500 Nm
- Robust, one-part cage rings
- Smooth, self-enclosed construction
- Permissible concentric run deviation increased by 50% in freewheels with 12-mm sprag heights
- Interchangeable with the previous model

Special sizes can be realized thanks to the modular structure.

Literature:

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