

## 2. Caged Ball/Roller Technology



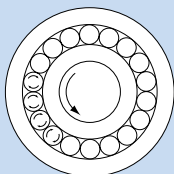
The early forms of ball bearings were full-ball types without ball cages. Friction between balls caused loud noise, made high-speed rotation impossible and shortened the service life.

Twenty years later, a Cage Ball design was developed for ball bearings. The new design reduced the number of balls used while enabling high-speed rotation at a low noise level and extending the service life. It marked a major development in the history ball bearings.

Similarly, the quality of needle bearings was significantly improved by the Caged Ball structure.

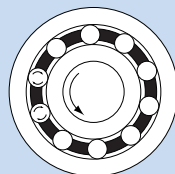
With cage-less types of ball bearings, balls make metallic contact one another and produce loud noise. In addition, they rotate in opposite directions, and the sliding contact between two adjacent balls occurs at a speed twice the ball-spinning rate. It causes sever wear and shortens the service life. Normally, an oil film breaks under a bearing stress of  $3 \text{ kg/mm}^2$ . Without a cage, balls make point contact, increasing bearing stress and facilitating breakage of the oil film. In contrast, each caged ball contact the cage over a wide area. Therefore, the oil film does not break, the noise level is low and balls can rotate at a high speed, resulting in a long service life.

### ●Rotary ball bearing



Early bearing (full-ball type)

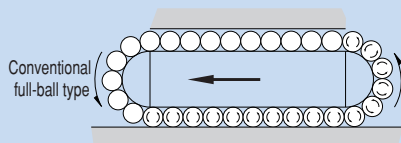
- Adjacent balls contact each other at a point. As a result, contact stress is high and the oil film breaks due to friction.
- The service life becomes shorter.



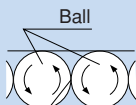
Current bearing (Caged Ball type)

- The service life is prolonged due to the elimination of wear caused by friction between balls.
- The absence of friction between balls results in reduced heat generation during high-speed rotation.
- The absence of friction between balls eliminates collision noise of the balls.
- Even spacing of the balls enables them to move smoothly.
- Retention of lubricant in the ball cage ensures a long service life.

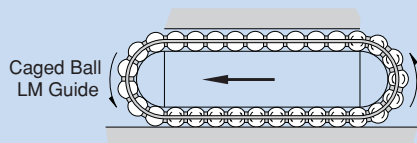
### ●LM Guide



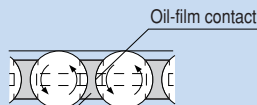
Conventional full-ball type



High bearing stress due to ball-to-ball contact



Caged Ball LM Guide



Extremely low bearing stress achieved with ball-to-cage contact