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Development of Two-Way Roller Clutch without Backlash

Takeshi Yamamoto [1)]

1) Tokai University , School of Engineering
4-1-1 Kitakaname, Hiratsuka-shi, Kanagawa 259-1292, Japan (E-mail: yama-ken@tokai.ac.jp)

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A roller clutch mechanism based on a two-way clutch is proposed as a connection element that combines the advantages of a frictional clutch, which can be connected even when there is a difference in rotational speed, and a dog clutch, which does not require external power to maintain the connection during transmission. A design method was developed and a prototype was built to investigate the function and performance of the proposed mechanism.

Figure 1 shows a schematic diagram of the proposed two-way roller clutch. The clutch has a roller pair for each direction of rotation. Springs are placed between each pair of rollers to provide an initial force. Therefore, the rollers in both directions of rotation are in contact with the inner and outer rings, and there is no backlash. To disconnect, a sleeve with a tapered end is inserted in the axial direction to push the rollers apart. When the sleeve is pulled out and the inner and outer rings have a speed difference in the disconnected state, the springs press the rollers onto the cam surface, generating a frictional force that provides a synchronizing effect and thus reduces the sliding speed. When the friction coefficient is larger than the tangent of the cam surface, the cam generates a contact force and enters the connected state.

Formulas were derived to calculate the forces acting on the roller and sleeve, and a method was developed to obtain the optimal specifications for the allowable size and load conditions. The power required to operate the sleeve was calculated and found to be several tens of watts, which is feasible. A prototype was designed and manufactured using the developed method (Fig. 2). An experimental evaluation of its transmission and connect-disconnect performance was conducted. The results are shown in Fig. 3. As shown, the power is transmitted without slip in the connected state and no drag torque is generated during disconnection. Connection is possible in a short time of 0.1 s for a rotational speed difference of 100 rpm.

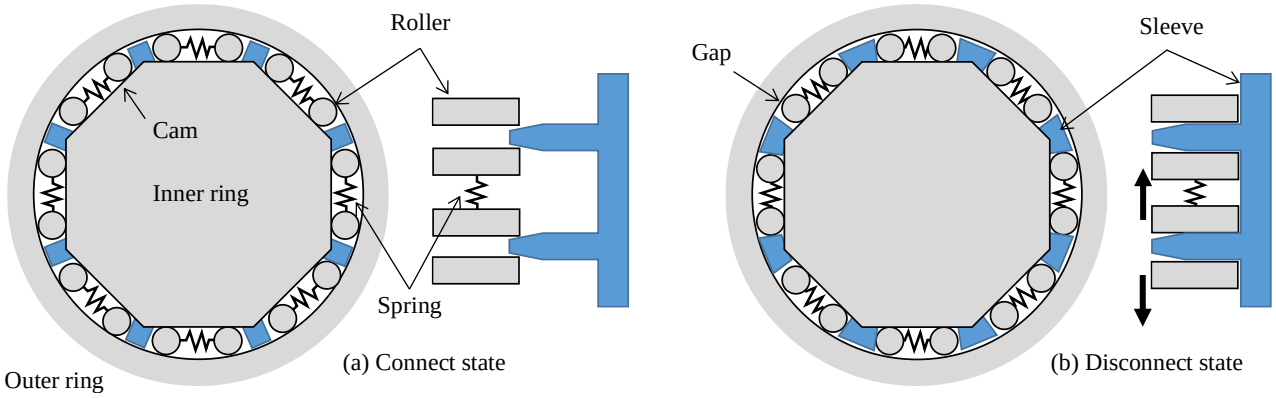

Fig. 1 Structure and mechanism of the two-way roller clutch

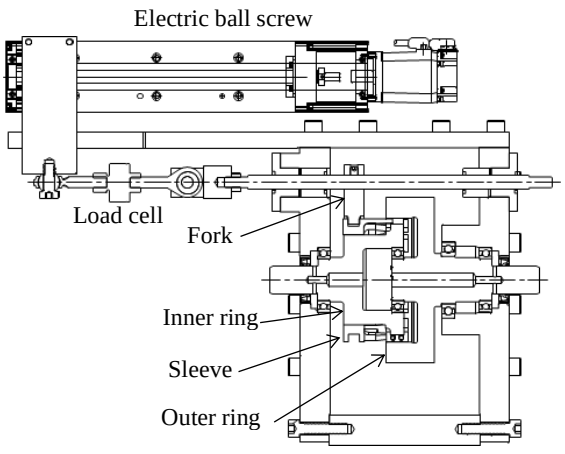

Fig. 2 Prototype of the two-way roller clutch

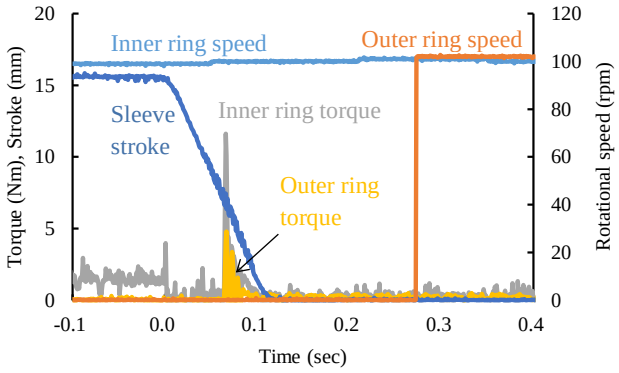

Fig. 3 Measured connecting performance