What Is A Cycloidal Speed Reducer?
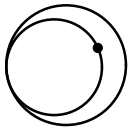
The word *Cycloid*, with its adjective *Cycloidal*, is derived from *Hypocycloid* which describes the curve traced by a point on the circumference of a smaller circle rotating inside the circumference of a larger fixed circle. Just like words such as helical, worm, spur, and bevel, *cycloidal* is a generic adjective; it merely describes the gearing mechanism inside the speed reducer.

- To understand the operating principle, you should first know how to determine the reduction ratio of a cycloidal reducer.

$$Ratio = (P-L) / L$$

Where   P = Number of ring gear pins/rollers
            L = Number of lobes on a cycloidal disc

For example, please refer to drawing on the right, the number of ring gear pins/rollers (P) equals 12, and the number of lobes (L) on the cycloidal disc equals 11.

$$Ratio = (12-11) / 11 = 1 / 11 = 11:1$$

- As the input shaft turns, the eccentric bearing goes into a rocking motion. This rocking motion exerts an outward radial force on the cycloidal disc (Figure 1).

Confined inside the ring gear housing with pins/rollers, the cycloidal disc goes into a planetary motion as the eccentric bearing turns. See Figure 2, as a smaller circle rotates inside the circumference of a larger circle, the smaller circle goes into a planetary motion. Relative to its own center, the smaller circle is rotating in the CCW direction. However, relative to the center of larger circle, the smaller circle is advancing in the CW direction. (Figure 2, left) Cycloidal mechanism works the same way. The smaller circle as described earlier is now almost as large as the larger circle and has the shape of a cycloidal disc. The larger circle now has the shape of a ring gear with pins/rollers. (Figure 2, right) As the eccentric bearing drives the cycloidal disc, the cycloidal disc rotates in one direction relative to its own center. However the cycloidal disc advances in the opposite direction relative to the center of the speed reducer. This planetary motion looks almost like the wobbling movement of hula hoops.
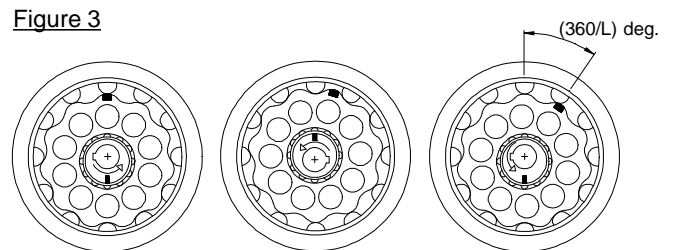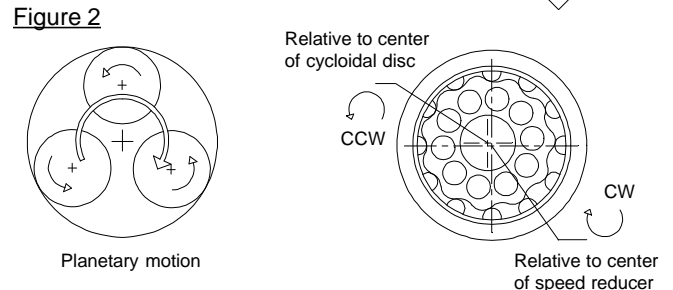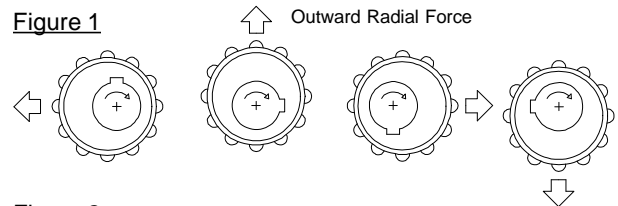
As the eccentric bearing turns one revolution, the cycloidal disc advances in the opposite direction by (360/L) degrees or (P/L) pitches of pins/rollers. (Figure 3) **Output direction of the single stage cycloidal reducer equals to the opposite of input direction.**

In order to convert the wobbling motion of a cycloidal disc into the smooth concentric movement of output shaft, several output shaft rollers are placed inside the small circles of a cycloidal disc. These rollers are also attached to the output shaft pins. The difference (2C) between the diameter of output shaft roller and the small circle is exactly twice the eccentricity (C) of eccentric bearing. This distance (2C) is also the radial difference between the valley and crest of a cycloidal disc lobe. (Figure 4)

With the arrangement above, the mechanism is capable of converting the rocking motion of an eccentric bearing into the wobbling planetary motion of a cycloidal disc. This motion is then transformed to the smooth concentric movement of output shaft through the output shaft rollers. The speed reduction is achieved, and torque transmission is accomplished.
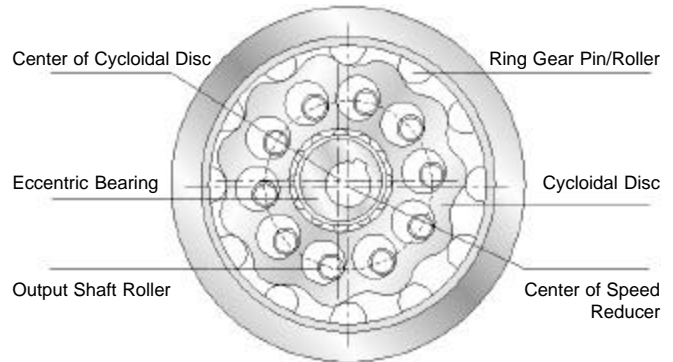
Cutaway View of a Ring Gear Sub-Assembly

Figure 1

Figure 2

Planetary motion

Figure 3

As the eccentric bearing turns one revolution, the cycloidal disc rotates in the opposite direction equal to (360/L) degree or (P/L) pitches of roller/pin.

Figure 4

Concentric movement relative to center of speed reducer

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