Simple calculations determining angular velocity and torque of the output shaft

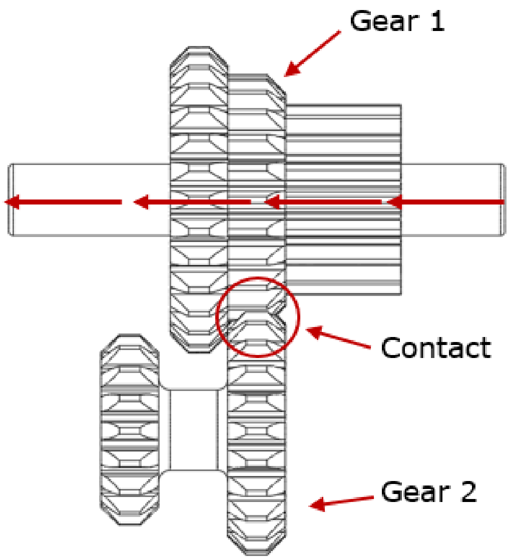

Fig. 3-B Side View of Internal Gearing demonstrating contact between *Gear 1* and *Gear 2* as first position.

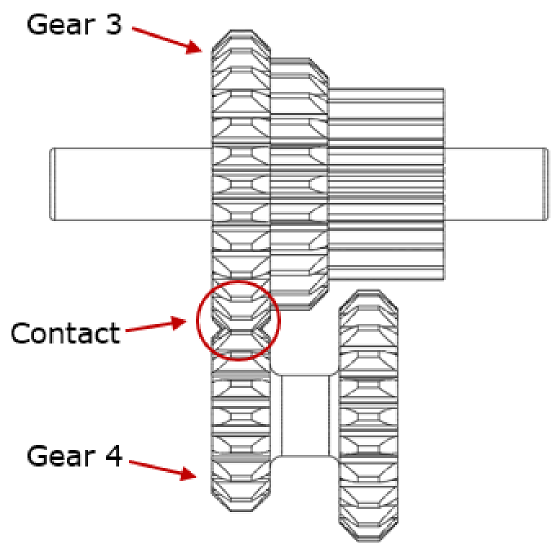

Fig. 3-C Side View of Internal Gearing demonstrating contact between *Gear 3* and *Gear 4* as second position.

To determine the angular velocity and torque of the output shaft in both positions (*Fig. 3-B* and *Fig. 3-C*), we will calculate the gear reduction (using tooth count instead of diameter) and substitute the result in an output speed formula.

If Gear 1 and Gear 2 has 24t in *Fig. 3-B,* we can achieve the following calculations for the first position:

$$Gear\ reduction_A = \frac{Output\ Gear\ Teeth}{Input\ Gear\ Teeth} \quad (3.1)$$

$$Gear\ reduction_A = \frac{24}{24} = 1 \quad (3.2)$$

If the motor torque has 14.76 in-lbs. and the gear reduction from (3.2) equals 1 then the output torque and output angular velocity can be calculated.

$$Output\ Torque_A = Input\ Torque\ x\ Gear\ Reduction \quad (3.3)$$

$$Output\ Torque_A = 14.76\ x\ 1 = 14.76\ in - lbs. \quad (3.4)$$

$$Output\ Angular\ Velocity_A = \frac{Input\ Angular\ Velocity}{GearReduction} \tag{3.6}$$

$$Output\ Angular\ Velocity_A = \frac{100RPM}{1} = 100RPM \tag{3.7}$$

Since the gear ratio for the first position is 24:24, the output torque and output angular velocity will remain the same. Let observe what happens to these variables when the gear ratio changes.

If Gear 3 has 30t and Gear 4 has 18t in *Fig. 3-C,* we can achieve the following calculations for the first position:

$$Gear\ reduction_B = \frac{Output\ Gear\ Teeth}{Input\ Gear\ Teeth} \tag{3.8}$$

$$Gear\ reduction_B = \frac{18}{30} = 0.6 \tag{3.9}$$

If the motor torque (in torque configuration) has 14.76 in-lbs. and the gear reduction from (3.9) equals 0.6 then the output torque and output angular velocity can be calculated.

$$Output\ Torque_B = Input\ Torque\ x\ Gear\ Reduction \tag{3.10}$$

$$Output\ Torque_B = 14.76\ x\ 0.6 = 8.86\ in - lbs. \tag{3.11}$$

$$Output\ Angular\ Velocity_B = \frac{Input\ Angular\ Velocity}{GearReduction} \tag{3.12}$$

$$Output\ Angular\ Velocity_B = \frac{100RPM}{0.6} = 166.67RPM \tag{3.13}$$

Since the gear ratio for the first position is 30:18, the output torque decreased by 39.97% and output angular velocity increased by 66.67%.