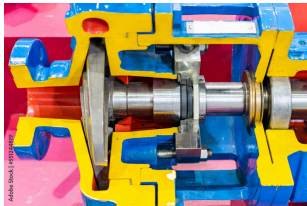


MA3001 Machine Element Design
CA1: Introduction to Machine Components
Tutorial Group: MA7 Group C

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Part List

S/N	Name	Function	Figure
1	Gear	Gears are toothed mechanical components used to transmit motion and power between rotating shafts. In power transmission systems, they serve to adjust the relationship between the speed of the driving source (e.g., engine) and the driven component (e.g., wheels), thereby enabling controlled variation of torque and rotational speed.	
2	Internal Retaining Ring	Internal retaining rings (typically located in a housing groove) are placed into bores or housings to hold mating components or assemblies in place. In this assembly, it holds the shaft and ball-bearing assembly in place and prevents the ball bearing from moving axially within the housing.	

3	Ball Bearing	Ball Bearing is a type of bearing that helps to enable rotational motion while supporting axial and radial loads, reduces rotational friction and positions moving machine parts. In this assembly, it positions the shaft along the centreline and allows it to spin at high speed and low friction for power transmission between the gear and sprocket. Fitted with interference fit with both the housing and shaft assembly at the shaft shoulder, preventing it from moving axially. Especially under high torques and loads.	
4	Housing	Housing is a container that provides attachment points for internal mechanisms. It is usually the body of a device. It also shields the components from dirt, dust and fouling. This maintains the cleanliness of the system and protects other components from structural stress and getting damaged from the surrounding environment.	
5	Roller Bearing	Roller bearing is a type of rolling element bearing. It is similar to ball bearing with the exception of using a cylinder instead of a ball. The cylindrical bearings allow for a larger radial load and are able to support heavier loads. It has an interference fit with the housing and shaft (shaft shoulder) and is retained in place axially, locked by a	

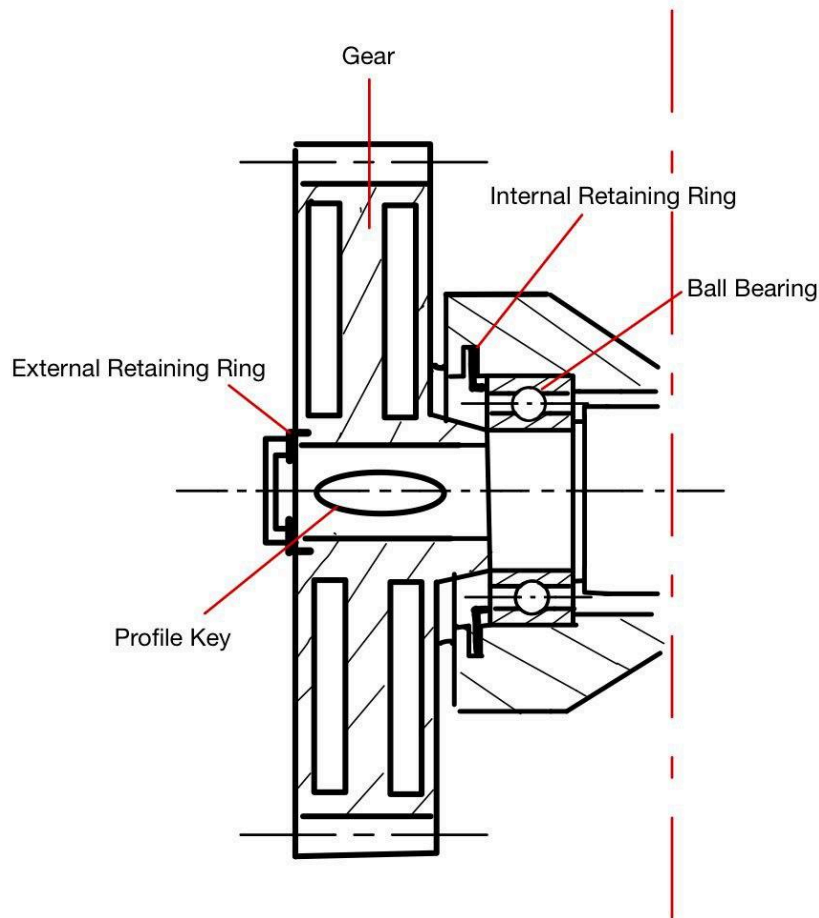
		cap.	
6	Countersunk Screws	Countersunk Screws also known as “Flat-head screws” allows the screw heads to be level with the material surface while securing two or more components together. In this assembly, it secures the housing and cap together.	
7	Cap	Caps are often used together with machine screws to clamp machine parts together. The tensile load created when it is tightened clamps the parts together. In this assembly, it encloses the shaft, spacer and rubber lip seal and prevents the roller bearing from moving axially.	
8	Rubbing Lip Seal	Rubbing lip seals keep the oil or grease lubricant inside the application and prevents the ingress of contaminants such as dirt, water and other liquids. In this assembly, it has an interference fit with both the cap and the spacer to prevent dust and dirt contamination.	
9	Sleeve (Spacer)	Sleeve spacers are cylindrical components used to maintain a distance between components within an assembly. It ensures proper alignment, preventing contact and ensuring longevity and functionality of different elements within the system. In this assembly, it maintains the distance between the chain sprocket and roller bearing and protects the shaft as the lip seal clamps down onto the	

		spacer instead of the shaft, preventing it from experiencing wear and tear.	
10	Chain Sprocket	Chain sprocket consists of a toothed wheel paired with a roller chain. It transmits rotational motion and power between different parts of a mechanical system. As the sprocket spins, the teeth grab onto the chain and move other parts that are interlocked with the chain. In this assembly, it is held in place between the spacer, washer and hexagon nut while being locked with a sliding fit with the shaft by a woodruff key.	
11	Woodruff Key	Woodruff keys are semicircular machine keys that prevent gears, hubs, and other components from moving or spinning independently. In this assembly, it is used to prevent the shaft from moving independently from the chain sprocket.	
12	Washer	Washers are typically used with a screw fastener such as bolts and nuts. It either helps to prevent the screw from loosening or distributes the load from the nut or bolt head over a larger area. These thin flat rings of soft steel are used for their effective load distribution capabilities. In this assembly, it is positioned between the hexagon nut secured onto the shaft and sprocket assembly to hold them in place.	

13	Hexagon Nut	Hexagon nuts are six-sided fasteners that secure components in position by attaching onto bolts and screws. The hexagonal shape facilitates ease of use, efficient storage and effective manufacturing. Many mechanical and structural applications rely on it. In this assembly, it fastens onto the end of the shaft with the help of a washer to hold the sprocket and shaft assembly in place through an interference fit.	
14	Profile Key	Profile keys are used to connect a rotating machine element and a shaft. It allows sliding fit while preventing relative rotation between the two parts and enabling torque transmission. In this assembly, it is used to ensure that the gear rotates with the shaft.	
15	External Retaining Ring	External retaining rings apply a spring-like pressure against the groove walls, preventing axial movement of components outside of a shaft or within a housing groove. The ring has a small gap that facilitates easy installation and removal. In this assembly, it is used to secure the shaft, keyway shaft and gear in position.	
16	Shaft	A rotating machine component which transmits power from a driver to a driven part, typically from a machine that produces power to a machine that absorbs power. In this assembly, it is secured by both	

		rollers through interference fitting while the ends have a sprocket and gear held in place by a nut, washer and external retaining ring respectively.	
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Section 1



Interface between Gear & Shaft + Profile Key

- The interface between a gear and a shaft is essential for proper gear engagement and power transmission. Gears are toothed wheels designed to transmit rotational motion and power, while shafts are cylindrical components that rotate and support various mechanical parts as the middleman of components. The rotating shaft transmits power to the gear, providing rotational motion. As a result, there is a strong interference fit between the gear and the shaft, allowing motion to be transmitted between them without slipping, maximising the transfer of torque.
- The shaft and gear are fitted with a profile key and a tight fit (interference fit) to prevent relative rotation between the shaft and the gear while allowing them to effectively transmit torque and rotational motion.

- The gear is held in place by an external retaining ring which exerts outward pressure against the groove walls, preventing axial movement and effectively holding the gear in place on the shaft.

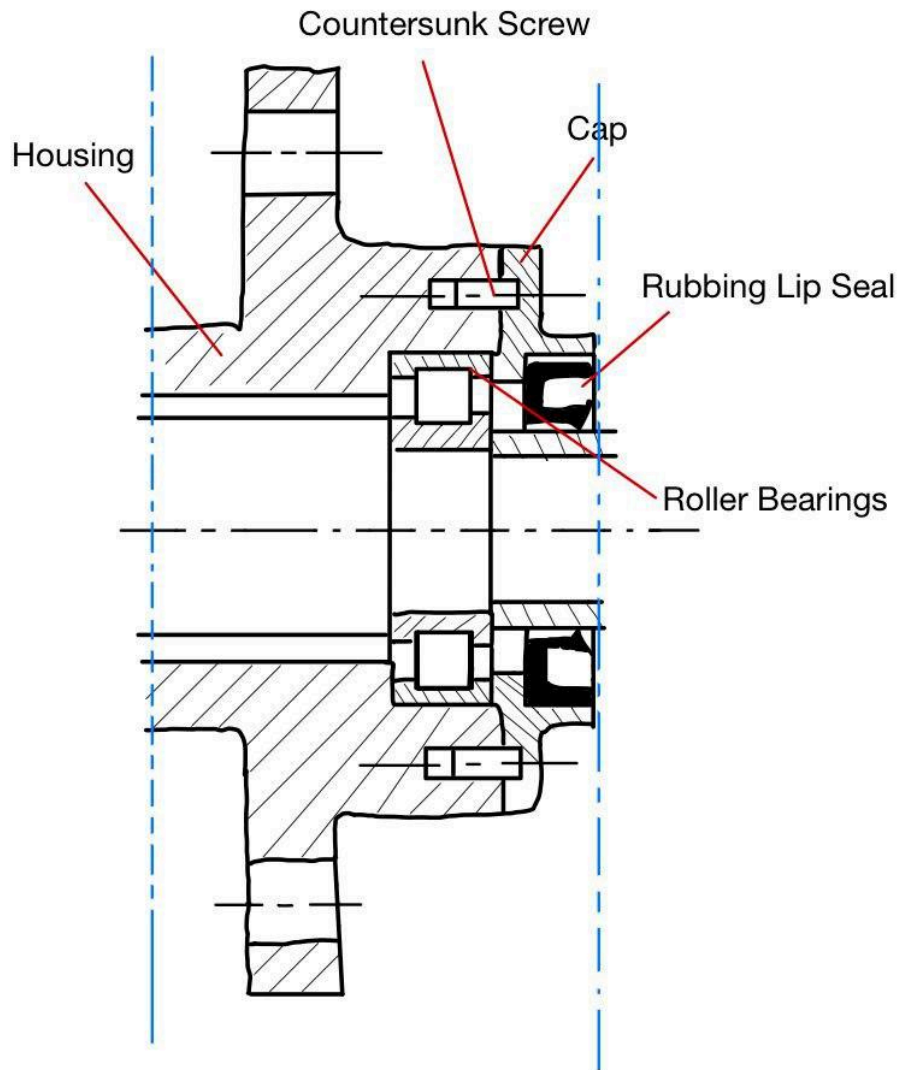
Interface between Ball Bearing & Housing:

- The external ring of the ball bearing is installed into the housing with an interference fit.
- The inner retaining ring prevents the axial movement of the ball bearing.
- A few advantages are:
 - Reduced vibration and noise, with reduced movement between the components.
 - Uniform load distribution, preventing concentration of stresses.
 - Enhanced axial stability by preventing axial movement of the bearing within the housing.

Interface between Ball Bearing & Shaft

- The inner ring of the ball bearing is installed into the shaft with an interference fit.
- The ball bearing is mounted against the shaft shoulder, to prevent it from moving in the axial direction.
- A few advantages are:
 - Minimised slippage between the bearing's inner ring and the shaft.
 - Stable operations by preventing any rotational play between bearing and shaft.
 - Uniform load distribution.

Section 2



Interface between housing and roller bearing

- An interference fit ensures a secure and firm connection between the bearing and the housing, which is especially useful in high-torque situations where precise alignment and minimal movement are essential to handle increased loads and forces. The slightly overlapping dimensions of the roller bearing's outer surface and the housing's inner surface create a light press fit, pressing the bearing into the housing.
 - Some benefits of using an interference fit include:
 - Improved torque transmission

- Higher load capacity
- Reduced vibration and noise

Interface between cap and countersunk screw

- For high-torque applications, a commonly used fit is the "Class 2A" external thread and "Class 2B" internal thread fit. This combination strikes a balance between easy assembly and strong engagement.
- In high torque applications, it is also typical to employ additional locking mechanisms, such as locking washers, thread-locking compounds, or prevailing torque nuts, to prevent loosening due to vibrations or dynamic loads.

Interface between housing and shaft

- The shaft is installed inside the housing with a clearance fit .A keyed connection using woodruff keys is employed to prevent relative rotation between the shaft and the housing, ensuring efficient torque transmission. This is achieved by inserting a key into a slot on both the shaft and the housing.
 - The benefits of using a keyed connection with woodruff keys include:
 - Accurate alignment
 - Even distribution of stress
 - Effective torque transmission

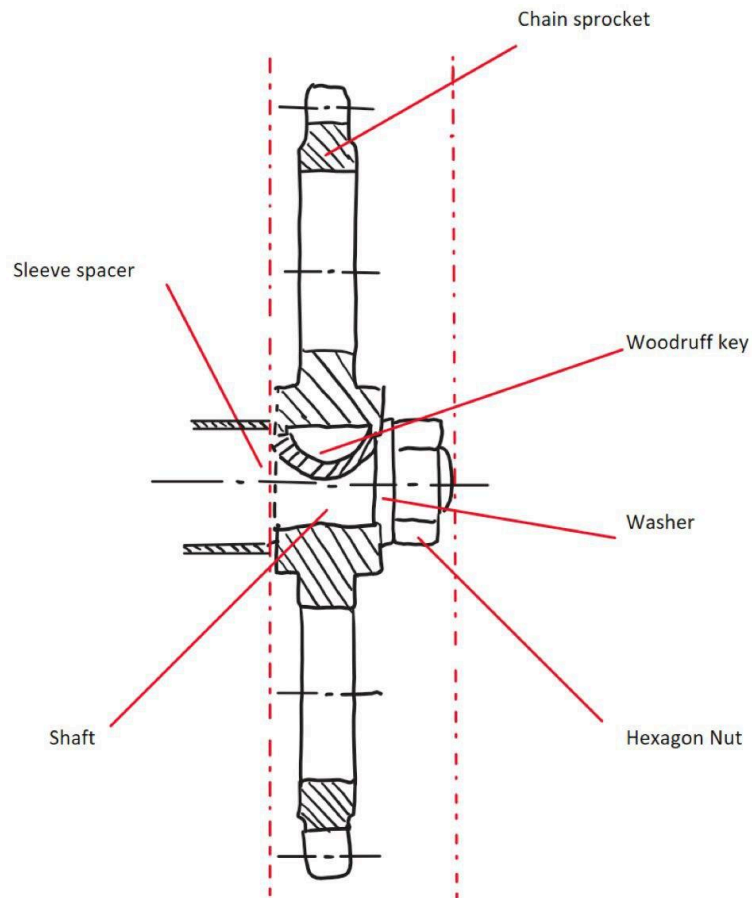
Interface between roller bearing and shaft

- A 'Pressed fit' is commonly used between the roller bearing and the shaft. This type of fit ensures that the inner ring of the roller bearing is tightly secured onto the shaft, creating a firm connection that prevents any relative movement between the bearing and the shaft, providing axial retention of the bearing of the shaft, effectively preventing any axial movement.

Interface between housing and cap

- The common interfaces used in this application are Bolted and Flanged connection.
- Bolted connection:
 - Involves the clamping force generated by the bolts, holding the 2 components together and ensuring torque transmission through securing the cap to the housing using bolts and nuts.
- Flanged connection:
 - It involves securing the cap using bolts, providing torque transmission and structural integrity by attaching a flange on the cap to a mating flange on the housing

Section 3



Interface between Chain Sprocket & Shaft:

- The connection between the chain sprocket and the shaft is established using a woodruff key. This ensures a secure engagement and prevents any relative movement between the sprocket and the shaft.
- The chain sprocket is mounted onto the shaft with an interference fit to facilitate easy removal of the chain sprocket.

Interface between Hexagonal Nut, Washer and Chain Sprocket:

- The interaction among the chain sprocket, washer, and hexagon nut forms a cohesive assembly. The chain sprocket is positioned, secured by the washer, and then fastened using the hexagon nut to create a secure connection, denying

any movement in the axial direction.

- The washer and hexagon nut work together to secure components in place. The washer provides a flat surface and distributes pressure.

Interface between Hexagonal Nut & Shaft:

- The hexagon nut is fastened in conjunction onto a threaded shaft to hold everything (from the spacer to the washer) firmly.

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