MIET2510

Mechanical Design

Week 5 – Shaft Design, Key, and Seal – Part 2

School of Science and Technology, RMIT Vietnam

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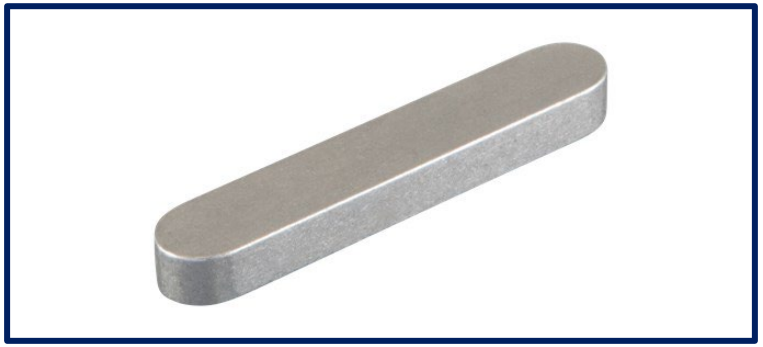
Key Introduction

- In many machine designs, torque must be transmitted between shafts and gears, pulleys, chain-wheels and other hubs. In almost all cases, this must be done without allowing slip between the two parts.
- Keys are the most widely used method of torque transfer.



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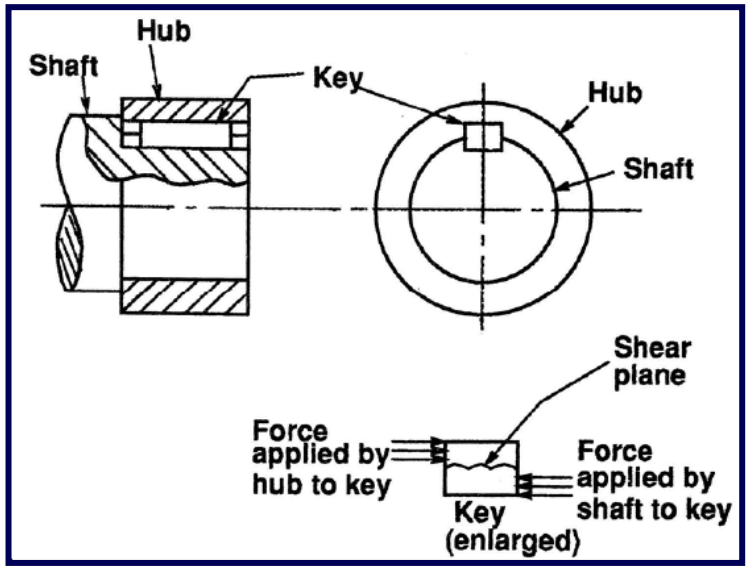
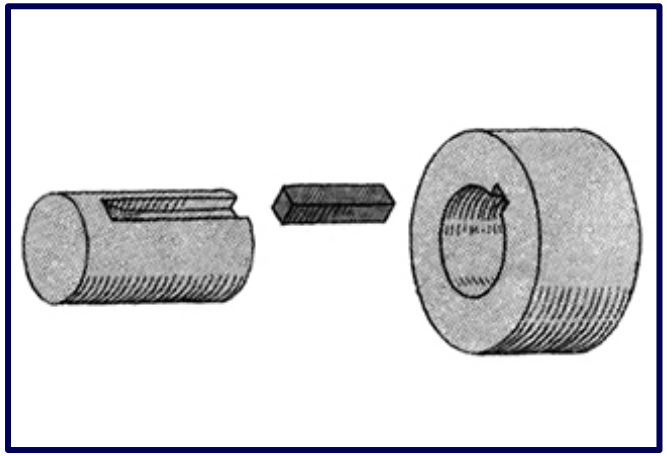
Key Introduction

A longitudinal groove called a **keyway** is machined into the shaft and a corresponding groove into the bore of the hub. The **key** fits simultaneously into both grooves, locking them together.





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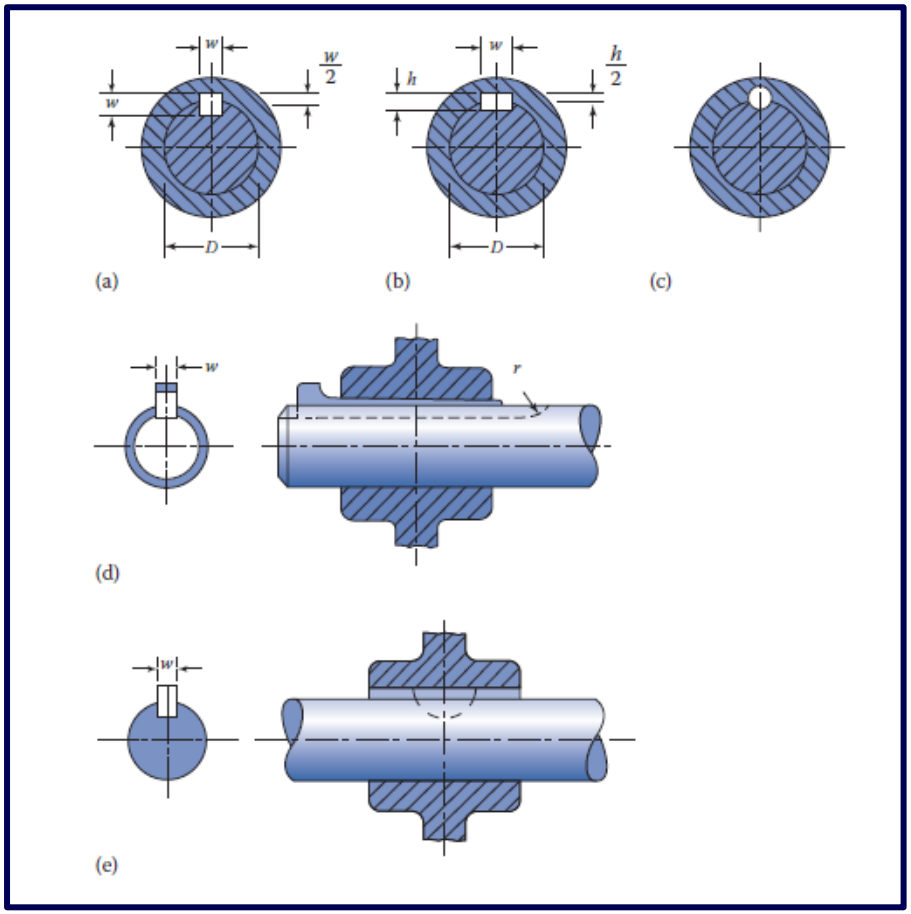
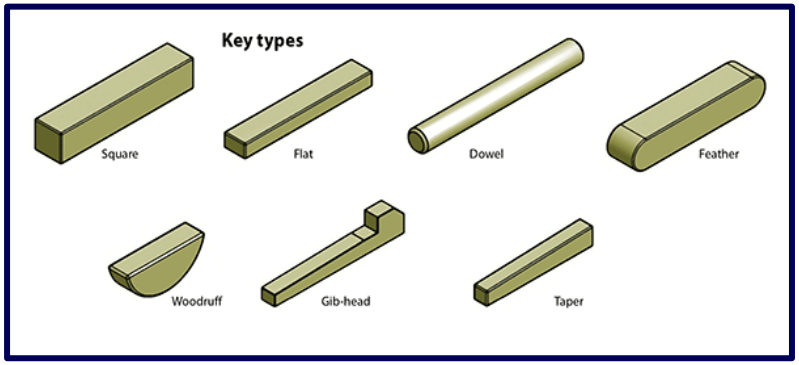
Types of Key

Common types of shaft keys: (a) square key ($w \approx D/4$), (b) flat key ($w \approx D/4$, $h \approx 3w/4$), (c) round key (often tapered), (d) gib-head key, and (e) Woodruff key.





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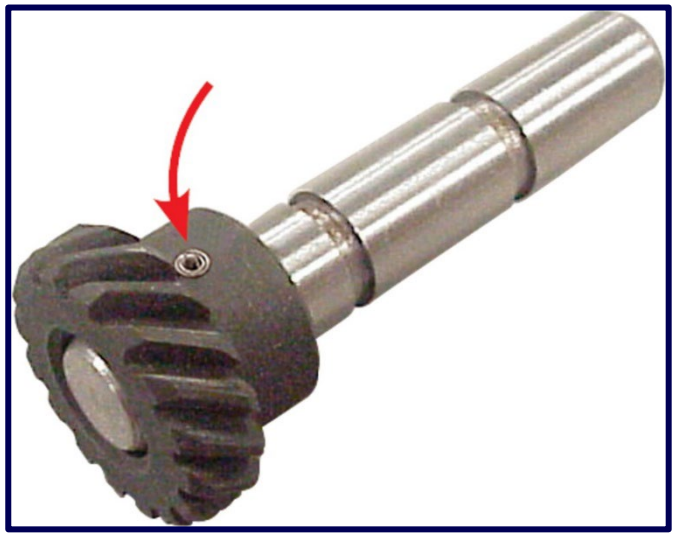
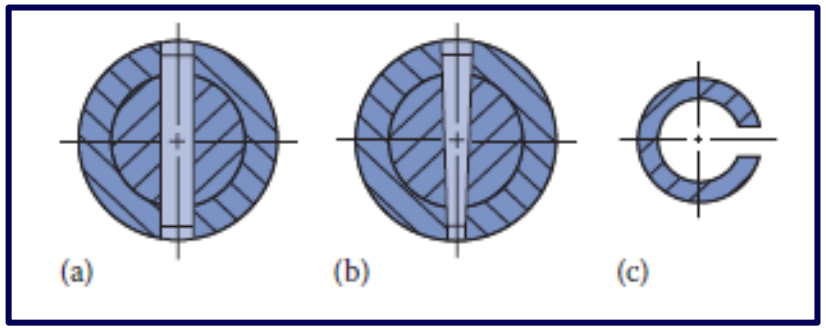
Pins and Keys

A pin is employed for axial positioning and the transfer of relatively light torque or axial load (or both) to the hub. Some types of shaft pins are the (a) straight round pin, (b) tapered round pin, and (c) roll pin.





Some types of pins: (a) straight round pin, (b) tapered round pin, and (c) cross section of a split-tubular pin or so-called roll pin.

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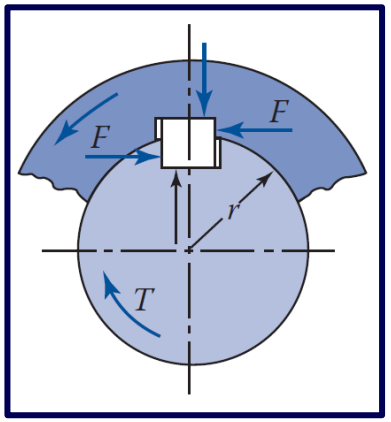
Stress in Keys

The distribution of the force on the surfaces of a key is very complicated. It is applied in practice that the entire torque T is carried by a tangential force F located at the shaft surface and uniformly distributed along the full length of the key as:

$$T = Fr$$



Shear and compressive or bearing stresses are calculated for the keys from force F, using a sufficiently large factor of safety. For steady loads, a factor of safety of 2 is commonly applied. On the other hand, for minor to high shock loads, a factor of safety of 2.5 – 4.5 should be used.

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Key Parameter Calculation

- **Given shaft parameters, input torque**
  - Calculate force and stress.
  - Determine the key length (if width/radius is provided).
- **Given shaft parameter, input torque**
  - Calculate torque, and stress.
  - Determine the key width/radius (if length is provided).

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Square Key Equation

- **The required length of the square key is calculated as**

$$L = \frac{2Fn}{S_y w}$$

where F is the force at the shaft surface

S_y is the yield strength

n is the safety factor

w is the width of square key

Key Design Procedure

- **Selecting the type of the keys**

According to the configurations, working condition, centering quantity, fixing and location to select key type.

- **Assure the configuration and size of the keys**

According to the diameter of the shaft, get the section (b × h) of the key.

- **Strength calculations of key joints to define L of the key**

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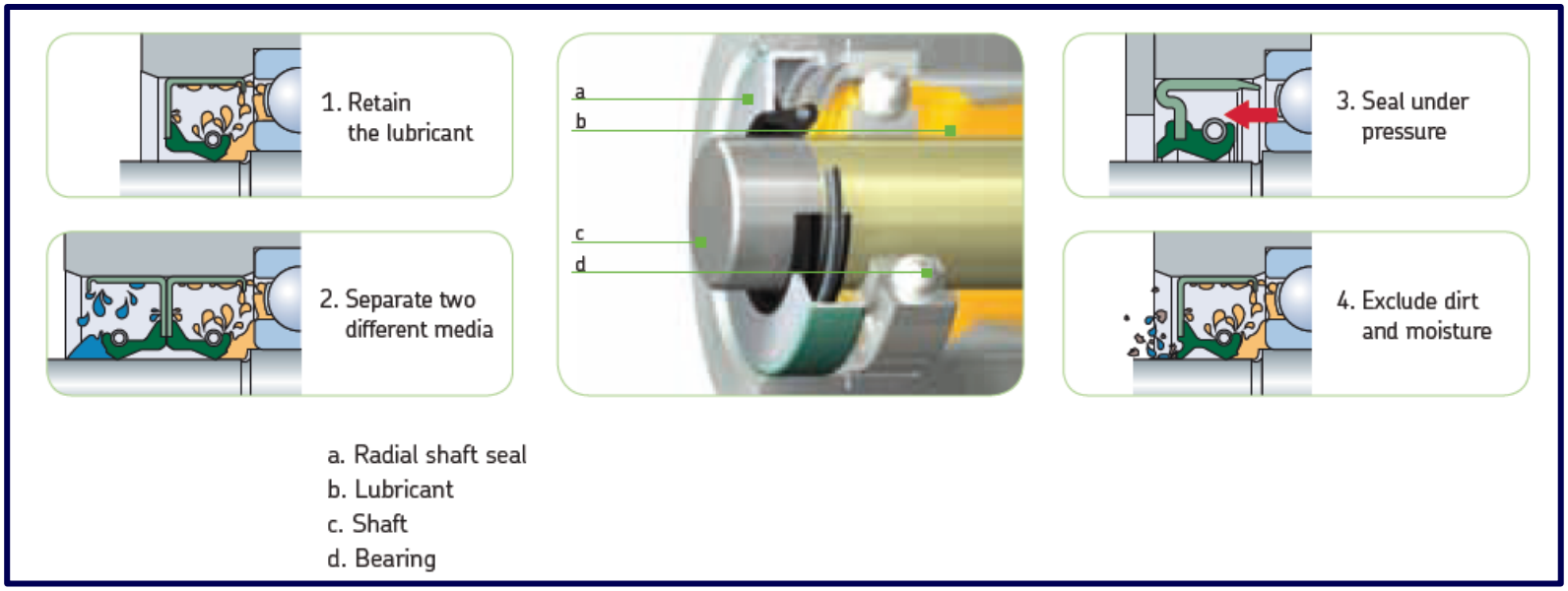
Seal

Seals are used between rotating and stationary machine components or between two components in relative motion.



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Reference

- *Mechanical Design of Machine Components (2nd) by Ansel C.Ugural.*
- *Mechanical Engineering Design (10th) by Richard G.Budynas and J. Keith Nisbett.*
- *Theory of Machines and Mechanisms (5th) by John J.Uicker, Gordon R.Pennock, Joseph E. Singley.*

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