

Shafts and Shaft Components

Shaft Layout

Shafts and Shaft Components

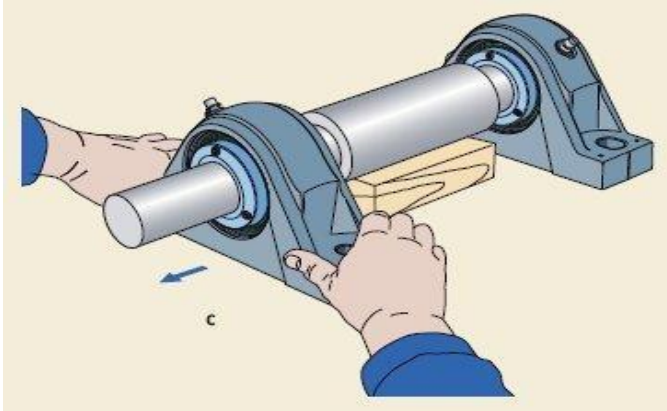
Issues to consider for shaft layout:

- ❑ Axial layout of components
- ❑ Supporting axial loads
- ❑ عزم دورانه Torque transmission
- ❑ Assembly & Disassembly

Axial Layout of Components

في معظم الحالات وجود 2 bearings يكون كافياً. إذا كان المحور طويلاً جداً

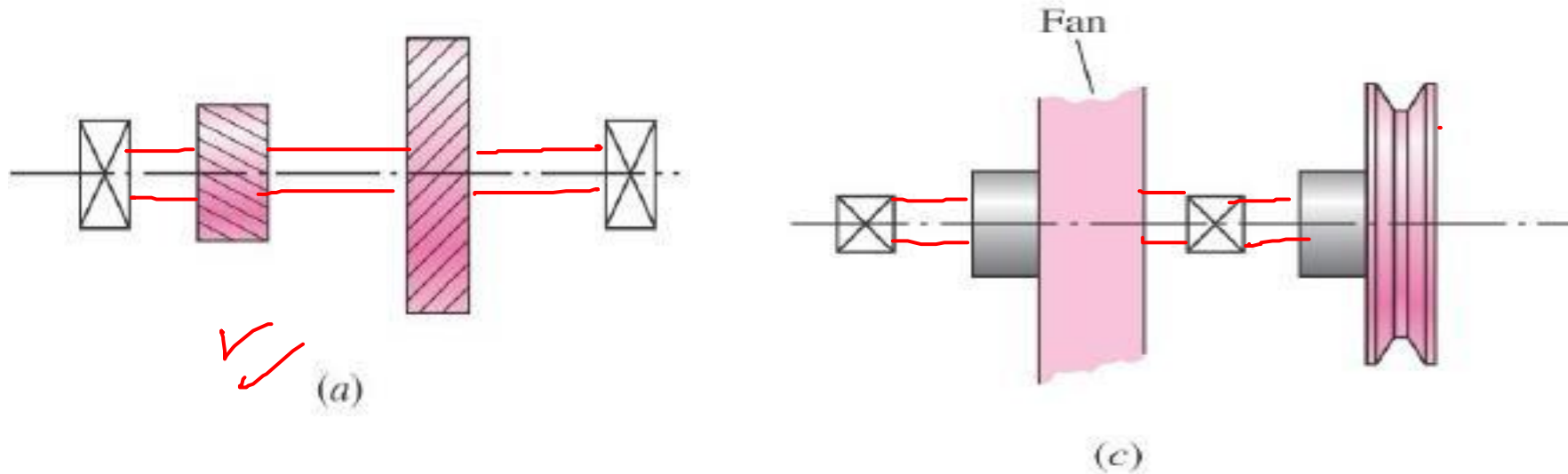
- Only two bearings should be used in most cases. For extremely long shafts carrying several load-bearing components, it may be necessary to provide more than two bearing supports.



- Shafts should be kept short to minimize bending moments and deflections. Some axial space between components is desirable to allow for lubricant flow and to provide access space for disassembly of components.

Axial Layout of Components

-In general, it is best to support load-carrying components between bearings, such as in Fig. a, rather than cantilevered outboard of the bearings, such as in Fig. c.

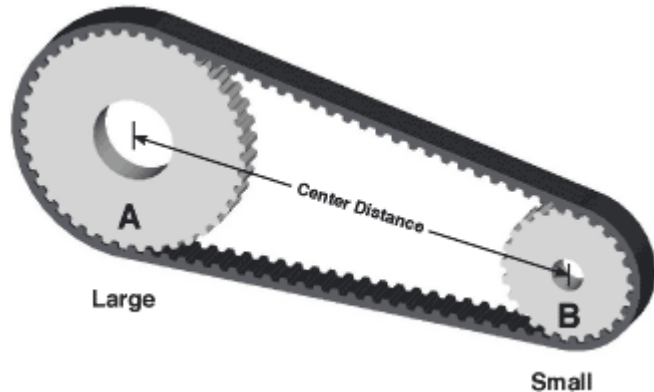


من الأفضل أن يكون مكان الbearings في أقصى يمين وأقصى يسار العمود وباتى المكونات بينهم .

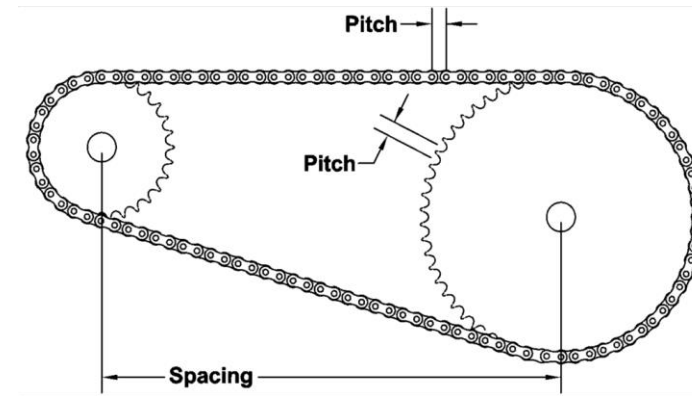
Axial Layout of Components

- Pulleys and sprockets often need to be mounted outboard for ease of installation of the belt or chain. The length of the cantilever should be kept short to minimize the deflection.

Cantilever



Pulleys + belt

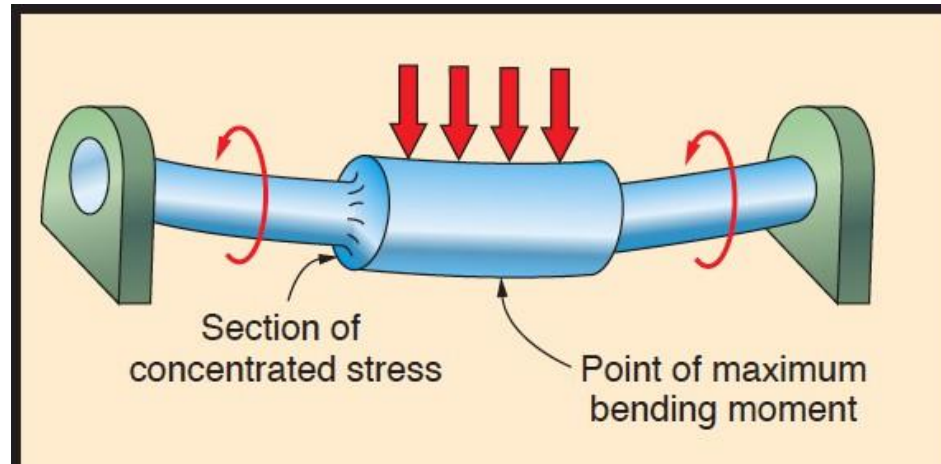


sprockets + chain

سے بے استغاب فی حالہ وجود Sprockets & Pulleys نہ تکیہ Cantilevered لے سہولت
الغٹ والترکیب

Axial Layout of Components

- Load bearing components should be placed near the bearings, to minimize the bending moment at the locations that will likely have stress concentrations, and to minimize the deflection at the load-carrying components.

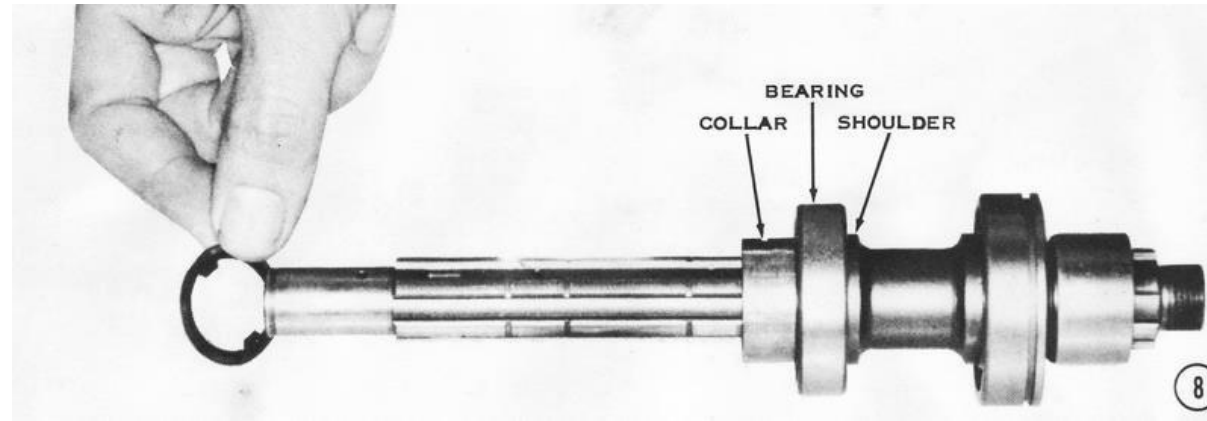


← نحاول بقدر الإمكان أن تكون المكونات المحيطة على الـ Shaft

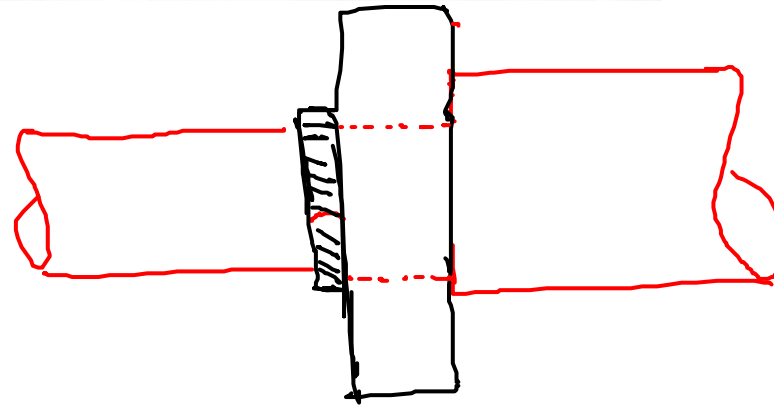
قريب من الـ bearings لتقليل الـ bending moments والـ deflections

Axial Layout of Components

-The primary means of locating the components is to position them against a shoulder of the shaft. A shoulder also provides a solid support to minimize deflection and vibration of the component.

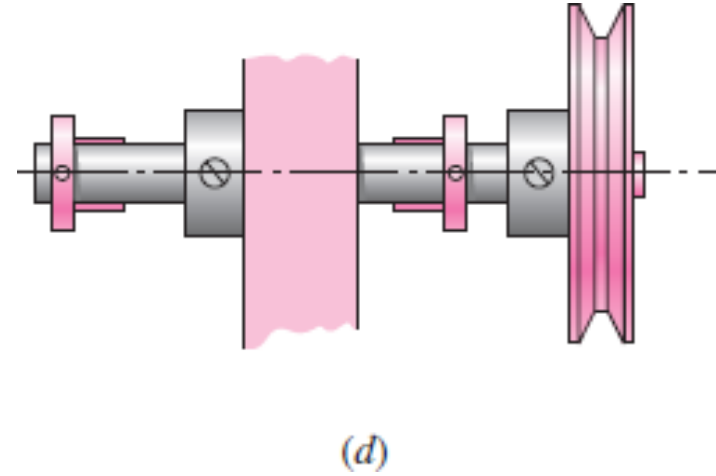
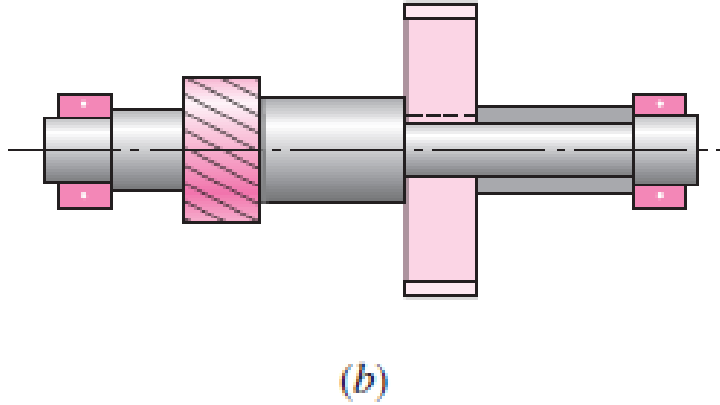


axial loads ↑↑↑



Axial Layout of Components

- Where axial loads are very small, it may be feasible to do without the shoulders entirely, and rely on press fits, pins, or collars with setscrews to maintain an axial location. See Fig. b and d



Supporting Axial Loads

- In cases where axial loads are not negligible, e.g. for helical or bevel gears, or tapered roller bearings, it is necessary to provide a means to transfer the axial loads into the shaft, then through a bearing to the ground.
- Often, the same means of providing axial location, e.g., shoulders, retaining rings, and pins, will be used to also transmit the axial load into the shaft.



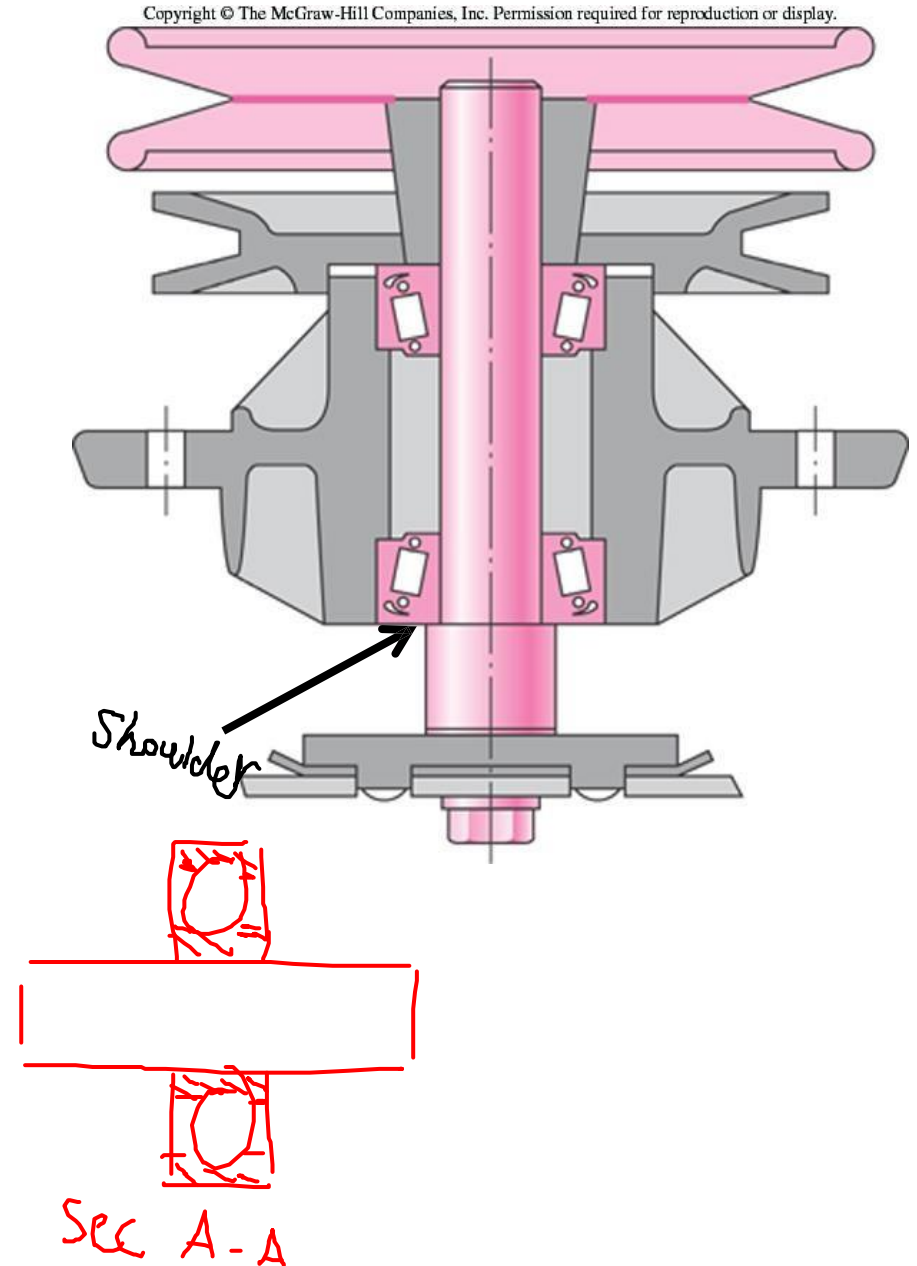
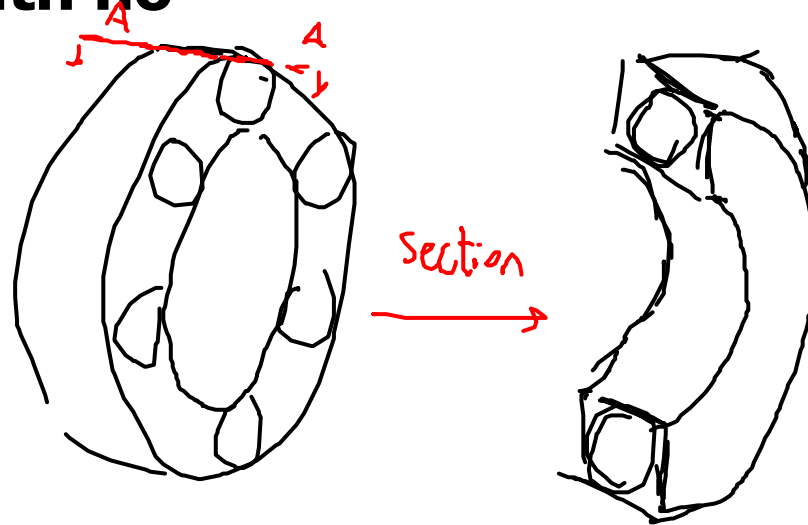
rings



pins

Supporting Axial Loads

-The figure shows example of shaft with only one bearing carrying the axial load against a shoulder, while the other bearing is simply press-fit onto the shaft with no shoulder.



Providing for Torque Transmission

- The shaft must be sized to support the torsional stress and torsional deflection. The common torque- transfer elements, that used to provide a means of transmitting the torque between the shaft and the gears, are:

- Keys
- Splines
- Setscrews
- Pins
- Press or shrink fits
- Tapered fits

Providing for Torque Transmission

- Keys:

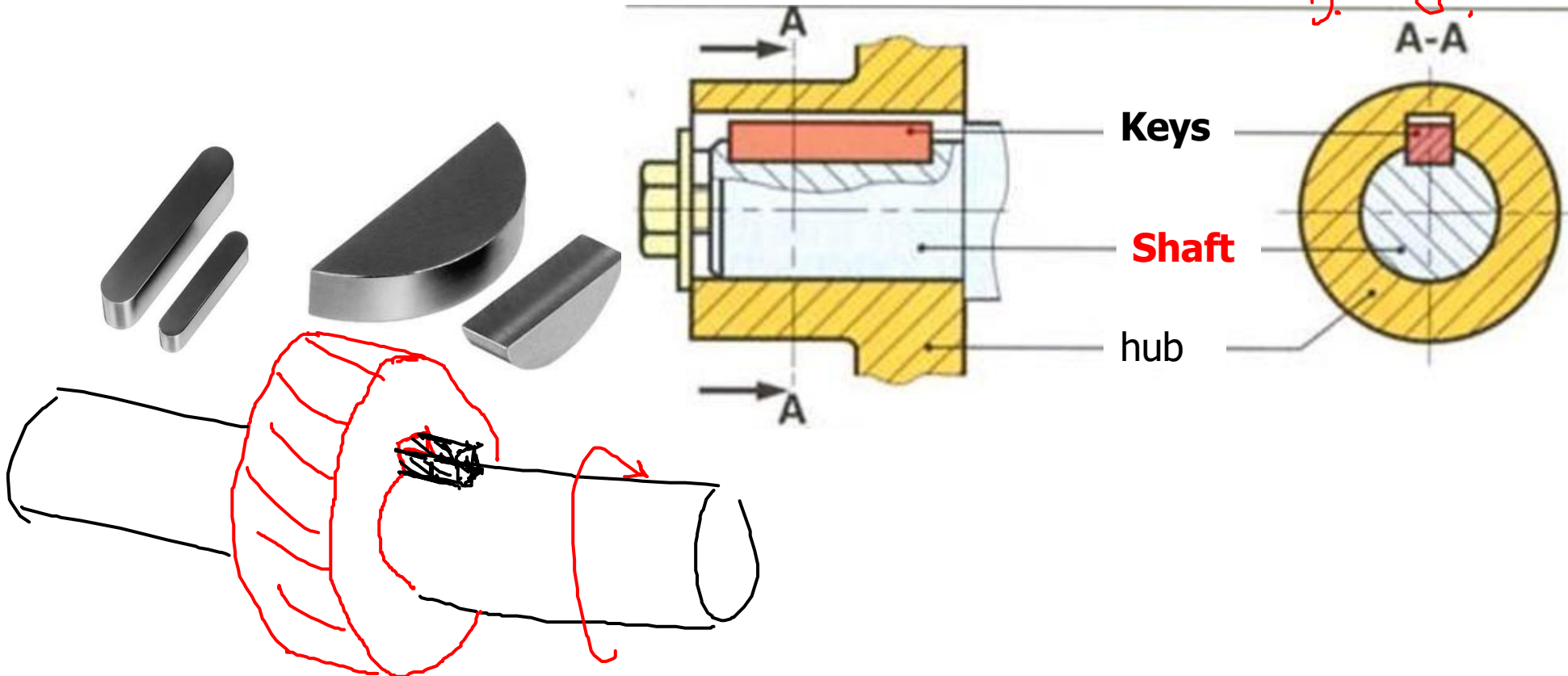
- Moderate to high levels of torque

تركيب بسهولة

- Slip fit of component onto shaft for easy assembly

- Designed to fail if torque exceeds acceptable operating limits, protecting more expensive components.

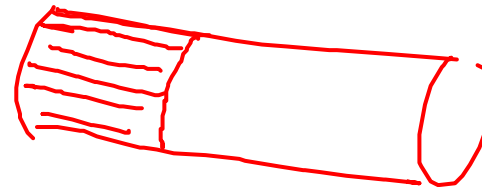
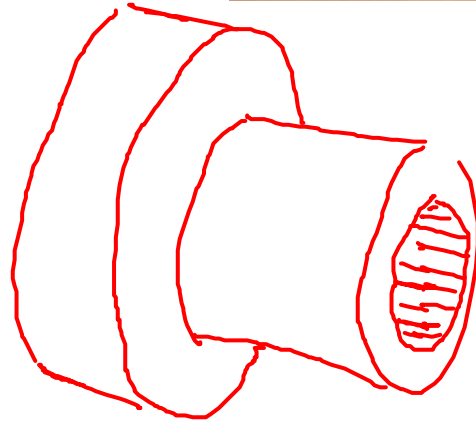
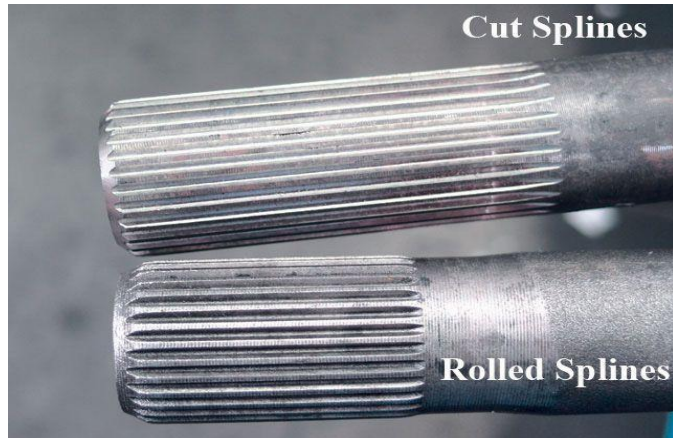
ينهار إذا تجاوز العزم الحد المسموح به لحماية باقي الأجزاء.



Providing for Torque Transmission

Splines

- Gear teeth formed on outside of shaft (a) and on inside of the hub (b) of the load-transmitting component.
- Transfer high torques



Providing for Torque Transmission

Pins, setscrews in hubs, tapered fits, and press fits

Low torque transmission

Press and shrink fits: used both for torque transfer and for preserving axial location.

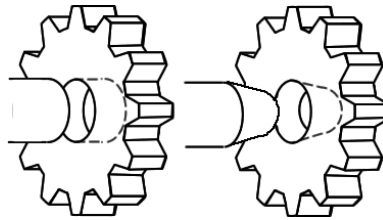
A split hub with screws to clamp the hub to the shaft. This method allows for disassembly and lateral adjustments.



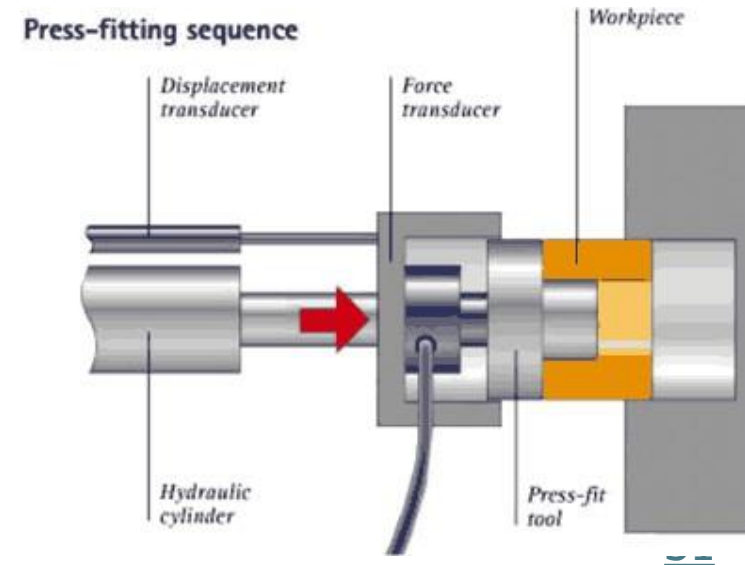
Pins



setscrews

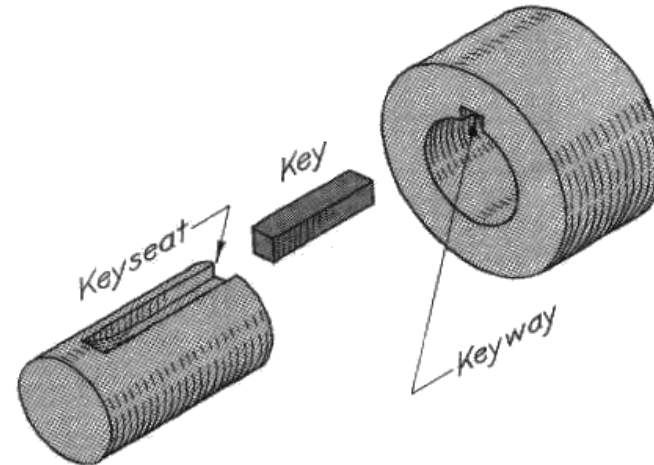


tapered fits



Providing for Torque Transmission

- In addition to transmitting the torque, many of these devices are designed to fail if the torque exceeds acceptable operating limits, protecting more expensive components.
- One of the most effective and economical means of transmitting moderate to high levels of torque is through a key that fits in a groove in the shaft and gear.



Providing for Torque Transmission

- Keyed components generally have a slip fit onto the shaft, so assembly and disassembly is easy.
- Splines are generally much more expensive to manufacture than keys, and are typically used to transfer high torques.
- One feature of a spline is that it can be made with a reasonably loose slip fit to allow for large axial motion between the shaft and component while still transmitting torque.

Slip fit → تركيب بسهولة

Press fit → تركيب بالضغط (بالقوة)

Shrink fit → تركيب (بتسخين المفتح و
لتنمدد ثم تنكش على الـ shaft)

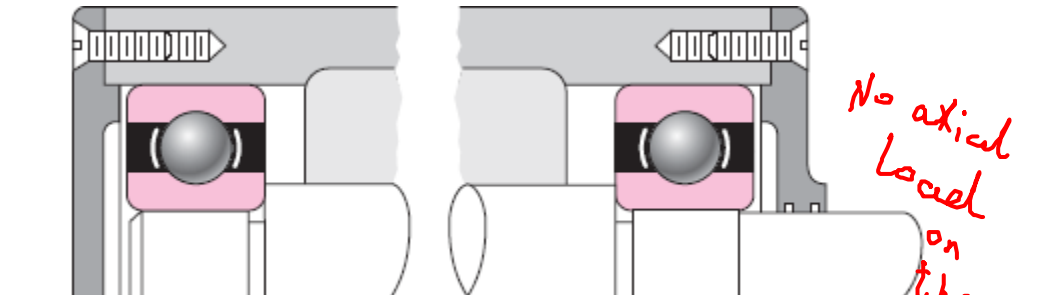
Providing for Torque Transmission

- At the early stages of the shaft layout, the important thing is to select an appropriate means of transmitting torque. It is necessary to know where the shaft discontinuities, such as keyways, holes, and splines, will be in order to determine critical locations for analysis.
- Consideration should be given to the method of assembling the components onto the shaft
- This generally requires the largest diameter in the center of the shaft, with smaller diameters towards the ends to allow components to be slid on from the ends.

Assembly and Disassembly

-The gearbox will need means to physically position the shaft into its bearings, and the bearings into the frame.

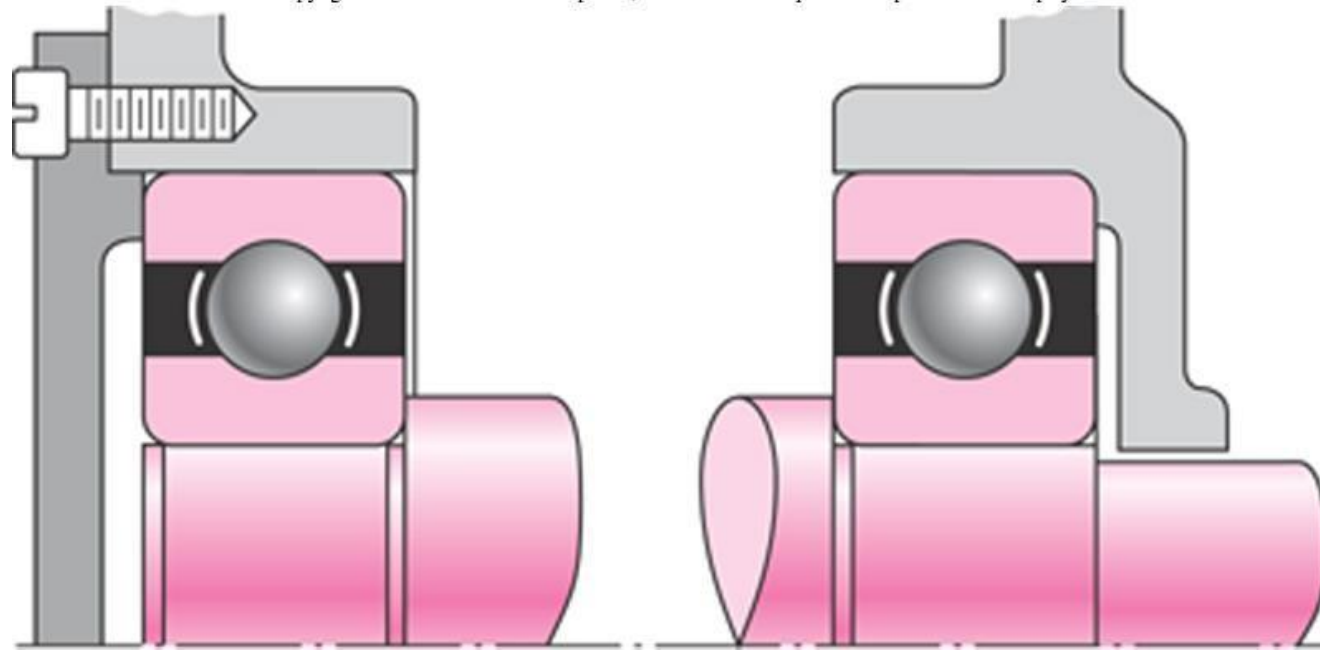
⇒ This is typically accomplished by providing access through the housing to the bearing at one end of the shaft.



Arrangement showing bearing inner rings press-fitted to shaft while outer rings float in the housing of the gearbox.

Assembly and Disassembly

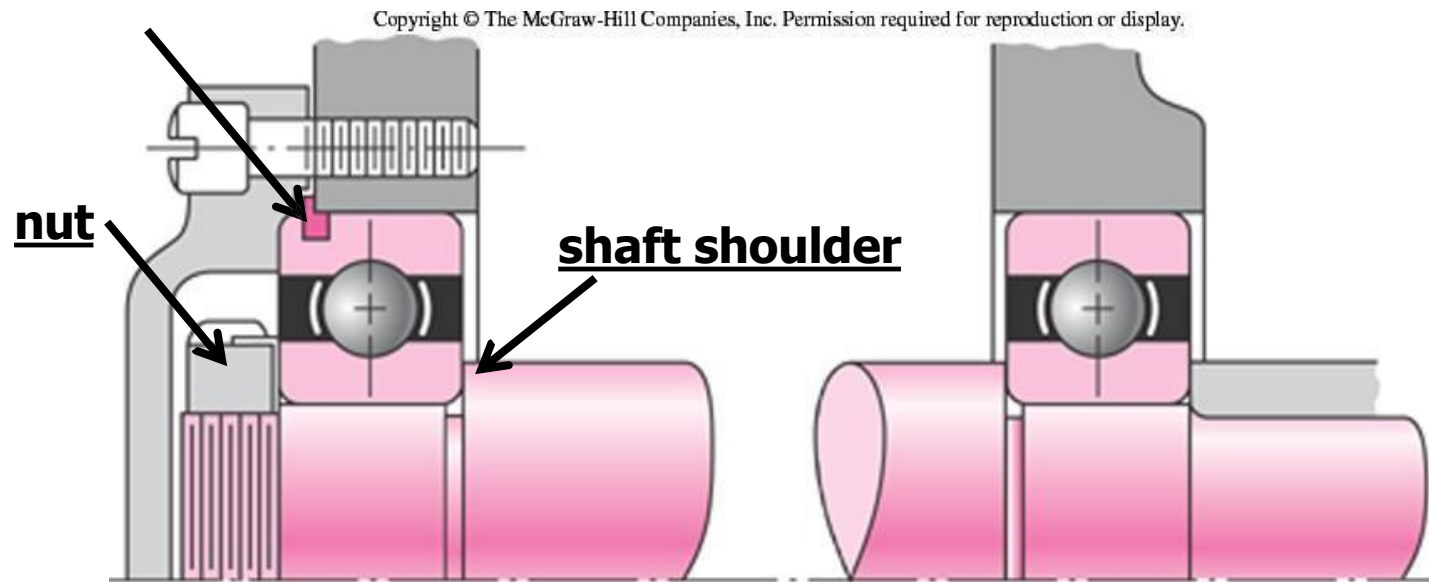
Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



Arrangement showing bearing inner rings press-fitted to shaft and outer rings are preloaded by the housing of the gearbox.

Assembly and Disassembly

snap ring



- In this arrangement the inner ring of the bearing is locked to the shaft between a nut and a shaft shoulder. The snap ring in the outer race is used to positively locate the shaft assembly in the axial direction.

Assembly and Disassembly

- This arrangement is similar to the previous one, in that the lefthand bearing positions the entire shaft assembly.
- In this case the inner ring is secured to the shaft using a snap ring.
- Note the use of a shield to prevent dirt generated from within the machine from entering the bearing.

