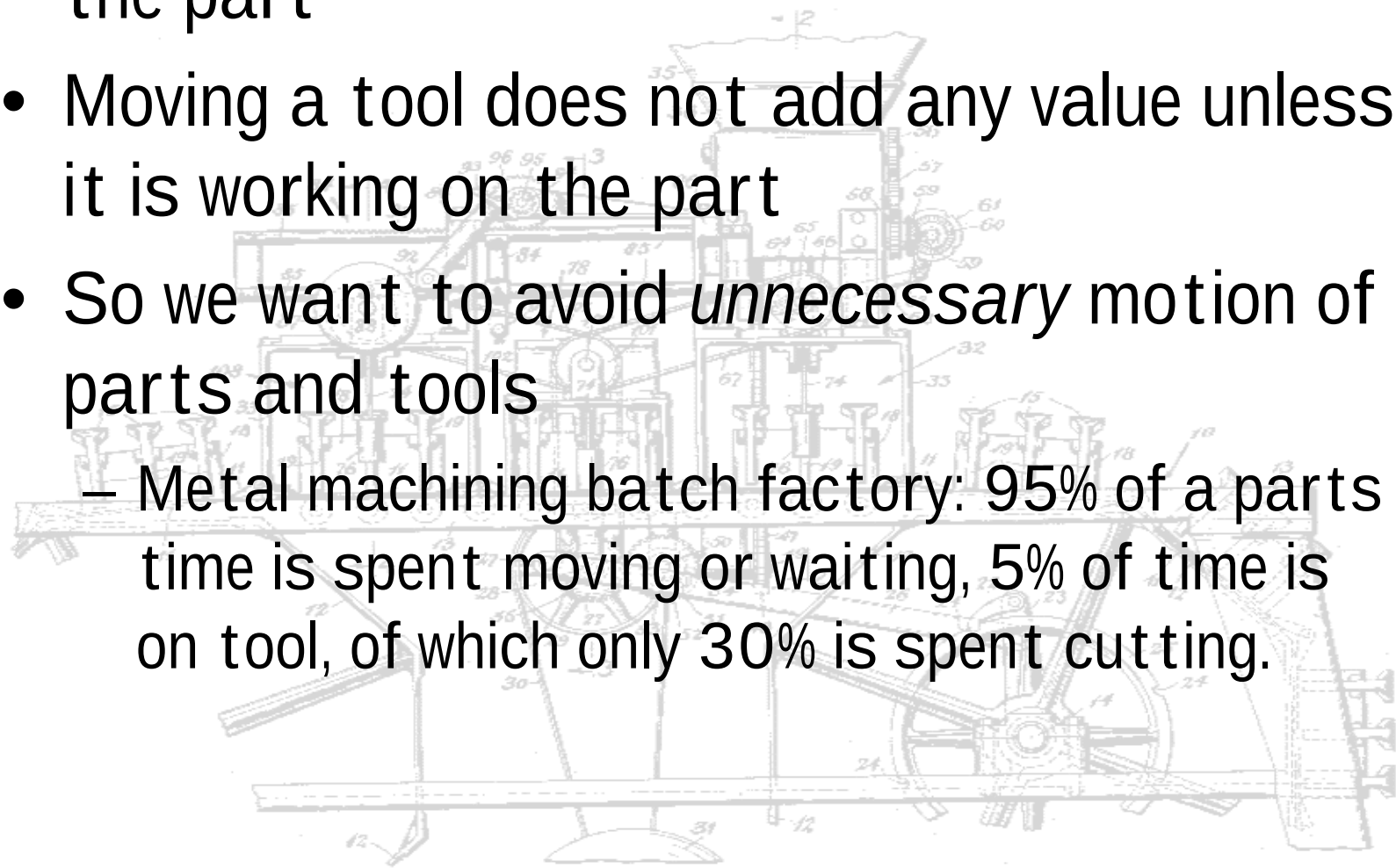
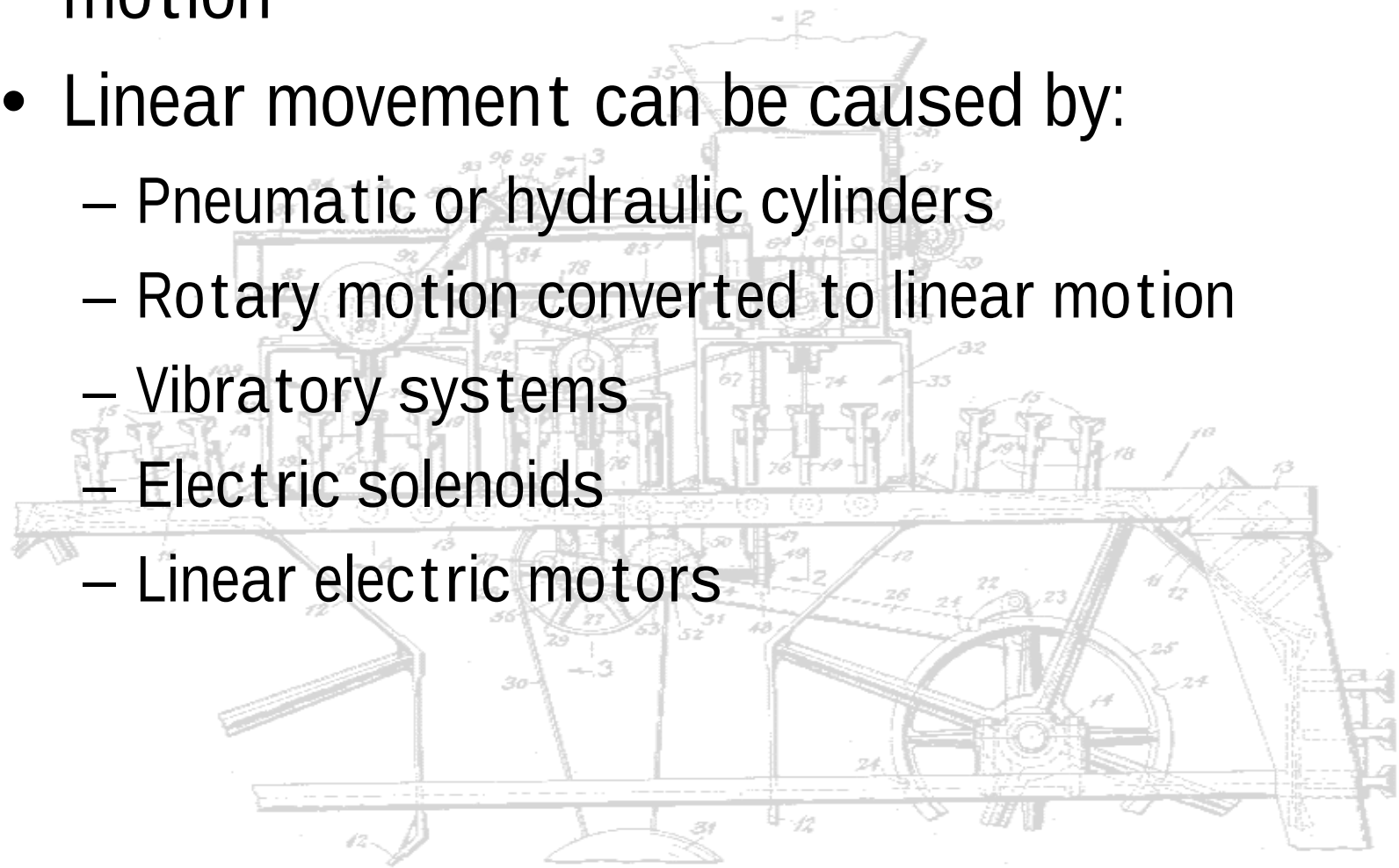
Generating Motion

- Moving a part does not add any value to the part
- Moving a tool does not add any value unless it is working on the part
- So we want to avoid *unnecessary* motion of parts and tools
  - Metal machining batch factory: 95% of a parts time is spent moving or waiting, 5% of time is on tool, of which only 30% is spent cutting.



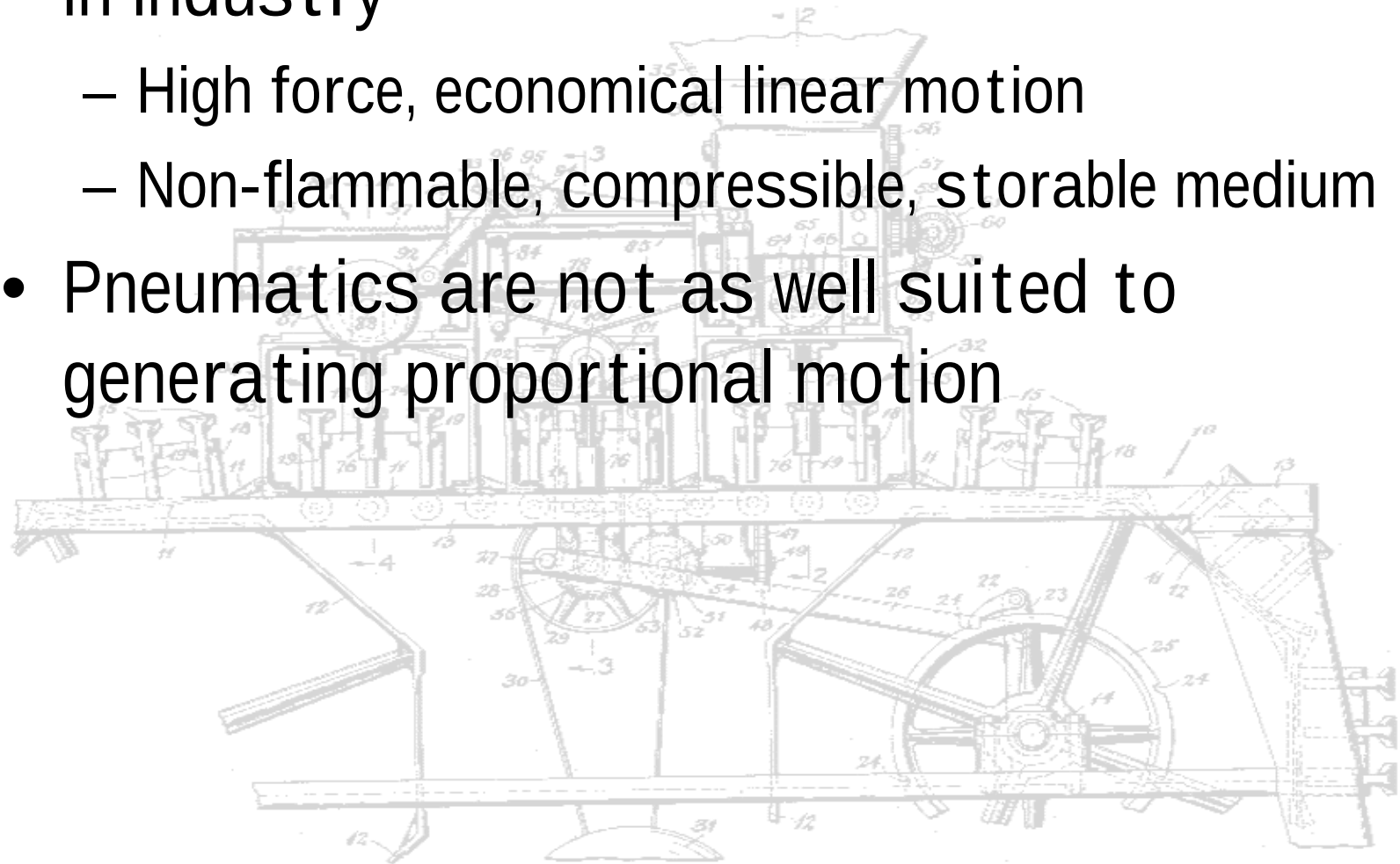
Linear Motion

- Linear translation is the most common motion
- Linear movement can be caused by:
  - Pneumatic or hydraulic cylinders
  - Rotary motion converted to linear motion
  - Vibratory systems
  - Electric solenoids
  - Linear electric motors



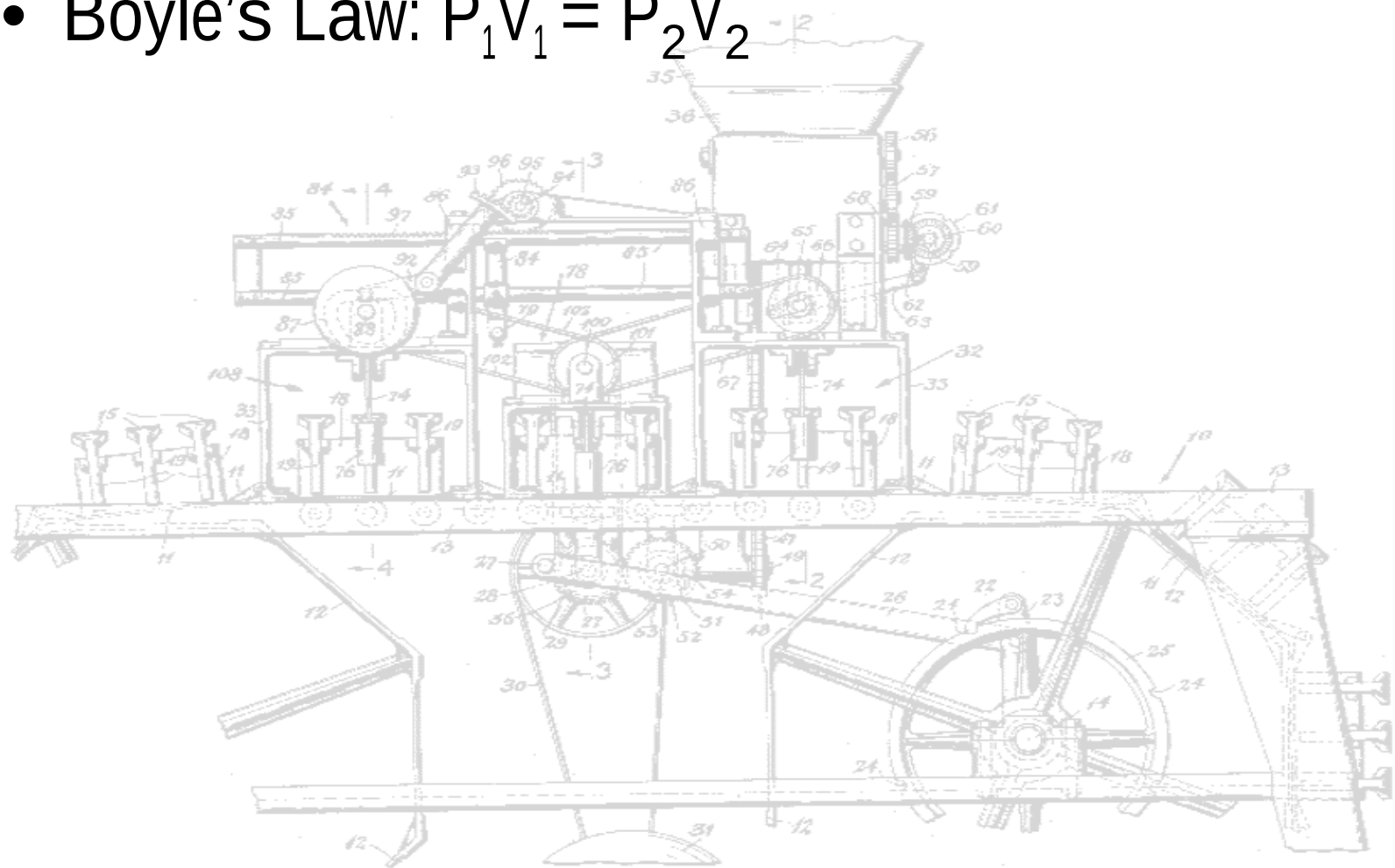
Pneumatic Systems

- Pneumatic power systems are very popular in industry
  - High force, economical linear motion
  - Non-flammable, compressible, storable medium
- Pneumatics are not as well suited to generating proportional motion

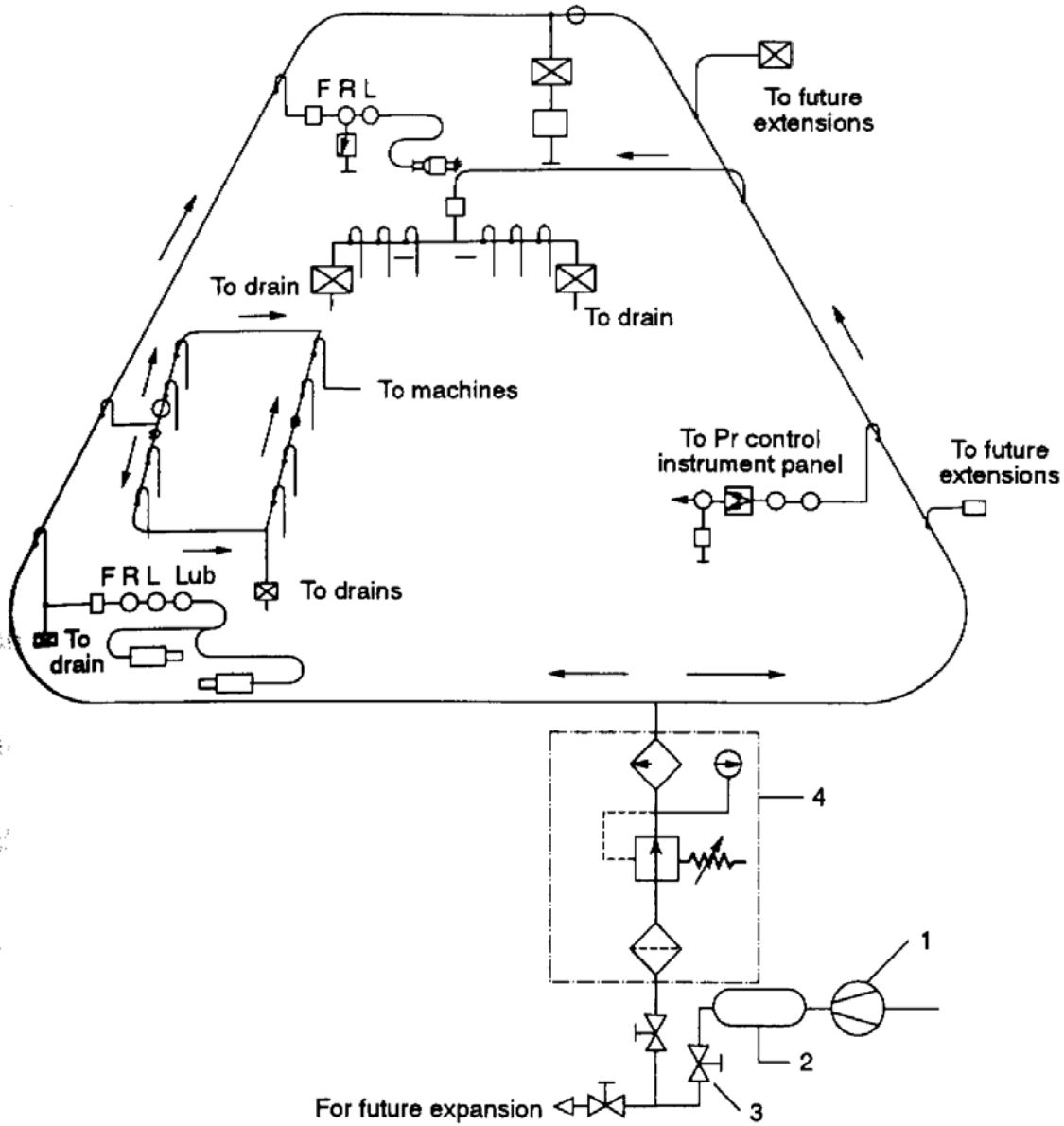


Pneumatic Systems

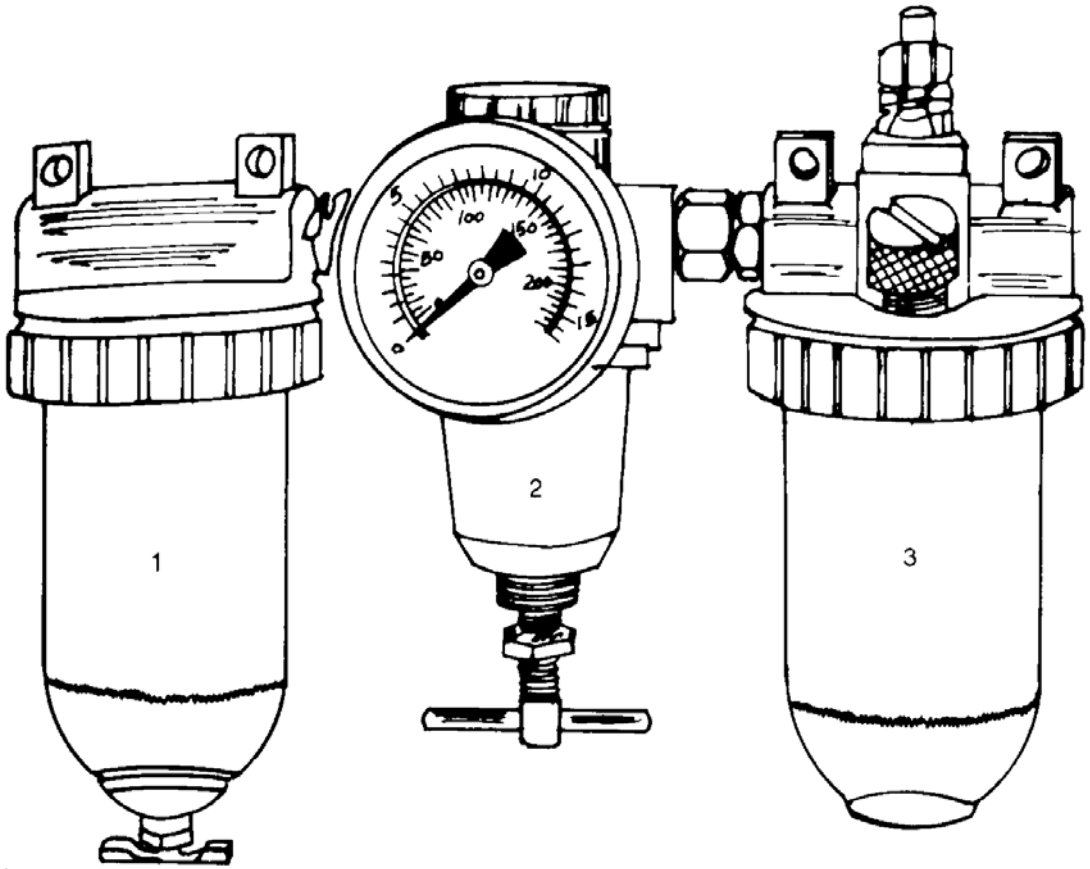
- Gas Law: PV=mRT
- Boyle's Law: $P_1V_1 = P_2V_2$

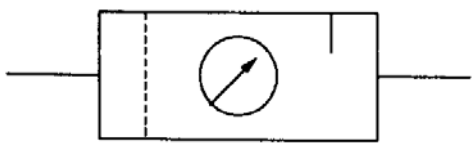


Pneumatic System Layout

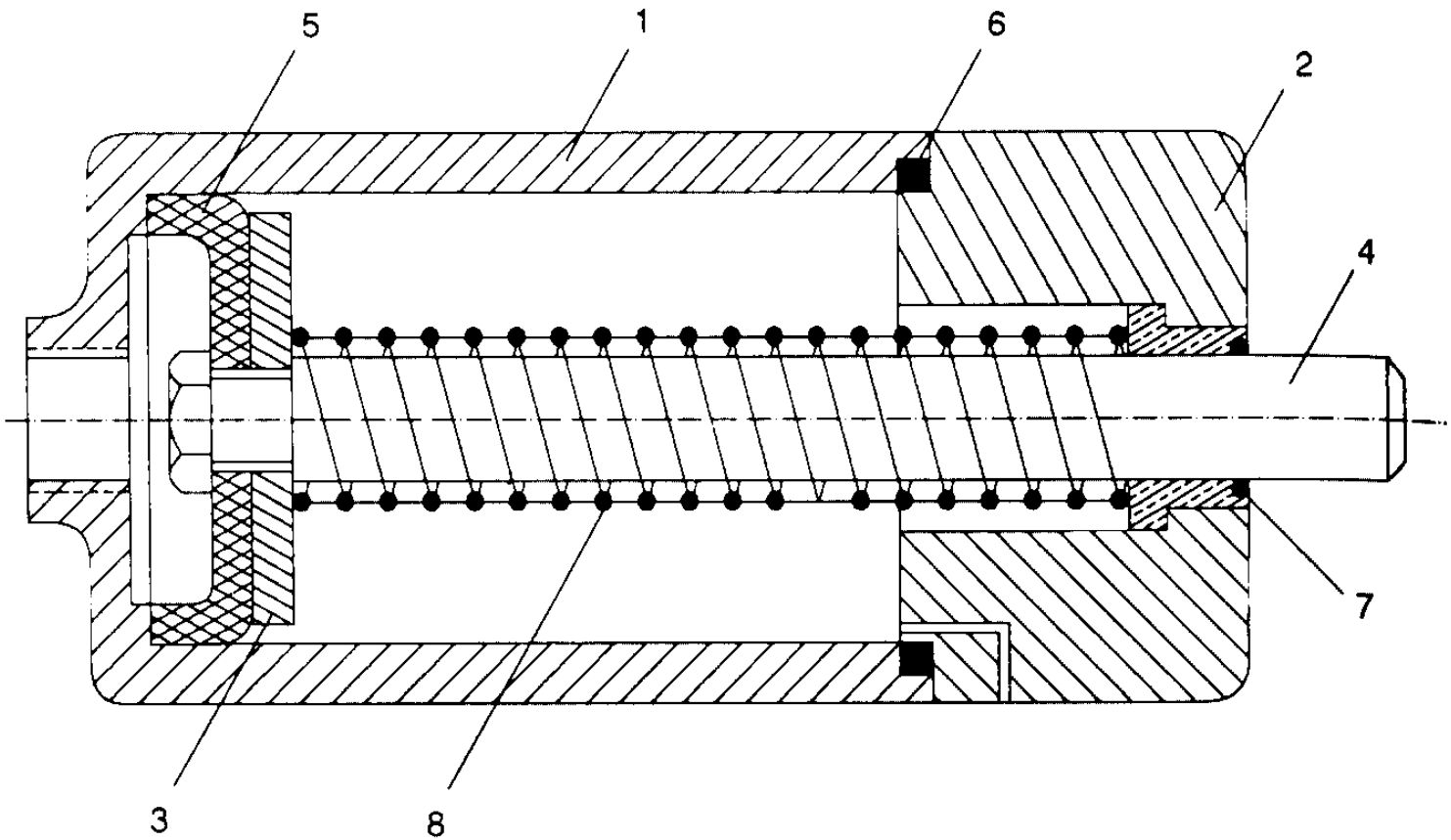


Air Preparation

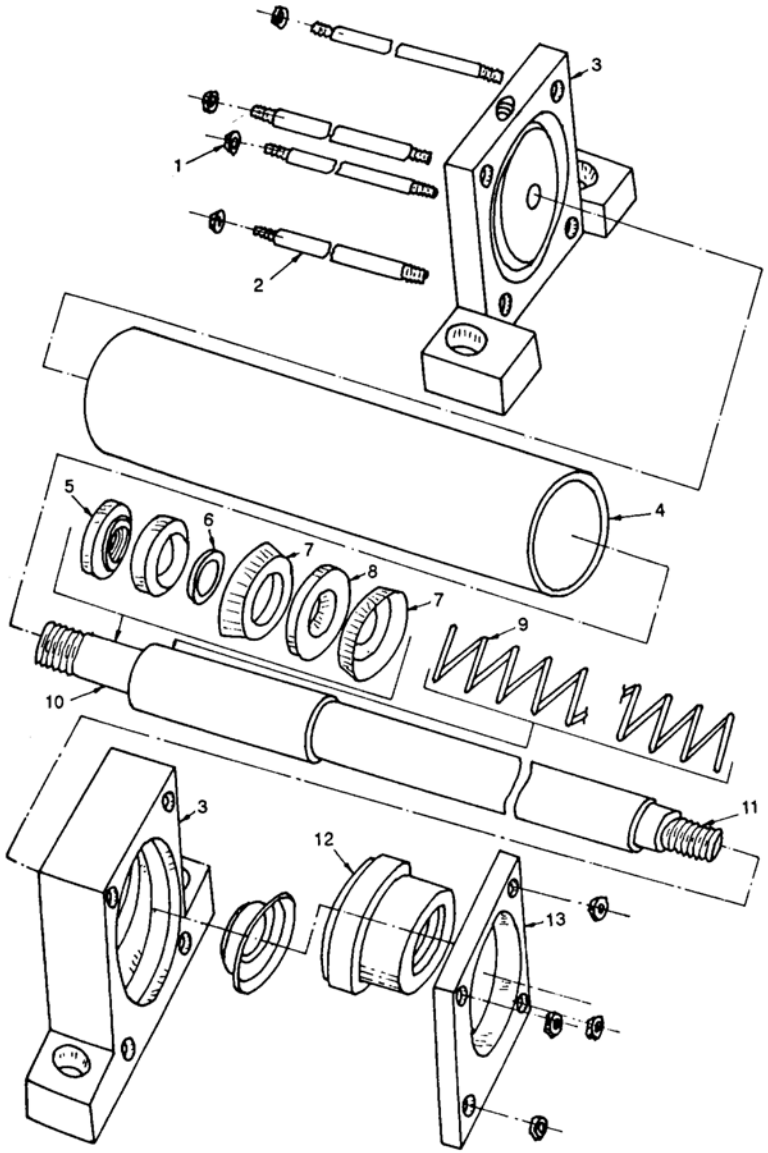




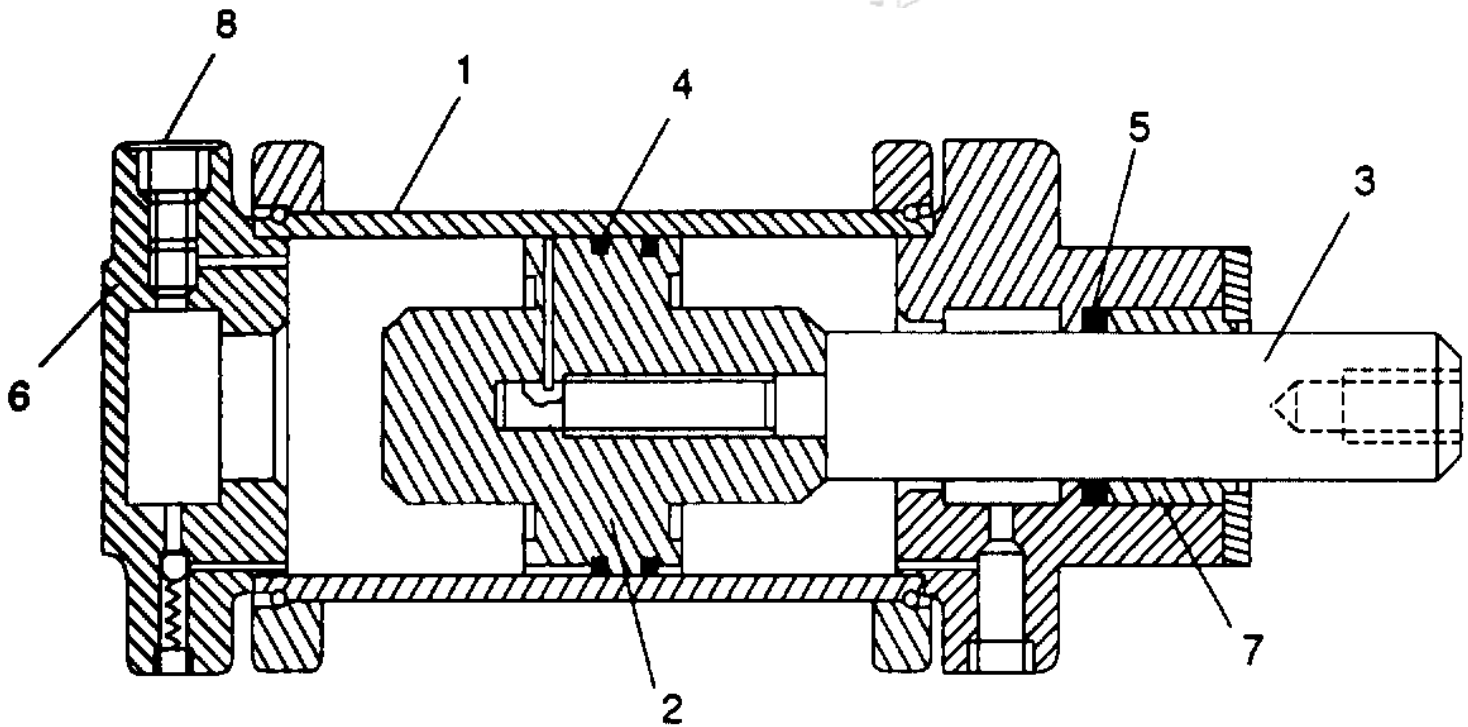
Single-Acting Cylinder



Single-Acting Cylinder

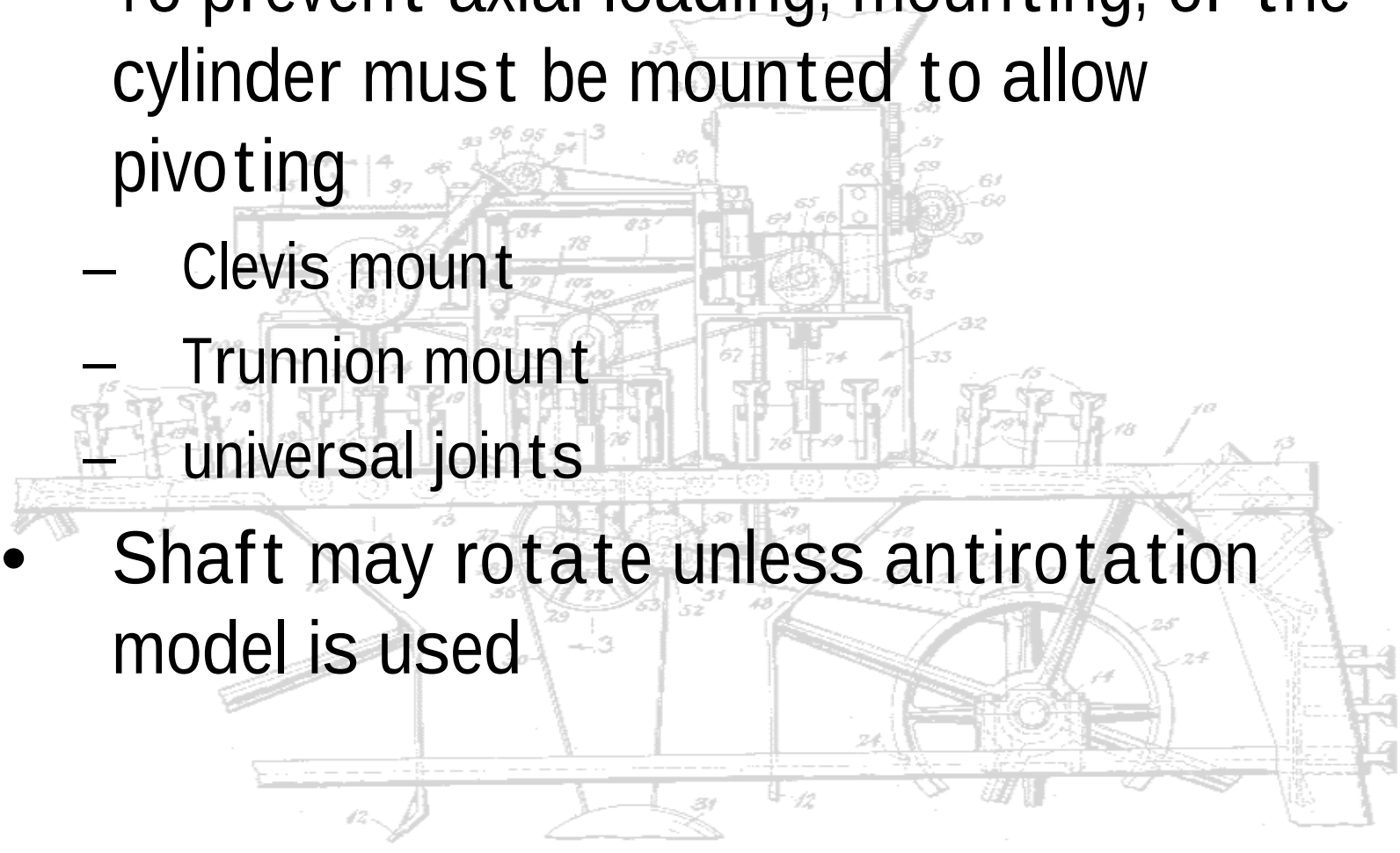


Double-Acting Cylinder

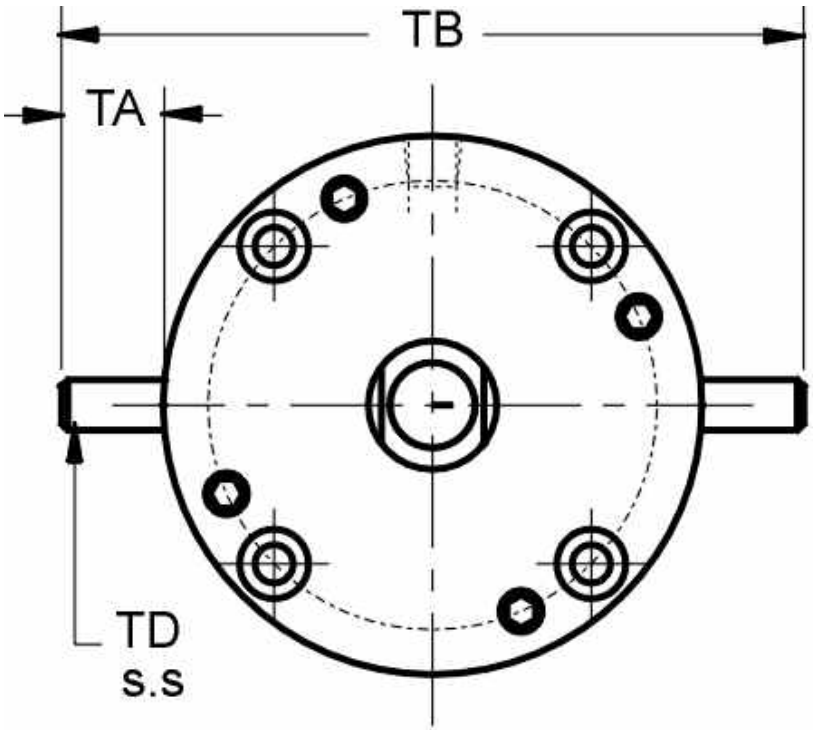


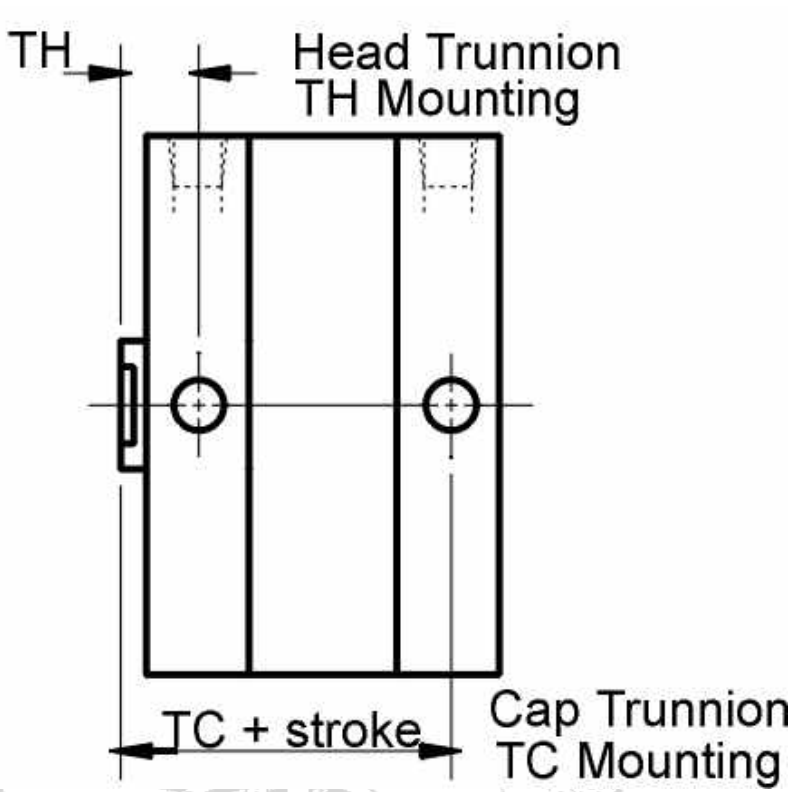
Pneumatic Cylinder Mounting

- Off-axis loading must be prevented
- To prevent axial loading, mounting, or the cylinder must be mounted to allow pivoting
  - Clevis mount
  - Trunnion mount
  - universal joints
- Shaft may rotate unless antirotation model is used

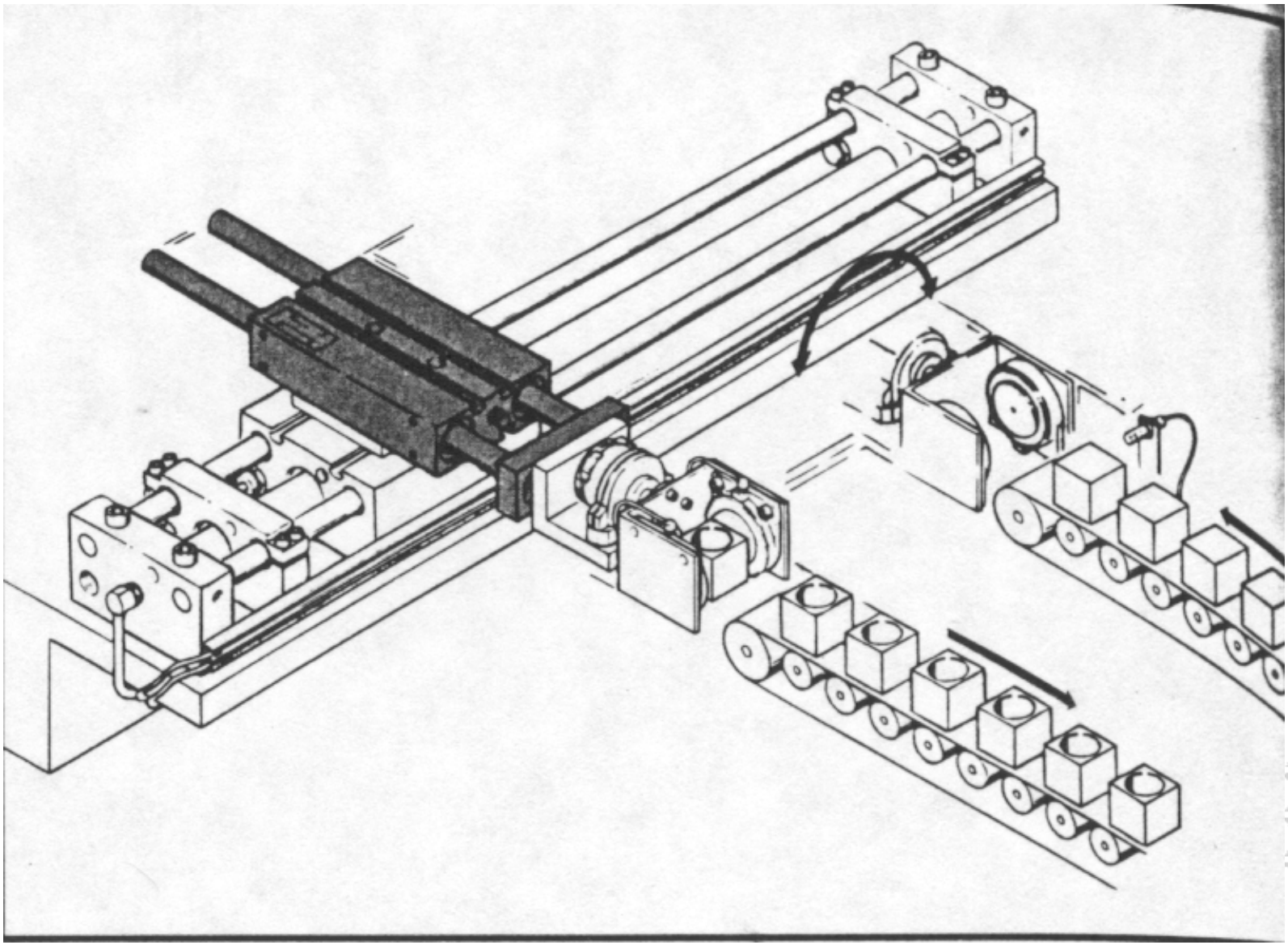


Trunnion Mount

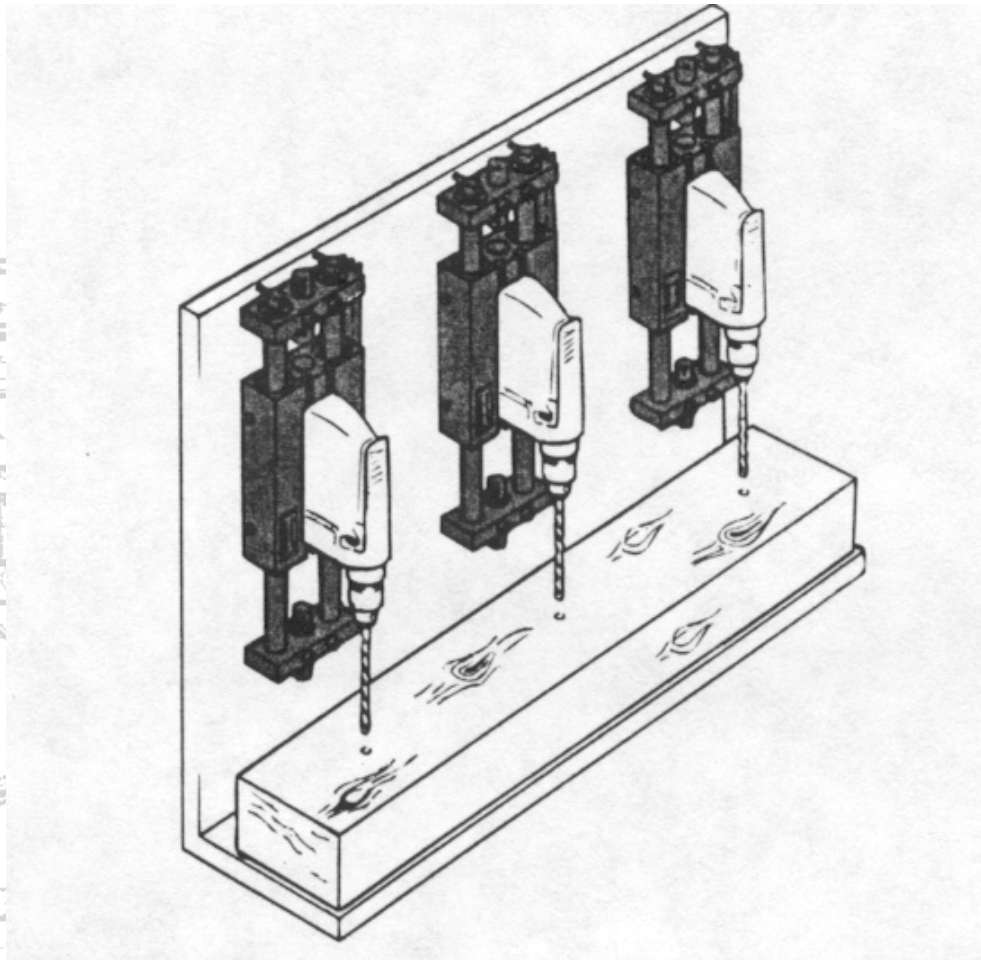




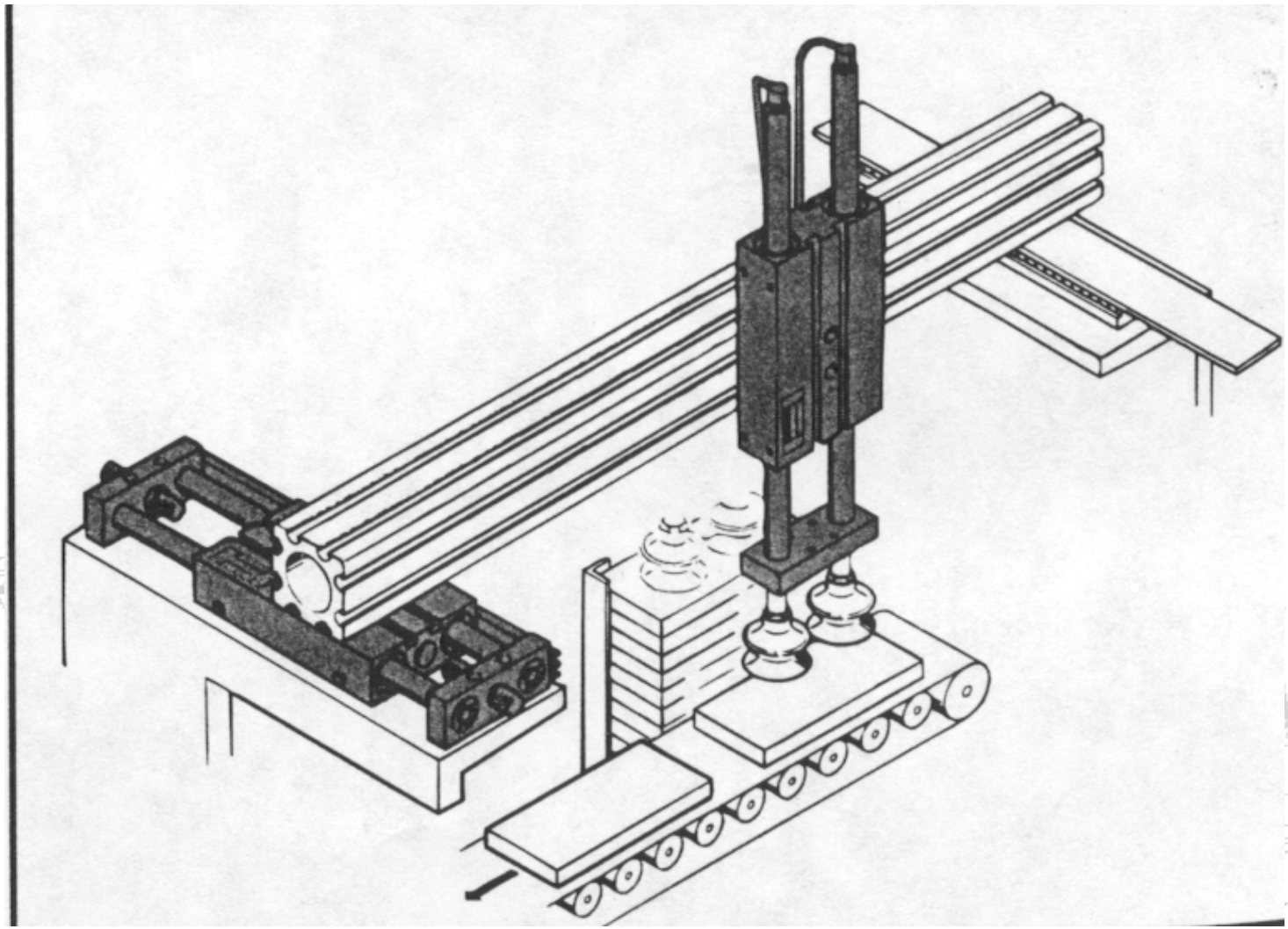
Pneumatic Twin Cylinders



Pneumatic Twin Cylinders

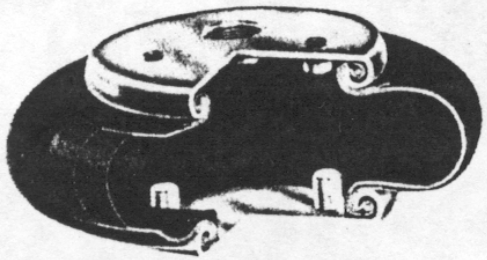


Pneumatic Twin Cylinders

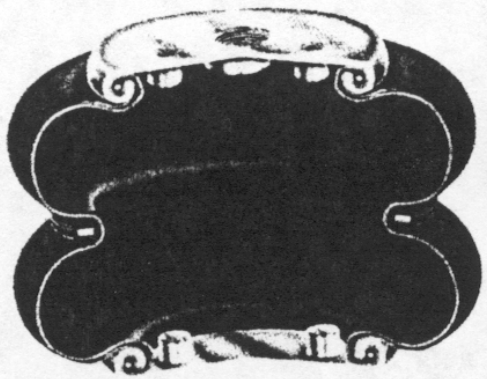


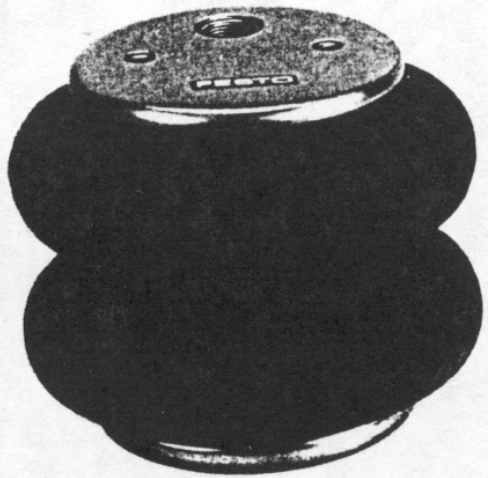
Pneumatic Bellows

Single Fold Bellows Cylinder



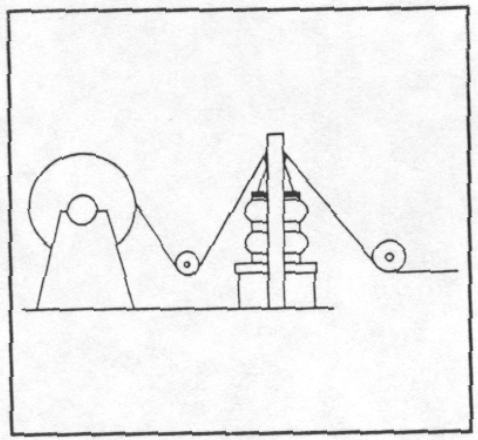
Double Fold Bellows Cylinder



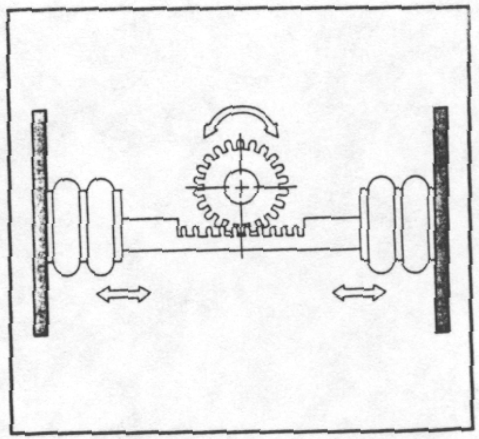


Pneumatic Bellows

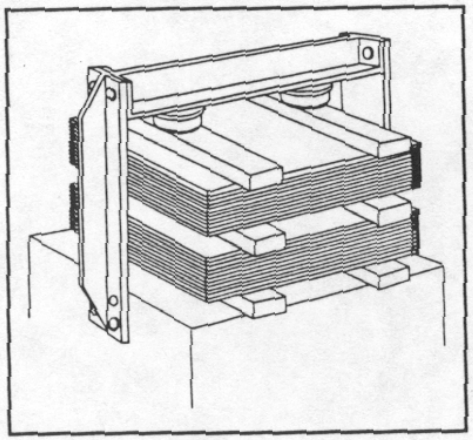
Sample Applications:



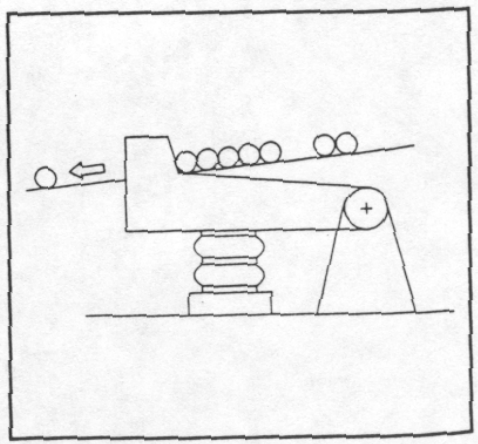
Web Tensioning Device



Rotary Valve

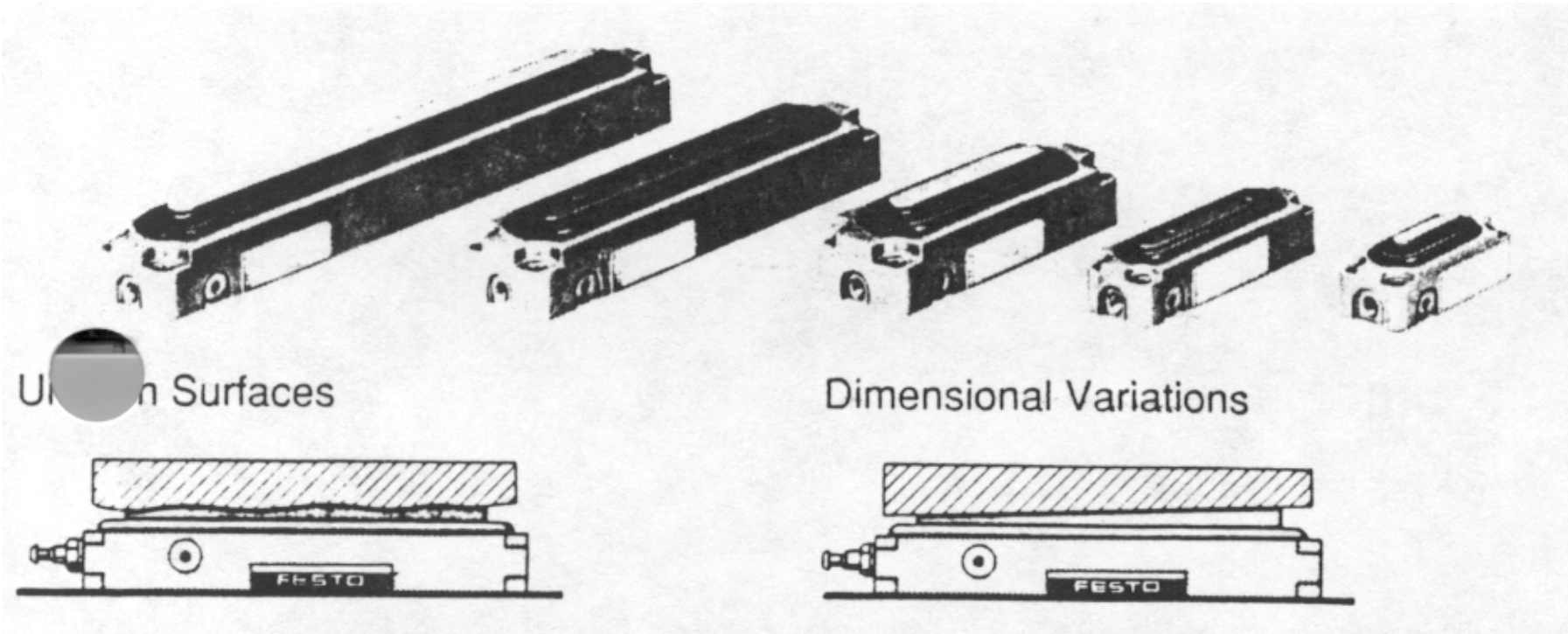


Gluing Press



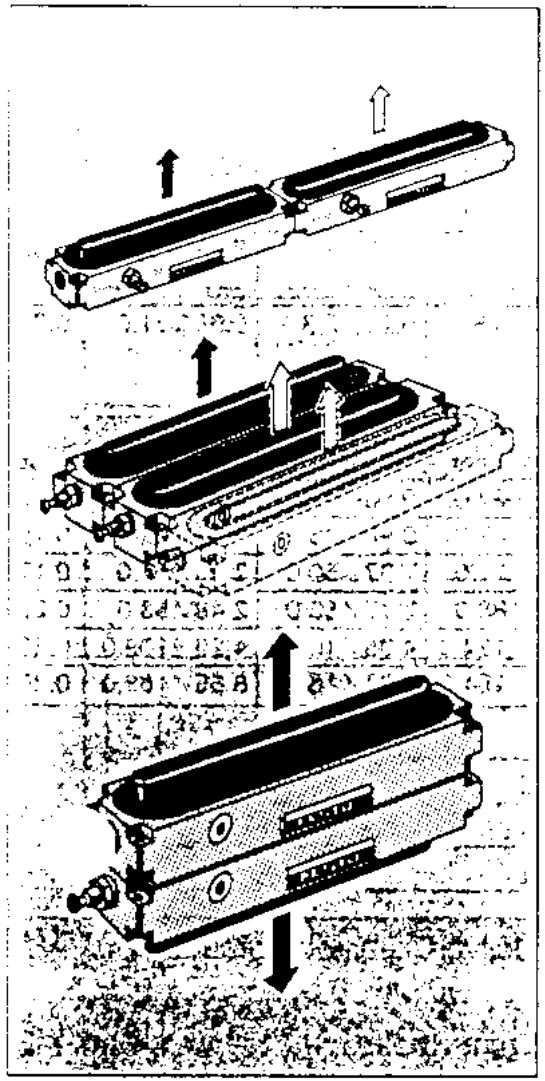
Hinged Actuated Gravity Gate

Pneumatic Bellows

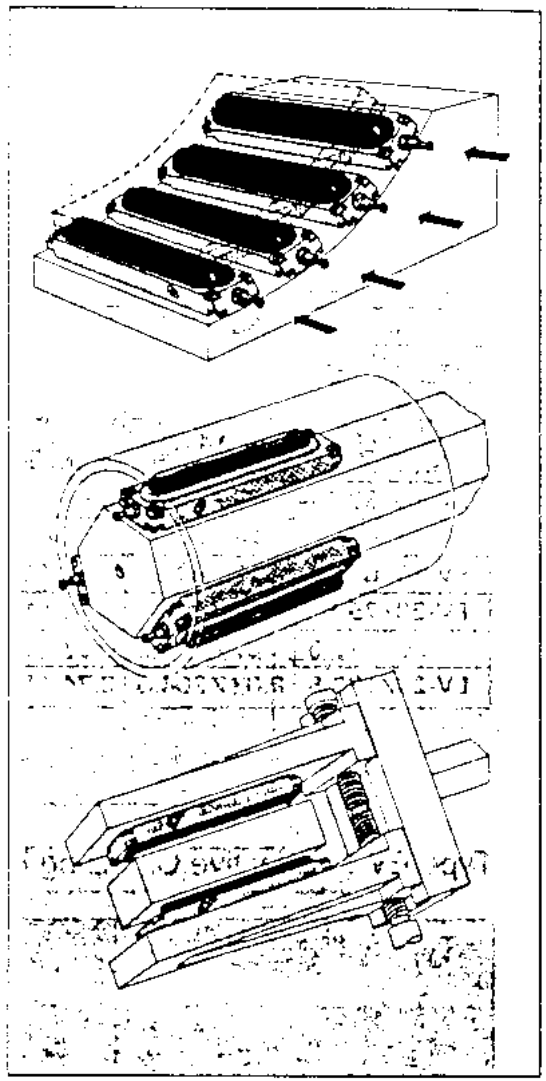


Pneumatic Bellows

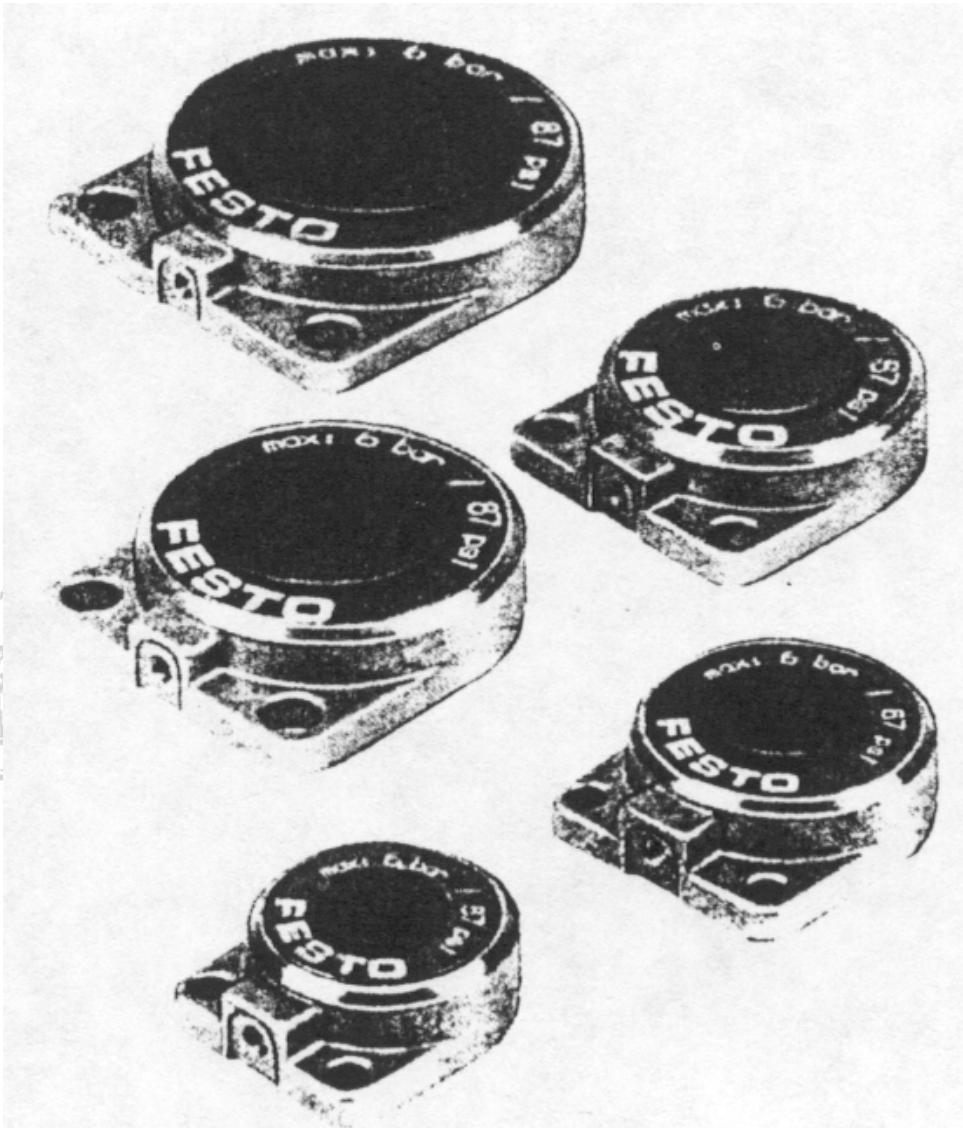
Mounting Versatility



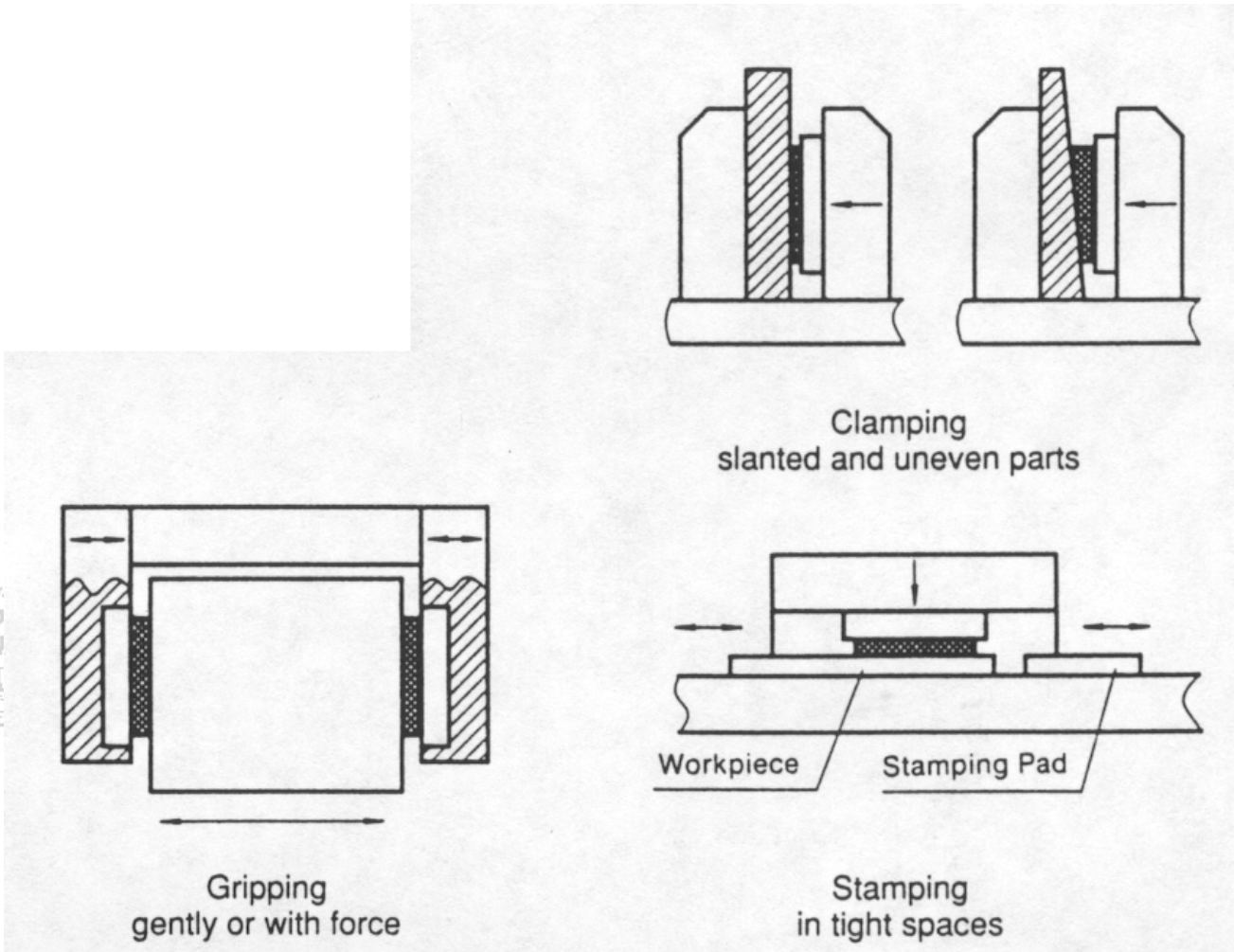
Application Examples



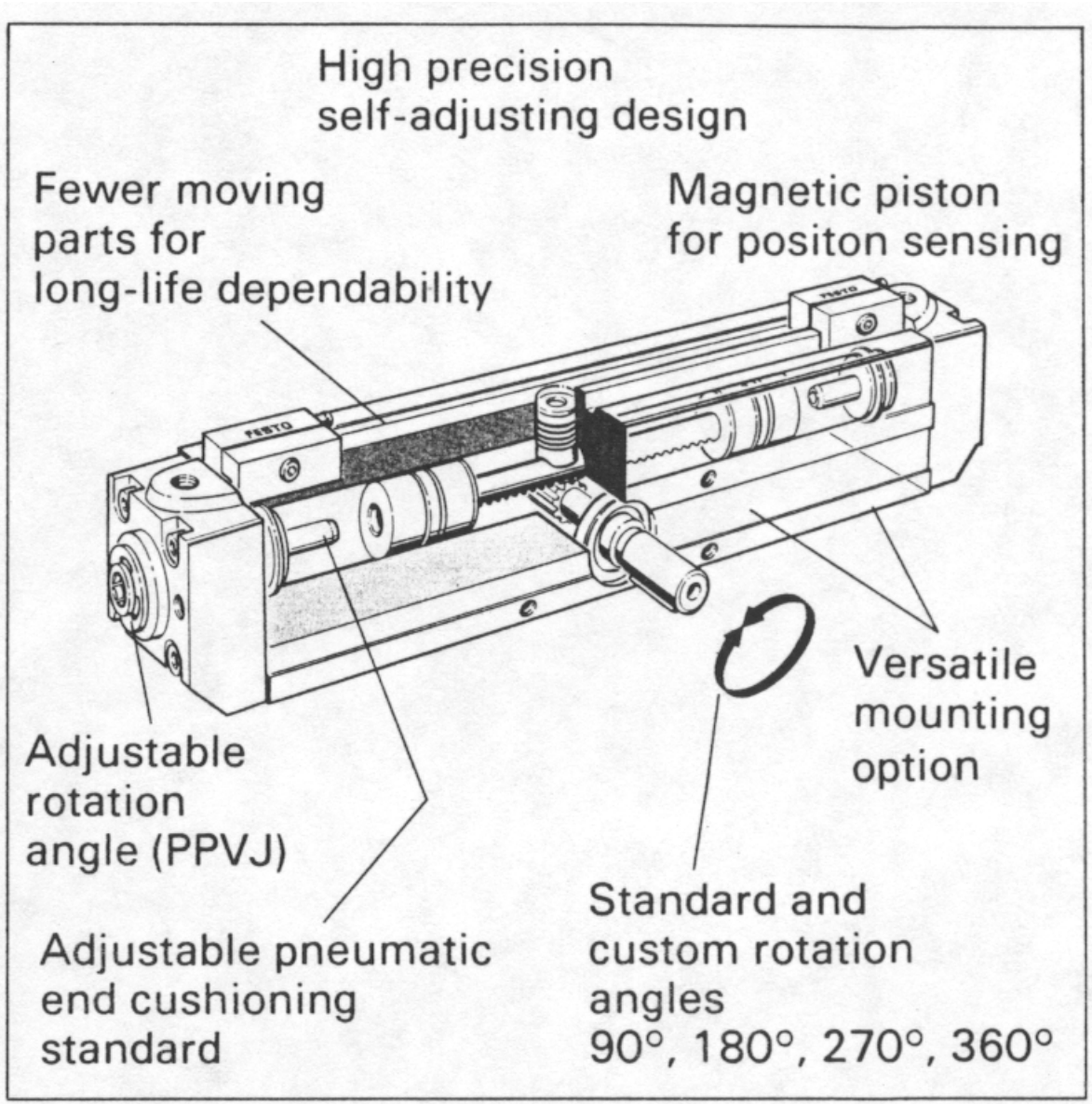
Pneumatic Bellows



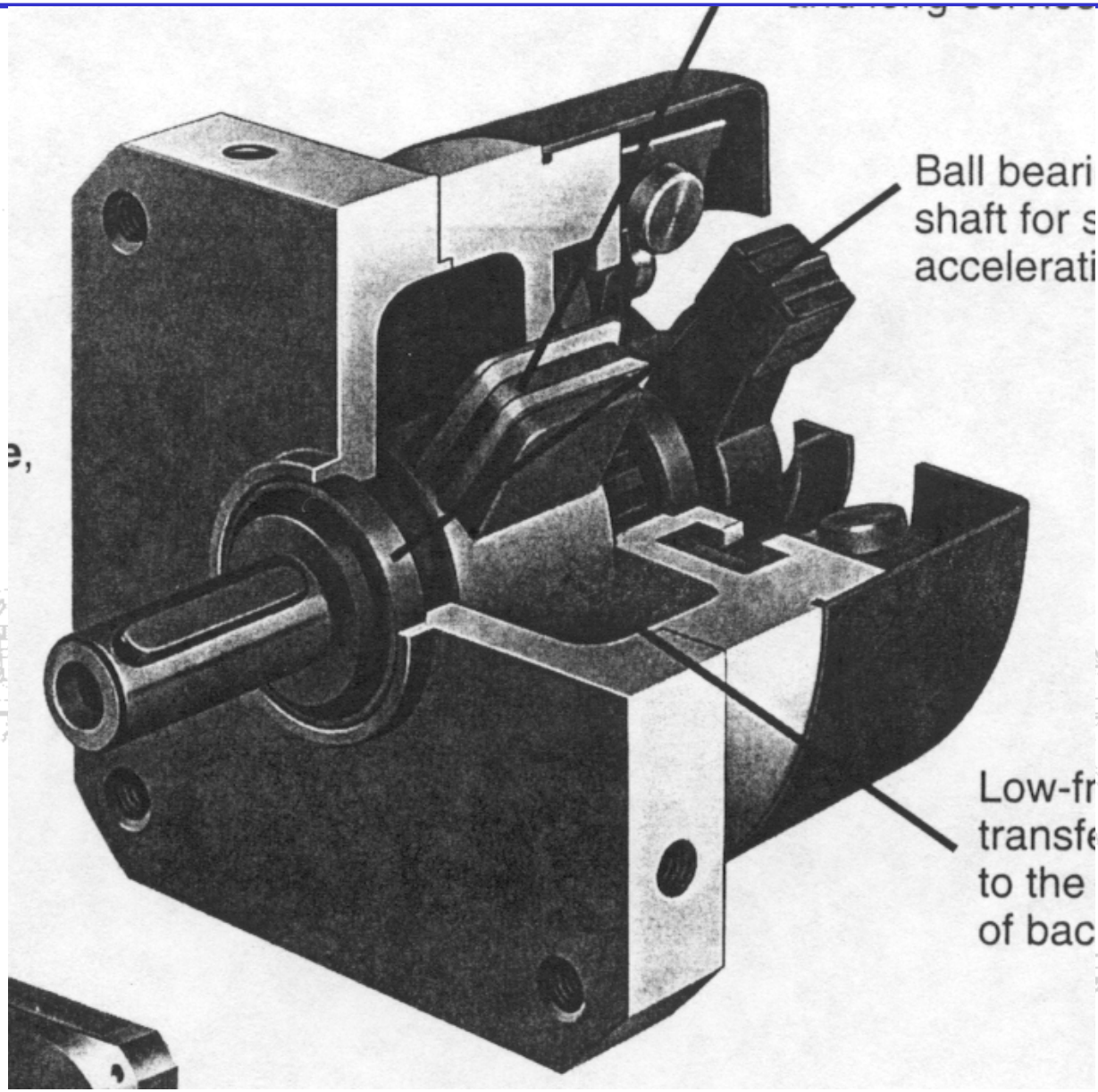
Pneumatic Bellows



Pneumatic Rotary Actuators



Pneumatic Rotary Actuators



Pneumatic Rotary Actuators