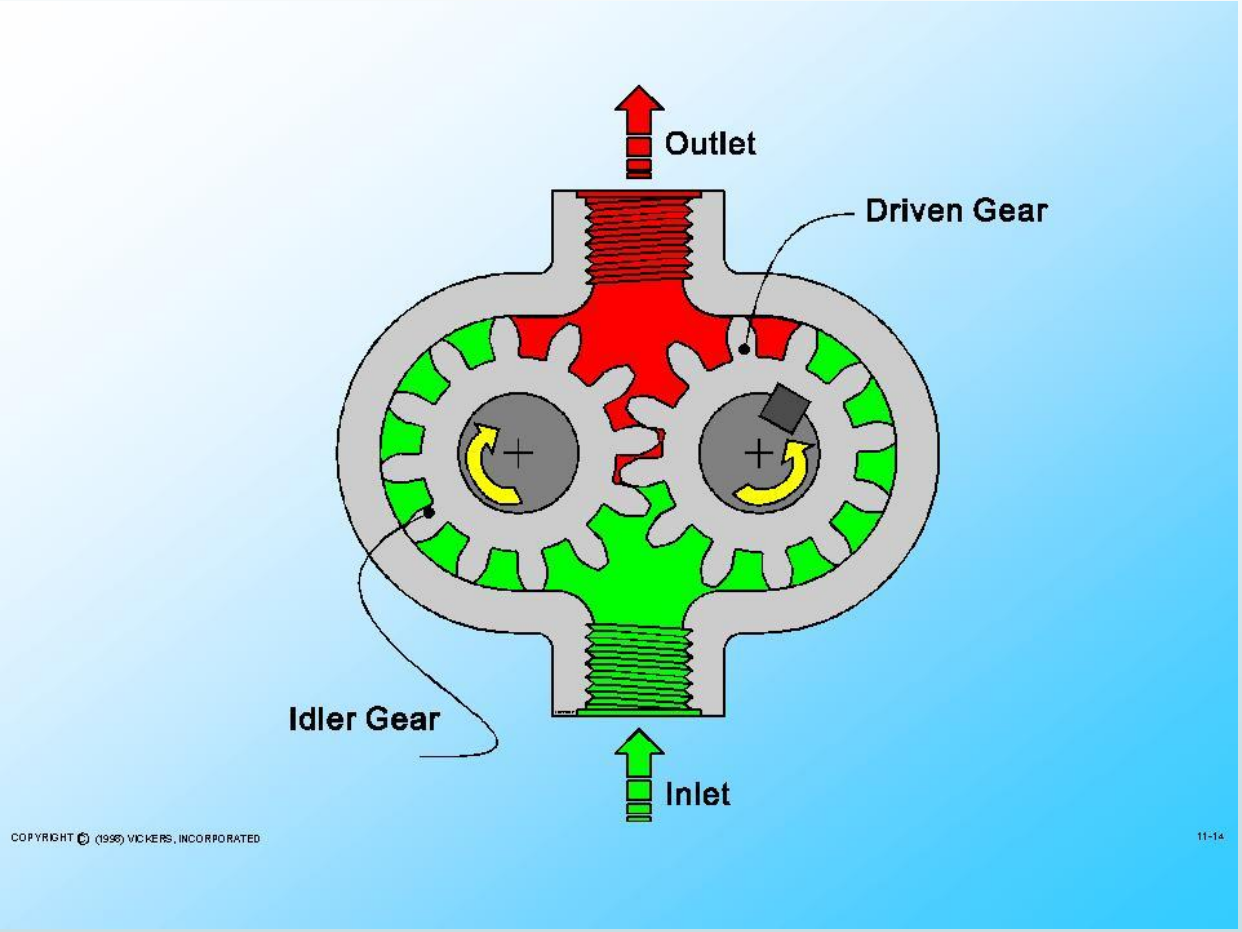
Hydraulic Pumps

Gear Pumps (External Gear)

- Pumping Mechanism



Gear Pumps (External Gear)

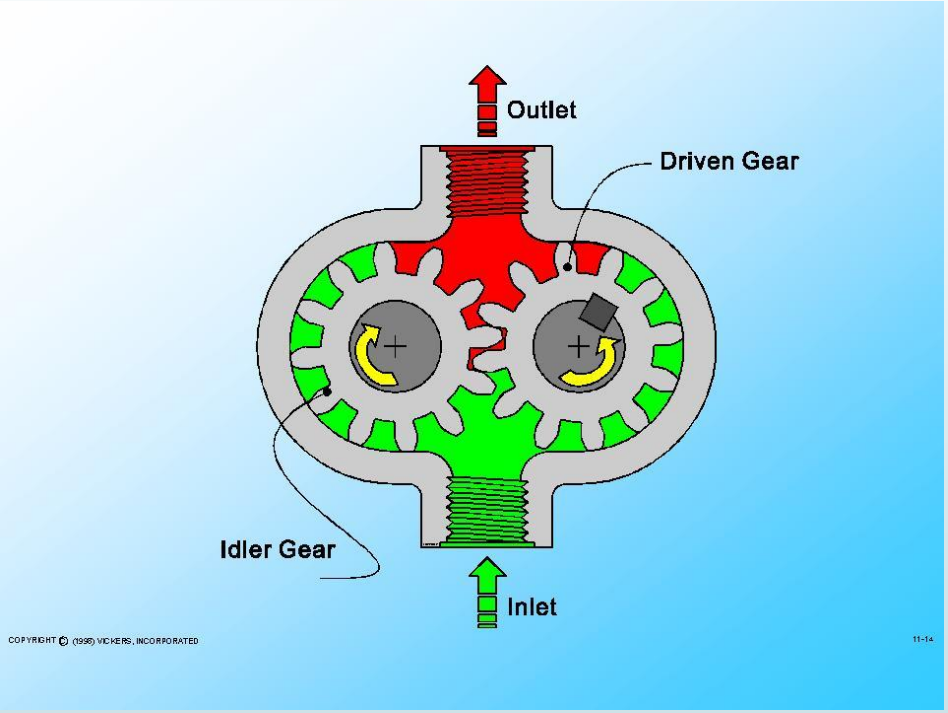
- Displacement parameters and determination
- Displacement = $\pi/4(D_o^2 - D_i^2)L$
- D_o = Outer diameter of the two gears
- D_i = Inner diameter of the two gears
  - *(Actually it is the diameter of the circle defined by the center of one gear and the outer diameter of the other.)*

Gear Pumps (External Gear)

- Advantages:
  - Easy to manufacture
  - Compact
  - Cheap

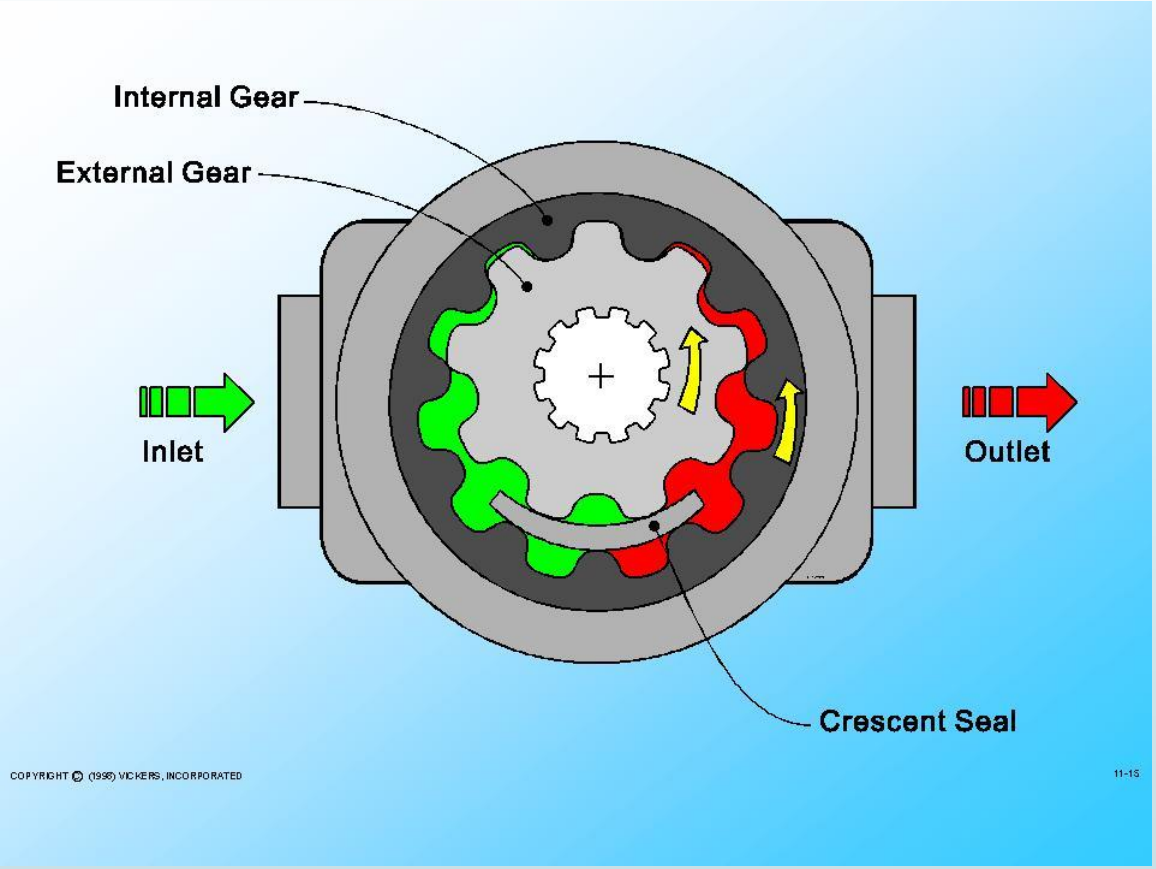
Gear Pumps (External Gear)

- Disadvantages
  - Limited pressure capability
  - Unbalanced (note where pressure is) Results in large bearing loads
  - Can be noisy (gear mesh noise)
  - Volumetric efficiency?
  - Fixed Displacement



Gear Pumps (Internal Gear)

- Pumping Mechanism



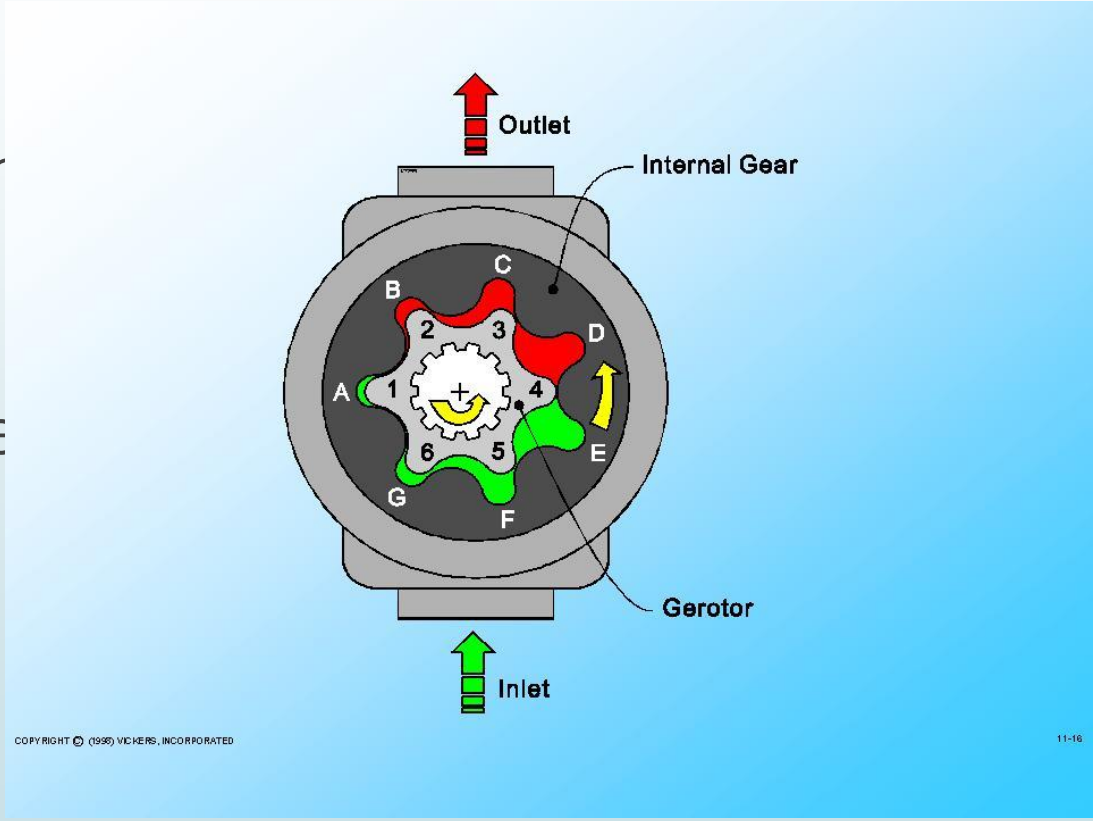
Gear Pumps (Internal Gear)

- Displacement is a function of the number of teeth on the internal and external gears and the size of the crescent divider.

- Advantages
  - Similar to external gear pumps in many respects
  - Quieter as gear slap is reduced
- Disadvantages
  - Somewhat more difficult to manufacture
  - Same issues of volumetric efficiency
  - Same issues of unbalanced forces
  - Fixed displacement

Gear Pumps (Internal Gear - Gerotor)

- Mechanism
  - External (inside) gear is shaft driver
  - Internal gear is driven by external
  - Single tooth space is displaced
  - Design keeps tolerance close throughout the cycle

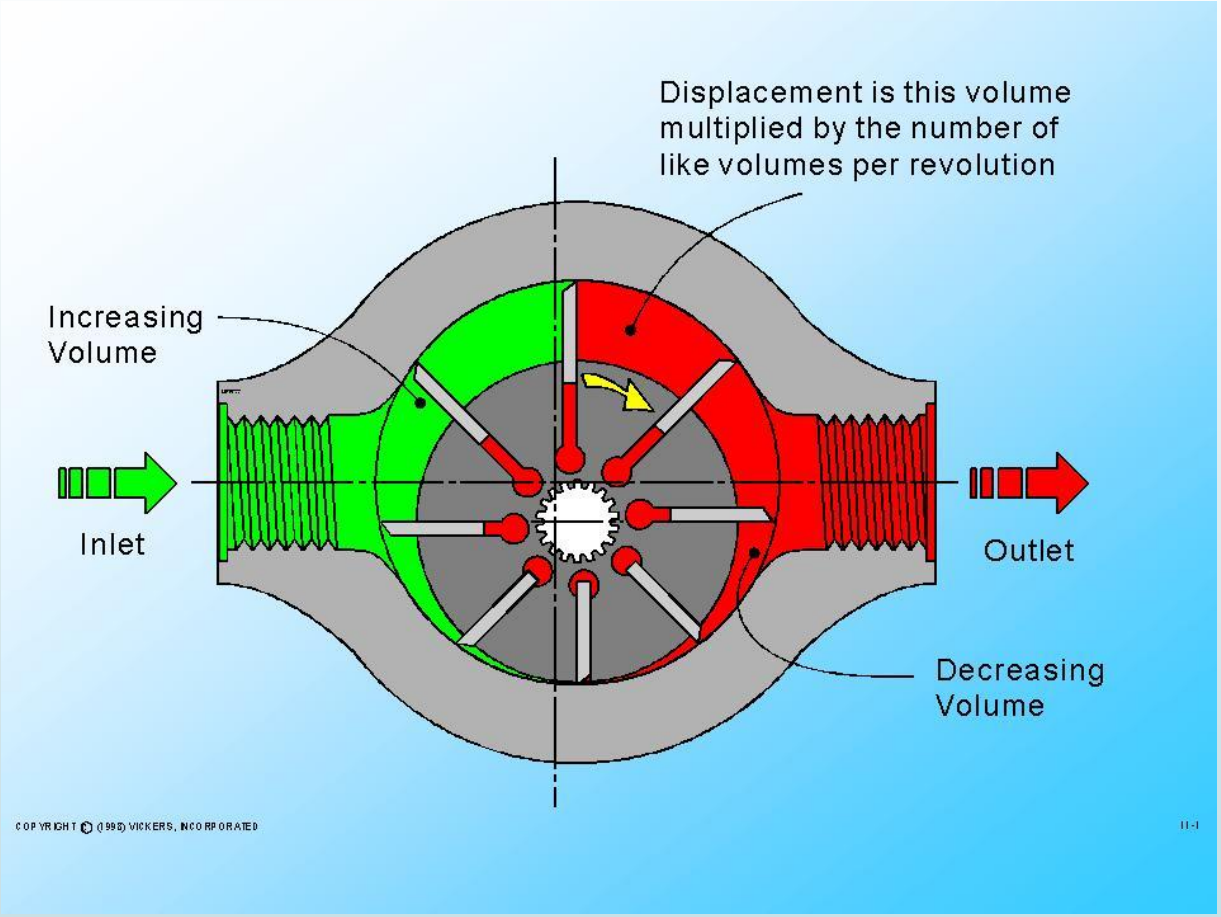


Gear Pumps (Internal Gear - Gerotor)

- Advantages
  - Cheap
  - Simple
  - Cheap
- Disadvantages
  - Limited pressure capability
  - Unbalanced design
  - Fixed displacement
  - Frequently used as a charge pump

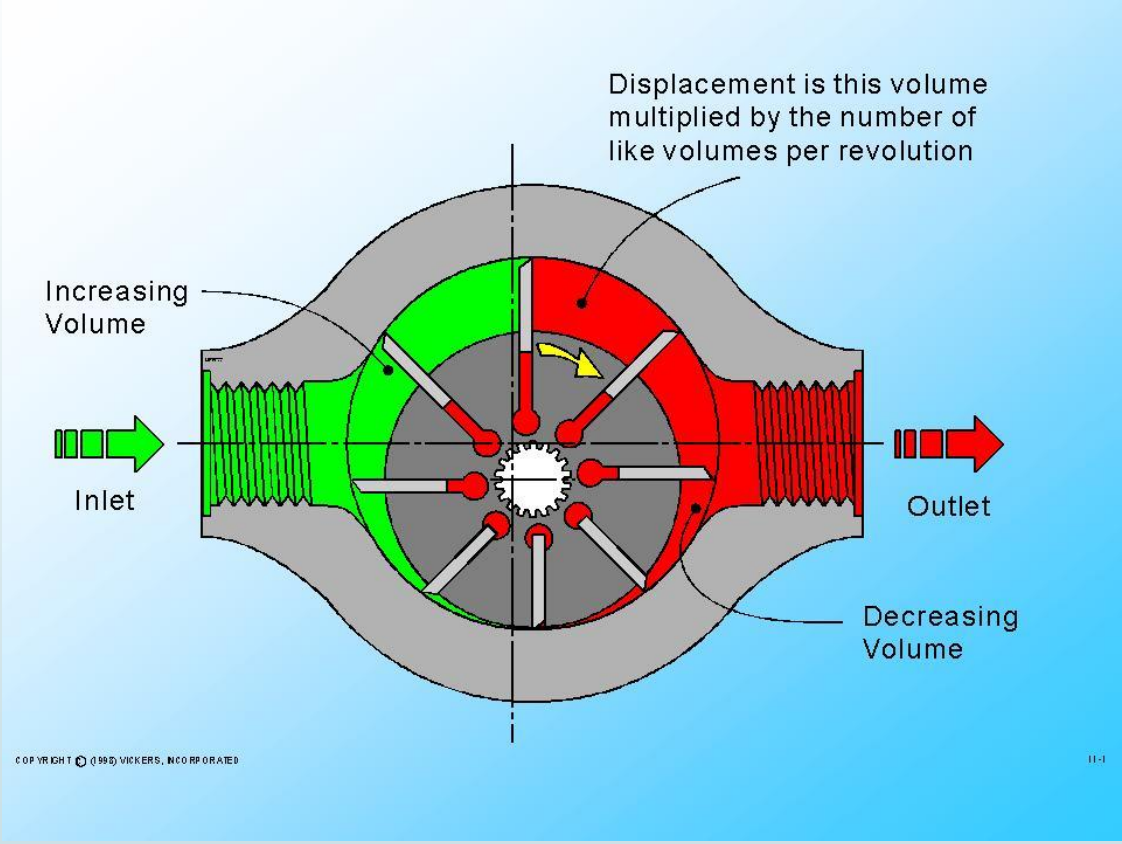
Vane Pumps

- Pumping mechanism



Vane Pumps

- Displacement
  - $V_D = \pi/2(D_c - D_R)eL$
  - C = Cam
  - R = Rotor
  - E = eccentricity
  - L= depth

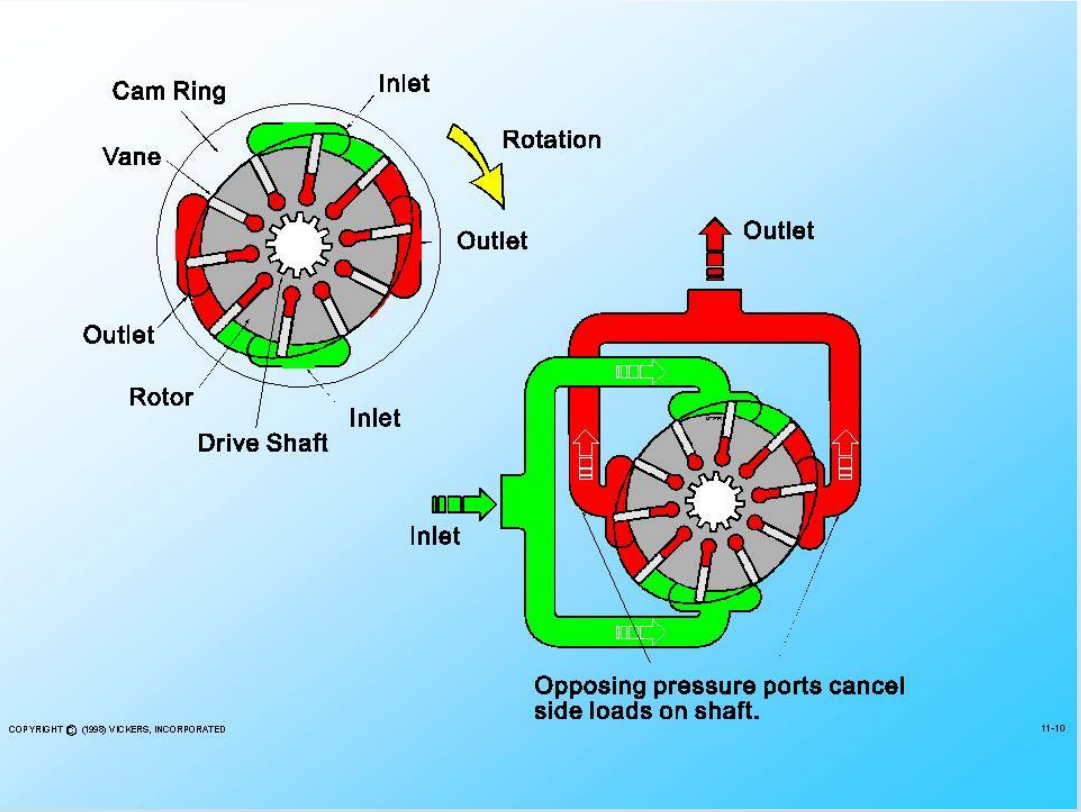


Vane Pumps (Variations)

- Vane tip pressure control options
  - Outlet pressure under the vanes
  - Surface pressure under the vanes
  - Intravanes: outlet pressure is applied always to a small area of the vane while surface pressure is applied to the rest of the area
- These are probably Vickers innovations and hence are highlighted in the text

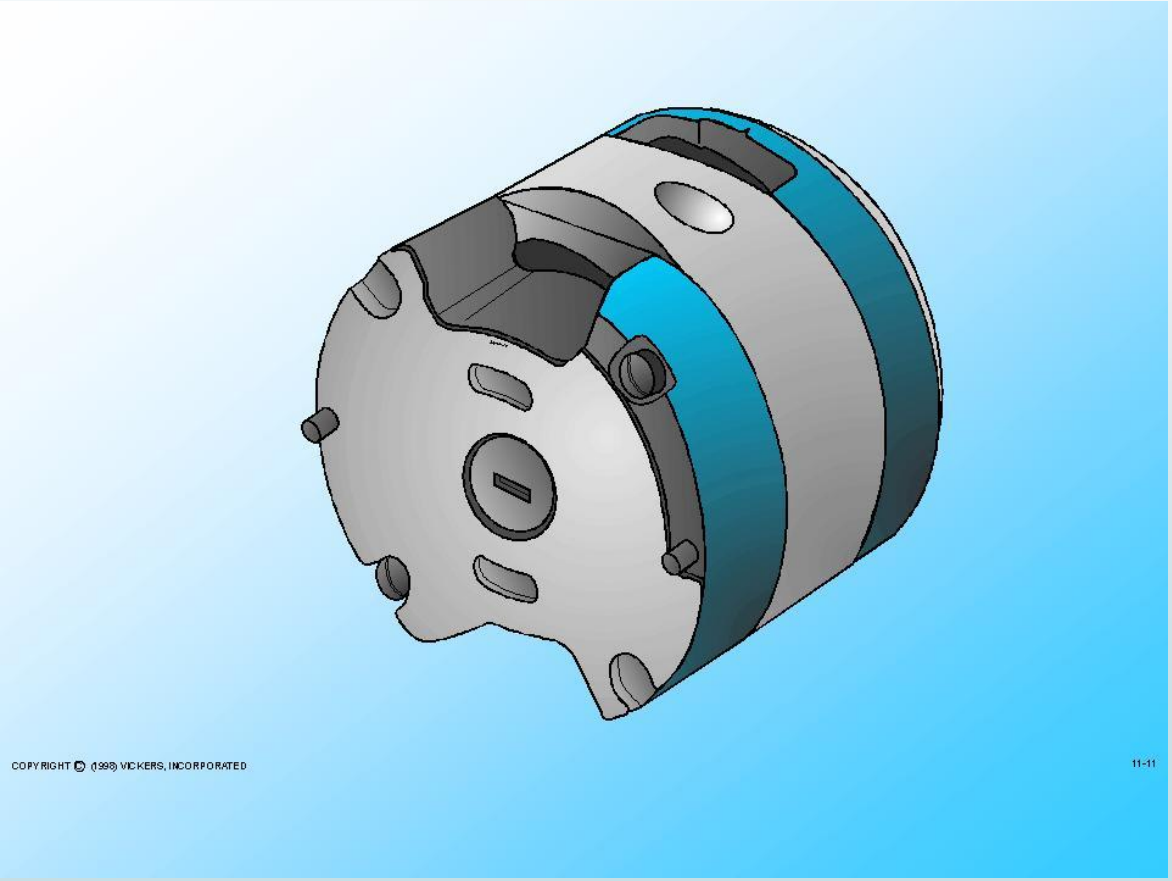
Vane Pumps (Variations)

- Balanced designs



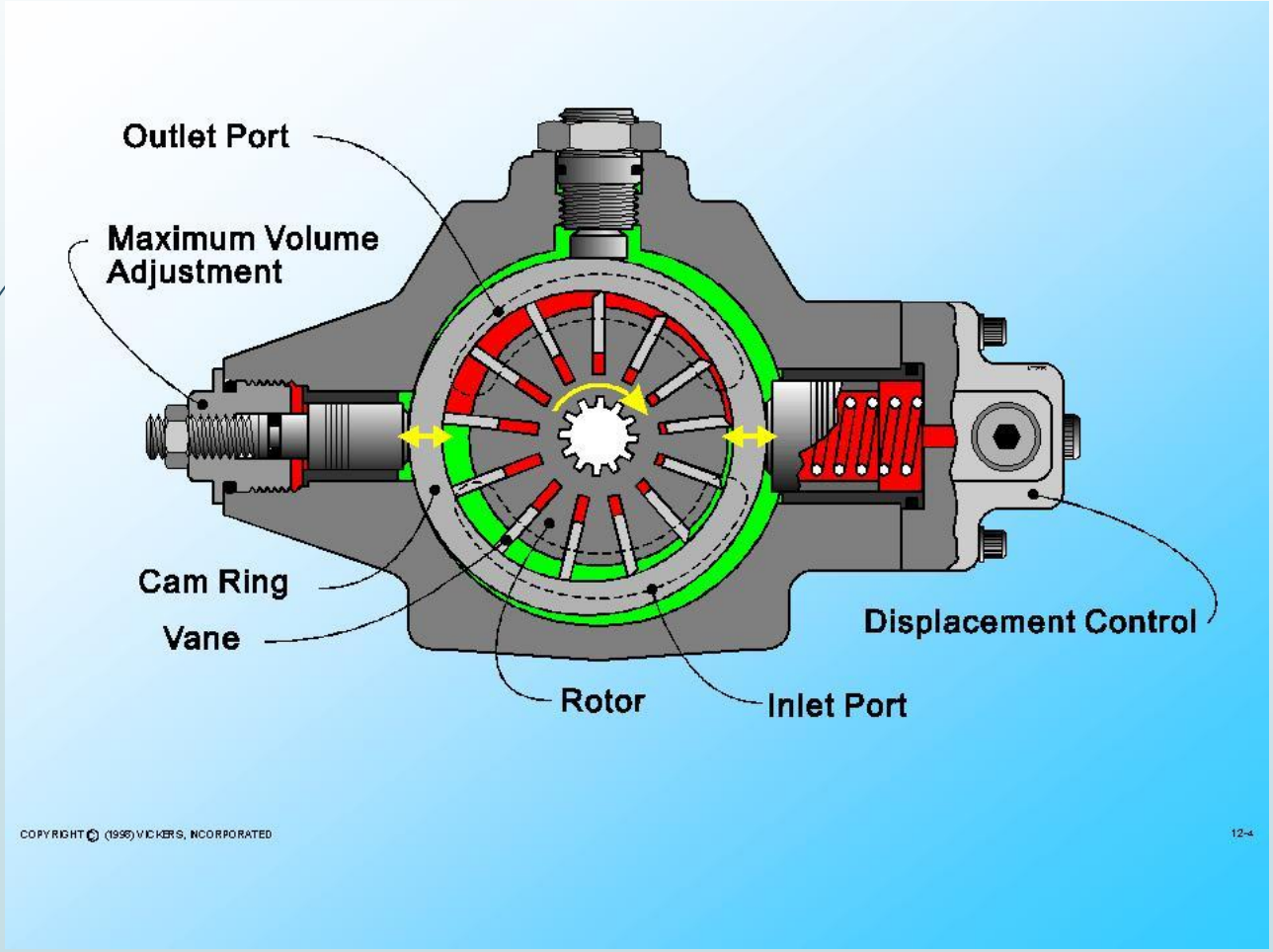
Vane Pumps Advantages

- Cartridges to quickly replace rotating group



Vane Pumps (Variations)

- Variable Displacement Design

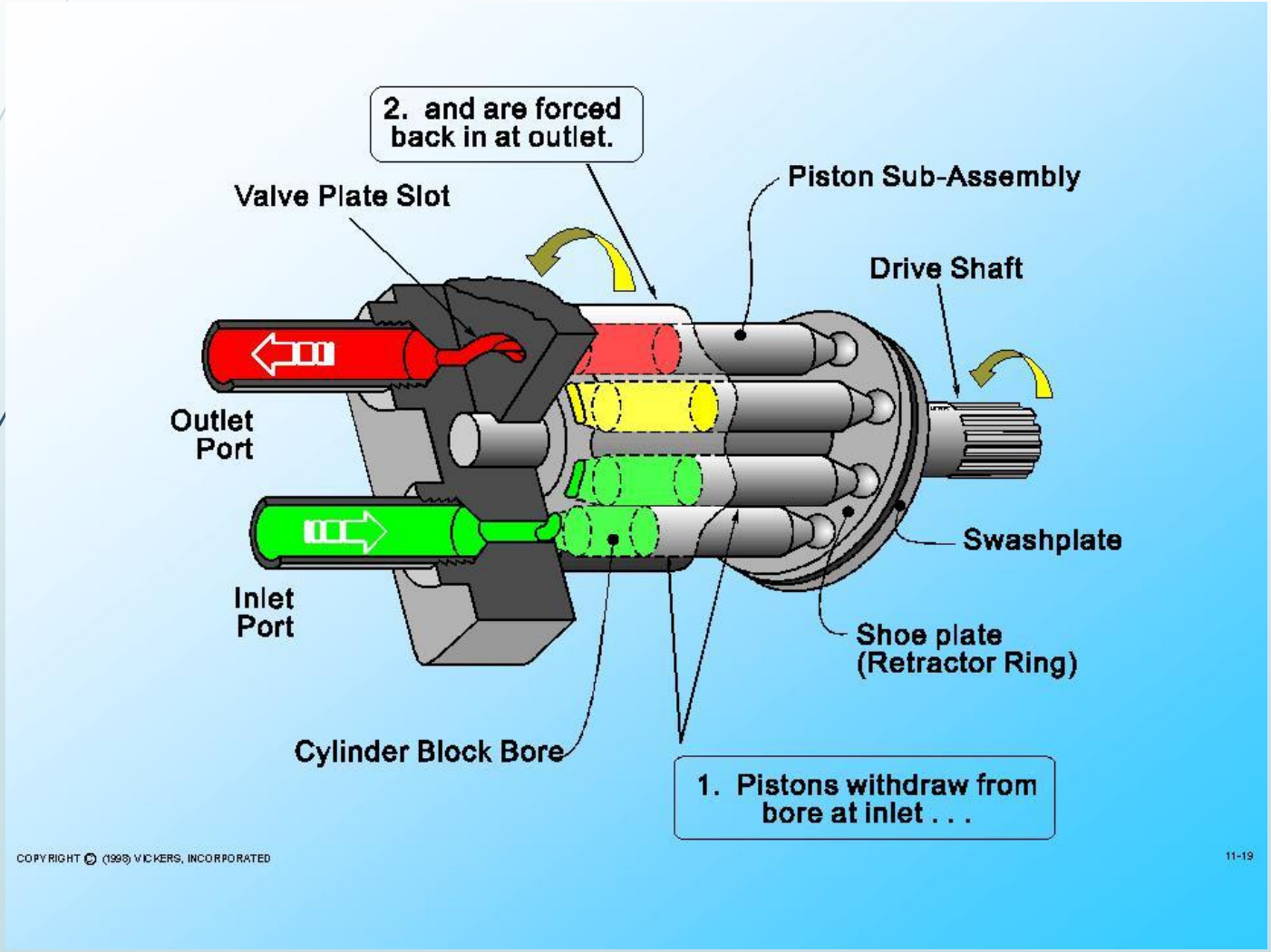


Vane Pumps

- Advantages
  - Quieter than gear pumps
  - Higher pressure capability than gear pumps?
  - Better volumetric efficiency than gear pumps?
  - Can be balanced in design for longer life
  - Variable displacement an option
- Disadvantages
  - More complex and expensive than gear pumps

Piston Pump Designs

- Axial Piston

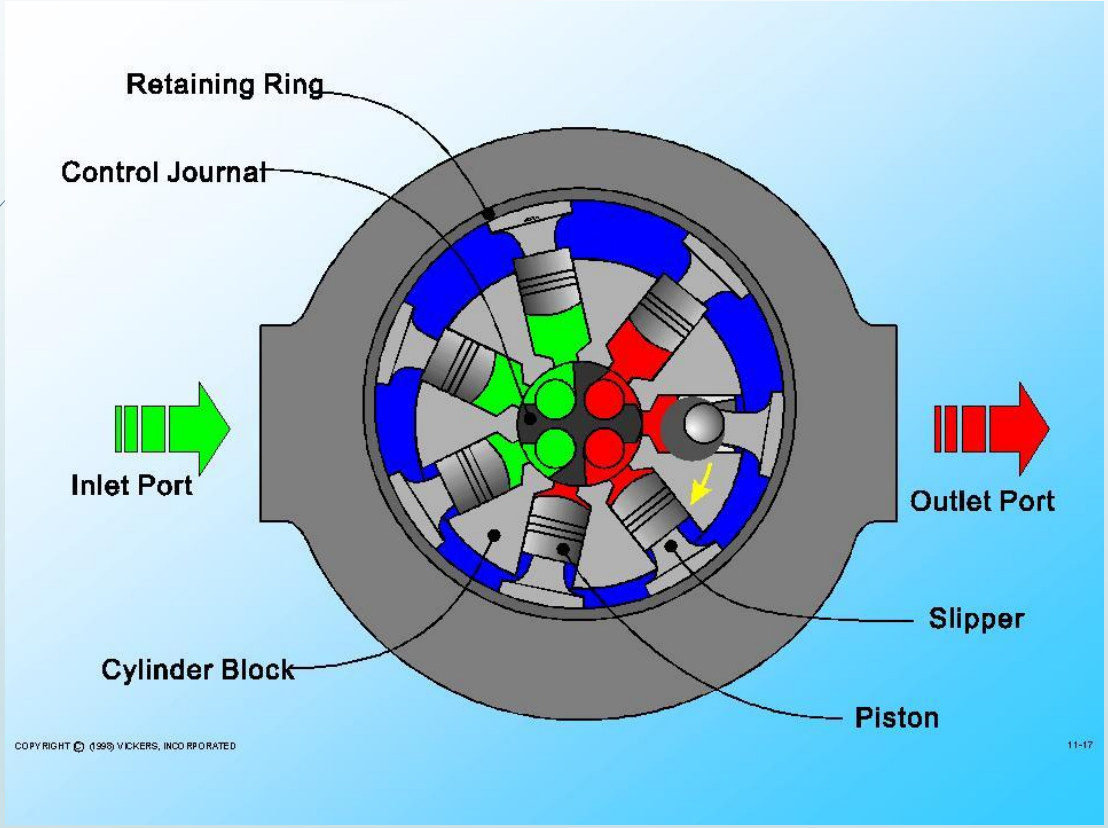


Piston Pump Designs

- Displacement of an axial piston pump
  - V_D = YAD *tan(θ)*
  - Y = Number of Pistons in the rotating group
  - A = the area of a single piston
  - D = is the diameter of the centerline circle of the piston bores
  - *θ* is the angle of the swashplate or the bend angle

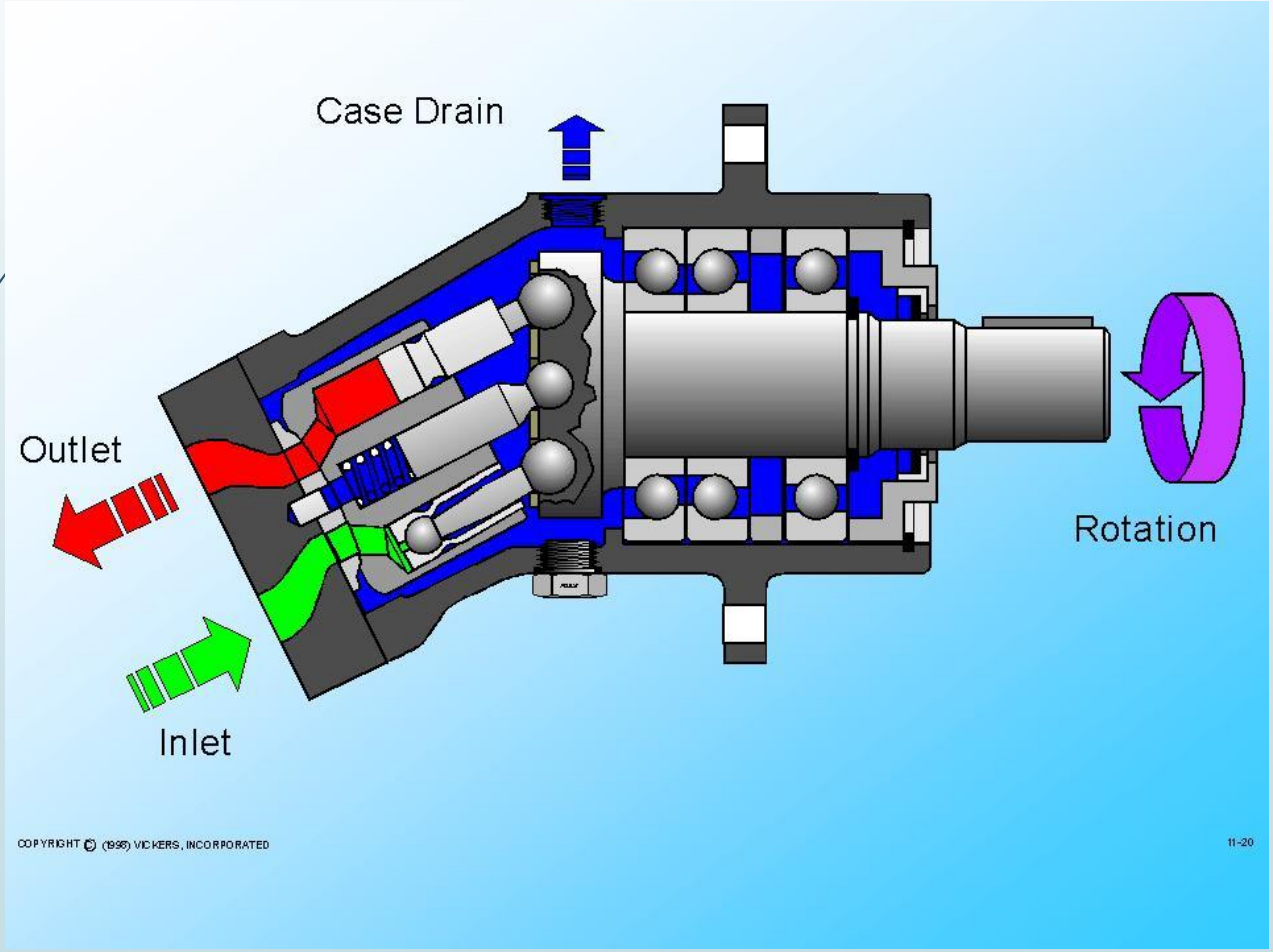
Piston Pump Designs

- Radial piston design



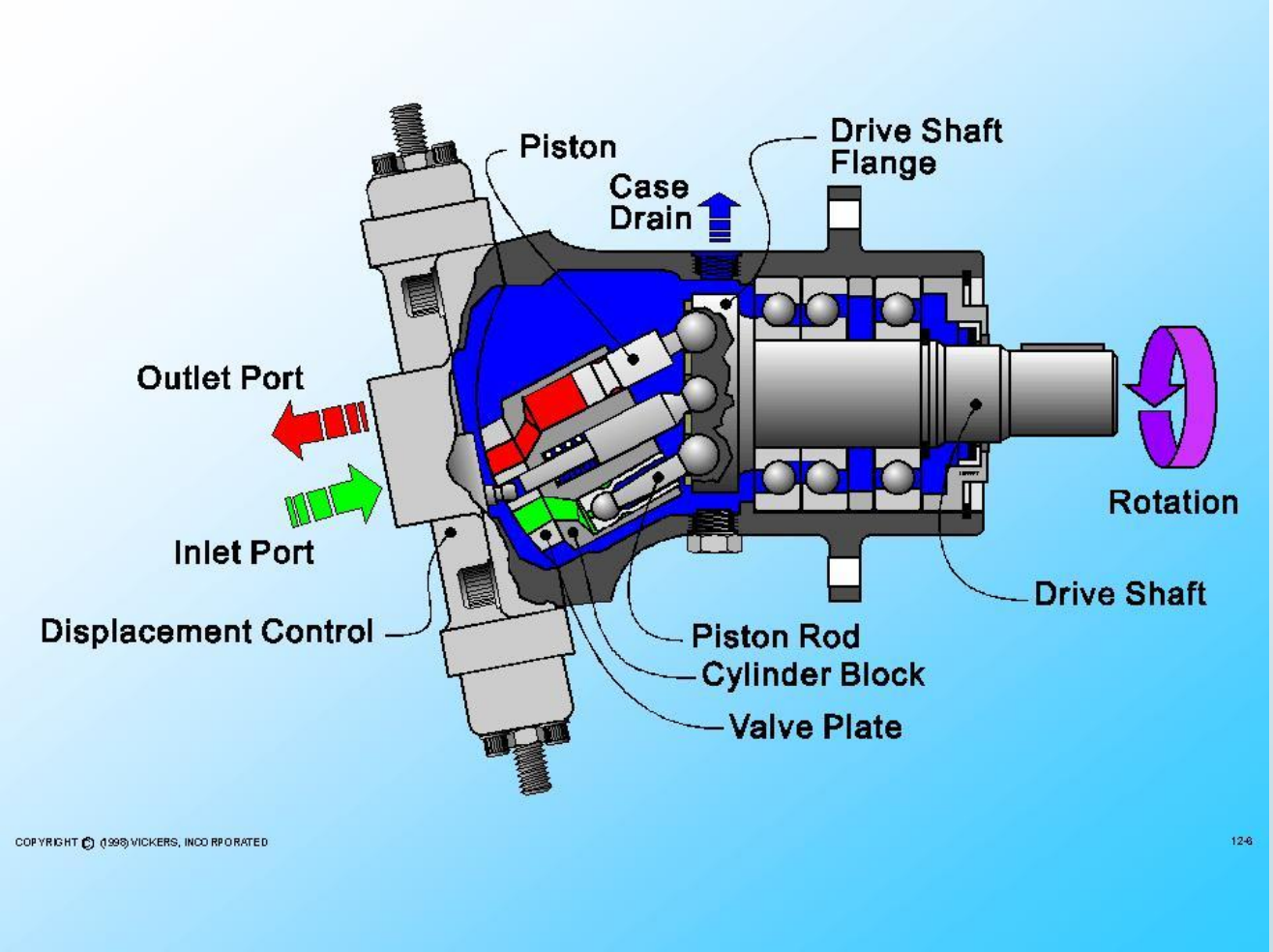
Piston Pump Designs

- Bent axis design



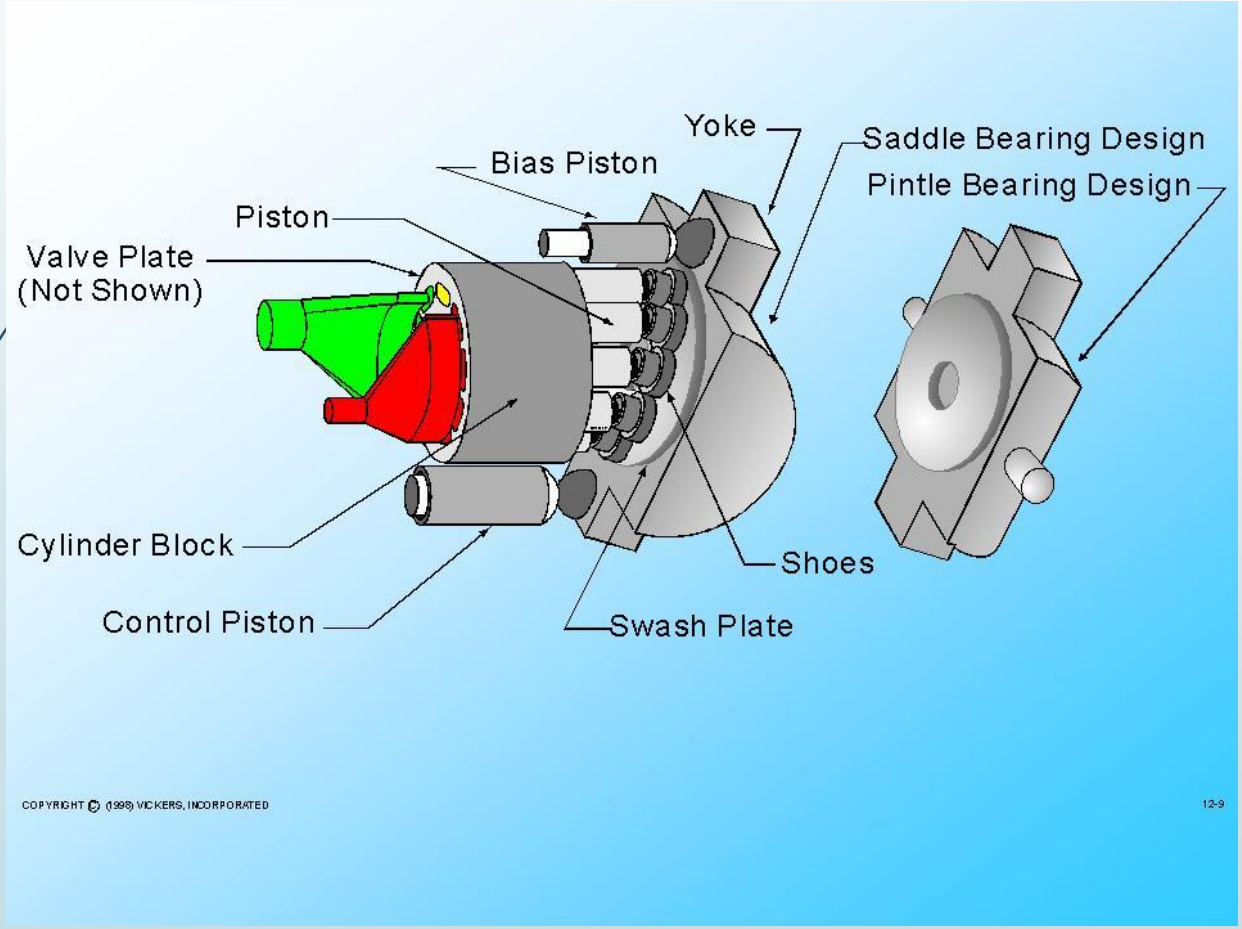
Piston Pump Designs

- Bent axis – variable displacement design



Piston Pump Designs

- Axial piston – variable displacement design



Piston Pump Advantages

- Generally highest volumetric efficiency
- Generally highest pressure capability
- Variable displacement designs

Piston Pump Disadvantages

- Higher cost (complexity)