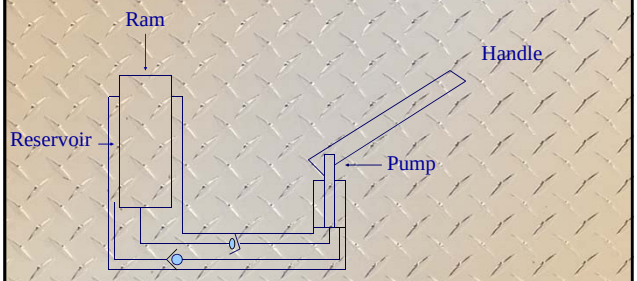
Understanding Mobile Hydraulics.

SYSTEM COMPONENTS

SIMPLE HYDRAULIC SYSTEM



COMPONENTS

- Reservoirs
  - Dissipate heat store fluid
- Strainer/filters
  - Clean fluid
- Prime movers
  - Electric motors, internal combustion engines

Pumps
- Gear, vane, piston

Valves
- Relief valve for protection of hyd. components
- Flow control
- Directional control

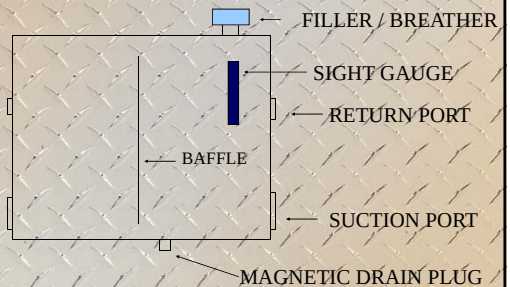
PRIME MOVERS

Electric motors
- AC or DC

Internal combustion engines
- Gas engines
- Diesel engines

POWER TAKE OFF

RESERVOIRS



RESERVOIR CONSTRUCTION

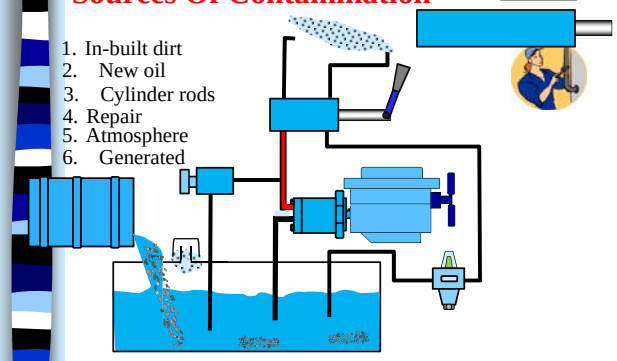
- Baffle
  - Between the inlet side of the pump and the returning fluid
- Filler/Breather
  - Allows air to escape, removes large debris when fluid is being added
- Drain port
  - Place to drain fluid, magnetic plug catches steel particles floating in the fluid
- Temperature/sight gauge
  - Monitor fluid level & temperature
- Return port
  - Located on the middle of the reservoir, one on each side
- Suction port
  - Located on the lower side one on each side

FILTERS

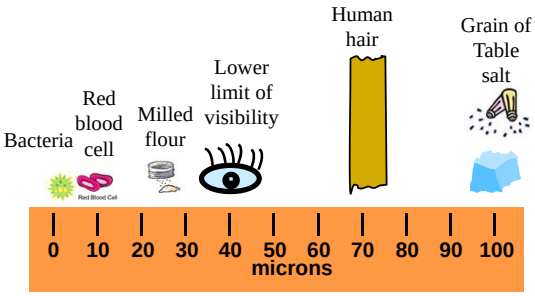
- -Suction
- -Return
- -Pressure

Sources Of Contamination

1. In-built dirt
2. New oil
3. Cylinder rods
4. Repair
5. Atmosphere
6. Generated



Relative size of objects



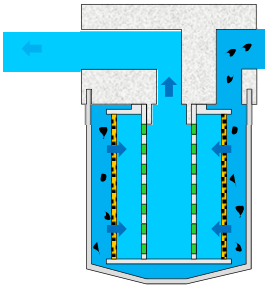
Placing Filters

- **Main system contamination control**
  - Ingression prevention
    - All air entering the reservoir needs to be filtered
    - All fluids entering the system should be filtered
  - Pressure line
    - The pump produces contamination, this will help prevent silting
    - Fluid that passes over the relief does not get filtered
  - Return line
    - Return line is an excellent location however the filter should still see about 20% of system flow per minute.

Flushing New or Rebuilt Systems

- Dislodge the dirt and transport it to the filter
  - Dislodging and transporting contaminates is best accomplished by using low viscosity fluid at a high velocity.
- Flow fluid through all of the lines and all of the components
  - To be sure fluid flows through all of the components. The valves should be actuated several times. Lines may also need to be connected around components to pass the high velocity flow.
- Capture the dirt with a high efficiency filter
  - The flushing target cleanliness code should be two ISO codes below the target cleanliness level for system operation.

Filter Ratings



Hydraulic filters are rated by the "size" of the largest opening in the filter media. This "size" is measured in Microns.

Filter Ratings

- Nominal Rating is an arbitrary Micrometer or Micron value indicated by the filter manufacturer. Due to the lack of reproducibility, this is depreciated.
- Absolute Filtration Rating: The diameter of the largest hard spherical particle that will pass through a filter under specified test conditions. This is an indication of the largest opening in the filter element.
- Filtration Ratio (Bn): The ratio of the number of particles greater than a given size (n) in the inlet to the number of particles greater than the same size (n) in the filter outlet.

SUCTION STRAINERS

- Designed to filter out the larger contaminants prior to the pump
- Rated in mesh
- Usually threaded into the reservoir
- In most applications it will be necessary to drain the reservoir before the strainer can be serviced
- Low PSI bypass

RETURN LINE FILTERS

- There are two types of return line filters
- In-line
  - Installed in-line with the return flow, usually as close to the reservoir as possible
  - Arrow to indicate direction of flow
  - 15-25 PSI check valve & gage port
  - Spin on type
- In-tank
  - Mounted in the reservoir on the top
  - Allows changing the filter without losing fluid
  - Costs more money

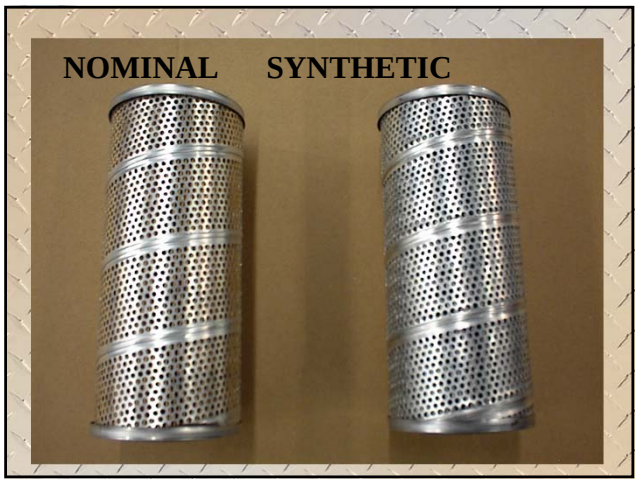
COMMON INTANK FILTER

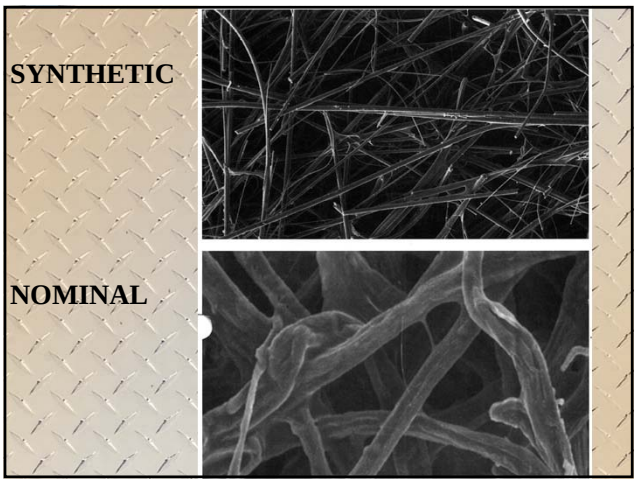
HIGH PRESSURE FILTER

- Plumbed between pump outlet and valve inlet.
- Can withstand system pressure.
- Added protection for valve, which is most expensive component and hardest to troubleshoot.

FILTER ELEMENTS

- Replace elements annually (or more often if known contaminants are prevalent)
- 10 Micron vs. 25 Micron
  - 10 micron recommended (1/4 size of head of pin)
- Nominal (Cellulose) vs. Synthetic
  - Synthetic recommended
  - Has twice the dirt holding capacity as paper
  - Both filter down to 10 microns, but synthetic can do it for twice as long on same element





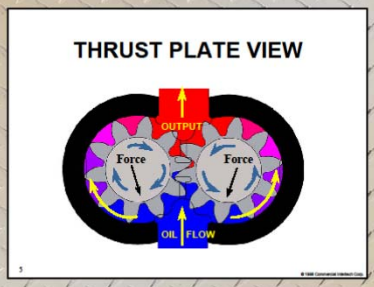
PUMPS

- Pump types
  - Positive displacement
  - Variable
- Pump classifications
  - Gear
  - Vane
  - Piston

GEAR PUMPS

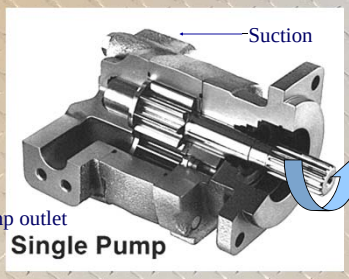
- Produce high volumes of oil
- Good speed capabilities
- High tolerance to contamination
- Relatively efficient
- Operate at lower RPM's
- Least expensive to manufacture
- Usually operate in an open center circuit

DIRECTION OF FLOW



This diagram indicates the direction of flow from the reservoir through the pump. If the pump is rotating in a CCW rotation the oil is carried around the perimeter of the pump, as the oil is compressed at the outlet side it becomes flow. The work (resistance to flow) creates the pressure in the system and the pump will also see the same pressure.

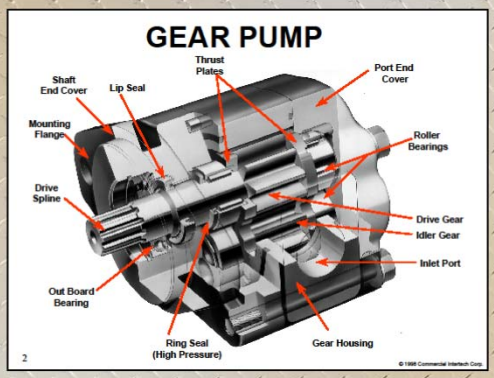
PUMP ROTATION



CCW rotation
Left hand

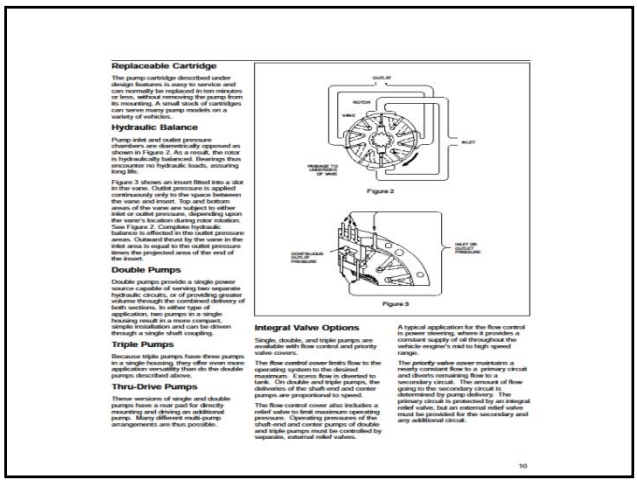
Belly down

GEAR PUMP COMPONENTS



VANE PUMPS

- Higher efficiencies than gear pumps
- Quiet
- Low contamination tolerance



Replaceable Cartridge

The pump cartridge described under design features is easy to service and can normally be replaced in ten minutes or less, without removing the pump from its mounting. A small stock of cartridges can serve many pump models on a variety of vehicles.

Hydraulic Balance

Pump inlet and outlet pressure chambers are diametrically opposed as shown in Figure 2. As a result, the rotor is hydraulically balanced. Bearings thus encounter no hydraulic loads, assuring long life.

Figure 3 shows an insert fitted into a slot in the vane. Outlet pressure is applied continuously only to the space between the vane and insert. Top and bottom areas of the vane are subject to either inlet or outlet pressure, depending upon the vane's location during rotor rotation. See Figure 2. Complete hydraulic balance is maintained as long as pressure areas. Outward thrust by the vane in the inlet area is equal to the outlet pressure times the projected area of the end of the insert.

Double Pumps

Double pumps provide a single power source capable of serving two separate hydraulic circuits, or of providing greater volume through the combined delivery of both sections. In either type of application, two pumps in a single housing result in a more compact, simple installation and can be driven through a single shaft coupling.

Triple Pumps

Because triple pumps have three pumps in a single housing, they offer even more application versatility than do the double pumps described above.

Thru-Drive Pumps

These versions of single and double pumps have a rear pad for directly mounting and driving an additional pump. Many different multi-pump arrangements are thus possible.

Integral Valve Options

Single, double, and triple pumps are available with flow control and priority valve covers.

The *flow control cover* limits flow to the operating system to the desired maximum. Excess flow is diverted to tank. On double and triple pumps, the deliveries of the shaft-end and center pumps are proportional to speed.

The flow control cover also includes a relief valve to limit maximum operating pressure. Operating pressures of the shaft-end and center pumps of double and triple pumps must be controlled by separate, external relief valves.

A typical application for the flow control is power steering, where it provides a constant supply of oil throughout the vehicle engine's mid to high speed range.

The *priority valve cover* maintains a nearly constant flow to a primary circuit and diverts remaining flow to a secondary circuit. The amount of flow going to the secondary circuit decreases as pressure increases. The primary circuit is protected by an integral relief valve, but an external relief valve must be provided for the secondary and any additional circuit.

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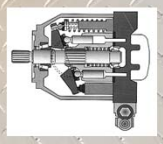
PISTON PUMPS

- Two types
- In-line
- Bent axis
- Variable or Fixed displacement
- High pressure
- Low contamination tolerance
- Higher filtration required

PISTON PUMP THEORY OF OPERATION



Piston Shoe Retainer holds the shoes in place.

Piston Shoe rides on film of oil and will crack in its absence (debris then takes out the rest of the pump in a short time.)

Case Drain s/b located as close to top as possible. Use same size hose as port is (5/8). Fill at start-up! For leakage/relieves pressure. Case should = less than 30 psi and less than 10% of flow.

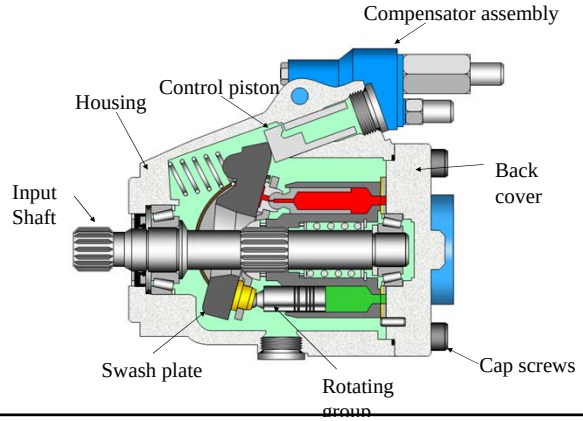
Valve Plate directs the flow.

Pistons; Odd number, so one always just ready to draw while another is just ready to push out, otherwise they would work against each other. More flow (displacement) more pistons (5, 7,9,11).

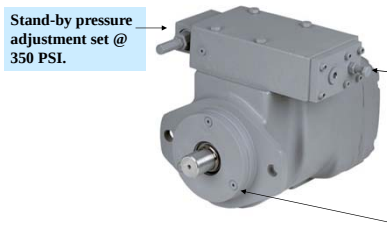
Swash Plate is adjusted by servo piston, which is acting in accordance with load sense signal. As the swash increases in angle, flow increases as the pistons go around.

Compensator has the low & high system settings (Low Press. Standby-By or Differential Press. - & High Press. Setting). Low Press. Effects the sensitivity of a system – too low no move, too high too quick or jumpy. Low usually 250-500 depending on pump. High 3000 – 4500 (4200 is now common for Hook lift applications).
L.S. = 4 Hoses; Pressure Comp. = 3
Pressure compensator would be on high pressure stand by – Good for construction, an example would be a boom truck.

Eaton 420 Pump



FASD 34/45 PISTON PUMP



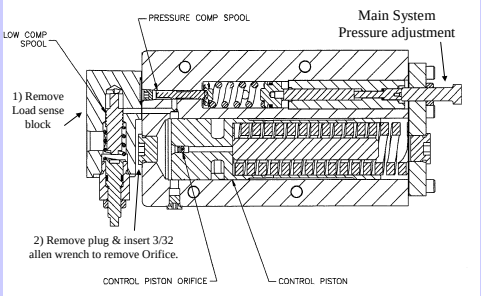
Stand-by pressure adjustment set @ 350 PSI.

System pressure adjustment. This adjustment will be set @ 1800 psi, which is the maximum operating pressure of the system.

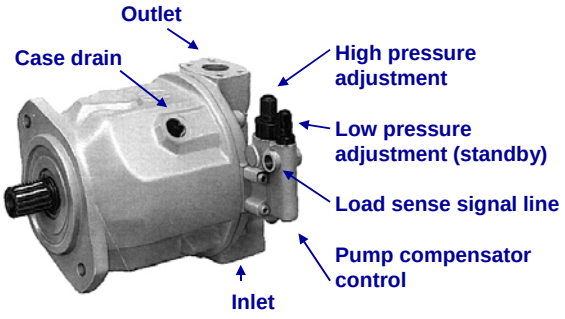
The Force pump has a specially designed seal assembly to protect the pump. Removal of these three bolts will allow access to the shaft seal. The area behind this plate is packed with grease.

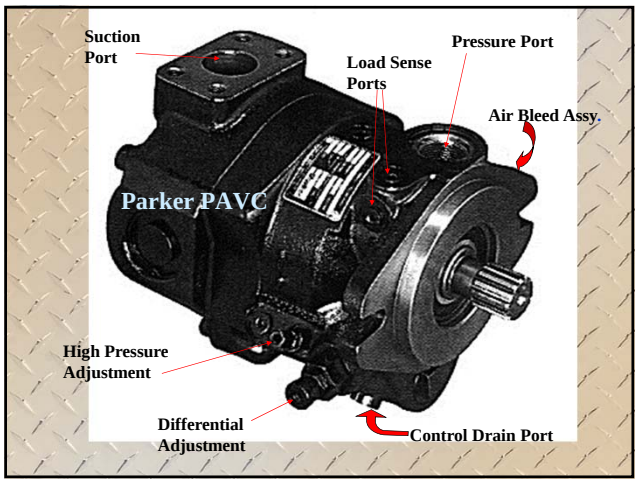
CONTROL PICTORAL DRAWING

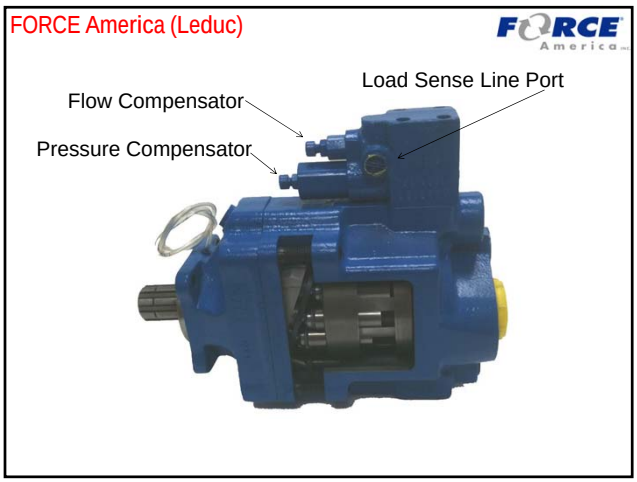
PVWH Control

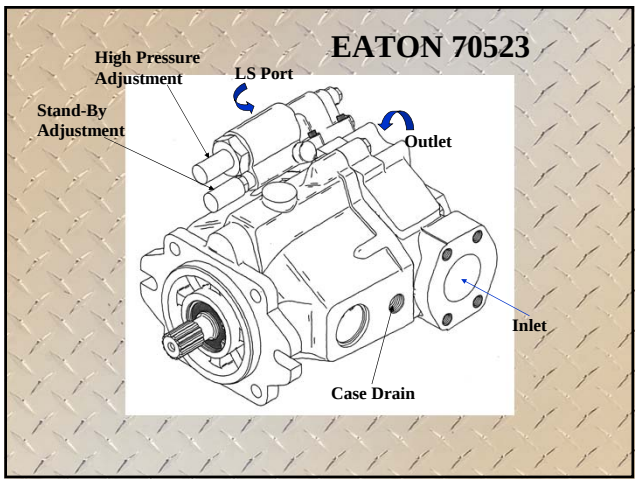


REXROTH PISTON PUMP A10V071





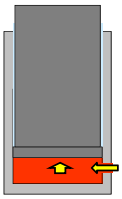




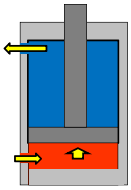
ACTUATORS

- LINEAR
- ROTARY

Two Main Types of Cylinders



Single Acting



Double Acting

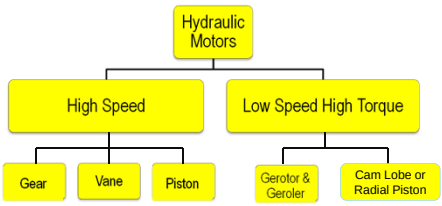
Hydraulic Motors

- Advantage of using Hydraulic Motors
  - More versatile than a electric motor
  - Can be reversed easily
  - Starting and stopping under load
  - Horsepower to size ratio is smaller than any other rotary device (high power density)
  - Rated by displacement, torque capacity and maximum pressure limitations
  - Provide low RPM ranges
  - High torque capabilities

Hyd Motor symbol

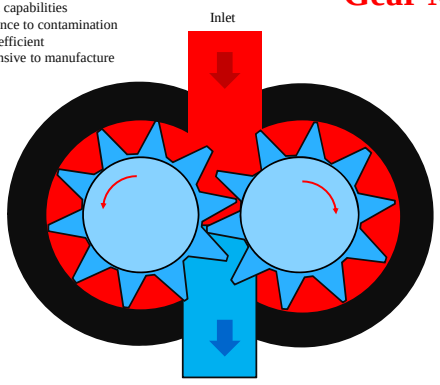
FORCE America Inc.

Hydraulic Motors



Gear Motor

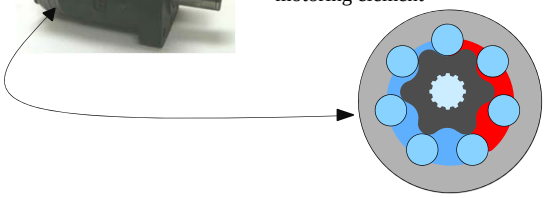
- Lower torque than most of the other hydraulic motors
- High speed capabilities
- High tolerance to contamination
- Relatively efficient
- Least expensive to manufacture
- Low cost



Geroler Motor

- Low speed high torque
- Built in 6 to 1 hydraulic reduction
- Used a lot on mobile equipment
- High power density
- Lots of available displacement options

This is the Geroler which is the motoring element



Piston Motor

- Produce high volumes of oil
- High pressure capabilities
- Good speed capabilities
- Lower tolerance to contamination than the gear motor
- High efficiency