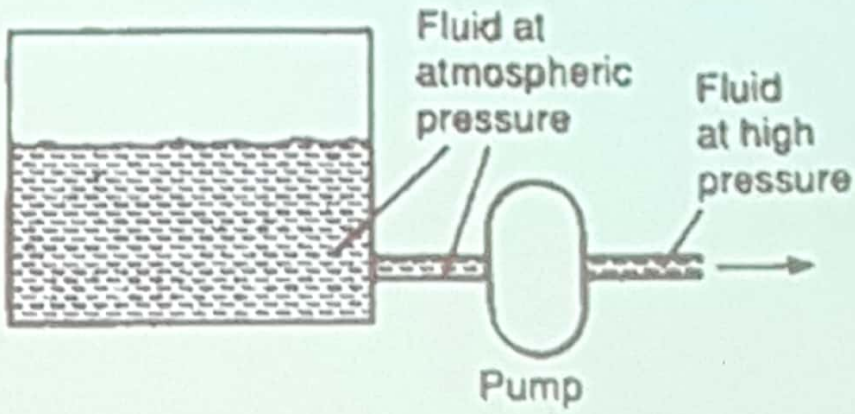
Pump

Pump

- A hydraulic takes oil from a tank and delivers it to the rest of the hydraulic circuit. In doing so it raises oil pressure to the required level.



(a) Operation of a pump

Pump

➢ Pump

➢ On hydraulic circuit diagrams a pump is represented by the symbol .with the arrowhead showing the direction of flow.

(b) Pump symbol, arrow shows direction of flow

Pump

Pump

- Hydraulic pumps are generally driven at constant speed by a three phase AC induction motor rotating at 1500 *rpm* in the UK (with a 50 Hz supply) and at 1200 *or* 1800 *rpm* in the USA (with a 60 Hz supply).

Pump

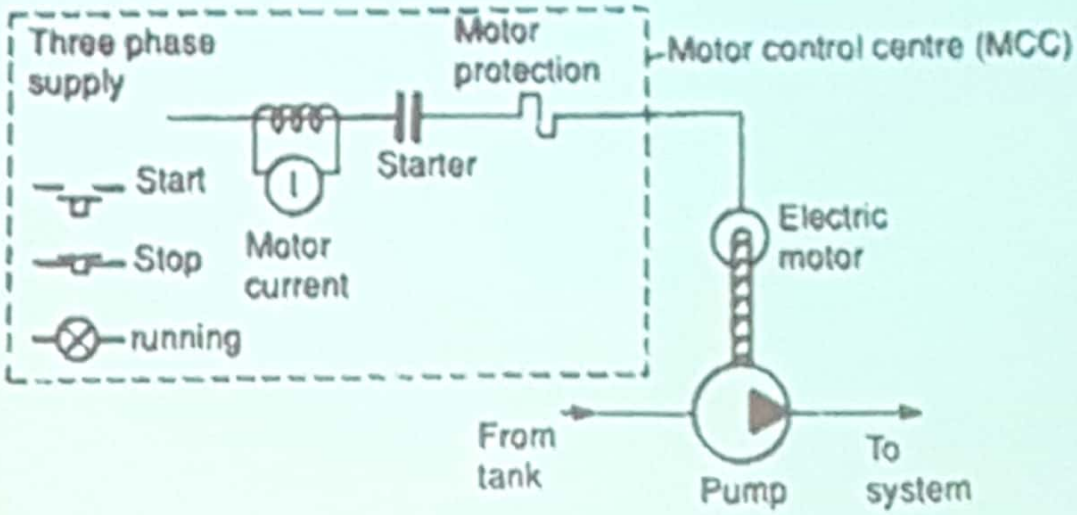
➢ Pump

- **Hydraulic pumps are generally driven at constant speed by a three phase AC induction motor rotating at 1500 *rpm* in the UK (with a 50 Hz supply) and at 1200 *or* 1800 *rpm* in the USA (with a 60 Hz supply).**
- **There are two types of pump (for fluids) or compressor (for gases).**

1. Hydrodynamic pumps (**Non-positive displacement pump**), and are primarily used to shift fluid from one location to another at relatively low pressures. Water pumps are a typical application.
2. a positive displacement or hydrostatic pump. Hydraulic pumps are invariably hydrostatic.

Pump

Pump



(c) Pump associated components

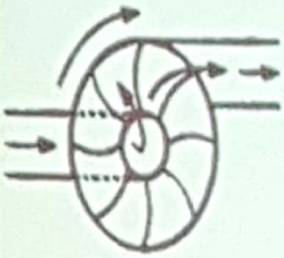
Pump

- **Hydrodynamic pumps (Non-positive displacement pump**

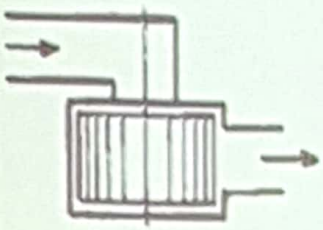
- In these pumps the fluid is pressurized by the rotation of the propeller and the fluid pressure is proportional to the rotor speed
- These pumps can not withstanding high pressures and generally used for low-pressure and high-volume flow applications.
- The fluid pressure and flow generated due to inertia effect of the fluid.
- The fluid motion is generated due to rotating propeller.
- These pumps provide a smooth and continuous flow but the flow output decreases with increase in system resistance (load).

Pump

- **Hydrodynamic pumps (Non-positive displacement pump**



Side view



Top view

(a) Hydrodynamic pump

- **In these pumps the fluid is pressurized by the rotation of the propeller and the fluid pressure is proportional to the rotor speed**
- **These pumps can not withstanding high pressures and generally used for low-pressure and high-volume flow applications.**
- **The fluid pressure and flow generated due to inertia effect of the fluid.**
- **The fluid motion is generated due to rotating propeller.**
- **These pumps provide a smooth and continuous flow but the flow output decreases with increase in system resistance (load).**

Thanks & Questions

Pump

- Hydrodynamic pumps (Non-positive displacement pump

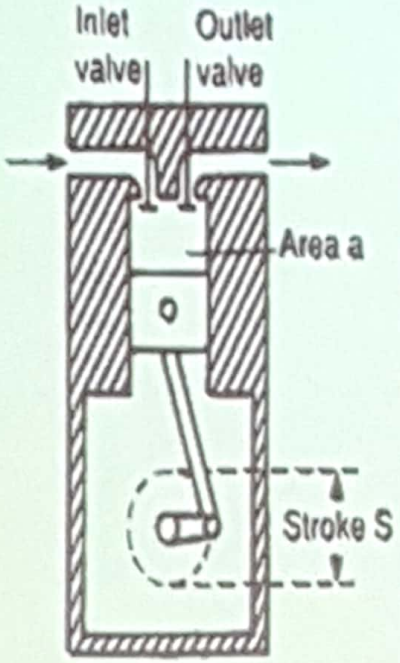
- The flow output decreases because some of the fluid slip back at higher resistance.
- The fluid flow is completely stopped at very large system resistance and thus the volumetric efficiency will become zero. Therefore, the flow rate not only depends on the rotational speed but also on the resistance provided by the system.
- The important advantages of non-positive displacement pumps are lower initial cost, less operating maintenance because of less moving parts.
- These pumps are primarily used for transporting fluids and find little use in the hydraulic or fluid power industries

Pump

- positive displacement or hydrostatic pump

- As the piston is driven down, the inlet valve opens and a volume of fluid (determined by the cross section area of the piston and the length of stroke) is drawn into the cylinder.
- Next, the piston is driven up with the inlet valve closed and the outlet valve open, driving the same volume of fluid to the pump outlet.
- Should the pump stop, one of the two valves will always be closed, so there is no route for fluid to leak back.

Pump



(b) Positive displacement pump

ositive displacement or hydrostatic pump

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Thanks & Questions

Pump

- positive displacement or hydrostatic pump

- The important advantages of positive displacement pumps over non-positive displacement pumps include capability to generate high pressures, high volumetric efficiency, high power to weight ratio, change in efficiency throughout the pressure range is small and wider operating range pressure and speed
- The fluid flow rate of these pumps ranges from 0.1 and 1500 gpm, the pressure head ranges between 10 and 10,000 psi
- It is important to note that the positive displacement pumps do not produce pressure but they only produce fluid flow

Pump

- positive displacement or hydrostatic pump

- More important, though, is the fact that the pump delivers a fixed volume of fluid from inlet to outlet each cycle regardless of pressure at the outlet port. Unlike the hydrodynamic pump.
- Typical efficiencies for pumps range from around 90% (for cheap gear pumps) to about 98% for high quality piston pumps. An allowance for pump efficiency needs to be made when specifying pump capacity or choosing a suitable drive motor.
- The motor power required to drive a pump is determined by the pump capacity and working pressure.

Pump

- positive displacement or hydrostatic pump

$$Power = \frac{work}{time}$$

$$= \frac{force \times distance}{time}$$

- a pump forces fluid along a pipe of area A against a pressure P, moving fluid a distance d in time T. The force is PA, which, when substituted into expression

Pump

➢ positive displacement or hydrostatic pump

$$Power = \frac{work}{time}$$

$$= \frac{force \times distance}{time}$$

➢ **a pump forces fluid along a pipe of area A against a pressure P, moving fluid a distance d in time T. The force is PA, which, when substituted into expression**

$$Power = \frac{P \times A \times d}{T}$$

but $A \times d/T$ is flow rate, hence:

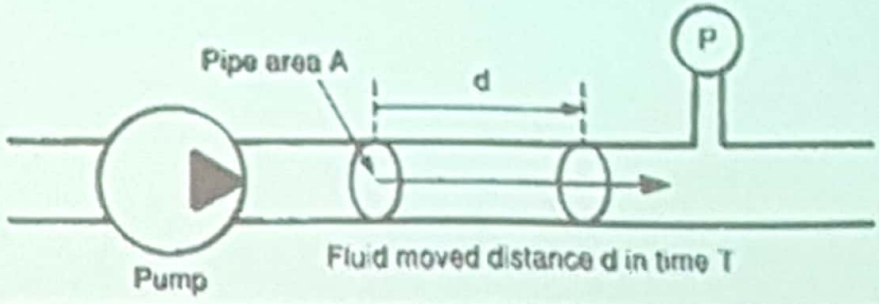
$$Power = pressure \; x \; flow \; rate.$$

Pump

- positive displacement or hydrostatic pump

- Unfortunately, expression is specified in impractical SI units (pressure in pascal, time in seconds, flow in cubic meters). We may adapt the expression to use more practical units (pressure in bar, flow rate in *liter s min−1*) with the expression:

$$Power = \frac{pressure \times flow\ rate}{600}\ Kw.$$



Pump

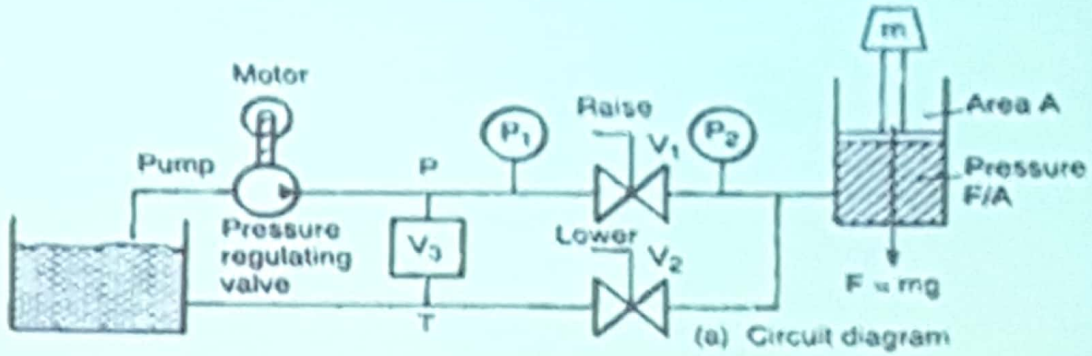
- positive displacement or hydrostatic pump

- For Imperial systems (pressure in psig, flow rate in $gallons\,min{-}1$), the expression becomes:

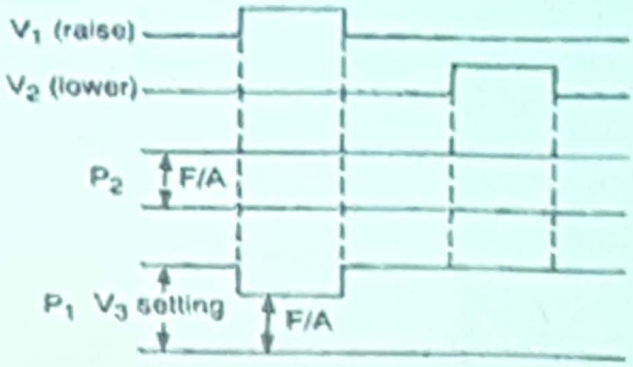
$$Power = \frac{pressure \times flow\ rate}{1915}\ Kw.$$

$$Horsepower = 0.75\ x\ power\ in\ Kw.$$

Pump



(a) Circuit diagram



(b) Pressure recording

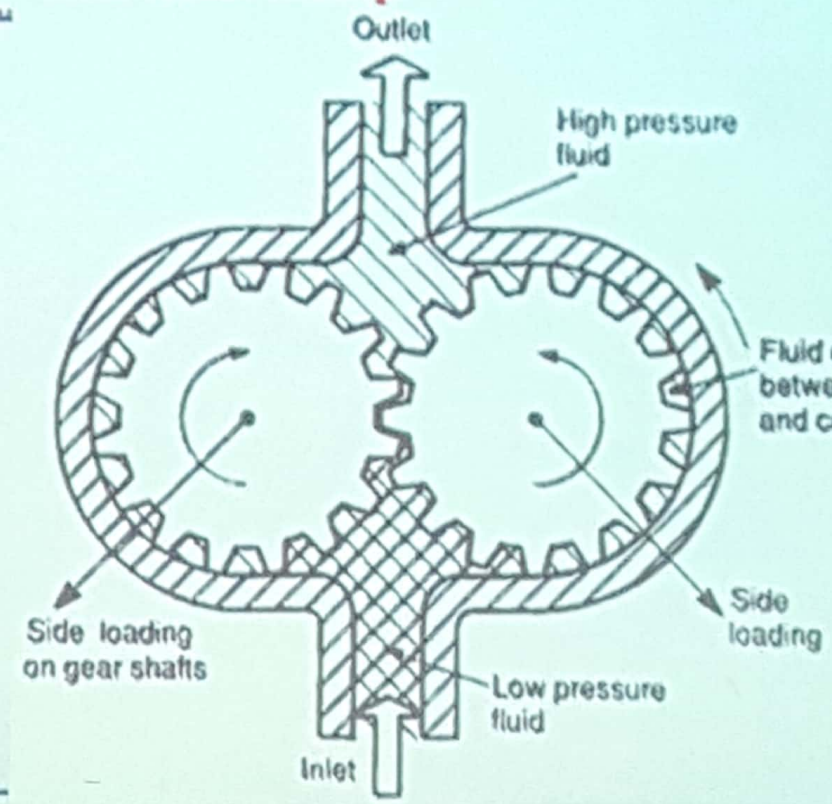
Pump

The Types of Pumps

- Positive displacement pumps
  - Gear pumps
  - Vane pumps
  - Piston pumps

Pump

The Gear Pump



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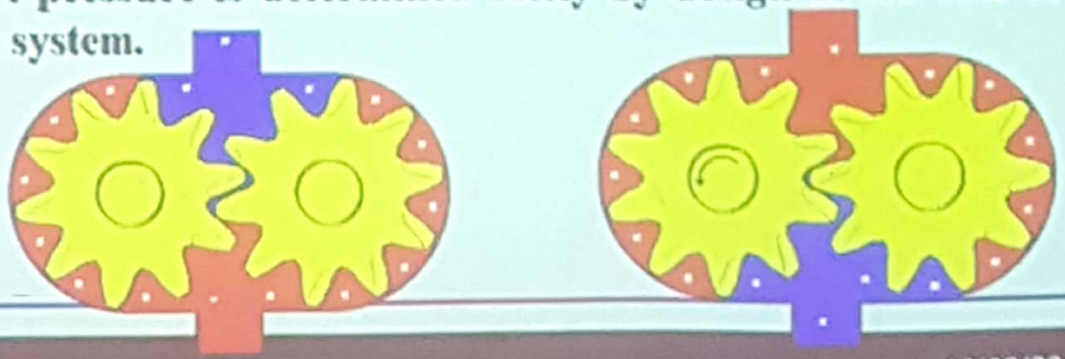
Pump

The Gear Pump

- Typically, gear pumps are used at pressures up to about 150 bar and capacities of around 150 *gpm* (6751 *min*−1). Volumetric efficiency of gear pumps at 90% is lowest of the three pump types.
- Pump displacement is determined by: volume of fluid between each pair of teeth; number of teeth; and speed of rotation. Note the pump merely delivers a fixed volume of fluid from inlet port to outlet port for each rotation; outlet port pressure is determined solely by design of the rest of the system.



Pump

The Gear Pump

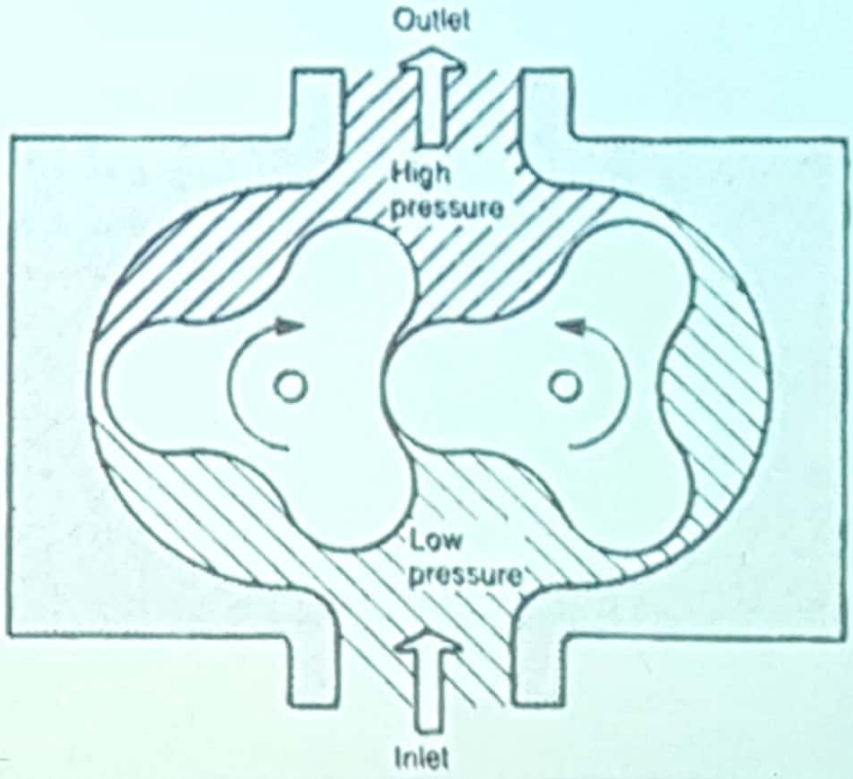
Gear Pumps

- External gear pump
- Lope pump
- Internal gear pump
- Gerotor pump

جهاز العرض يتعرض لإرتفاع كبير في درجة الحرارة.

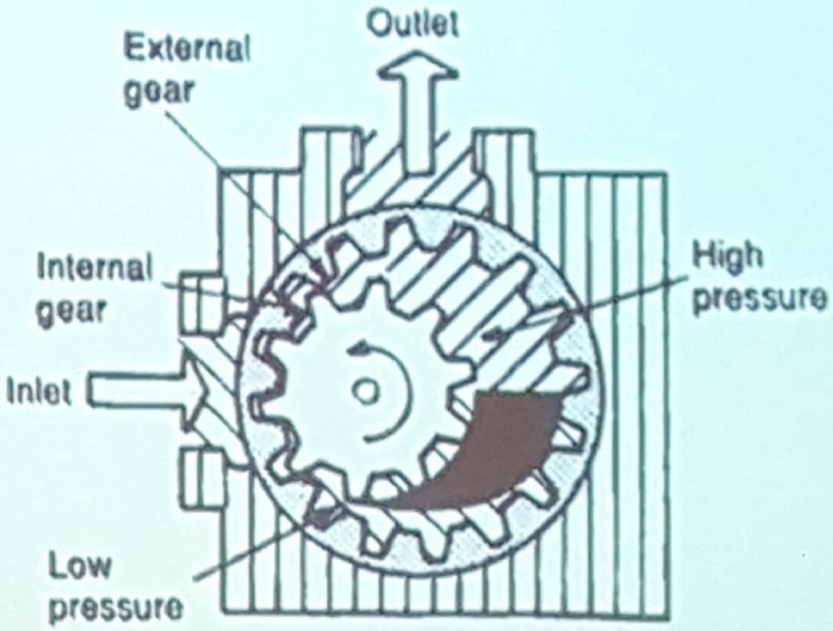
Pump

The Lope pump



Pump

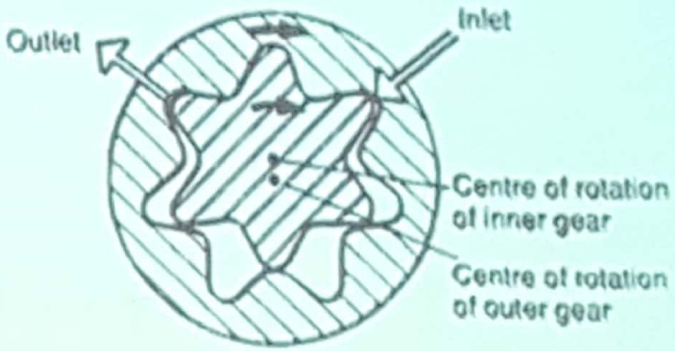
The Internal Gear Pump



(a) Internal gear pump

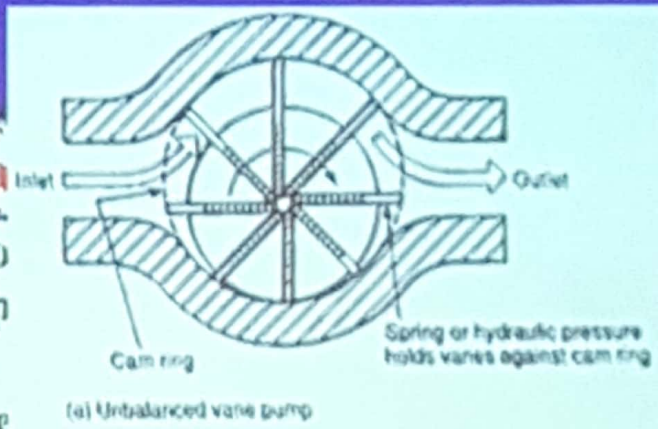
Pump

The Gerotor Pump



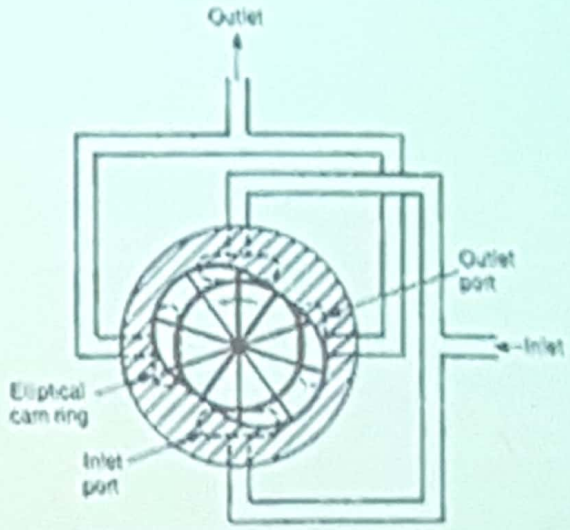
(b) Gerotor pump

- The Va



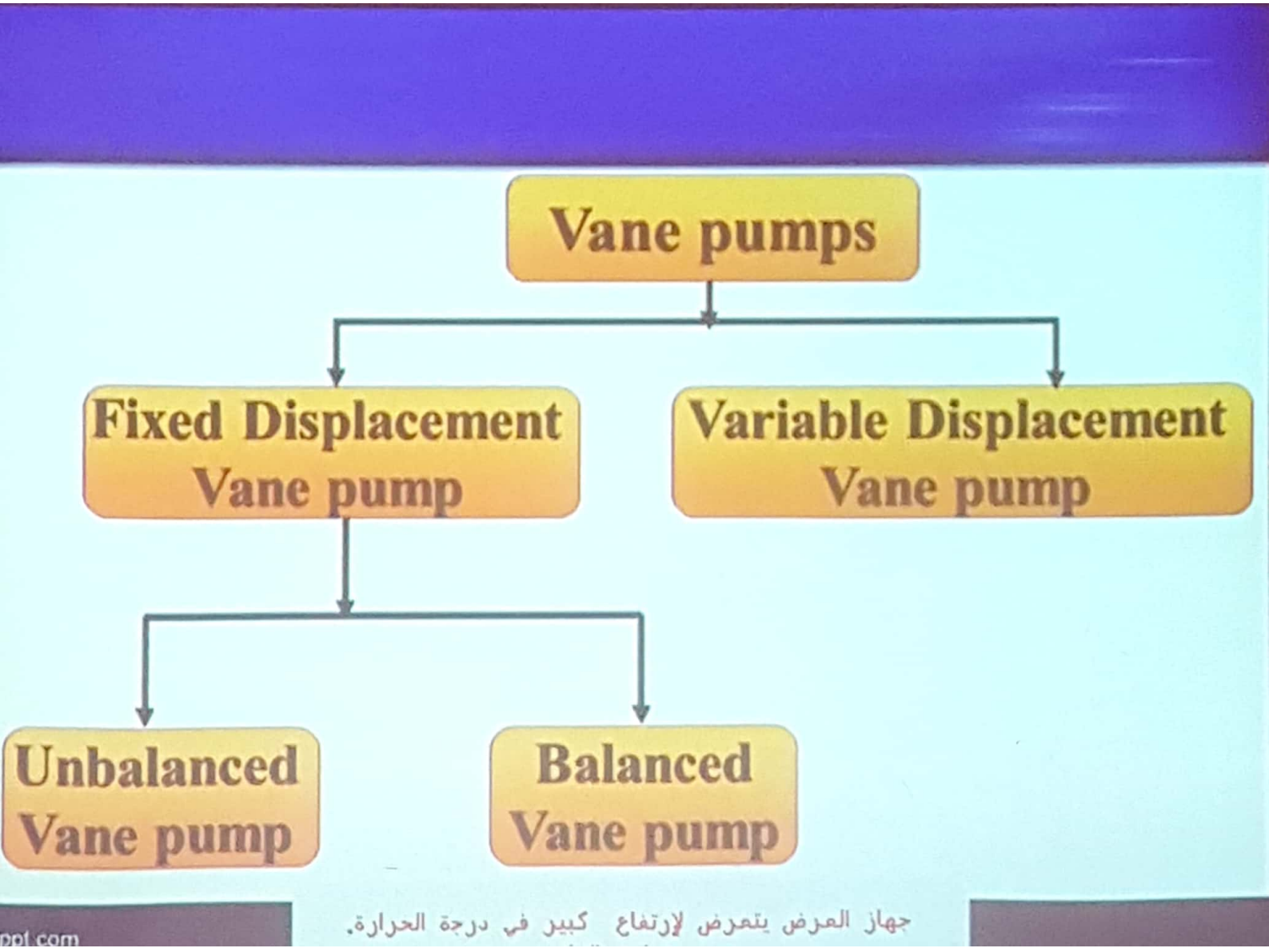
(a) Unbalanced vane pump

- The majo … arises from the small gap … eeth and pump housing.
- The vane … sing spring (or hydraulic … rotor.



(b) Balanced vane pump

جهاز المرض يتعرض لإرتفاع كبير في درجة الحرارة.



جهاز العرض يتعرض لإرتفاع كبير في درجة الحرارة.

1- Fixed Displacement vane pump

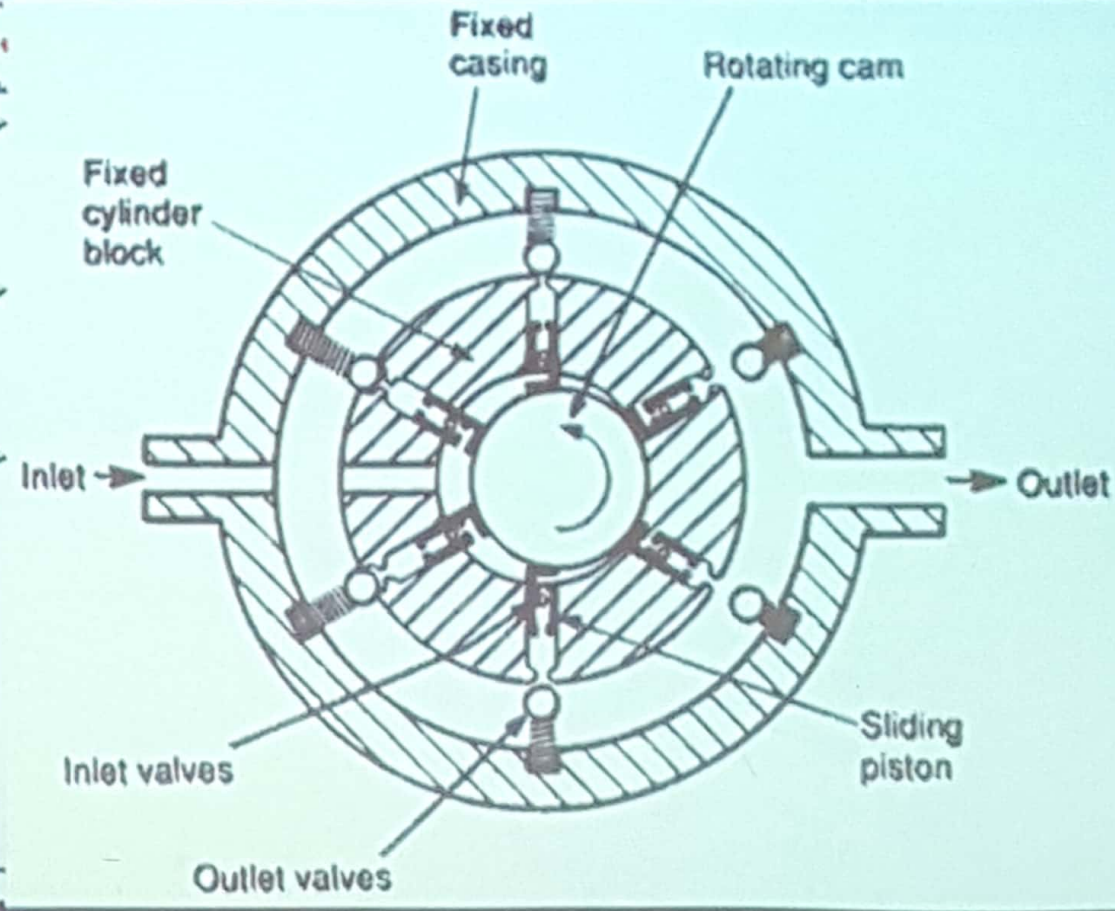
In this type of pump the eccentricity between pump cam-ring and rotor is fixed and pump discharge always remain same at a particular pressure.

There are two types of fixed displacement Vane Pump:-

1- Unbalanced Vane Pump

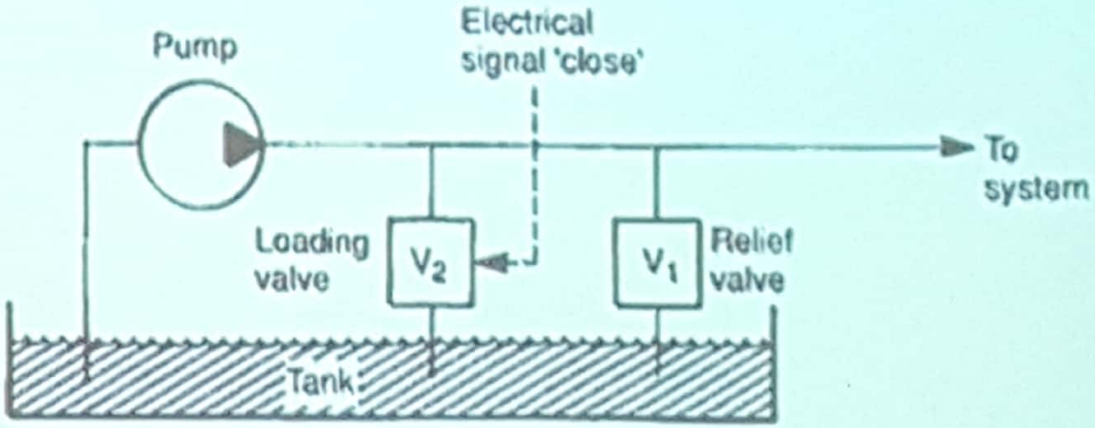
2- Balanced Vane Pump

Pump



Loading and Relief valves

- The Loading and Relief valves



Loading and Relief valves

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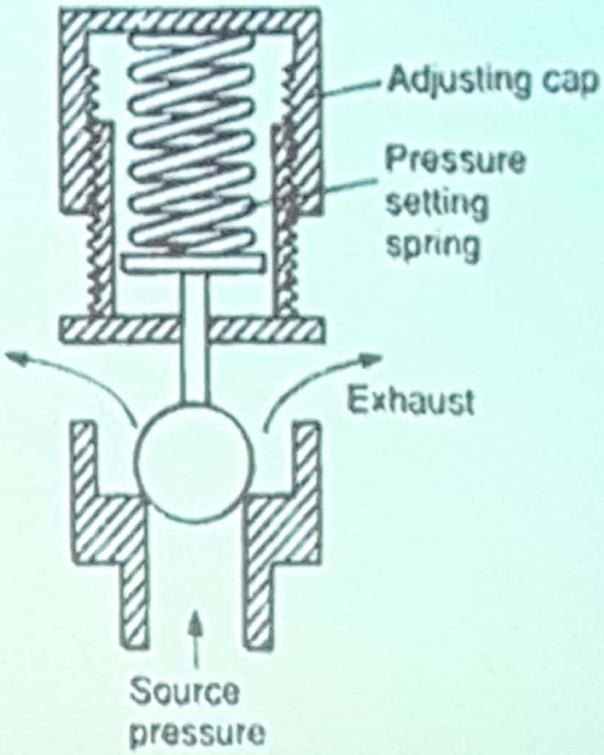
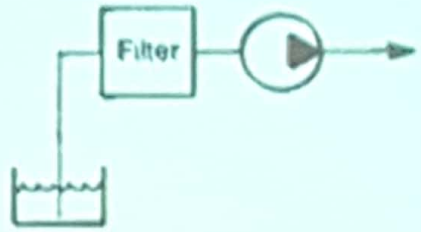
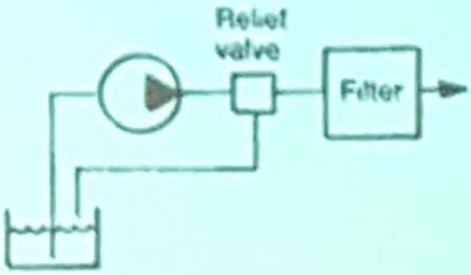


Filters

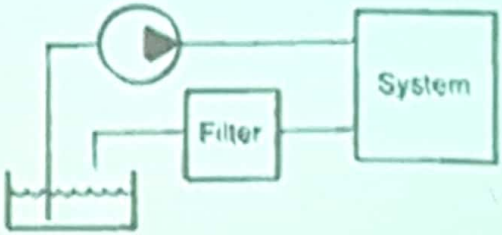
- **The Filters**



(a) Inlet line filter



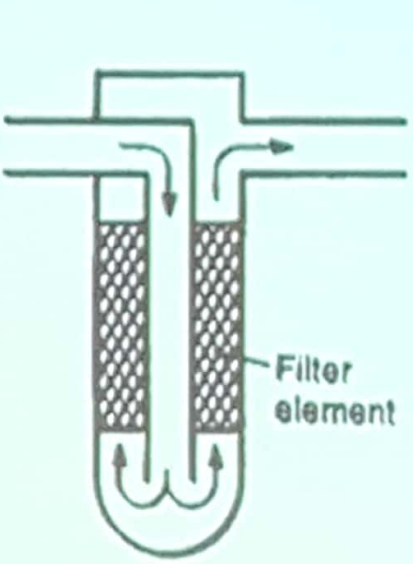
(b) Pressure line filter



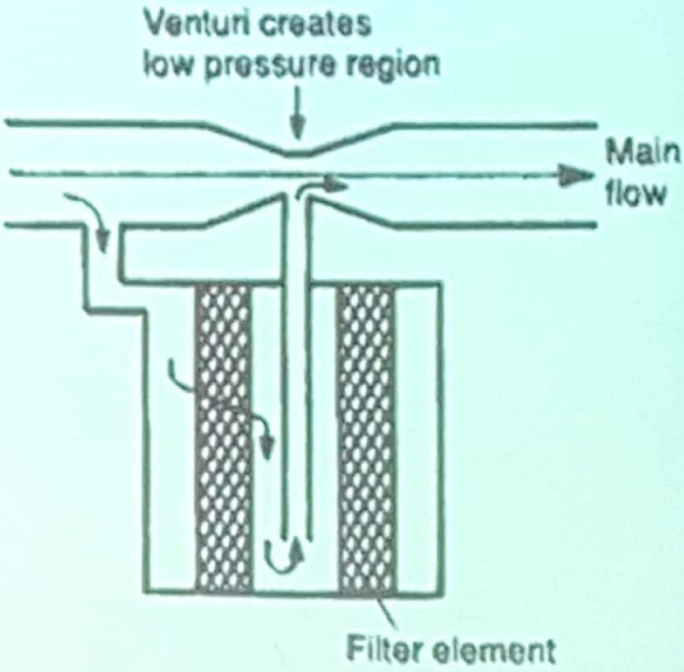
(c) Return line filter

Filters

- **The Filters**



(a) Full flow filter

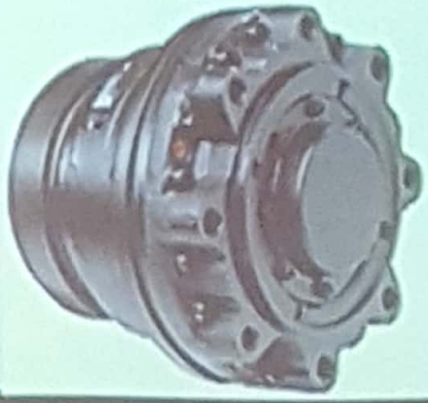


(b) Proportional flow filter

Experiment – 3: Hydraulic Rotary Motor

- **Hydraulic Rotary Motor**

Rotary actuators
(Hydraulic Motors)



Experiment – 3: Hydraulic Rotary Motor

- **Hydraulic Rotary Motor**

Purpose

- A hydraulic motor converts hydraulic energy from pressure into rotary motion and torque to drive an implement or system.

Types

- Fixed positive displacement – gear, piston, geroter & vane types
- Variable positive displacement – piston

Typical Applications

- Wheel Motors – drive mobile equipment wheels (skid steers, tractors, lifts)

Experiment – 3: Hydraulic Rotary Motor

- **Hydraulic Rotary Motor**

Typical Applications continued

- **Fan Drives – hydraulic fan drives (engine cooling, industrial equipment, drive train cooling, gen sets, grain driers)**
- **Industrial Machinery – (conveyers, machine tools, cutters, cranes, augers, winches)**
- **Agricultural Equipment – Harvesters, Trenchers, Lawn Mowers, Forestry Equipment**

Experiment – 3: Hydraulic Rotary Motor

- **Hydraulic Rotary Motor**

Fixed Positive Displacement Motors

- Motor displacement is fixed
- Torque is proportional to inlet pressure
- Speed is proportional to flow rate
- Regulate torque and speed with either valves, variable displacement pump or pump speed.

Gear Motors

- Inlet flow / pressure rotates a gear set causing the output shaft to rotate and create torque

Experiment – 3: Hydraulic Rotary Motor

- **Hydraulic Rotary Motor**

Gear Motors

Advantages

- Low cost – initial and rebuild
- Good availability / many suppliers
- Cast iron motors have high pressure capability
- Tolerant to contamination
- Compact - desirable packaging

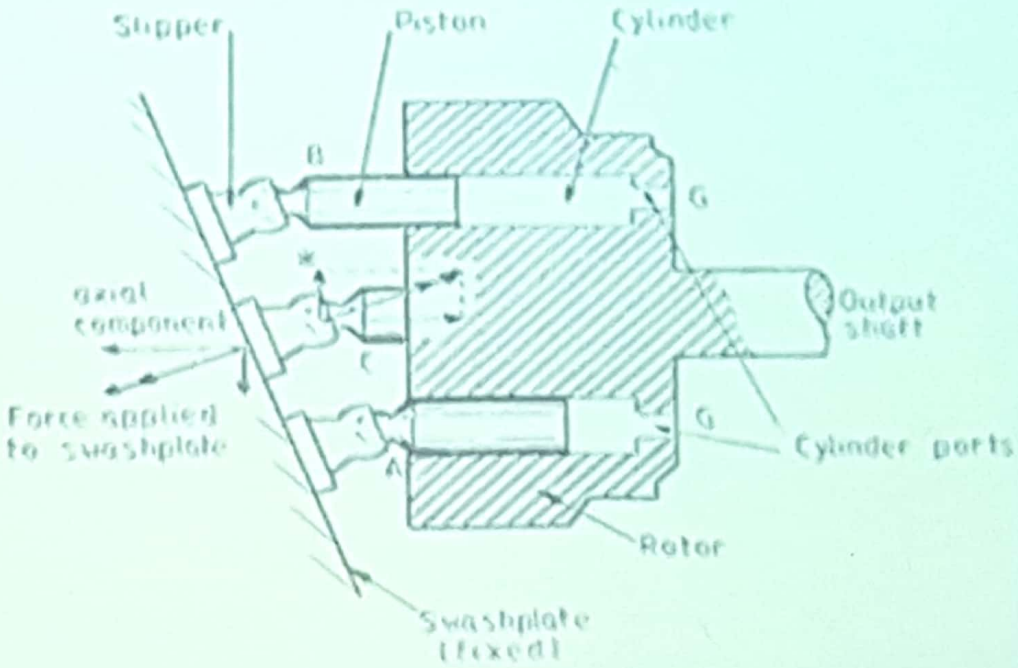
Disadvantages

- Lower efficiency compared to other types
- Lower torque per unit displacement compared to piston or Geroter / Geroler types

جهاز العرض يتعرض لإرتفاع كبير في درجة الحرارة.

Experiment – 3: Hydraulic Rotary Motor

- **Hydraulic Rotary Motor**



Axial-piston Motor

جهاز العرض يتعرض لإرتفاع كبير في درجة الحرارة.
يرجى تنظيف الفلتر

Experiment – 3: Hydraulic Rotary Motor

➢ **All hydrostatic motors:**

1. Produce a gross torque proportional to flow.
2. Have a velocity proportional to flow.

➢ **Static friction, running friction and efficiency**

✓ Static friction or stiction, is the torque that must be applied before the motor will begin to move. It is generally higher than the low-speed running friction.

Experiment – 3: Hydraulic Rotary Motor

Experiment - Preliminary procedure

1. Connect the outlet of the hydraulic power supply to the 'supply' connection on the servo unit.
2. Connect the return connection to the transparent return hose of the hydraulic reservoir.
3. 3. Plug the rectangular control unit plug into the servo unit socket.
4. Plug the multi-pin plug of the electronic power unit into the control unit socket.
5. Plug the electronic power unit into the electricity supply.
6. Plug the hydraulic power supply unit into the electricity supply. DO NOT start the pump until told.
7. Ensure that the setting of the Orifice Calibrator is fully open.
8. Check the connections between the hydraulic power supply, control unit, servo unit and electronic power supply.