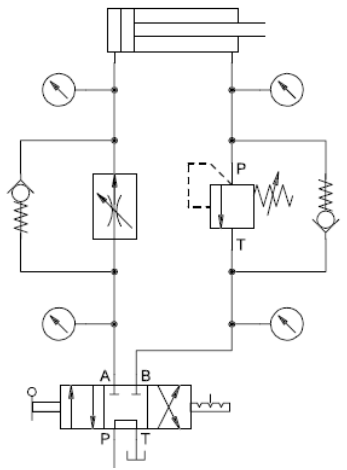


بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

***Hydraulic &
Pneumatic Circuits***



Tanta University



**Faculty of Engineering
Mechanical power
Engineering Dept.**

Lecture (3)

on

***Components of Hydraulic
Action and Control***

By

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Fayoum University*

2014 - 2015

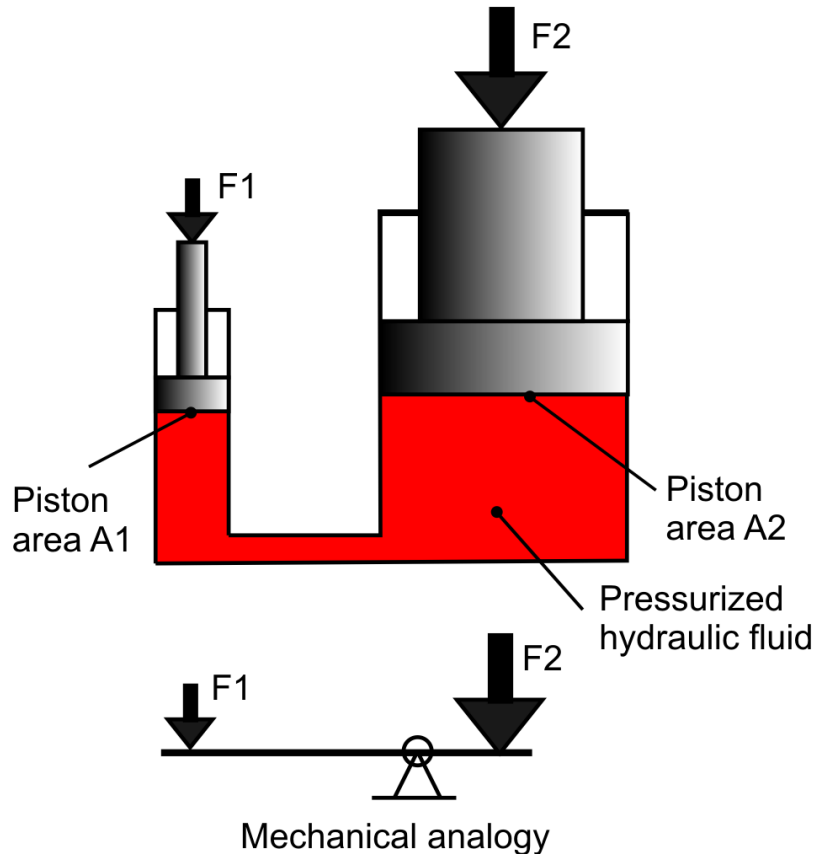


Hydraulic Motors

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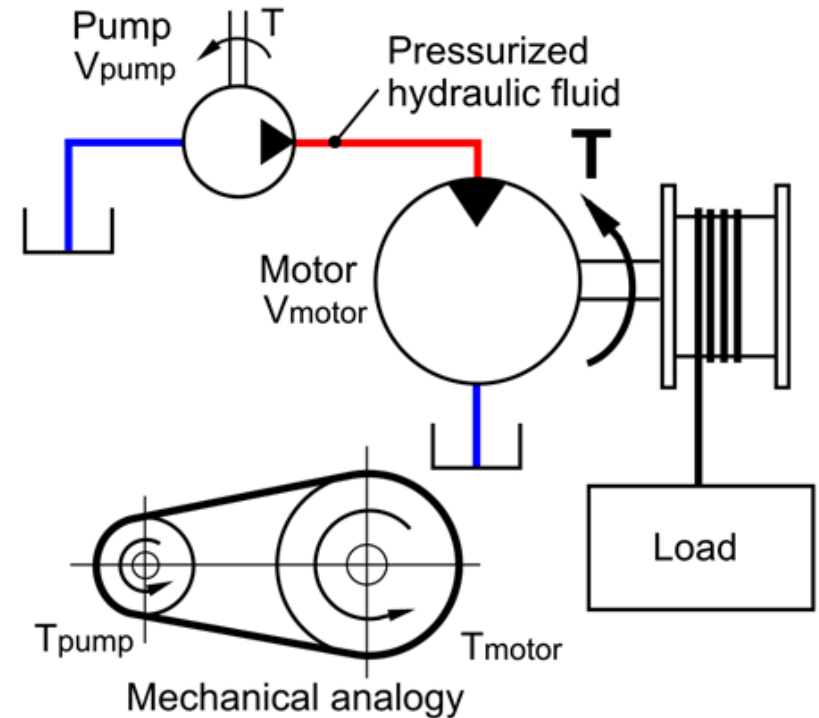
Force increase with hydraulics

$$F_2 = F_1 \cdot (A_2/A_1)$$



Torque increase with hydraulics

$$T_{\text{motor}} = (V_{\text{motor}}/V_{\text{pump}}) \cdot T_{\text{pump}}$$

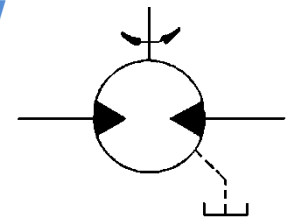
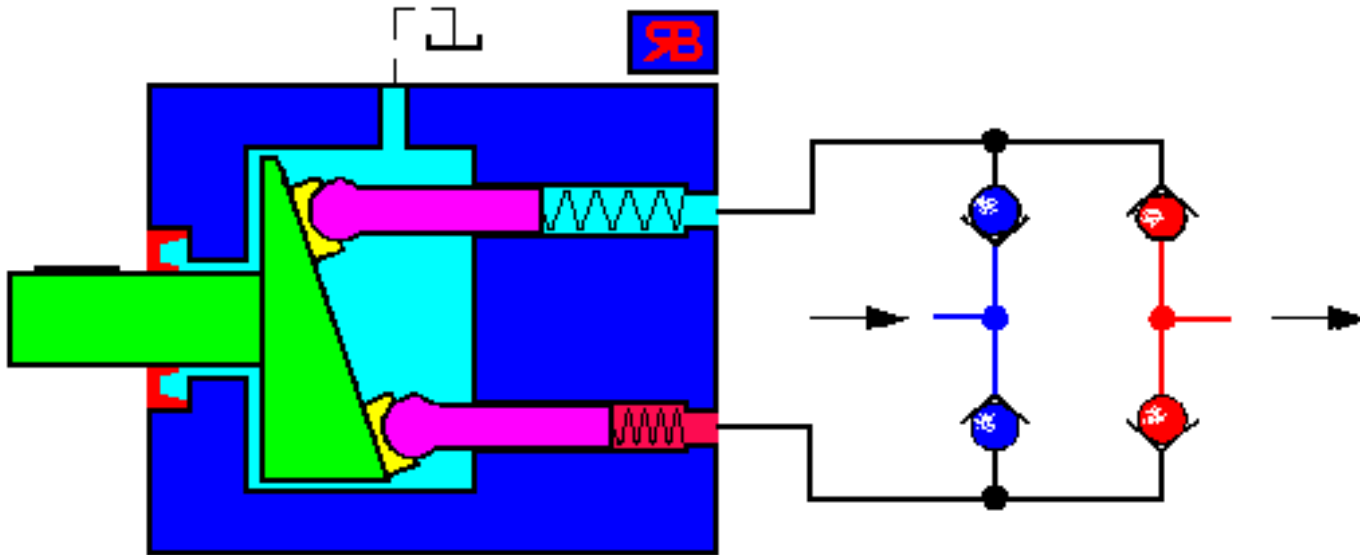




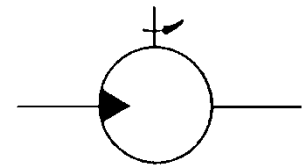
Hydraulic Motors

4

Hydraulic motors convert the working energy of a hydraulic system into rotary mechanical energy.



Bi-directional Motor Symbol



Hydraulic Motor Symbol (Uni-directional)





Hydraulic Motors

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Hydraulic motors selection performance quantities

1. Speed and speed ranges
2. Torque and power, both peak and continuous
3. Type of load (constant or fluctuating)
4. Type of duty
5. Constant or variable displacement
6. Angular acceleration
7. Swivel times of control systems
8. Magnitude of starting torque
9. Steady-state motion in the low speed range
10. Type of operating medium





Hydraulic Motors

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Comparison of different types of motor

Type of motor		Rexroth designation	Nominal size, i.e. displacement in cm ³	$P_{max} > P_{rated}$ in bar	Speed range according to size in rev/min	Starting characteristics	Noise level	Efficiency $\eta_{t max}$	
Fixed displacement motors	Gear motors	G2 G3	6 to 38	250	500 to 3000			85	
	axial piston motors	high speed	Bent-axis types	A2FM A2FE A2F/BR5	10 to 250 28 to 180 355 to 1000	450 450 400	50 to 6000 50 to 4750 50 to 2240		92
			Swash plate types	A4FM	22 and 28	450	30 to 4000		91
		Slow-speed types	MCS MC(4) MC(6)	200 to 1500	250	5 to 500		90	
	Orbit-type motors	MZA MZD MZF MZK	60 to 270	225	10 to 1000			85	
	Radial piston motors	Cam-ring type	MCR	500 to 3000	450	3 to 250			91
		Eccentric type	MR	190 to 7000	420	1 to 500			92
Variable displacement motors	Radial-piston motors	MRV	190 to 7000	420	1 to 500			92	
	Axial piston motors	Bent-axis type	A6VM A6V	28 to 355 28 to 107	450	50 to 8000 **			92
		Swash-plate type	A10VM A4VS * A10VSO*	45 40 to 250 28 to 71	315 400 315	30 to 3600 ** 6 to 4900 ** 40 to 3600 **			91

good
 better
 very good
 excellent

* Suitable for use in load matching (secondary control) circuits.
 ** Values only applicable when untitled.

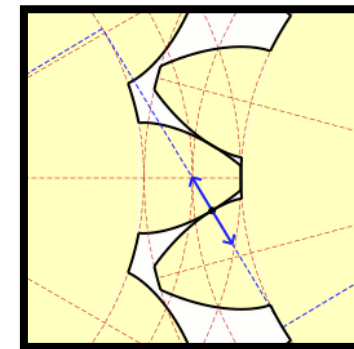
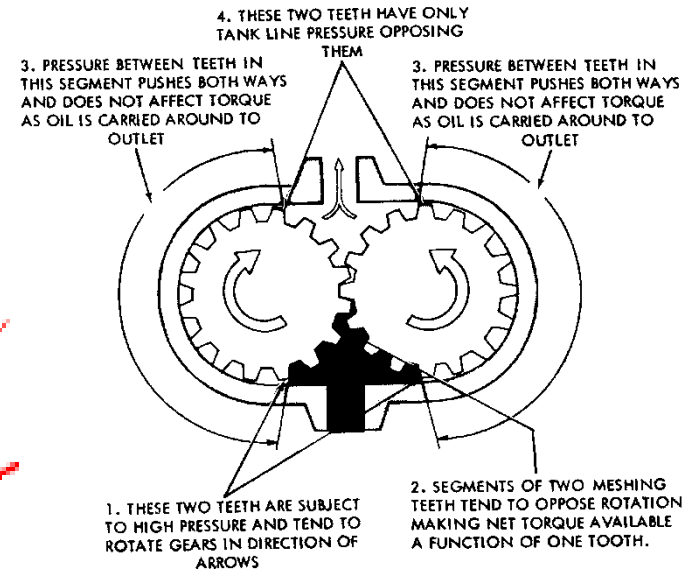
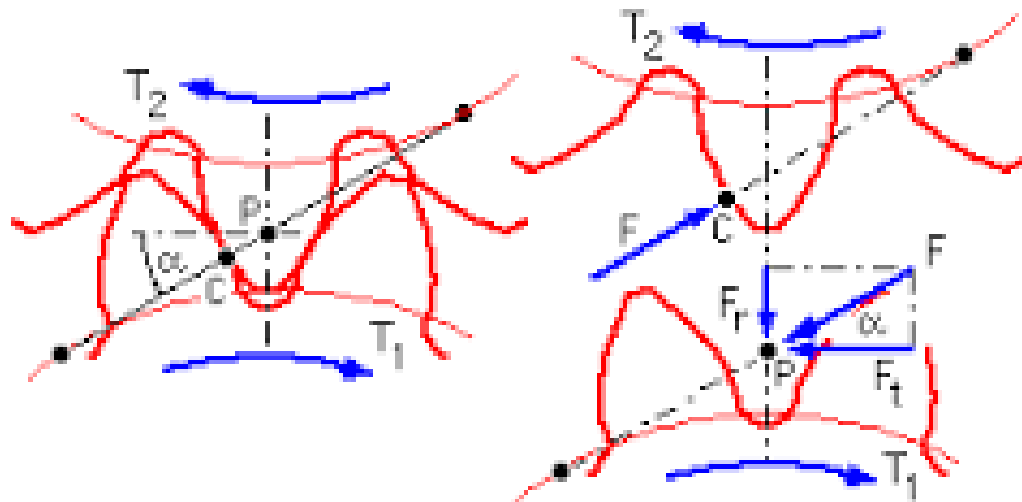




Hydraulic Motors - External Gear Motors

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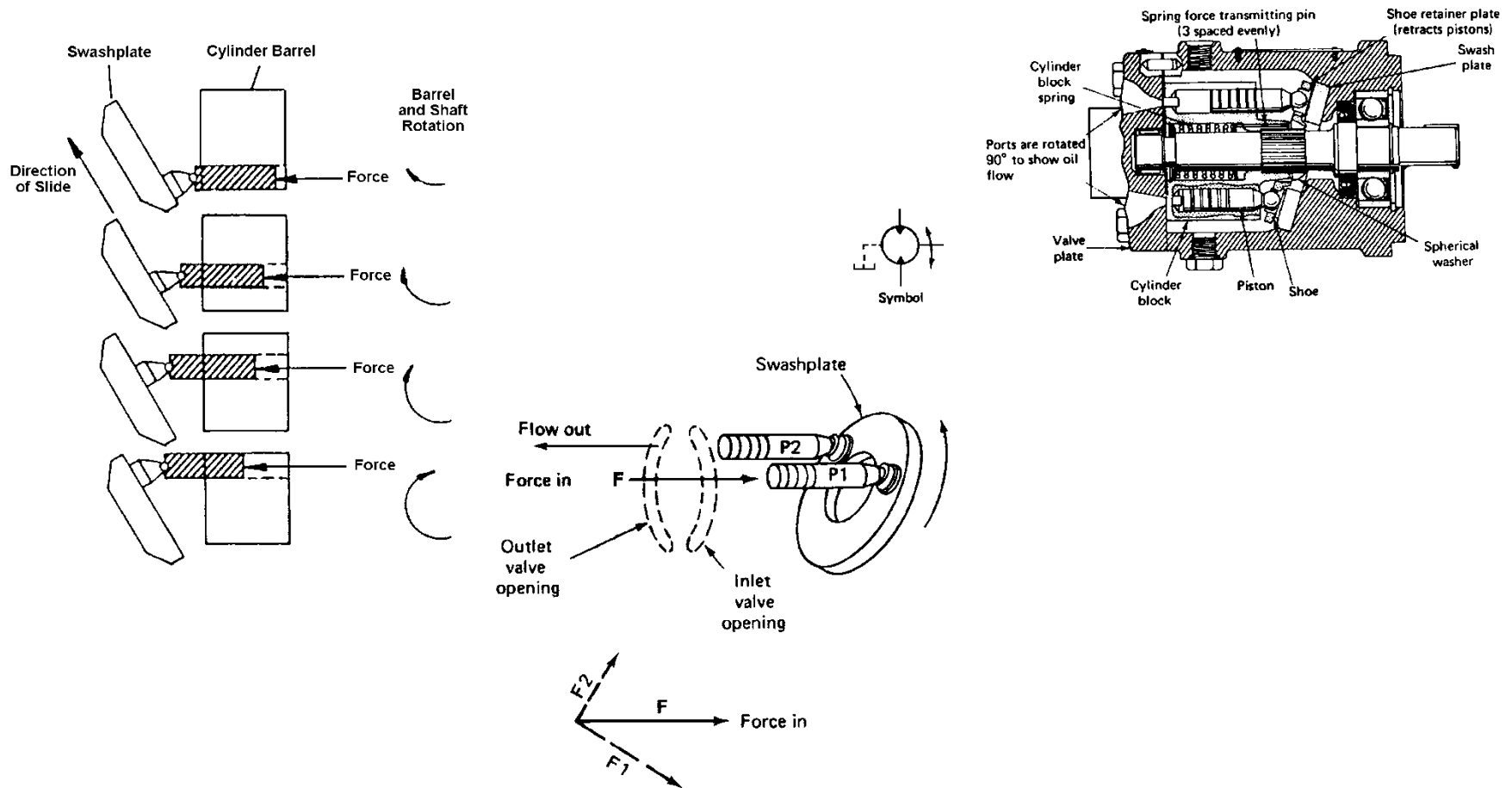
Comparison of different types of motor





Hydraulic Motors - Axial Piston Motors

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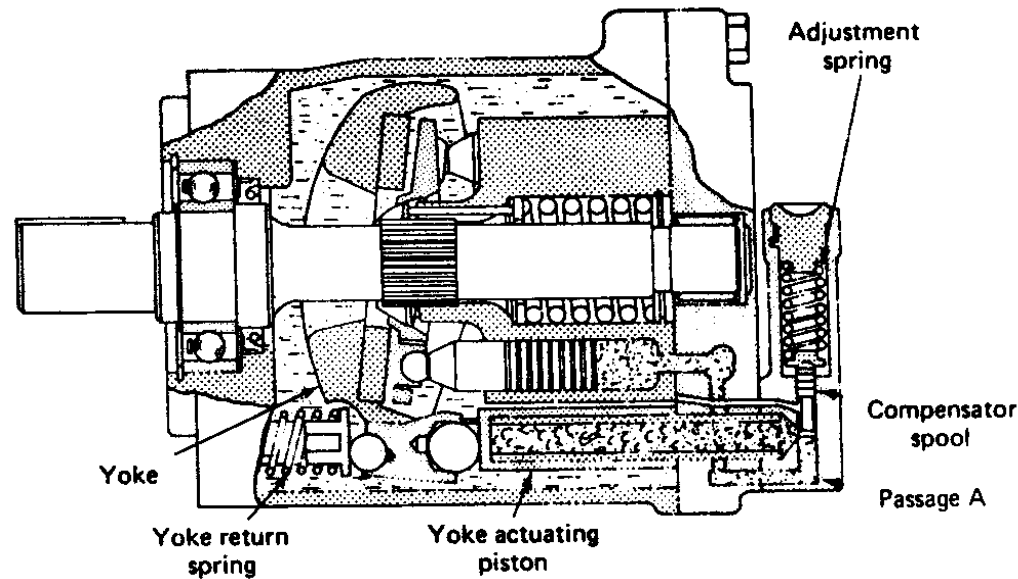
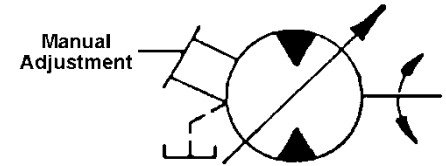


Hydraulic Motors - Axial Piston Motors

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Variable Displacement Axial Piston Motors

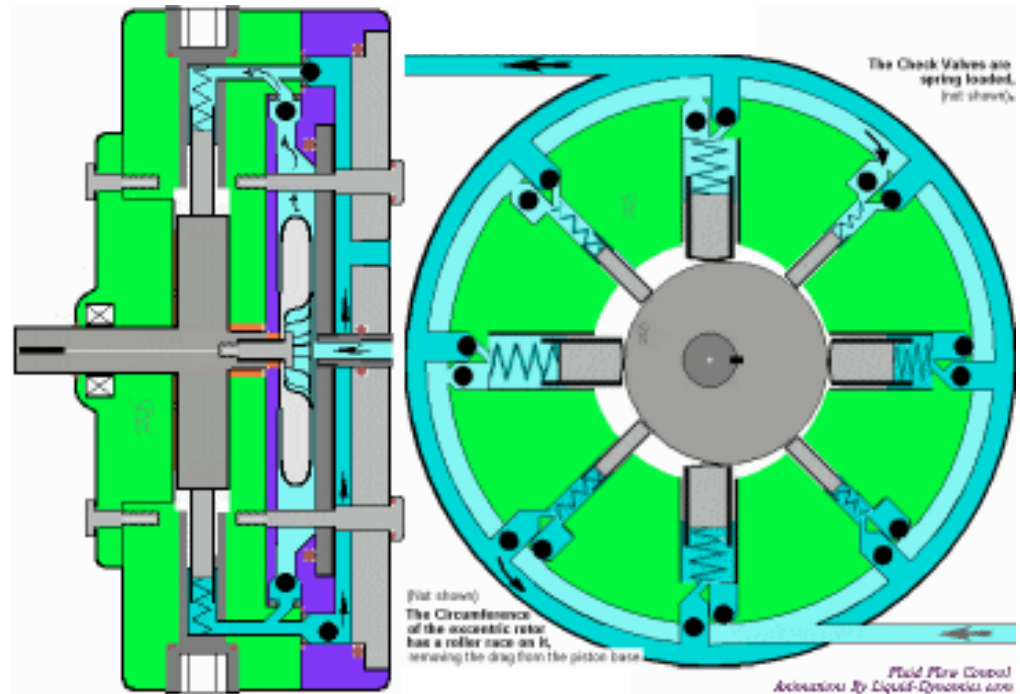
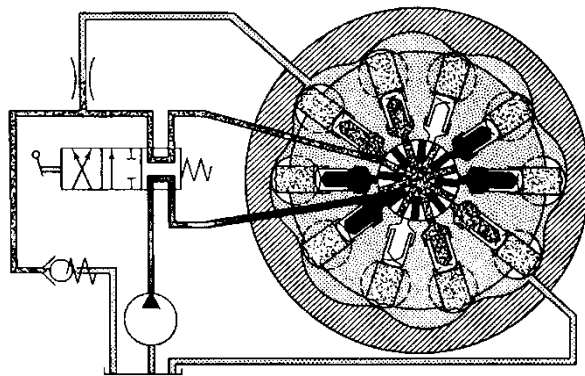
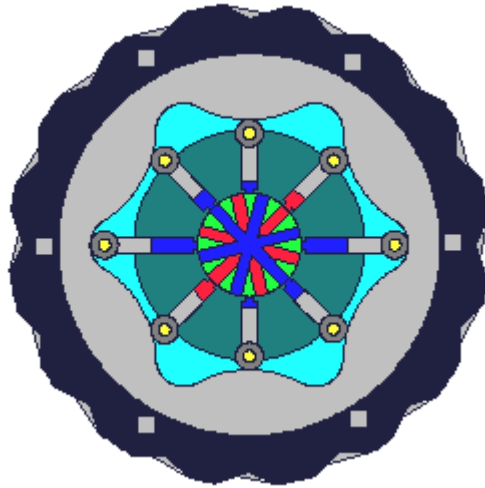
By varying the angle of the swashplate then, the motor's displacement and consequently its shaft speed and torque output can be changed.





Hydraulic Motors - Radial Piston Motors

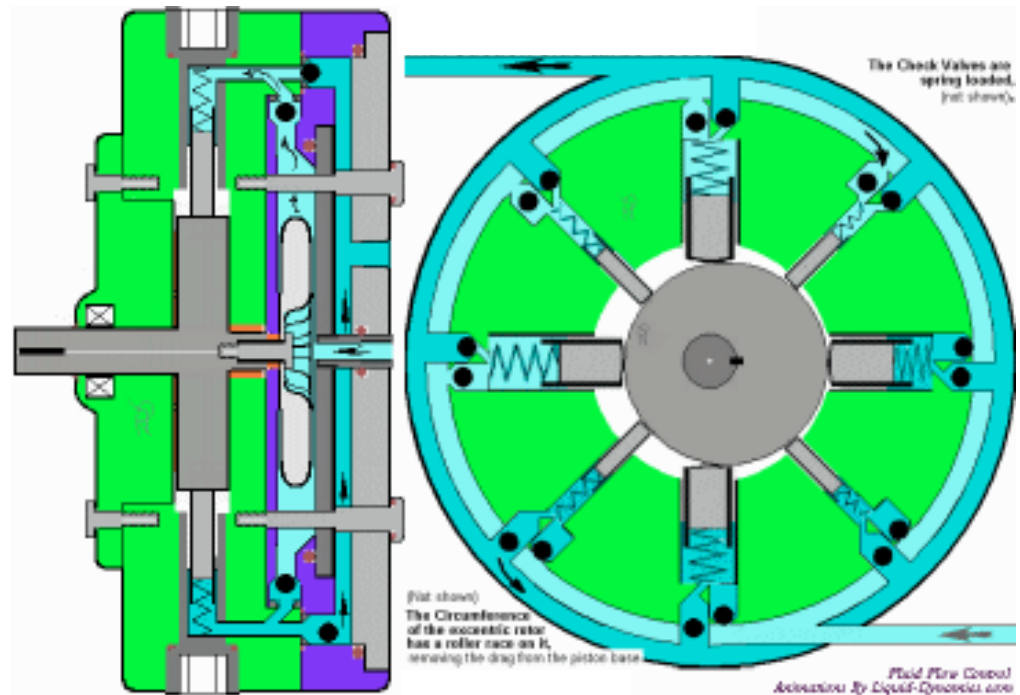
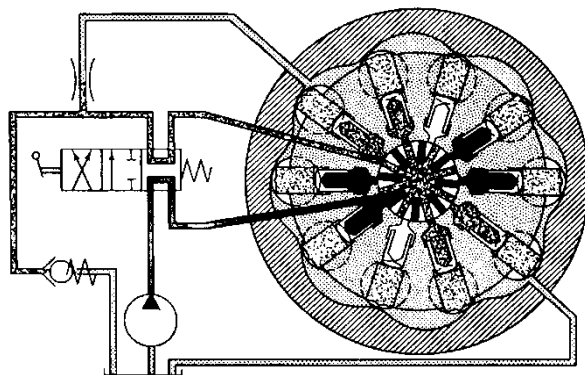
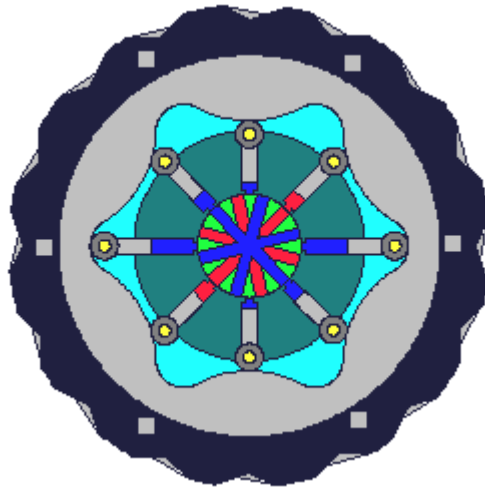
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Hydraulic Motors - Radial Piston Motors

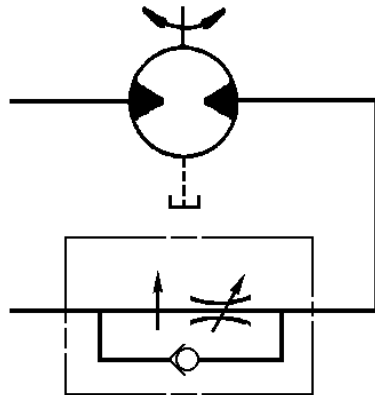
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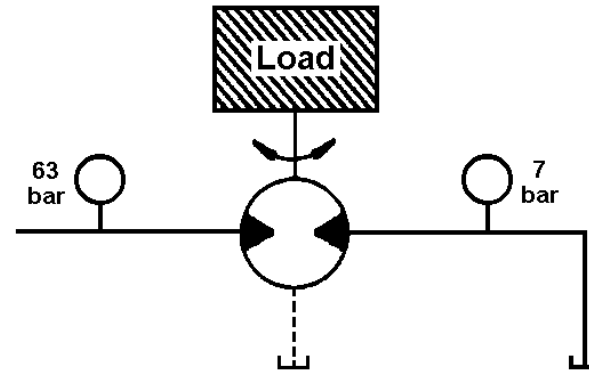


Hydraulic Motors in a Circuit

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Meter-out with motor



A meter-out circuit controls the flow as it discharges from the motor and is not concerned with leakage. This is the only circuit which can control a motor's shaft speed accurately regardless of load.

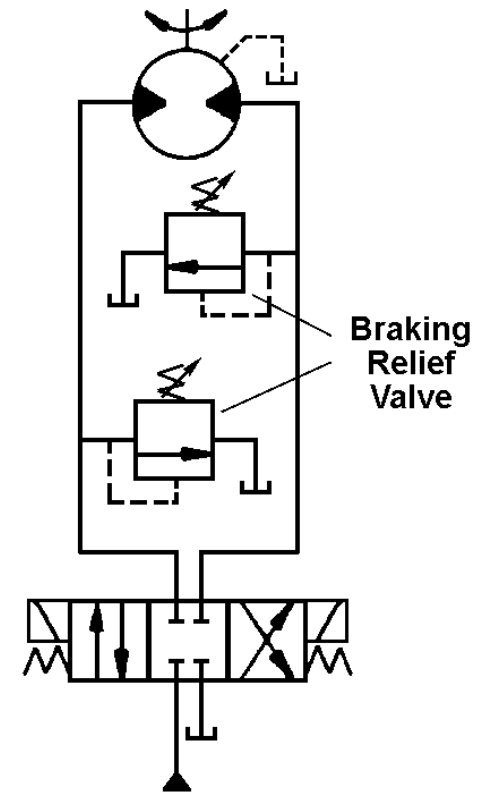
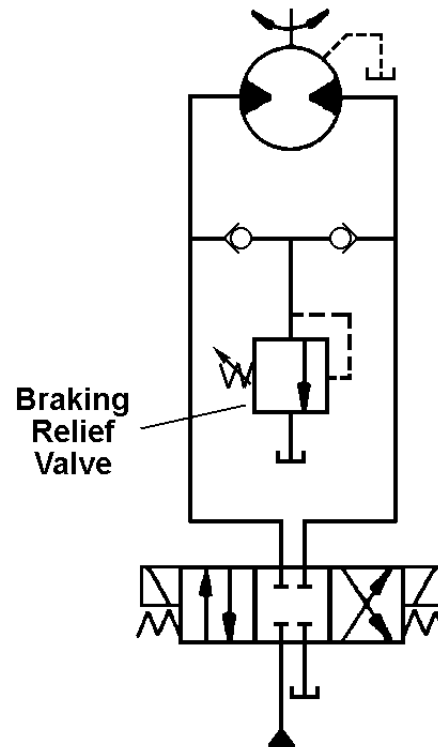
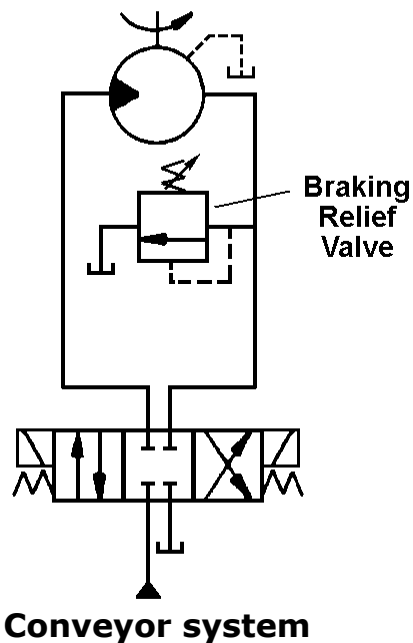
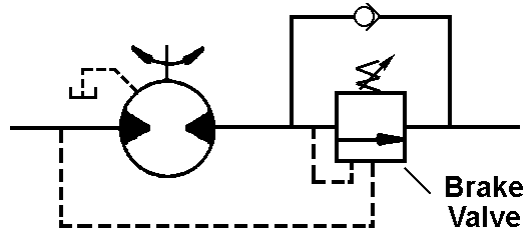
To accurately control the speed of a hydraulic motor, a meter-out circuit is used





Hydraulic Motors in a Circuit – Break valve

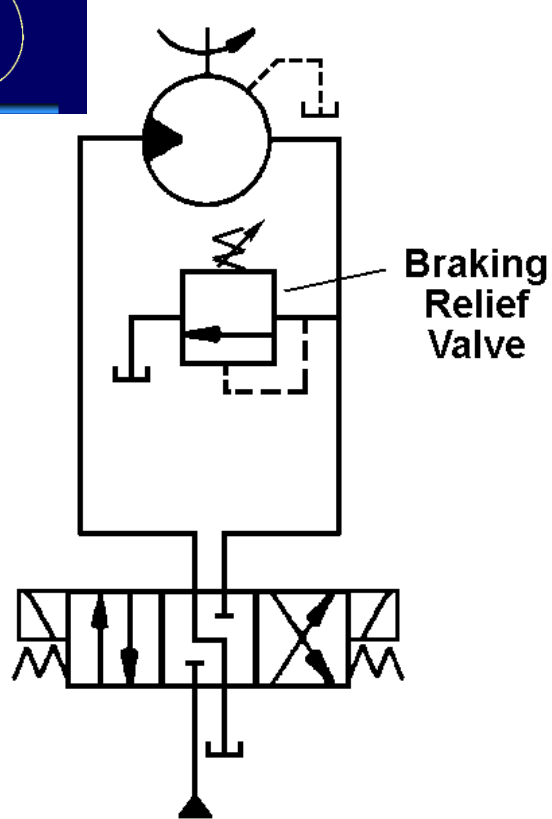
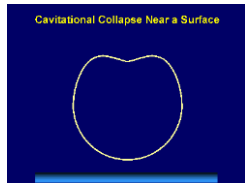
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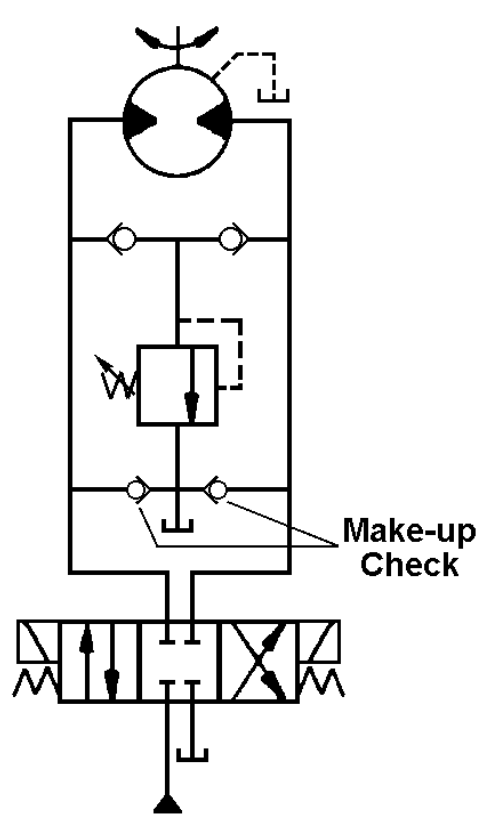


Hydraulic Motors in a Circuit – Motor Cavitation

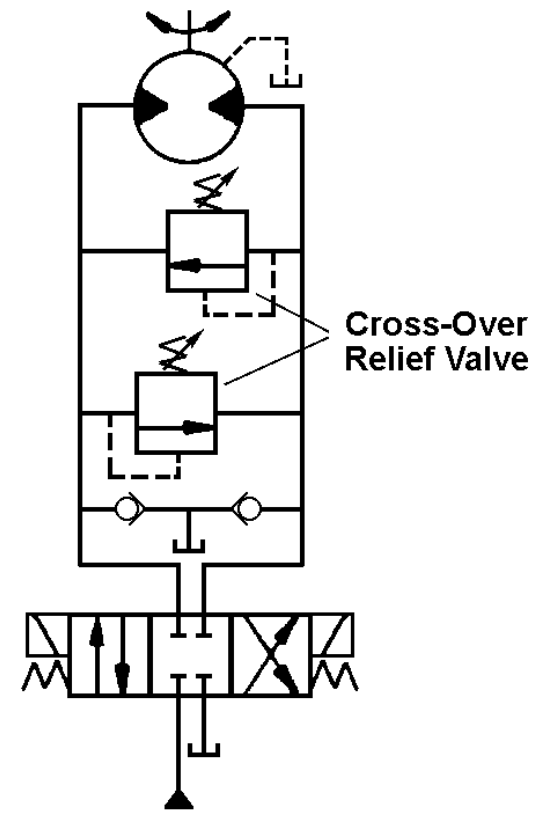
14



Avoiding cavitation in unidirectional motor circuit



Make-up Checks



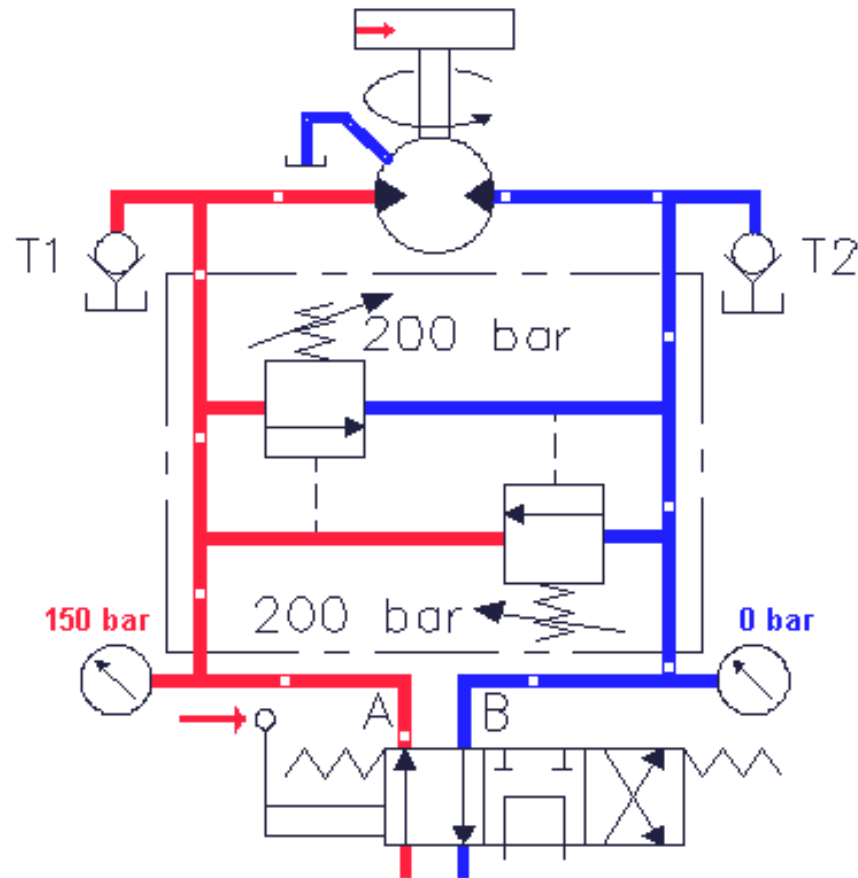
Cross-Over Relief Valves





Hydraulic Motors in a Circuit

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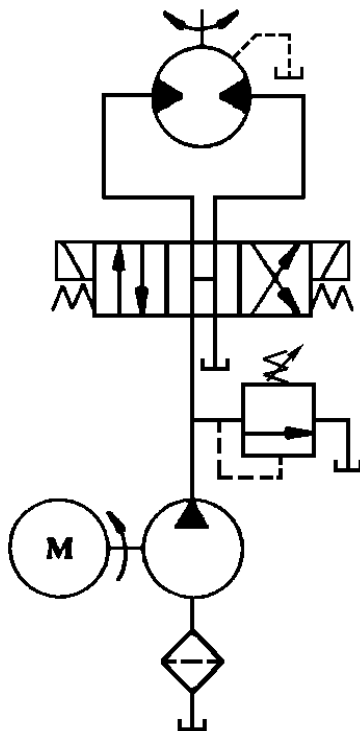




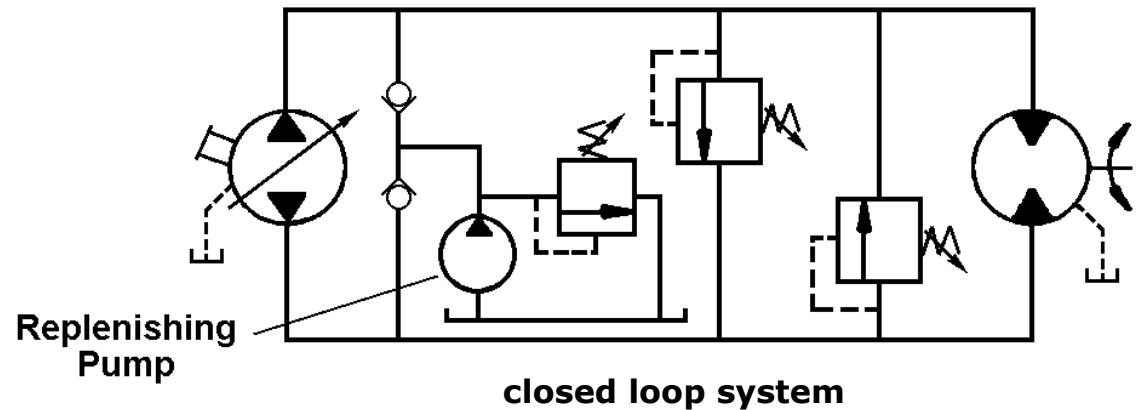
Hydraulic Motors in a Circuit - Hydrostatic Drive

16

The term hydrostatic refers to the transfer of energy from flow and pressure, not from the kinetic energy of the flow.



Open loop system



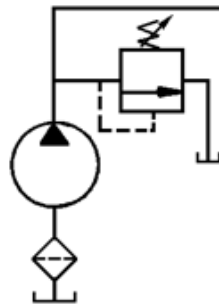
closed loop system



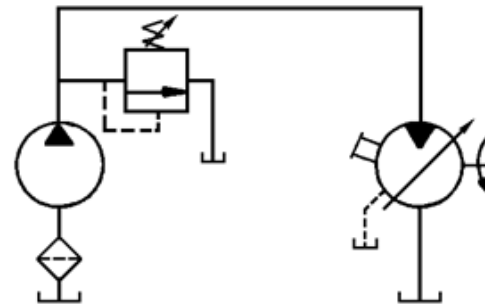


Pump-Motor Combinations

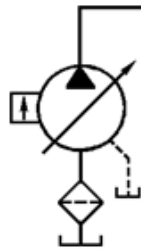
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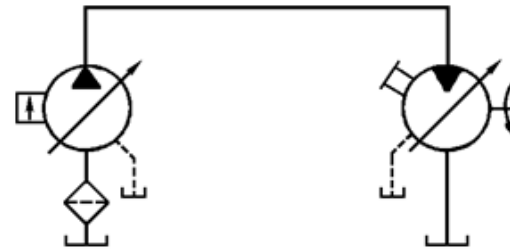
Fixed Hp, Torque and Speed



Fixed Hp, Variable Speed and Torque



Variable Hp and Speed, Constant Torque



Variable Hp, Speed and Torque

Displacement		Result		
Pump	Motor	Torque	Speed	Power
Fixed	Fixed	Fixed	Fixed	Fixed
Fixed	Variable	Variable	Variable	Fixed
Variable	Fixed	Fixed	Variable	Variable
Variable	Variable	Variable	Variable	Variable





Hydraulic Motors versus Electric Motors

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- 1. Instant reversing of a motor's shaft**
- 2. Stalling for indefinite periods without damage**
- 3. Torque control throughout its operating speed**
- 4. Dynamic braking easily accomplished**
- 5. A weight to horsepower ratio of 2.2 N/hp compared to 44 N/hp for electric motors.**
- 6. More flexibility in operating in unfavorable environments. Operation in explosive atmospheres and submerged in liquids is easier to do with hydraulic rather than electric motors.**





Hydraulic Motors versus Electric Motors

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Otherwise, the commonly used three-phase alternating current electric motors have certain advantages over hydraulic motors. A few are listed below:

- 1. Electric motor efficiency is greater. It may range from 90 to 95 percent. Hydraulic motor efficiency may range from 70 to 90 percent.**
- 2. Alternating-current motors have better speed regulation than hydraulic motors, since the speed regulation of the electric motor is a function of the line frequency.**
- 3. The starting torque of the electric motor is higher.**

