Synchros and Resolvers:-

Drive Based on Hydraulic Principles :

Hydraulic drives, as used in industrial process control, employ hydraulic pressure to drive an output member. These are used where high speed and large forces are required. The fluid used in hydraulic drives is highly incompressible so that pressure applied can be transmitted instantaneously to the member attached to it.

Motors work exactly on the reverse principle of pumps. In motors fluid is forced into the motor from pump outlets at high pressure. This fluid pressure creates the motion of the motor shaft and finally go out through the motor outlet port and return to tank.

Basic components to be used in hydraulic systems are categorized as follows.

(1) Energy converters (hydraulic pumps, motors, and cylinders)

(2) Energy controllers (directional, pressure, and flow control valves)

(3) Accessories (reservoirs, filters, accumulators, sensors, etc.)

The hydraulic systems consists a number of parts for its proper functioning. it consists of:

- a movable piston connected to the output shaft in an enclosed cylinder
- storage tank • filter • electric pump • pressure regulator • control valve
- leak proof closed loop piping.

- The output shaft transfers the motion or force, however, all other parts help to control the system. The storage/fluid tank is a reservoir for the liquid used as a transmission media.
- The liquid used is generally high-density incompressible oil. It is filtered to remove dust or any other unwanted particles and then pumped by the hydraulic pump.

  The capacity of the pump depends on the hydraulic system design. These pumps generally deliver constant volume in each revolution of the pump shaft. Therefore, the fluid pressure can increase indefinitely at the dead end of the piston until the system fails.
- The pressure regulator is used to avoid such circumstances which redirect the excess fluid back to the storage tank. The movement of piston is controlled by changing liquid flow from port A and port B.

The cylinder movement is controlled by using control valve which directs the fluid flow. The fluid pressure line is connected to the port B to raise the piston and it is connected to port A to lower down the piston. The valve can also stop the fluid flow in any of the port.

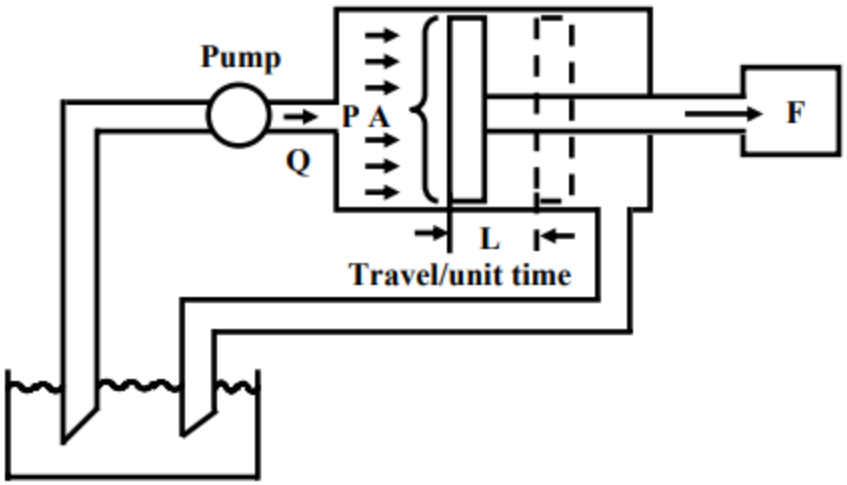


Fig. 26.1 Major hydraulic and mechanical variables

To calculate the power of fluid motor-

$$pq = Tw$$

p=input pressure

q=flow rate

T= output torque

w= angular speed rad/sec

Valves:

Valves are the most important mechanical links to the fluid interface in hydraulic systems. Basically, there are four main categories of valves in hydraulics.

A-Relief valve or Pressure valves, B-Speed control valve or Flow valves

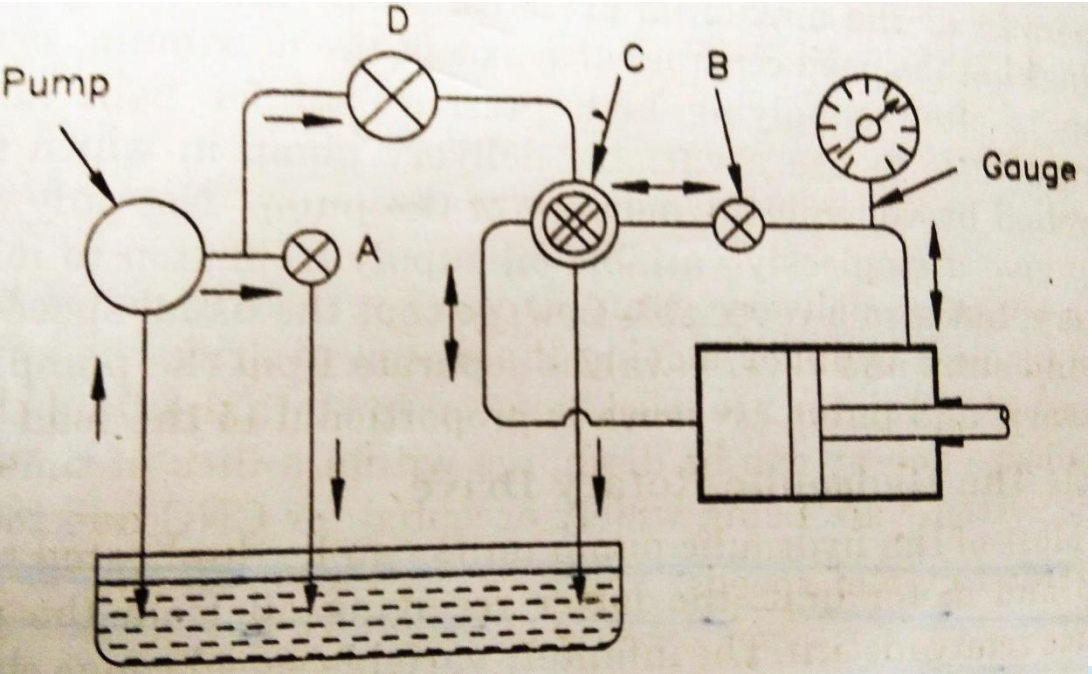
C-Reverse valve or Directional valves and D-Check valve

A-Relief valve or Pressure valves:-

These valves limit the maximum permissible system pressure. This valve diverts some flow to the tank if the pressure setting of the relief valve is reached.

B-Speed control valve or Flow valves:-

These valves are used to control the rate of flow from one part of the hydraulic system to another. They limit the maximum speed of actuators and limit the maximum power available to the sub-circuit by controlling their flow.



C-Reverse valve or Directional valves:- They control the flow of oil by changing the paths of the flow to different directions.

D-Check valve:-Check valves permit fluid flow in one direction, blocking the flow in the reverse direction. that consist of a truncated cone forming a seat, a ball that sits in the cone, closing it from reverse flow, and a preloading spring.

The hydraulic systems are being widely accepted for CNC due to:

- -wide range of speeds
- -No backlash effect
- -High power transmission
- -Sudden reversal without any damage
- -Long life due to lubricating effect of hydraulic oils
- -More stiff as compared to other drives

The **advantages** of hydraulics are as follows.

(1) Allows easy speed and position control;
(2) Facilitates stepless power control;
(3) Easily changes directions of movement;
(4) Capable of accumulating energy;
(5) Smoothly provides safety mechanisms, and;
(6) Allows for combination with electric controls

Compared to pneumatics and water hydraulics, oil hydraulics is:

(1) Superior in respect to lubricity and rust resistance and easy to maintain;
(2) Able to provide compact systems that operate under high pressures, and;
(3) Superior to pneumatics in respect to the rigidity of control and response speed.

Disadvantages:

• The material of storage tank, piping, cylinder, and piston can be corroded with the hydraulic fluid. Therefore one must be careful while selecting materials and hydraulic fluid.

• The structural weight and size of the system is more which makes it unsuitable for the smaller instruments.

• The small impurities in the hydraulic fluid can permanently damage the complete system, therefore one should be careful and suitable filter must be installed.

• The leakage of hydraulic fluid is also a critical issue and suitable prevention method and seals must be adopted.

• The hydraulic fluids, if not disposed of properly, can be harmful to the environment.

Hydraulics is applied in a wide range of industries:

(1) Construction machinery: excavators, cranes, wheel loaders, and bulldozers
(2) Agricultural/forestry machinery: tractors, combines, rice planting machines, lawn mowers, and logging machines
(3) Material processing/forming machinery: steel mill, machine tools, and plastic processing, die casting, press, and sheet metal processing machines
(4) Automobiles: power steering, transmissions, brake systems, and accessories for transport vehicles
(5) Industrial and special-purpose vehicles: fork lifts, platform vehicles, garbage trucks, concrete mixer trucks, concrete pump trucks, and accessories for transport vehicles (wing roofs and tail lifts)
(6) Ships/fishing machinery: steering, propulsion machinery, and deck cranes
(7) Aerospace machinery: steering, brake systems, and landing gear
(8) Testing machinery/simulator: vibration testers, flight simulators, and amusement machines
(9) Special equipment: hydraulic lifts, vibration control systems for high-story buildings and trains, sluice gates, crushers, and compactors

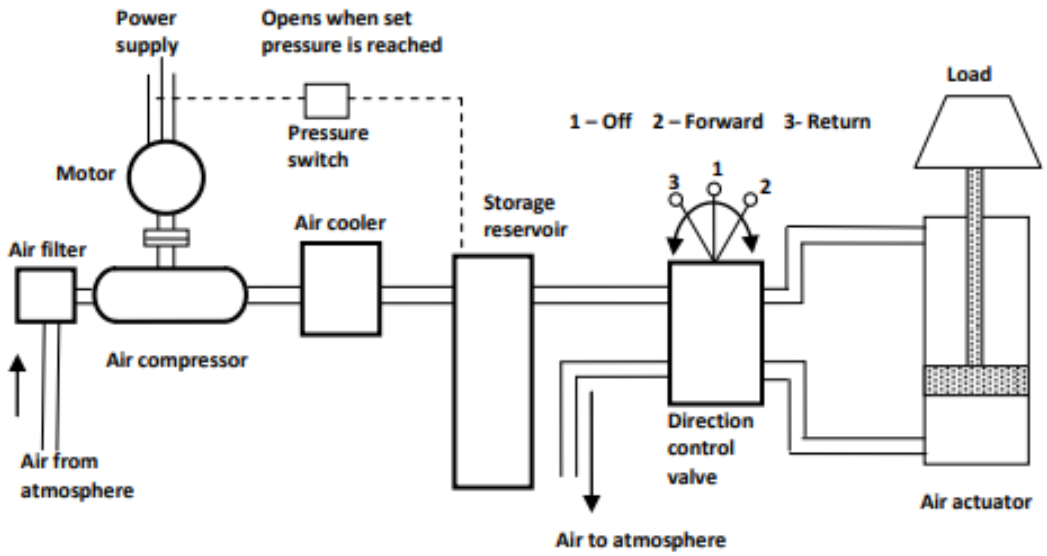
Pneumatic drives:

Fluid power systems: These are designed to perform work. In fluid power systems, work is obtained by pressurized fluid (gas or air) acting directly on a fluid cylinder or a fluid motor. A cylinder produces a force resulting in linear motion, whereas a fluid motor produces a torque resulting in rotary motion.

A pneumatic system carries power by employing compressed gas, generally air, as a fluid for transmitting energy from an energy-generating source to an energy-using point to accomplish useful work.

The functions of various components are as follows:

1. The pneumatic actuator converts the fluid power into mechanical power to perform useful work.
2. The compressor is used to compress the fresh air drawn from the atmosphere.
3. The storage reservoir is used to store a given volume of compressed air.



4. The valves are used to control the direction, flow rate and pressure of compressed air.
5. External power supply (motor) is used to drive the compressor.
6. The piping system carries the pressurized air from one location to another.

Air is drawn from the atmosphere through an air filter and raised to required pressure by an air compressor. As the pressure rises, the temperature also rises; hence, an air cooler is provided to cool the air with some preliminary treatment to remove the moisture. The treated pressurized air then needs to get stored to maintain the pressure. With the storage reservoir, a pressure switch is fitted to start and stop the electric motor when pressure falls and reaches the required level, respectively.

The three-position change over the valve delivering air to the cylinder operates in a way similar to its hydraulic circuit.

Advantages of Pneumatic Systems	
Availability	Air is available practically everywhere in unlimited quantities.
Transport	Air can be easily transported in pipelines, even over large distances.
Storage	Compressed air can be stored in reservoirs and removed as required. In addition, the reservoir is transportable.
Temperature	Compressed air is relatively insensitive temperature fluctuations. This ensures reliable operation, even under extreme conditions.
Explosion Proof	Compressed air offers no risk of explosion or fire.
Cleanliness	Un-lubricated exhaust air is clean. Any un-lubricated air that escapes through leaking pipes or components does not cause contamination.
Components	The operating components are of simple construction and therefore relatively inexpensive.
Speed	Compressed air is a very fast working medium. This enables high working speeds to be attained.
Overloads Safe	Pneumatic tools and operating components can be loaded to the point of stopping and are therefore overload safe.

Disadvantages of Pneumatic Systems	
Preparation	Compressed air requires good preparation and constant piston speeds.
Compression	It is not always possible to achieve uniform and constant piston speeds with compressed air.
Force Requirement	Compressed air is economical only up to a certain force requirement. Under normal working pressure of 600 to 700 KPa (6 to 7 bar) and dependent on the travel and speed, the output is limited between 40 000 to 50 000 Newton.
Noise Level	The exhaust air is loud. This problem can be solved by the use of sound absorption material and silencers.

Air brakes on buses and trucks /**Air brakes** on trains /**Air compressors**.
Air engines for pneumatically powered vehicles.
Barostat systems used in Neurogastroenterology and for researching electricity.
Cable jetting, a way to install cables in ***ducts****.*
Dental drill/
Compressed-air engines, Pressure sensors are used to measure the pressure of gases or liquids.
Pipe organs produce sound by pushing pressurized air through pipes that are chosen by pressing keys on a keyboard.
Inflatable structures, such as balloons, bouncy castles, or blow up figures are inflated with a gas - air, helium, nitrogen, or hydrogen. The pressure of the gas keeps the structure inflated.
Cable-jetting is a technique used to put cables into ducts. Compressed air is inserted and flows through the duct and along the cable.
Pneumatic mail systems deliver letters through pressurized air tubes. This was invented by a Scottish engineer in the 1800s.

Comparison between a **hydraulic and a pneumatic** system

S. No.	Hydraulic System	Pneumatic System
1.	It employs a pressurized liquid as a fluid	It employs a compressed gas, usually air, as a fluid
2.	An oil hydraulic system operates at pressures up to 700 bar	A pneumatic system usually operates at 5–10 bar
3.	Generally designed as closed system	Usually designed as open system
4.	The system slows down when leakage occurs	Leakage does not affect the system much
5.	Valve operations are difficult	Valve operations are easy
6.	Heavier in weight	Lighter in weight
7.	Pumps are used to provide pressurized liquids	Compressors are used to provide compressed gases
8.	The system is unsafe to fire hazards	The system is free from fire hazards
9.	Automatic lubrication is provided	Special arrangements for lubrication are needed