Hydraulic cylinders (linear actuators)

Objectives: At the end of this lesson you shall be able to
- **state the basic principle of hydraulic cylinder**
- **explain the construction of hydraulic cylinders**
- **state the sealing arrangement in a hydraulic cylinder**
- **name the parts of the hydraulic cylinder**
- **specify the hydraulic cylinder**
- **state the application of hydraulic cylinders**
- **calculate speed and force of a cylinder.**

Linear actuator

A hydraulic linear actuator is basically a cylinder, used to convert the hydraulic pressure and flow into a linear mechanical motion or force. Cylinder can be coupled with different types of mechanical linkages to produce enhanced or restricted movements in the combination of linear and rotary motions. Likewise with the arrangements, force can be multiplied or reduced.

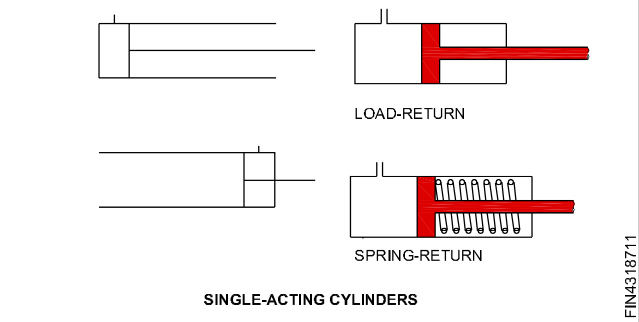
In a cylinder, the hydro-static pressure energy of the oil is converted into mechanical motion.

Working principle

Single acting cylinder

The Fig. 1 shows the cross-section of a single acting cylinder. Pressurised oil from the pump enter the pressure port. The pressure of oil exerts onto the piston and piston is moved (also against the force of spring tension), to other side.

Fig 1



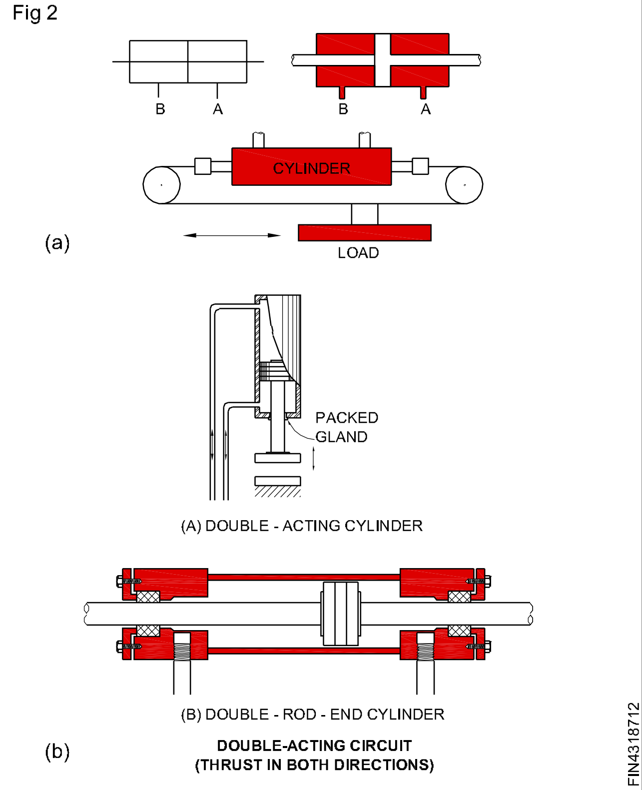
Useful work or movement can be attained from the free end of the piston-rod. After expansion of the oil, the spring tension overcomes the oil pressure. Now the spring pushes the piston to the left hand side. The oil is expelled through the same port.

Double acting cylinder

In a double acting cylinder Fig 2. Oil is supplied to both the sides of piston through ports A and B. When oil is supplied to port B, piston moves slowly. This is due to lesser area on the port side B, because force is proportional to the area. When the piston starts moving from left to right side, by the supply of oil pressure through port A, pressureless oil present on the right side is expelled through port `B' and vice versa.

To have an equal force on both the strokes, piston rod is provided on the left side of the piston also. (Fig 2a and 2b)

Fig 2



Construction of a double acting cylinder (Fig 3a)

The general construction of a double acting cylinder is shown in Fig 3a. Piston rod is made of a chrome plated and piston is made of cast steel. Cylinder head is honed inside and has rod bearing support and a port. Cylinder cap blocks the end of the cylinder and firmly attached to head by means of tie-rods and nuts.

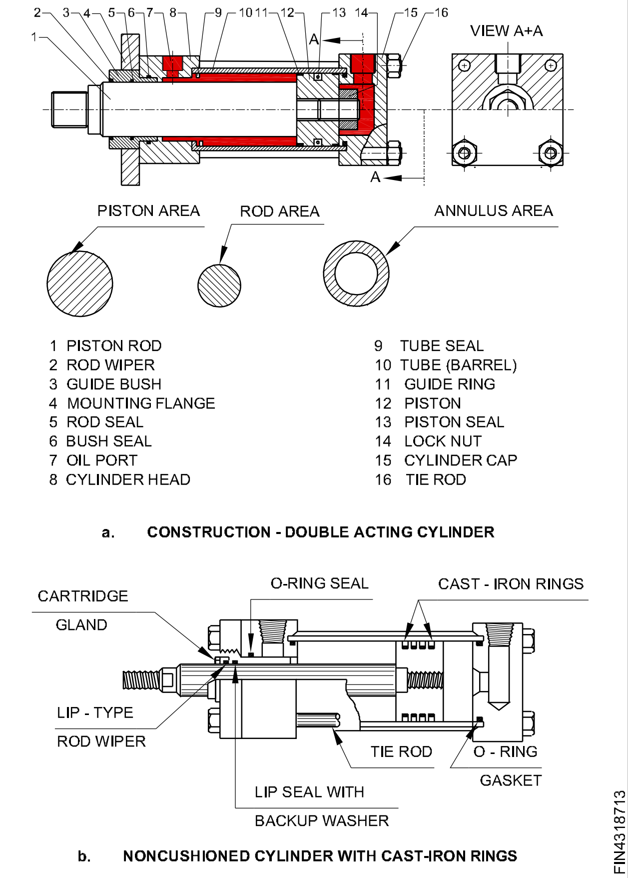
Static seals keeps the cylinder air-tight. Viper seals prevent the dust or other foreign particles from entering inside. The rod-bearing is usually replaceable by means of fasteners.

Piston seal prevents the oil from either-side of the piston, piston rings are made of high quality alloy steel/cast iron. (Fig 3b) For high pressures, cup packed seals are used.

These seals generally made of composition of rubber. For some right temperature applications, teflon seals are also used. Ports are threaded to connect the pipe ends/ connectors.

Leakage in between cylinder and head is prevented by O-rings made up of rubber as shown in the Fig. 3b. Better view of sealing arrangement can be seen in Figs. 3b.

Fig 3



End cushioning

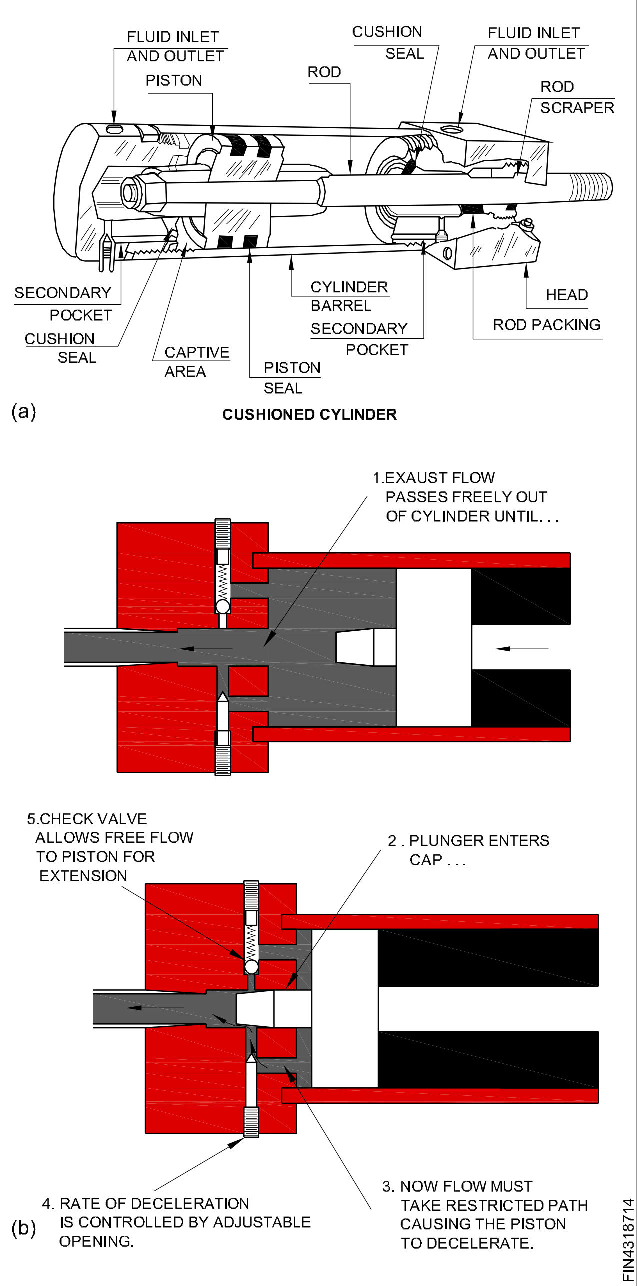
High pressure oil at the ends of the stroke will make the piston to impact on the ends of cylinder. To avoid this, end cushioning is generally provided. Springs find common application. But when the spring is compressed beyond its full home length, it is prone to damage. Hence cushioning is done by restricting the oil outlet as shown in the Fig. 4a. This arrangement is provided in the end portion of cylinder heads.

As shown in Fig. 4b the other side of the piston is provided with a plunger or cushioning piston. In the cylinder head, the check valve connects the passage from outlet to the cylinder. Another passage is connected by a restricted orifice 'O'.

This orifice can be adjusted by a screw.

As the piston travel to the left-hand side, the plunger or cushioning piston enters outlet port 'E'. Now oil can escape through limited passages C and O only. But the check-valve blocks the oil passage by means of a ball. Now the oil can pass through the passage 'O' only. Thus travel of the piston is slowed down at the ends.

Fig 4



Pressure and speed of piston

Pressure exerted by the piston = Pressure (Kg/cm^2) x Area of cross section of piston (cm^2)

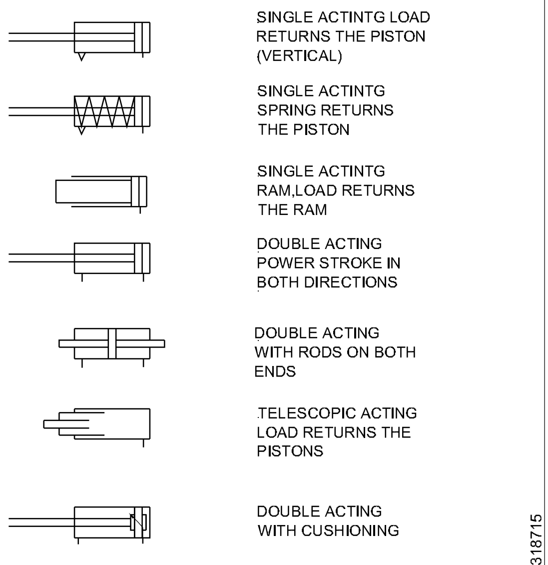
$$\text{Speed of the piston (cm/min)} = \frac{1000 \times \text{LPM}}{\text{Area of piston (cm}^2\text{)}}$$

Where LPM = Litres Per Minute.

Symbol

The symbols for hydraulic cylinders resembles the symbols of pneumatic cylinders. The symbols for commonly used cylinders are given in Fig 5.

Fig 5



GRAPHIC SYMBOLS FOR THE MORE COMMONLY USED LINER ACTUATIONS

Classification of cylinders

Two basic types of cylinders are

- Single acting cylinders
- Double acting cylinders

Single acting cylinders are further classified into

- Plunge type
- Piston type
- Ram type
- Telescopic type.

Double acting cylinders can be further classified into

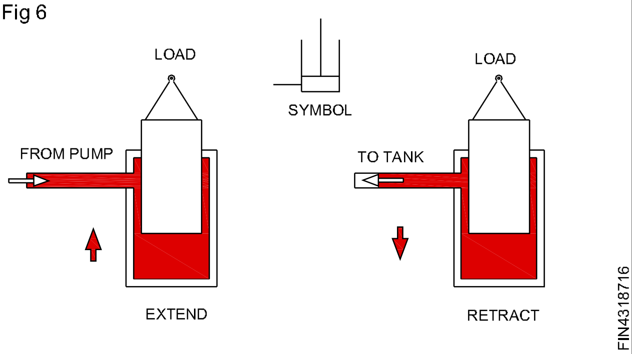
- Single piston rod type
- Double sided piston rod
- D.A. cylinder with end cushioning
- Telescopic type
- Pressure intensifier
- Tandem cylinder.

Ram

It is the simplest linear actuator as shown in Fig 6. It has only one chamber for oil. They are usually mounted vertical and ram descends down by its self weight. Rams are practically suitable for long strokes and used in elevators jacks and automobile.

Since the diameter of the Ram is throughout and there is no piston rod, if the Ram has to descends down at a faster rate than gravity, oil has to be supplied to the top as in the case of a double acting cylinder. (Fig 7)

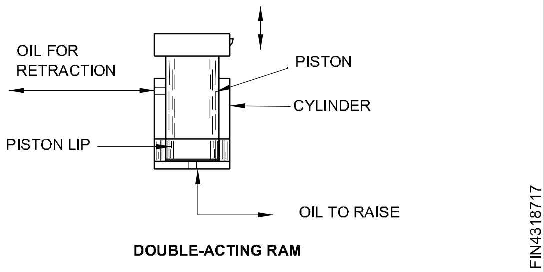
Fig 6



However, the diameter of the Ram can be reduced only to a little extent to have piston rod.

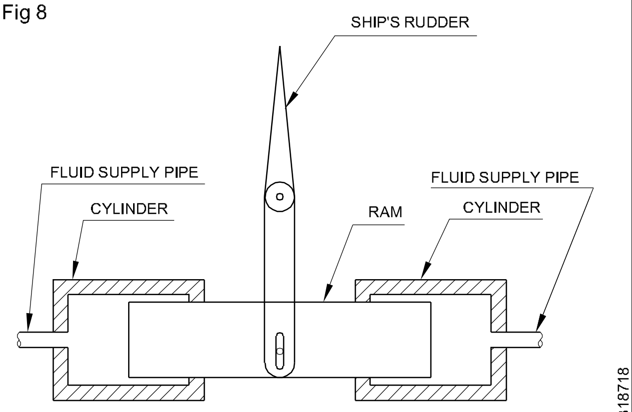
The application of a double sided or dual Ram in turning the rudder of a ship is shown in Fig 8.

Fig 7



DOUBLE-ACTING RAM

Fig 8

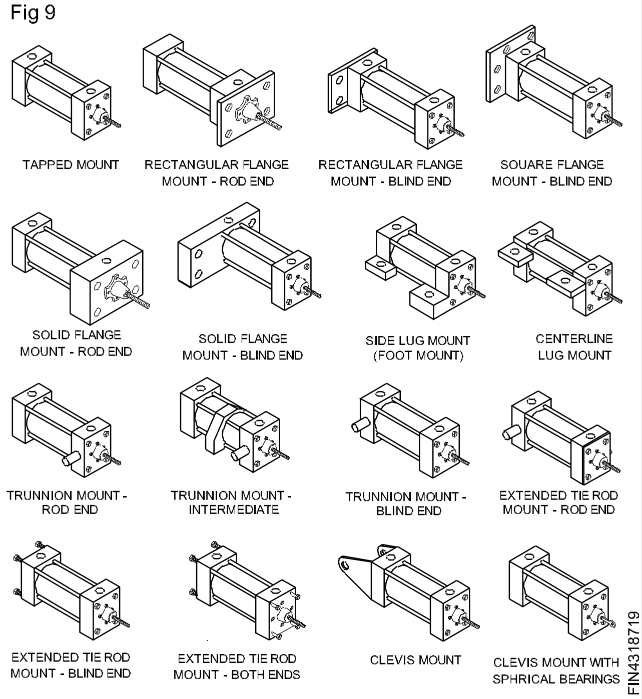


DUAL RAMS IN SHIP'S STEERING GEAR

Mountings of cylinders

Cylinders are mounted on different points to have a desirable movement space limitations, severity of load, direction of actuation etc. Fig 9 shows the possible methods of mounting a hydraulic cylinder.

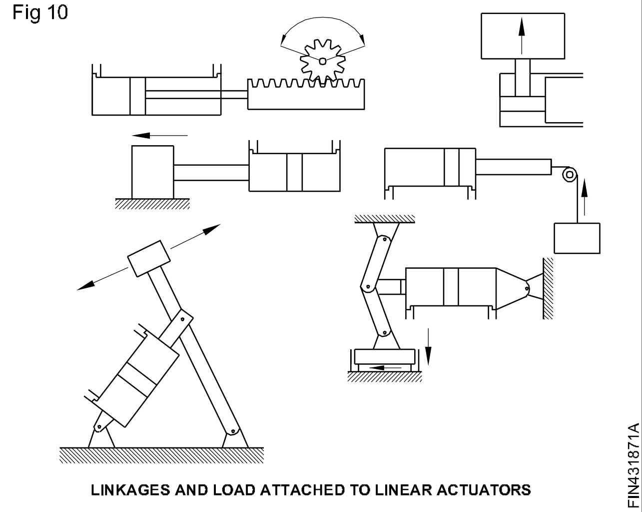
Fig 9



Actuation by linkages

Fig 10 shows the various methods of handling load, clamping, oscillation, lift, tilt and other kinds of applications of a cylinder along with mechanical linkages.

Fig 10



Hydro motors (Rotary actuators)

Objectives: At the end of this lesson you will be able to
- **state the principle of working of hydromotor**
- **state various types of hydromotor**
- **state the specification of hydromotor**
- **calculate the efficiency of hydromotor**
- **name the parts of the hydromotor.**

Hydromotor

This is a rotary actuator used in hydraulics, also called as hydraulic motors. This is very useful when a rotary motion is required. (The rotary action is achieved by this hydromotors) Similar to linear actuators, this also can be controlled in terms of displacement, direction of rotation, pressure or torque requirement. Nearly all elements used in linear circuits are used in rotary circuits also.

Cylinders provide linear motion where as hydromotors provide rotary motion.

Various types of hydromotors

Hydromotors are classified according to their internal design. Hydromotors are of three types namely:

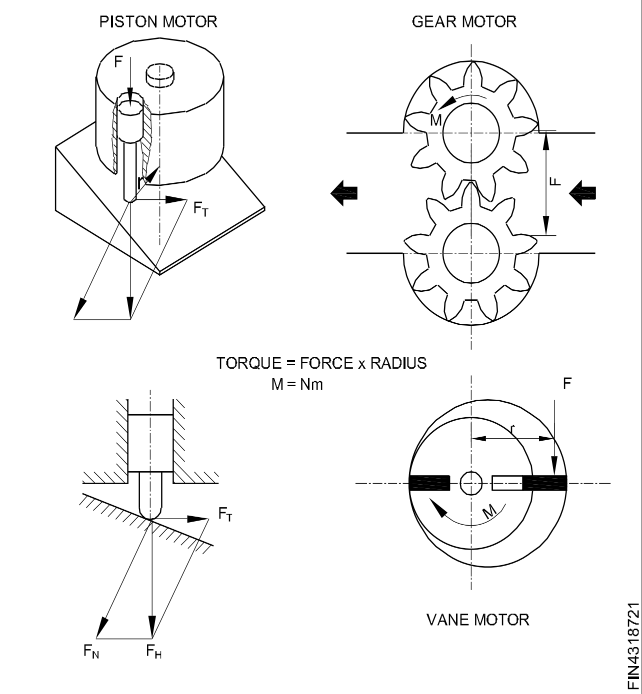
- Gear type
- Vane type
- Piston type.

All these types have the common principle of working. These almost resemble a hydraulic pump in construction.

Operation of hydraulic motor is opposite to that of hydraulic pump.

The principle of working is shown with a simple line sketch in Fig 1

Fig 1



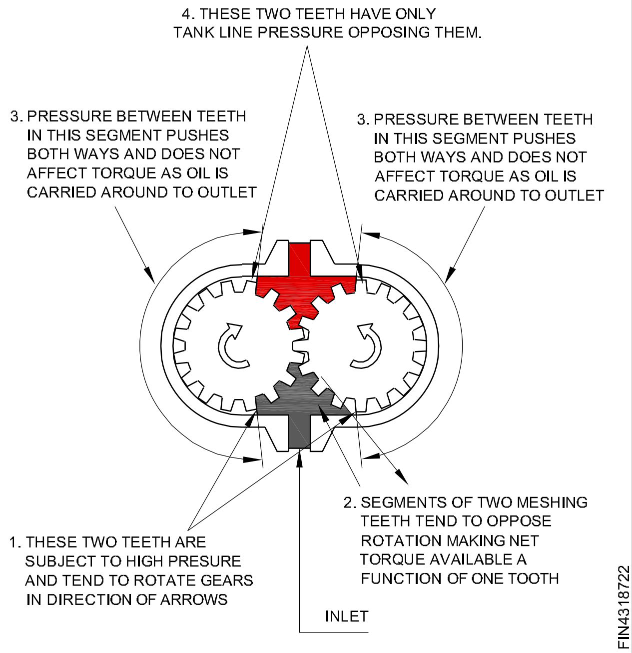
Gear type motors

Gear motors are designed either as

1 Gear on gear motor (external gear)
or
2 Gear in gear motor (internal gear).

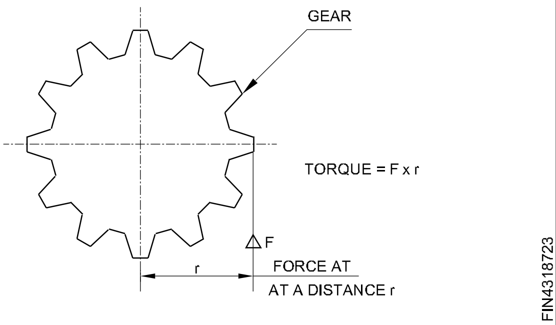
The figure 2 shows the gear on gear motor, oil enters the inlet port with pressure, this oil forces the gears to rotate and the oil flow out of the outlet. The speed of the motor depends on the amount of flow/minute and the motor torque depends on the pressure of oil. These motors have the lowest volumetric efficiency of about 70 to 80%.

Fig 2



The pressure of oil creates the torque in the same way as that of on a lever. (Fig 3)

Fig 3



The internal gear motor usually of gear type shown in the Fig. 4.

This is a motor which is very smooth in running and compact in design.

Vane type motors

This differs in the design when compared to gear motor. The simple line sketch in figure 5 shows the vane being moved along with the shaft by the oil flow. The prominent feature of the vane motor is the sliding vane. Each shaft

Fig 4

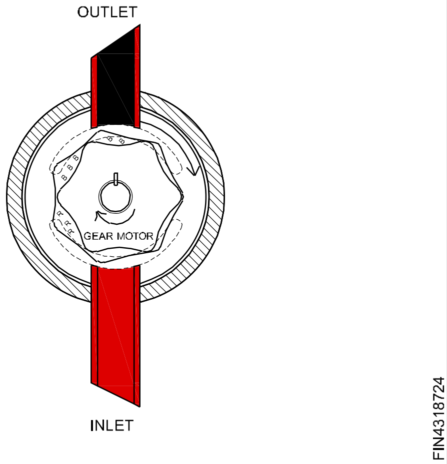
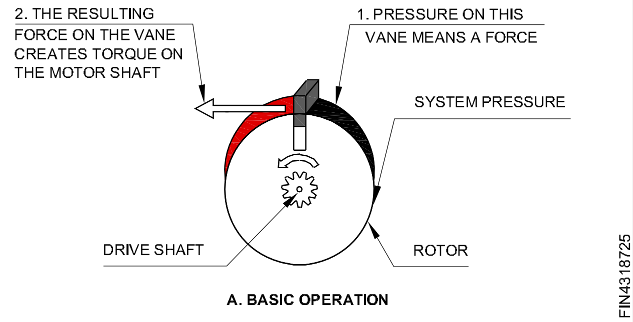
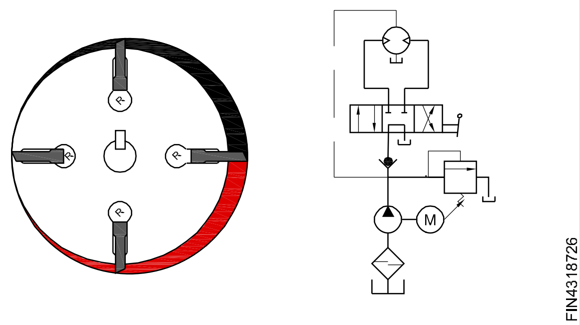


Fig 5



will have more than one vane which ensures continuous rotation of the shaft. (Fig 6)

Fig 6



The vanes in the slots extent out by the action of centrifugal force and oil pressure. This has a high speed operating character.

Piston type motor

Piston motor is totally different from the other two types in its construction. Piston motors are of two types namely

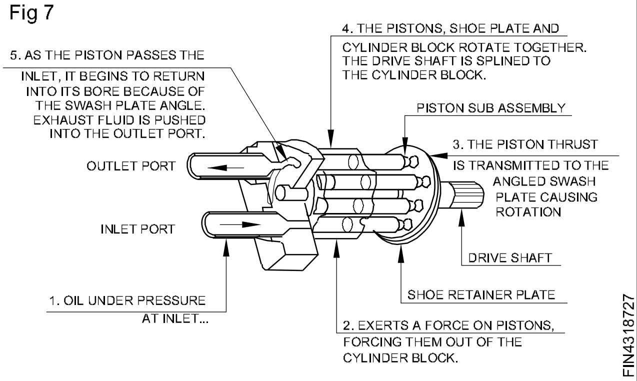
1 Axial piston motors (Fig 7)

2 Radial piston motors (Fig 8)

These motors are the most volumetrically efficient motors rating up to 95% efficiency.

The operating principle of these type of motors are shown in Fig 7&8. In a piston and barrel assembly when oil with pressure is allowed, it pushes the piston out.

Fig 7



This piston in turn in tune with the other pistons starts the rotary motion and continue the rotation.

Piston motors have the high volumetric efficiency and it is found its place in high efficiency, fast operating, high pressure circuitry.

Control of hydromotors

Hydromotors to perform effectively has to be controlled for it is speed and torque and direction.

Speed control of hydromotor

This is controlling the rpm of the hydromotor. This is usually done by controlling the quantity incoming fluid. This is also called as the displacement of the hydromotor. The control of flow of oil can be done by various methods which will be discussed in coming chapters.

Speed of a hydromotor depends on the quantity of oil passing through motor.

Torque control of hydromotor

Torque obtained in a hydromotor is the function of the fluid pressure. Thus by controlling the fluid pressure of the hydromotor the torque is also controlled.

Direction control of hydromotor

This is done by using a direction control valve in the circuit. This very much resembles the method of controlling the direction of movement of a double acting cylinder.

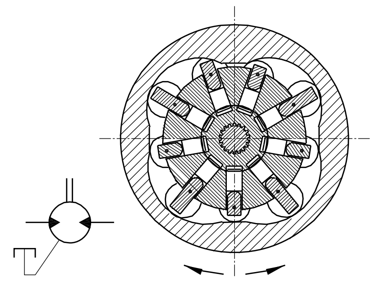
Direction of rotation of hydromotor depends on flow path of the oil.

Specification of a hydromotor

A hydromotor is usually designed and specified by the following parameters:

- max torque required
- max RPM required (outlet)
- max operating pressure
- efficiency.

Fig 8



Efficiency of hydromotor

Most of the times the hydromotor does not function as calculated. This is indicated by the various efficiencies of hydromotors. They are as follows

Volumetric efficiency

During operation same amount oil slip away without performing any work. This is a volumetric loss which is reflected in the volumetric efficiency

$$\eta(\text{Vol}) = \frac{\text{Theoretical flow rate}}{\text{Actual flow rate}}$$

Mechanical efficiency

During operation, particularly at low rpm and at high pressure conditions, there is a lot of mechanical losses. This is given by mechanical efficiency.

$$\eta(\text{Mech}) = \frac{\text{Actual torque}}{\text{Theoretical torque}} \times 100$$

Overall efficiency

This is used to calculate the power output of a hydraulic motor. It is expressed as the product of volumetric and mechanical efficiency.

$$\eta o = \frac{\eta \text{Vol} \times \eta \text{Mech}}{100}$$

Direction control valve

Objectives: At the end of this lesson you will be able to
- **explain function of various direction control valves and non return valve**
- **interprete direction control valve function in a hydraulic circuit**
- **define meaning of by - pass circuit**

Direction control valve are components which change, open or close flow path in hydraulics system. They are used to control the direction of motion of hydraulic actuator as well as responsible to stop the motion of actuator.

Direction control valves are classified as following according to the number of ports and positions:-

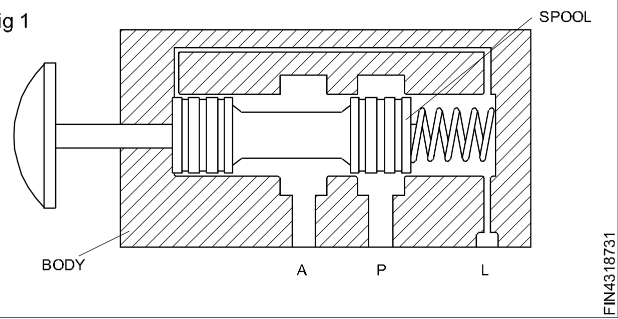
- 2/2- Way valve
- 3/2- Way valve
- 4/2-Way valve
- 4/3-Way valve

2/2 Way valve

The 2/2-way valve has a working port A, a supply port P and a leakage- oil port L. In the case of the valve shown here, of slide design, flow from P to A is closed in the normal position. (Fig 1)

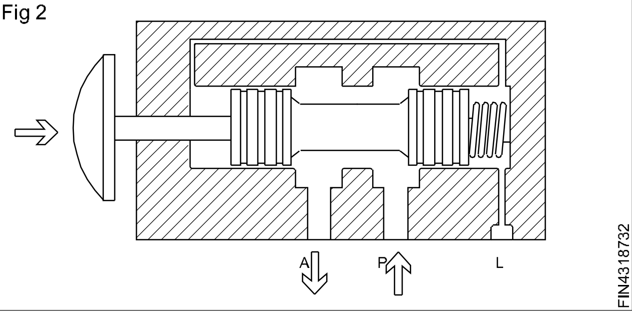
A relief line leading to the leakage - oil port is provided to prevent a build -up of pressure in the spring and piston chambers.

Fig 1



The 2/2-way valve is actuated and the passage from P to A is open. 2/2 -way valves are also available which are normally open from P to A. (Fig 2)

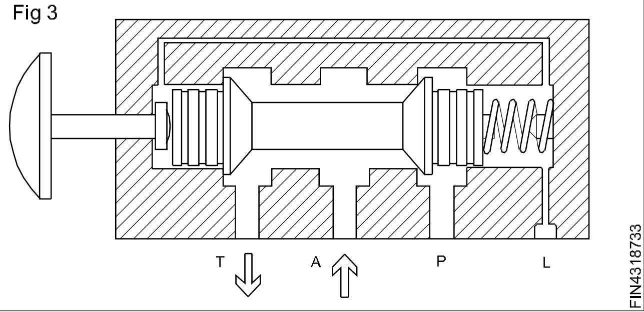
Fig 2



3/2-Way valve

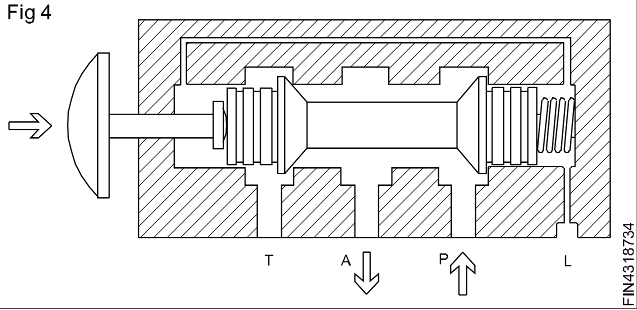
The 3/2-way valve has working port A, a supply port P and a tank port T. Volumetric flow can be routed from the supply port to the working port or from the working port to the tank port. The third port in each case is closed. In the normal position shown, P is closed and flow released from A to T. (Fig 3)

Fig 3



The 3/2-Way valve is actuated; flow is released from P to A, the outlet T is closed. 3/2-Way valves which are normally open from P to A and T closed are also available. (Fig 4)

Fig 4



Example of 3/2 way circuit with single acting cylinder. (Fig 5)

4/2 Way valve, two pistons

The 4/2-Way valve has two working ports A and B, a supply port P and a tank port T. The supply port is always connected to one of the working ports, while the second working port is routed to the tank. In the normal position, there is flow P to B and from A to T. (Fig 6)

The 4/2-Way valve is actuated,and there is flow from P to A and from B to T. 4/2-way valves are also available which are normally open from P to A and from B to T. (Fig 7)

Fig 5

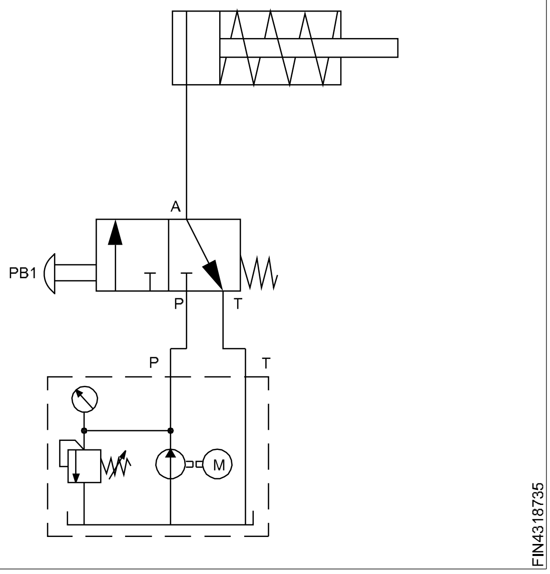


Fig 6

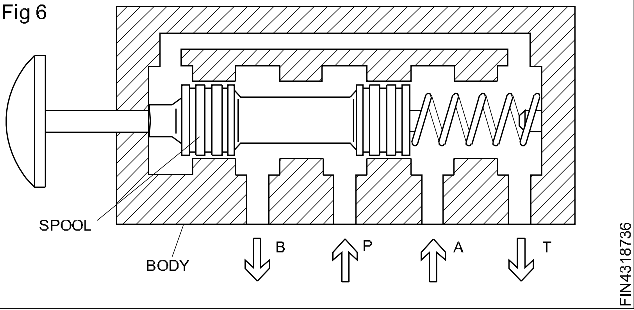
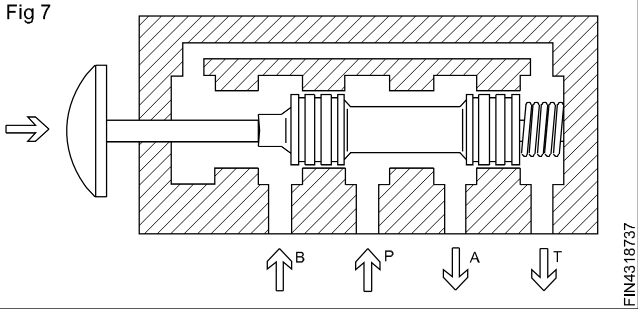
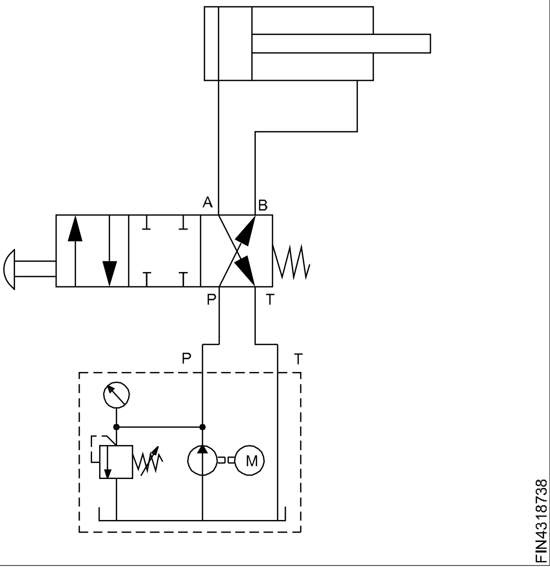


Fig 7



Example of 4/2 way circuit with double acting cylinder. (Fig 8)

Fig 8

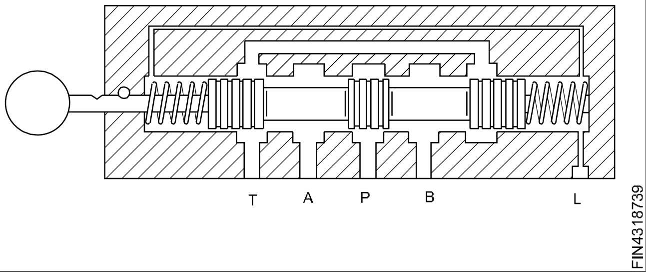


4/3- Way valve

From the logic point of view, 4/3-way valves are 4/2-way valves with an additional mid-position. There are various versions of this mid-position (in the mid-position in the example shown, the supply port P is directly connected to the tank T, see next illustration). In the switching position shown, there is flow from p to B and from A to T.

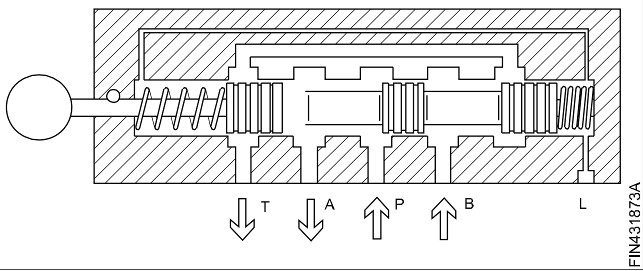
The 4/3-way valve is in its mid-position; there is flow from P to T, while A and B are closed. Since the output from the pump flows to the tank, this switching position is called pump bypass or also pump recirculation. In the case of pump bypass, the pump needs to operate only against the resistance of the valve, which has a favorable effect on the power balance. (Fig 9)

Fig 9



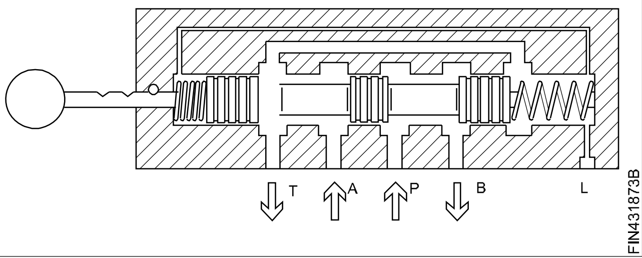
The valve is in its left-hand switching position; there is flow from P to A and from B to T. (Fig 10)

Fig 10



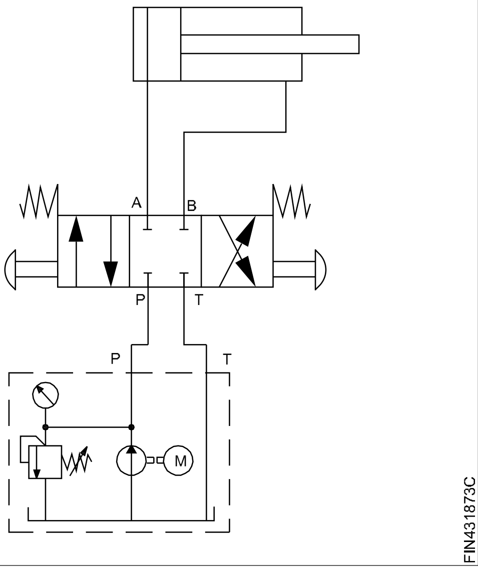
And the valve is in its right hand switching position there is flow from P to B and A to T. (Fig 11)

Fig 11



Example of 4/3 way circuit with double acting cylinder. (Fig 12)

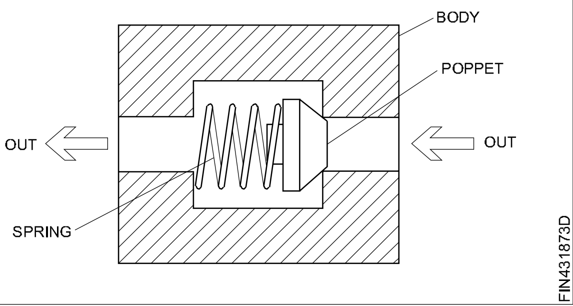
Fig 12



Non-return valve

Non-return valves block flow in one direction and allow free flow in the other. In the direction of flow shown, the sealing element is pressed against a seat by a spring and the hydraulic fluid. (Fig 13)

Fig 13



A spring loaded Non-return valve is shown in fig 13. If oil pressure is more on left side of NRV, poppet of valve will not open as well as it will not allow the flow of oil.

And when oil pressure is more on right side of valve then poppet of valve will move for opening and oil will flow through the valve. (Fig 14)

Fig 14

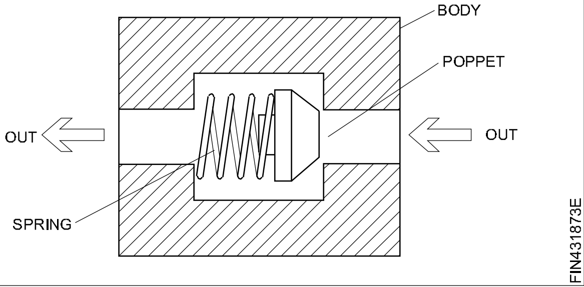
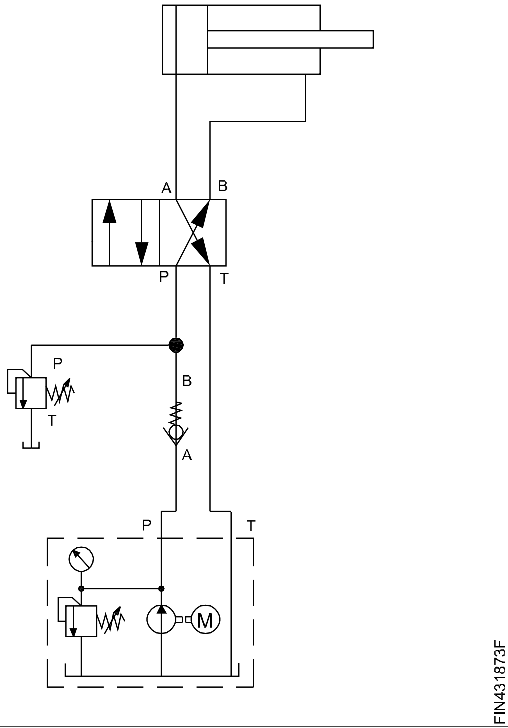


Fig 15 shows the application of non-return valve for pump protection. (Fig 15)

Fig 15



By- pass circuit

By-pass circuit is used to advance a cylinder rapidly than it could with pump flow alone. To achieve this, oil from the rod end of a cylinder is added to the pump flow to the blind end, increasing the rate of advance. Common applications of by-pass circuit are found in shearing and punching machines.

In general, differential cylinder is used in hydraulics machines. In this cylcinder the area ratio of the full piston surface to the annular piston surface is 2:1, since as the result the piston rod area is only half the size of the piston area, the return stroke is twice as fast as the advance stroke.

In most of machines less advance speed is required, but in some machines high speed is required in forward stoke of piston like in shearing and punching machines.

For example the piston area A_p of the differential cylinder equal 10cm^2, the annular piston surface A_{PR}= 2 cm^2. The mp delivers Q_p = 101/min. So that speed of piston in advance and return stoke is given below: (Fig 16)

Note: Regeneration circuits apply only to single rod cylinders in the extended direction.

Advance and Return speed

As we know from previous topics

$$V = Q/A$$

Q_{pump} = 101/min = 10,000 cm^3 / min

Advance speed

$V_{ADV} = 10,000\ cm^3 / 10\ cm^2\ min$

$V_{ADV} = 10,00\ cm/\ min$

$V_{ADV} = 10m\ /min$

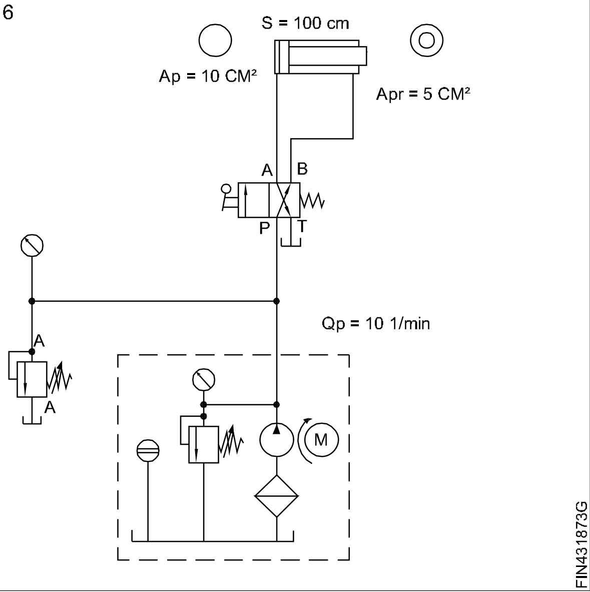
Return speed

$V_{RET} = 10,000\ cm^3 /2\ cm^2\ min$

$V_{RET} = 5000\ cm\ /\ min$

$V_{RET} = 50cm\ /\ min$

Fig 16

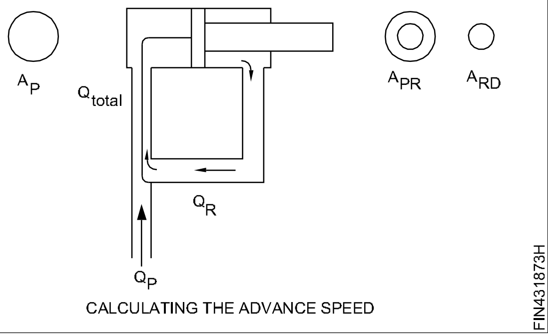


From this result it can be seen that the area ratio has a direct effect on speed and time.

For getting more forward speed in differential cylinder we can utilize the oil of rod side of cylinder into piston side, such a circuit is known as regeneration circuit or bypass circuit.

By- pass circuit (Fig 17)

Fig 17



Q_p = pump delivery

Q_R = return delivery from piston rod area

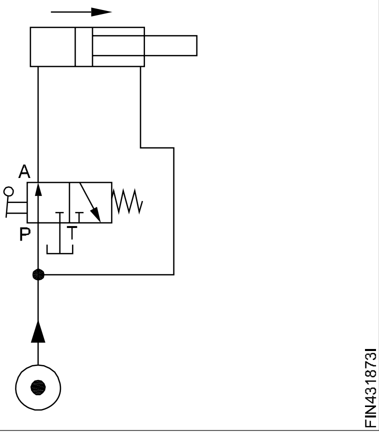
Q_{total} = Pump delivery + return delivery

It means oil which is going inside the piston end of cylinder is more than pump flow and more flow means more speed of actuator.

When the rod ends port is directly connected to the piston end port than during forward stoke of piston, rod end oil is recirculated and added on piston end of cylinder.

Below circuit is the example of a regeneration circuit along with 3/2 way valve. In normal condition (without actuation) oil is only going on the rod side of cylinder and from the piston end of cylinder oil is coming back into tank so that the piston remain in retracted position. (Fig 18)

Fig 18

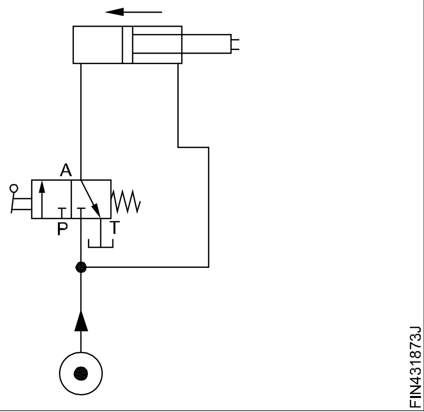


In actuated condition of valve, A port and B port are connected to P port, means pump flow is added with flow of rod side.

Q_{total} = Pump delivery + return delivery

More flow is going inside the cylinder in actuated condition so that speed becomes very high (Fig 19)

Fig 19



Flow control valve

Objectives: At the end of this lesson you shall be able to
- **state the need for flow control in a hydraulic circuit**
- **state the principle of operation of flow control valve**
- **draw different symbols of flow control valves and state the functions from the symbols.**

The whole purpose of a flow control valve is to vary the speed of an actuating cylinder or motor. This is possible by controlling the flow rate of the fluid.

A flow control valve accomplish any one or more of the following control functions:

- To limit the maximum speed of the linear or rotary actuators

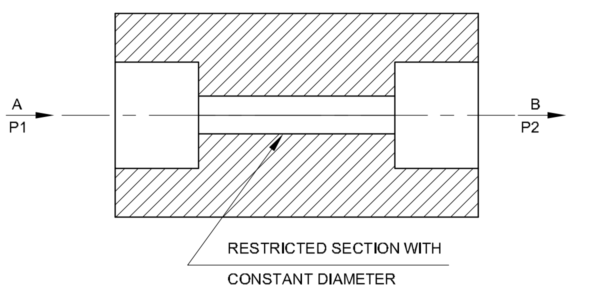
$$\left(\frac{\text{flow rate}}{\text{piston area}} = \text{piston speed}\right)$$

- To limit the maximum pressure available to branch circuits by limiting the flow. (power = flow rate x pressure)
- Proportionately divide or regulate the flow from pump to various branch circuits.

Principle of operation

As shown in Fig 1, the oil under pressure P1 enters the valve at A and flows through a restricted section, into the outlet B. While passing through the restricted passage, oil attains heat due to the friction. Thus the hydraulic energy in terms of pressure is converted into heat energy. The loss of energy is the result of drop in pressure.

Fig 1



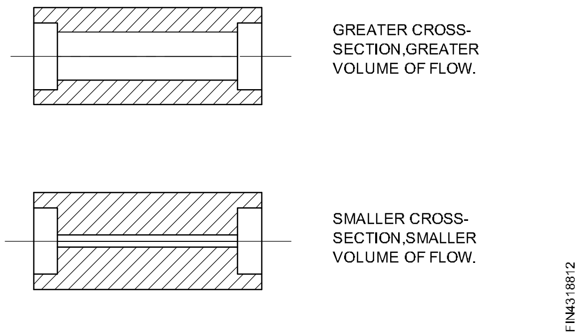
The difference between the two pressure is called pressure drop.

p = p1 - p2

The volume of flow (litres/min) is mainly dependent on the:

- Cross-section of restriction (Fig 2)
- Shape and length of orifice
- Pressure difference p
- Viscosity of the hydraulic oil.

Fig 2



The basic principle can be understood from Fig 3.

Symbol

As a general norm, the basic envelop is represented by a square to denote a valve. The flow line passes past through the square. The flow restrictions are denoted by curvatures above and below the flow line.

The arrow mark stroked across the curvatures means that, the flow restriction is adjustable. Sometimes full flow is to be ensured in the reverse direction. This can be made possible by connecting a check valve (non-return valve) in a right direction across the flow control valve. As indicated in Fig 3, in the forward direction, oil flows from pressure port (P) to working port (A). In the reverse direction oil flows from port A to port P, by pushing the spring loaded valve.

In case, if the return oil is to flow to the tank, the pressure port P will become tank port `T' by means of a direction control valve in the circuit.

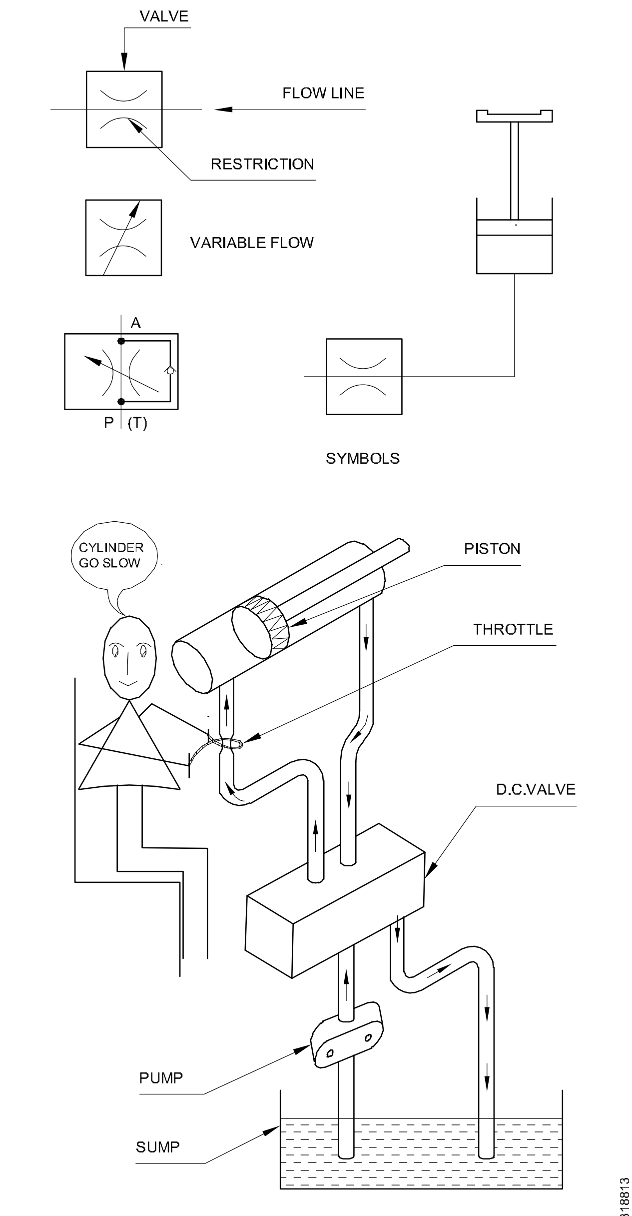
In Fig 4 symbols are given in combined operations. Fig 4A shows a control valve is adjustable and compensation is given for pressure as well as temperature. Fig 4B show a symbol for fixed type orifice and reducing valve-type compensation. Fig 4C indicates an adjustable orifice and relief valve type compensation.

The shape of on orifice and restrictor are shown in Fig 5. Restrictor is less sensitive to temperature variation.

The flow characters are changed in the following aspects

- The velocity past the valve.
-- The pressure at the outlet of the valve is less than that of the inlet.

Fig 3



WORKING PRINCIPLE OF A THROTTLE VALVE

Fig 4

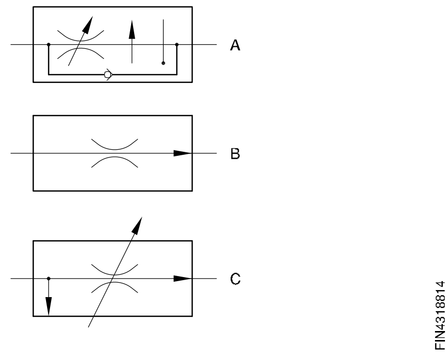
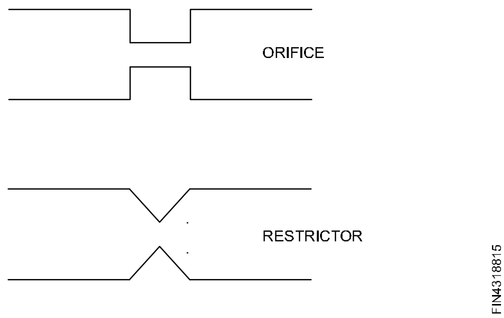


Fig 5



Variable flow control

Objectives: At the end of this lesson you shall be able to

- **state the need for a flow control valve**
- **state the principle of operation of a simple flow control valve**
- **name the different area of applications of a variable flow control valve**
- **distinguish the construction of a one way flow control valve**
- **name the areas of applications of one way flow control valves and different adjustable restrictors**
- **state the concept of maintaining constant flow rate.**

Need for flow control

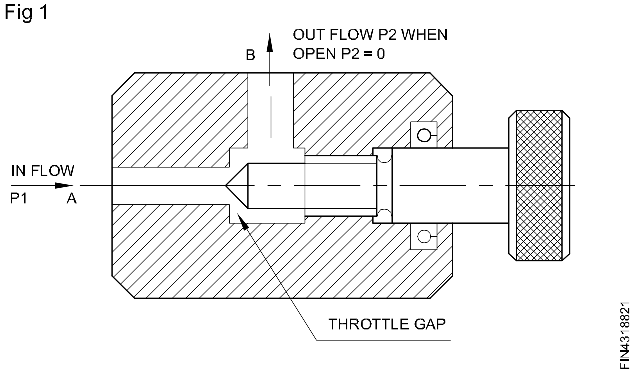
In a hydraulic circuit, to have a control over the speed of an actuator, the flow rate should be under control. This can be done by adjusting a variable delivery pump and a pressure relief valve. But the frequent adjustment of these elements will result in a power loss and reduction in their efficiency. Hence the need for separate flow control valve arises.

To enable the supply of variable flow to the circuits a flow control valve can be made adjustable. Tuning of a flow control valve to supply different flow rates is called 'Throttling' and the valve is also called throttle valve.

Principle of operation

As shown in Fig 1 oil enters the port A and its restricted flow enters port B. Flow is limited in the restricted passage called throttle. The amount of this gap can be varied by throttling screw. When the screw is fully closed, there is no flow at the outlet B.

Fig 1



It can be understood that the flow rate is dependent on the

- Pressure difference p = p1 - p2
- The size of throttle gap and
- Viscosity of oil.

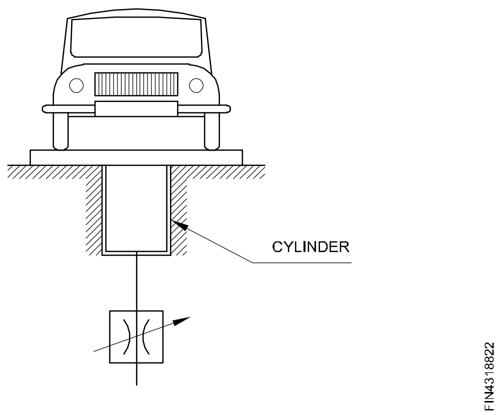
It is to be noted that valve can be operated in both the direction.

Application

By means of throttling, speed can be infinitely variable.

As shown in Fig 2, the platform for lifting a car can be raised faster or slower by means of cylinder movement. The cylinder movement, in turn can be varied by restricted oil supply through a flow control valve.

Fig 2



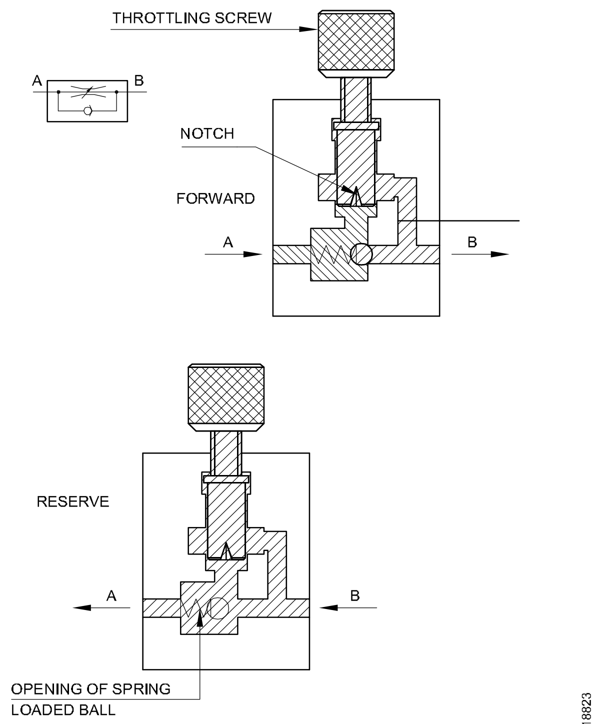
One-way flow control valve (Fig. 3)

A specific requirement of a flow control valve is that, an adjustable flow is required in one direction and a full flow is required in the reverse direction. It is possible, by the induction of a check valve.

As shown in Fig 3, the restricted passage is by means of a longitudinal notch in the valve body. Full flow oil coming from port A is restricted through this passage and only a limited oil flow through the outlet port B. It can be noticed that oil also acts on the ball in the spring direction, so that the ball firmly closes the port, that connects outlet port B.

Whereas in the reverse direction, i.e. from B to A, oil force acts on the ball against the spring force. Thus the ball is lifted off its seat and oil rushes to port A. At the same time, a limited passing of oil through the throttling passage also enters port A. Thus the full flow of oil is ensured at port A.

Fig 3

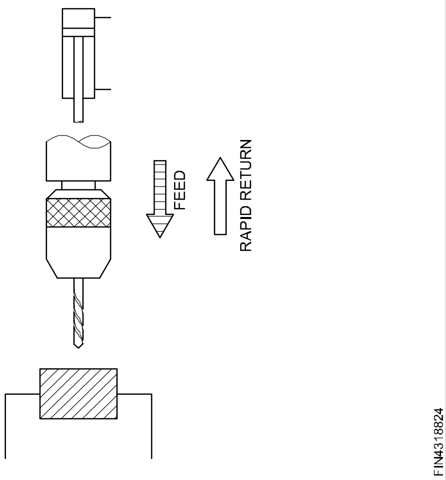


ONE-WAY FLOW CONTROL VALVE

Application

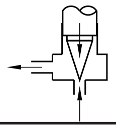
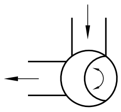
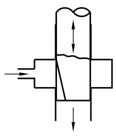
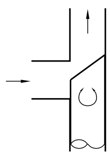
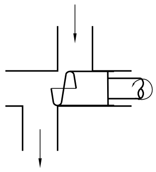
For a auto feed of the drilling operation as shown in Fig 4, the slow feed in vertical direction is imparted by a cylinder, receiving restricted flow of oil. After finishing the operation the drill head has to move fast in upward direction. This is possible by admitting full flow of oil against the check valve.

Fig 4



The following chart illustrates various designs of orifice restrictions, resistance offered, their dependence on viscosity, case of adjustment and effectiveness of the design.

Adjustable restrictors

Type	Resistance	Dependence on viscosity	Ease of adjustment	Design
Needle restrictor 	Increase in velocity, high friction owing to long thrott-ling path	Considerable due to high friction	Excessive cross-sectional design	Economical simple
Circumferential restrictor  By radial slot	As above	As above, but lower than for the needle restrictor surface,total adjustment travel only 90°	Steady cross-sectional enlarge-ment. Adjustment upto 90°	Economical, simple design more complicated than the needle restrictor
Longtiudinal retrictor  (By linear slot)	As above	As above	As above, however sensi-tive adjustment owing to long adjustment travel	As for circumferential restrictor
Gap restrictor or poppet 	Majority; increase in velocity, low friction short throttling path	Low	Unfavourable, even cross-sectional enlargement, adjustment travel of 180°	Economical
Gap restrictor with helix 	Increase in velocity, maximum friction	Independent	Sensitive, even cross-sectional enlargement adjustment travel to 360°	Expensive to produce helix

Requirements of adjustable restrictions

- Build-up of resistance
- Change in temperature and in turn the viscosity should not affect the resistance
- Adjustment of flow depends on the orifice cross-sec tional area and control surface area
- It should be economical in design
- Possibly it could allow the flow in either directions.

Maintaining constant flow-rate

The amount of flow out of a flow control valve, depends on the throttle passage, pressure difference and oil viscosity, set by the temperature.

The viscosity and passage remaining constant, the pressure difference on either side of the throttle alone affects the amount of flow. Hence if the flow is to be constant, the pressure, differential should also be constant. The flow control valve operating on this principle is called "Pressure compensated flow control valve". This type of valve can be also operated in either directions.

Common maintenance procedures for hydraulic and pneumatics control system

Objectives: At the end of this lesson you will be able to
- **plan hydraulics and pneumatic maintenance practices**
- **select proper practices of hydraulics and pneumatics maintenance.**

Key concepts

- Trouble shooting, done in a logical manner, can solve most hydraulic and pneumatic system problems.
- Safety should be the first consideration when trouble shooting.
- Inspect the equipment and question the operator to help solve problems in hydraulic and pneumatic systems.

Safety Precautions

Hydraulic systems operate under very high pressures. Shut the system down and relieve system pressure before opening any part of the system that is under pressure. Do not allow spray from any high pressure leak to contact any part of the body, as serious injection injuries may result. Pumps, valves and motor may beocme hot; be cautious of incidental contact between bare skin and hot surfaces. Keep hands and clothing away from moving parts of the system.

Basic hydraulics system maintenance

Weekly

- Check the systems performance and general condition.
- Check that the oil level in the reservoir is correct on the sight glass. (Hydraulic cylinder should be fully retracted when doing this) Check the oil color as compared to the sample of new oil.
- Check reservoir cover, solenoids and pipe connections for leaks and tighten as required.
- Check the indicator on filters and replace elements if required. When replacing elements, inspect for tell tale signs of impending unit failure, e.g., metal particles.
- Inspect relief valve locks, checking for unauthorized tampering.
- Check accumulator pre-charge (where fitted).

Annually and or every 3000 operation hours

- Check all mounting bolts for tightness. Remove coupling guards from pump / motor and check flexible couplings for wear. Replace the rubber sleeve if necessary.
- Check all the valve, pump and actuator for oil leak. Remove and replace the seals if necessary.
- Check filler breather, suction flter and systen filters element for cleanliness and replace if necessary.
- Check the cooler and clean the element. If necessary replace the seals.
- Have a sample of oil in the reserrvoir checked by a specialized laboratory for size end type of particle contamination. Drain the reservoir if recommended, clean the tank interior and refill with fresh oil of correct type if necessary.

Hydraulic system maintenance

Hydraulic system is recommended to be serviced at every 3000 operational hours or at least once a year.Continuous operation exceeding the mentioned period may cause increased contamination that may ruin components such hydraulic pump, valves, actuator, etc.,

More than 90% of all hydraulic systems failure are caused by contaminated hydraulic fluid. In order to reduce the contamination level, regular or schedule maintenance are essential.

Basic pnueumatic system maintenance

Once in a Week

- Drain comperssor, tank, filter, bowl, and any air lines that have drain cocks.
- Check compressor crankcase oil level
- Check compressor safety - relief valve

Once in a Month

- Inspect discharge air filter.
- Check pressure - reducing valve setting

Once in Every 3 Months

- Change crankcase oil
- Oil the compressor motors.
- Check compressor pressure switches.

Once in Every 6 Months

- Check for moisture, oil , and dirt in air lines.
- Clean the intake air filter, felt and screen types
- Check the compressor belt
- Check the pressure relief valves
- Check calibration, operation, nozzles, and and restrictors of transimt - temperature controllers, pressure controllers, thermostats and humidistats
- Check piping of pressure transmitters and controllers
- Clean elements and humidistats

Once in Year

- Replace cartridge - type intake air filters
- Check calibration of receiver controllers
- Check valves for tight close - off