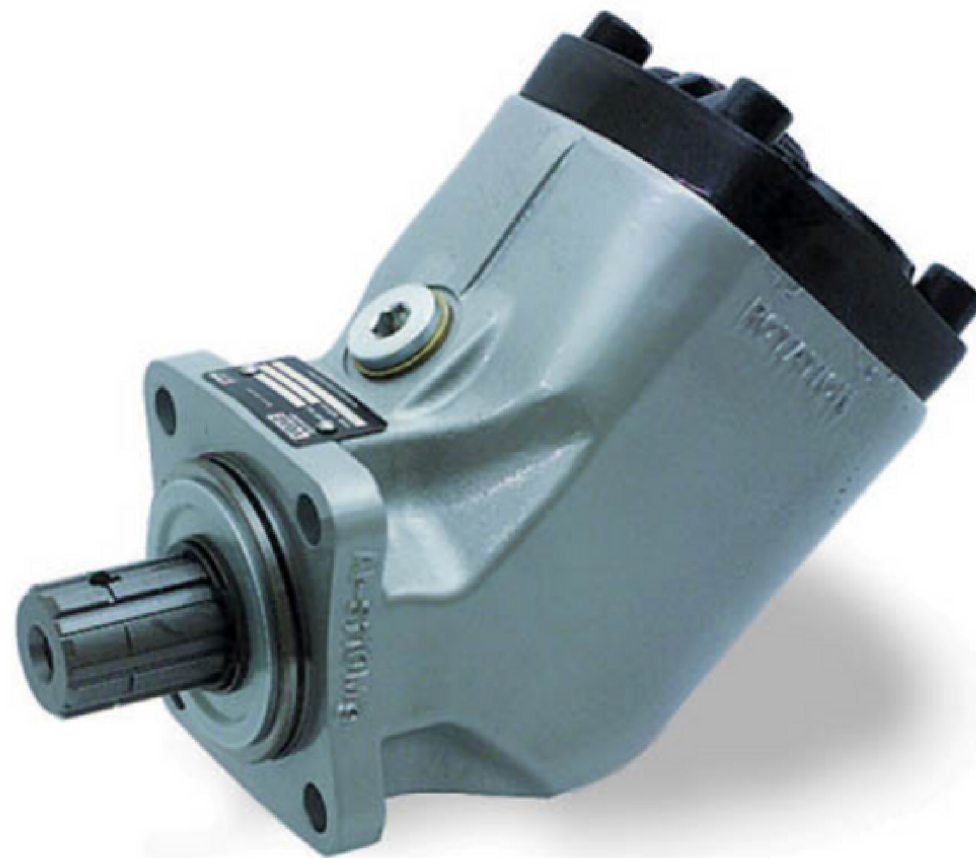


Parker Hannifin Plc Product Training

Fixed Displacement Bent Axis Pumps

Level 1



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1.0 Introduction

Level One training has been devised as a 'self teach' module for persons who have no, or very little, prior knowledge of the subject matter. The aim is for persons to work through the information provided at their own pace and in their own time. When they have completed the module and feel confident that they have increased their knowledge they can complete a test that accompanies the module. Successful completion of the module test permits progress onto Level Two.

1.1 What is a pump?

A pump is a device, which transfers a fluid (this can be a liquid or a gas) from one part of a system to another. A pump is therefore a device that produces a flow of liquid. There are many different types of pump using many different ways of producing flow. Gears, pistons, vanes and screws are just some examples of the different methods used to produce flow. In this module only the bent axis fixed displacement piston pump will be considered.

A flow from a pump is only possible when the fluid being pumped has somewhere to go. In a hydraulic system fluid is directed to an actuator, (motor or cylinder in order to perform some useful work), or it has a free flow passage back to the hydraulic reservoir. Pressure generation in a system is brought about when there is a resistance to the flow produced by a pump. This resistance is generally due to an external force acting against the movement of the actuator or some form of control device in the system preventing or reducing the full amount of flow from the pump. A simple example showing this is to turn on a water tap and note the flow. Then try and stop the flow by putting a finger or thumb over the end of the tap. Notice how the pressure increases the harder you try to prevent the flow from the tap.

1.2 How Does a Pump Work?

Pumps are connected directly or indirectly to a prime mover. This is generally an electric motor or an internal combustion engine. The prime mover provides the turning motion that enables the pump to produce flow. Pumps generally have an inlet port, where oil from a reservoir enters the pump, and a delivery port, from where the flow of oil is delivered into the hydraulic system. Very often these ports are referred to as suction and pressure ports respectively. However, it should be understood that when a pump begins to rotate, the type of pumping arrangement used, (in this case pistons), creates an increased volume in the inlet port as the pistons move back down their individual bores. This increased volume allows atmospheric pressure acting on the oil in the reservoir to push more oil into the inlet port. The oil in the piston bore is carried round to the delivery port from where it leaves the pump and flows out into the system. Figure 1.1 can be viewed in order to understand this principle more clearly.

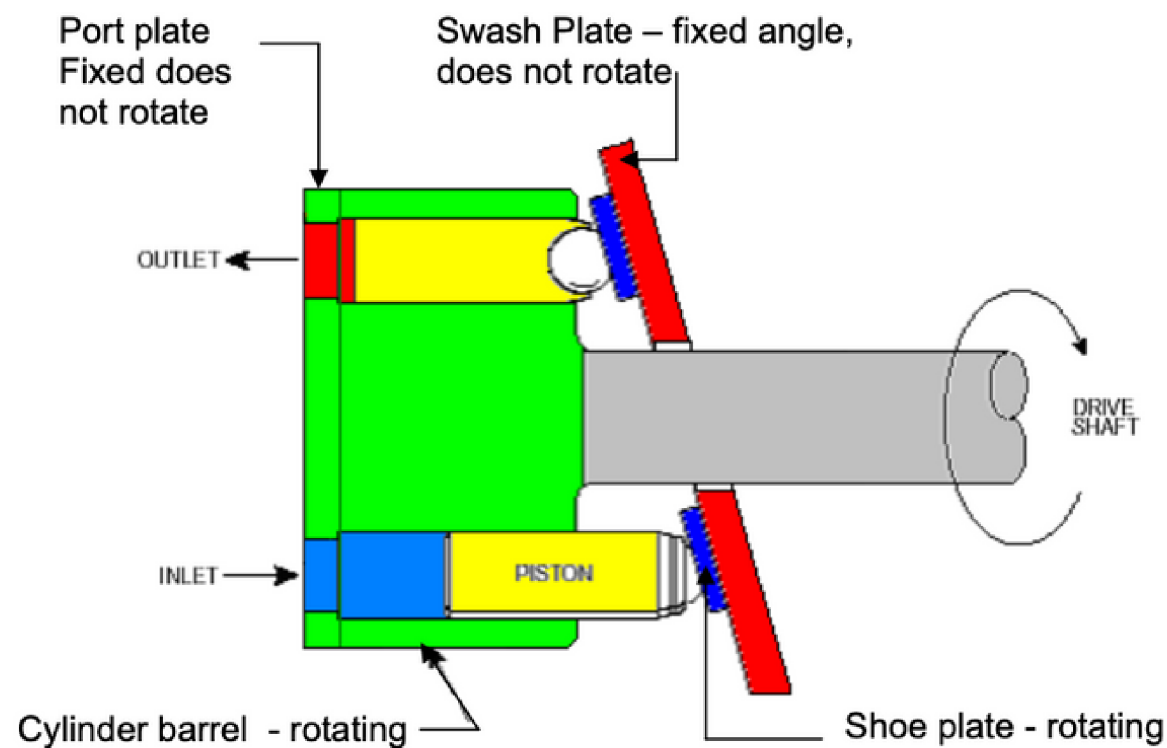


Figure 1.1 – principle of the axial piston pump. Oil enters through the port plate into the piston bore whilst the volume is increasing. As rotation takes place the piston is forced to move forwards by the fixed angle of the swash plate pushing the oil out of the bore through the port plate and into the system.

2.0 Bent Axis Pump Operation

A fixed displacement bent axis pump uses pistons to create flow. These pistons are caused to reciprocate during rotation of the pump due to the inclination of a swash plate or a piston barrel. The angle of the swash plate or piston barrel is set and cannot be adjusted and therefore the amount of oil displaced by the pump during each complete rotation is fixed. (Some types of bent axis pump are adjustable but for this module only the fixed type will be considered).

A port plate with kidney shaped ports, as shown in figure 2.1, is situated at the 'free' end of the cylinder barrel. This separates the inlet part of the pump from the delivery or outlet, and maintains a seal to prevent oil on the delivery side short-circuiting back to the inlet side.

The cylinder barrel contains a number of pistons, (numbers vary depending on style size and manufacturer), which are connected at one end to a linkage known as a

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shoe plate. This in turn is linked to the swash plate in a way that allows it to rotate with the cylinder barrel. As mentioned above, the angle of the swash plate determines how far the pistons travel within their respective bores. The greater the angle, the further the travel, and therefore the larger the delivery of oil will be per revolution of the cylinder barrel. Displacement per revolution with this type of pump is dependent upon three things; the size of the piston; the stroke of the piston (set by the angle of the swash plate; the number of pistons in the cylinder barrel. The speed of the pump does not effect the displacement, only the amount flow coming out of the pump changes.

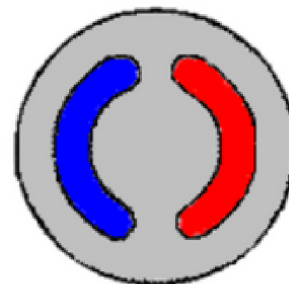


Figure 2.1 – Port plate. The kidney shaped ports align with the inlet and outlet ports of the pump.

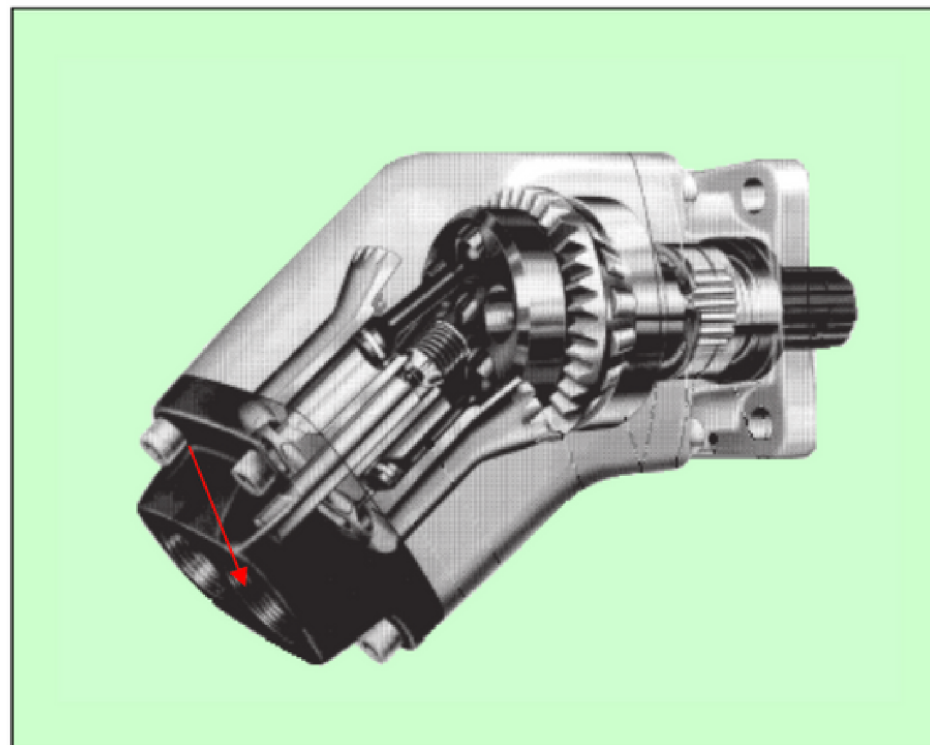
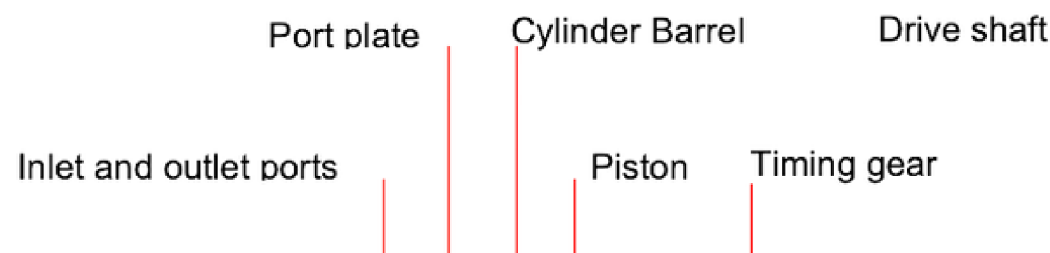


Figure 2.2 – Typical bent axis fixed displacement pump arrangement. Parker F1 series

3.0 Bent Axis Pump Construction

3.1 Body Housing

The body housing is generally made from cast iron or aluminium and is made up of two or three sections depending on style and manufacturer. The example shown in figure 2.2 comprises three parts, consisting of a bearing housing with a mounting flange, a barrel and timing gear housing, and an end cap for the inlet and delivery ports. Some two part arrangements consist of the bearing housing with mounting flange, and a combined barrel / end cap housing cast as one piece with the inlet and delivery ports being inline with the piston barrel or at ninety degrees to it.

3.1.2 Drive shaft

Manufactured from high-grade steel as a one-piece component, the drive shaft transmits the rotational force from the prime mover through the timing gear in order to rotate the piston barrel. The shaft extends through the bearing housing to mate with the drive from the prime mover. The drive end configuration of the shaft, of which there are many international standards, has to match that of the prime mover.

3.1.3 Bearings and mounting flange

Bent axis displacement pumps are fitted with heavy duty taper roller bearings behind the timing / drive gear in order to cope with the high end thrust created by this type of pump arrangement. (More on this in Level 2). One or two taper roller bearings can

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be used which are located in the bearing housing. This housing also has the pump mounting arrangement cast as an integral part. Mounting flanges are machined with mounting holes and a spigot-locating diameter for fixing to the prime mover. Mounting covers come in many configurations and meet the requirements of international interface standards.

3.1.4 Cylinder Barrel and port plate

Figure 2.2, shows how the end of the cylinder barrel is machined with a timing gear. This gear meshes with the timing gear on the drive shaft so as to provide rotation. Arranged on a pitch circle diameter around the center of the cylinder barrel are a number of holes, which accommodate the pistons. The barrel is made from high-grade case hardened steel. The port plate is located at the 'free' or non-drive end of the barrel. This is a hardened steel plate with two kidney shaped machined holes which separate the inlet and outlet flows.

3.1.5 End Cap (where fitted)

The end cap is a cast part with machined port arrangements for the connection of hose and tube adaptors. Depending on design, the port arrangements may be cast as part of the barrel housing and machined for various port connection arrangements.

4.0 Schematic Description

Hydraulic components are identified on schematic drawings by internationally recognised symbols. The symbol used for a hydraulic fixed displacement pump is shown at the foot of every page in this module. As mentioned in section 2.0, bent axis pumps with no adjustment capability are termed fixed displacement pumps. Figure 4.1 shows how a fixed displacement pump is shown on a typical section of a hydraulic schematic diagram.

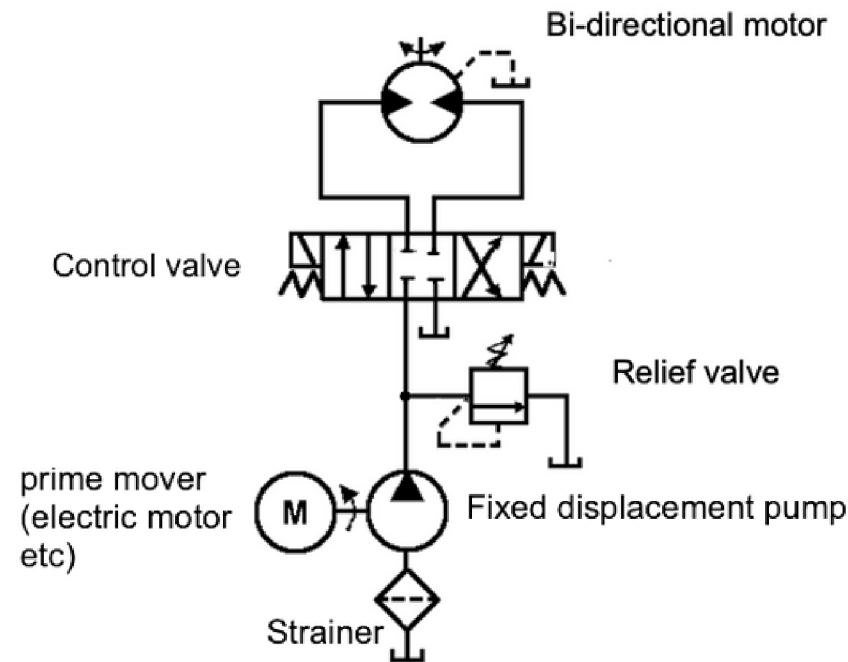


Figure 4.1 Schematic Diagram - typical arrangement of a single fixed displacement pump supplying part of a circuit.

5.0 Applications

Bent axis pumps are used in many applications both industrial and mobile. In mobile applications they are very often found coupled to the power take off of lorries and are used to supply all auxiliary hydraulic functions. A few examples are;

Forest Cranes

Hook Loaders

Tippers

Skip Loaders

Cargo Cranes

Summary Points

- Pumps produce flow
- Flow is only possible when the fluid has somewhere to go
- Pressure is a result of a resistance to flow
- Bent axis pumps are one of the most common pumps in the truck market
- Displacement of oil from a fixed bent axis pump is not adjustable
- Pumps are normally coupled to a prime mover
- Prime movers generally tend to be electric motors or diesel engines
- A valve or port plate is used to separate the inlet ports from the delivery ports
- Bent axis pumps usually consist of a bearing housing and a barrel housing
- One method of driving the cylinder barrel is by using a timing gear
- The cylinder barrel contains the bores for the pistons
- Gear and barrel housings are generally made from cast iron or aluminium
- A fixed displacement pump is represented on a hydraulic schematic diagram

by this symbol -



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