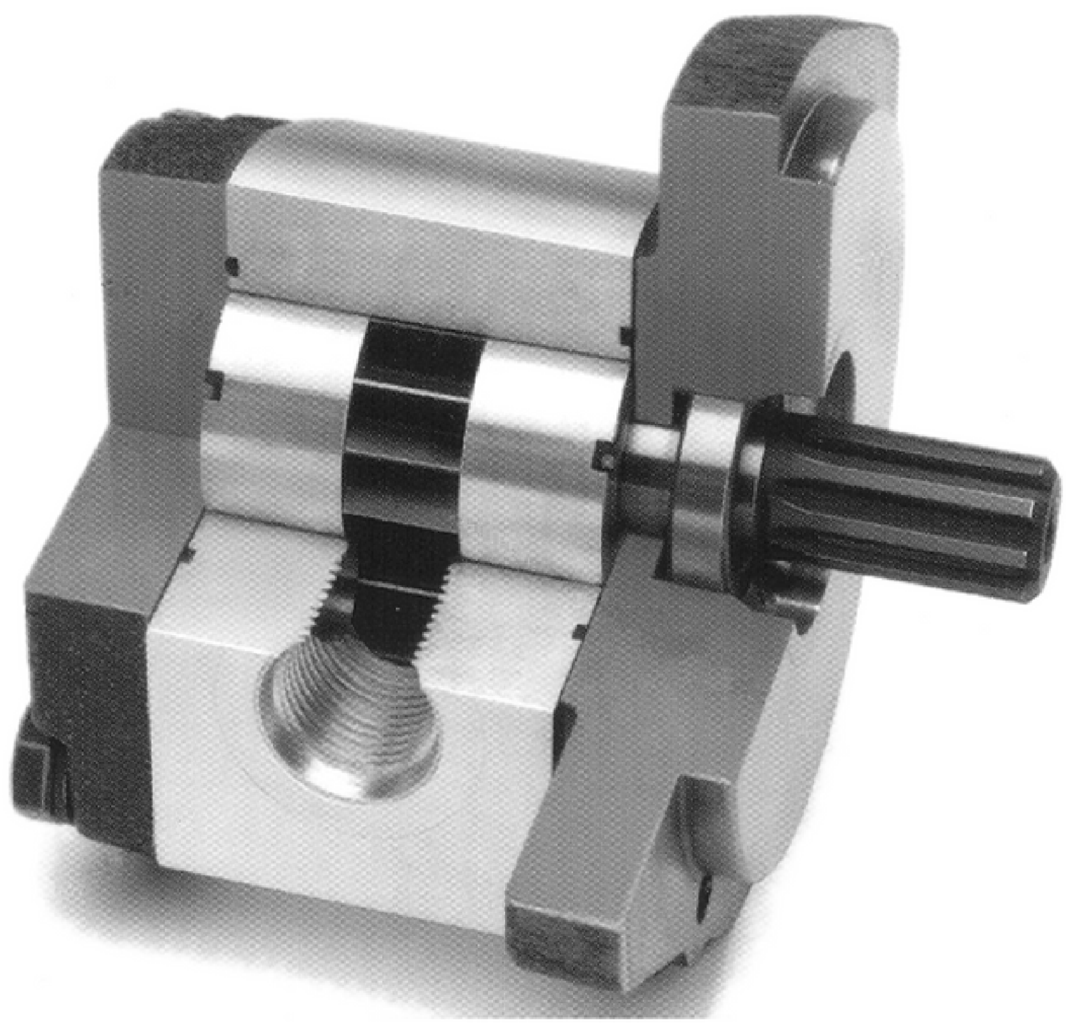
Parker Hannifin Plc
Product Training

Gear Pumps

Level 1



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1.0 Introduction

Level One training has been deviced 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 gear pump will be considered. Gear pumps are probably the most common type of pump in use today and can be found across a whole range of different industries and applications.

A flow from a pump is only possible when the fluid being pumped has somewhere to go. In an 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 gears), creates an increased volume in the inlet port as the gear teeth unmesh. This increased volume allows atmospheric pressure acting on the oil in the reservoir to push more oil into the inlet port. Figure 2.1 can be viewed in order to understand this more clearly.

2.0 Gear Pump Operation
Figure 2.1 shows the outline of a gear pump and can be used to describe the way in which oil flow is generated. Two gears known as a drive gear and a driven gear are contained within a housing. The drive gear (shown here with a keyed shaft for illustration purposes only) is connected to and turned by the prime mover. This meshes with the driven gear and rotates it in the opposite direction. As the two gears rotate, oil at the inlet port is collected between the un-meshing teeth of the gears (increasing volume) and carried around the inner edge of the housing. As the oil reaches the delivery port, the teeth of the two gears re-mesh and force the oil out from in between the teeth causing a flow from the delivery port.

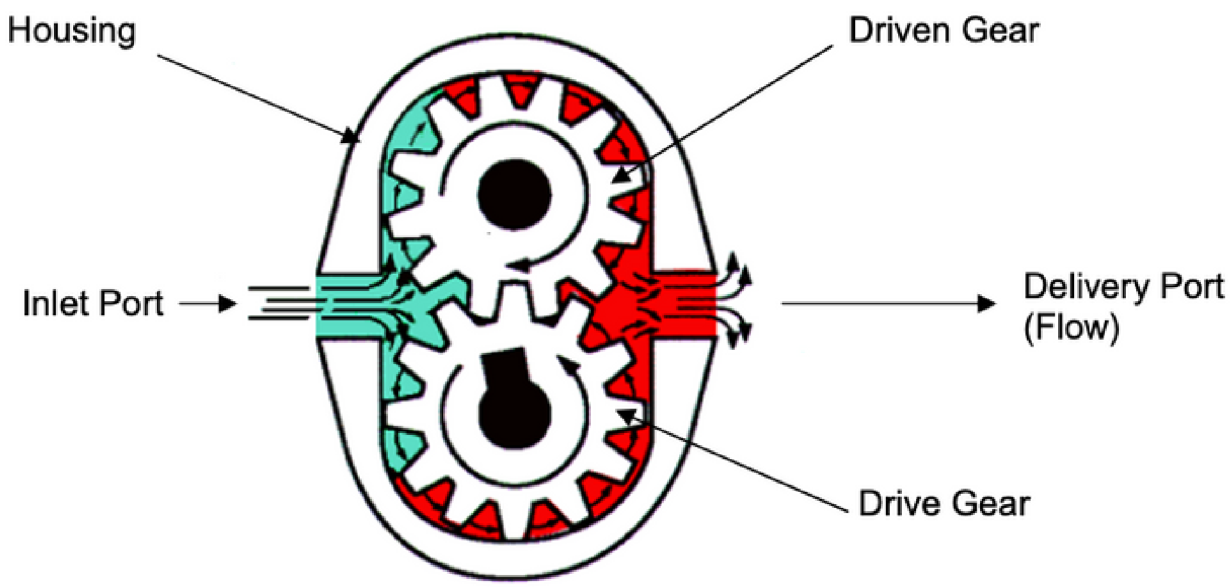


Figure 2.1 Principle of flow generation by a gear pump

The displacement of a gear pump, (the volume of oil that can be transferred from the inlet port to the delivery port in one full revolution of the gears), is determined by the size of the gears. As this cannot be adjusted gear pumps are generally termed fixed displacement pumps.

2.1 Gear Pump Construction

Having described the basic way in which the gear pump works the construction of a gear pump will now be covered. The various functions of the main components contained within a typical gear pump are described below. An example of an aluminium bush gear pump is shown in figure 2.2.

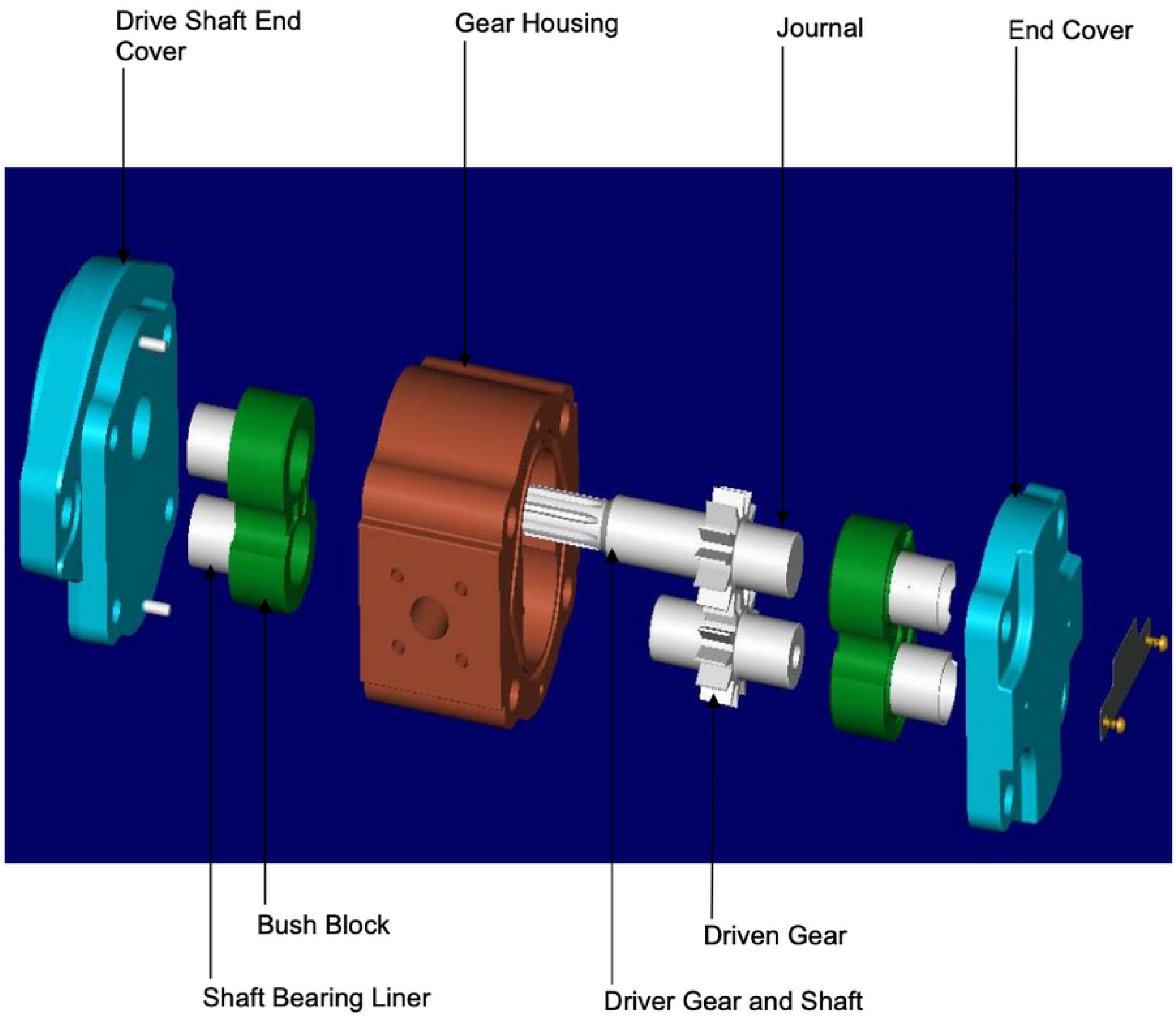


Figure 2.2 Example of a gear pump construction. (Parker 500 Series)

2.1.1 Drive Shaft End Cover and End Cover

The drive shaft end cover is usually made from cast iron or an aluminium alloy. Depending on the design of pump this cover can contain a bearing and a seal for the drive shaft. It can also contain machined grooves for the seals that are necessary between the cover and gear housing. (This is not the case in the example used in figure 2.2). Shaft end covers, sometimes referred to as mounting covers, are machined with mounting holes and a spigot locating diameter for fixing

to the prime mover. Mounting covers come in many configurations to meet the requirements of international interface standards.
The end cover is also usually made from cast iron or an aluminium alloy. Its function is to seal off the 'free' or non-drive end of the gear housing. Again, on some makes of pump this cover can contain a seal groove in order to locate the sealing arrangement between the gear housing and end cover

2.1.2 Gear Housing

Gear housings can be manufactured from any suitable material depending on the application. However for hydraulic applications the material used tends to be aluminium alloys or cast iron. In figure 2.2 the internal profile of the housing has to be machined accurately to accept the profile of the mating gears and the bush blocks. Clearance between the internal surface of the housing and the tips of the gear teeth has to be minimal otherwise oil will be allowed to pass back over the tips of the teeth instead of being forced out of the delivery port.
See section 2.2 for more detail.

2.1.3 Bush Blocks

These aluminium alloy blocks contain the shaft bearing liners for the driver and driven gear journals, as well as the seals on one side face to prevent the transfer of pressurised fluid back from the delivery side of the pump to the inlet side. (see figure 2.3). The outer profile of the block is machined to match the inner profile of the gear housing and therefore provide accurate location and alignment for the two gear shafts in relation to one another.

2.1.4 Driver Gear and Shaft

Manufactured from high-grade steel as a one-piece component, the drive gear shaft transmits the rotational force from the prime mover to the driven gear in order to produce a flow of oil from the pump. The shaft extends through the drive shaft end cover 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.

2.1.5 Driven Gear

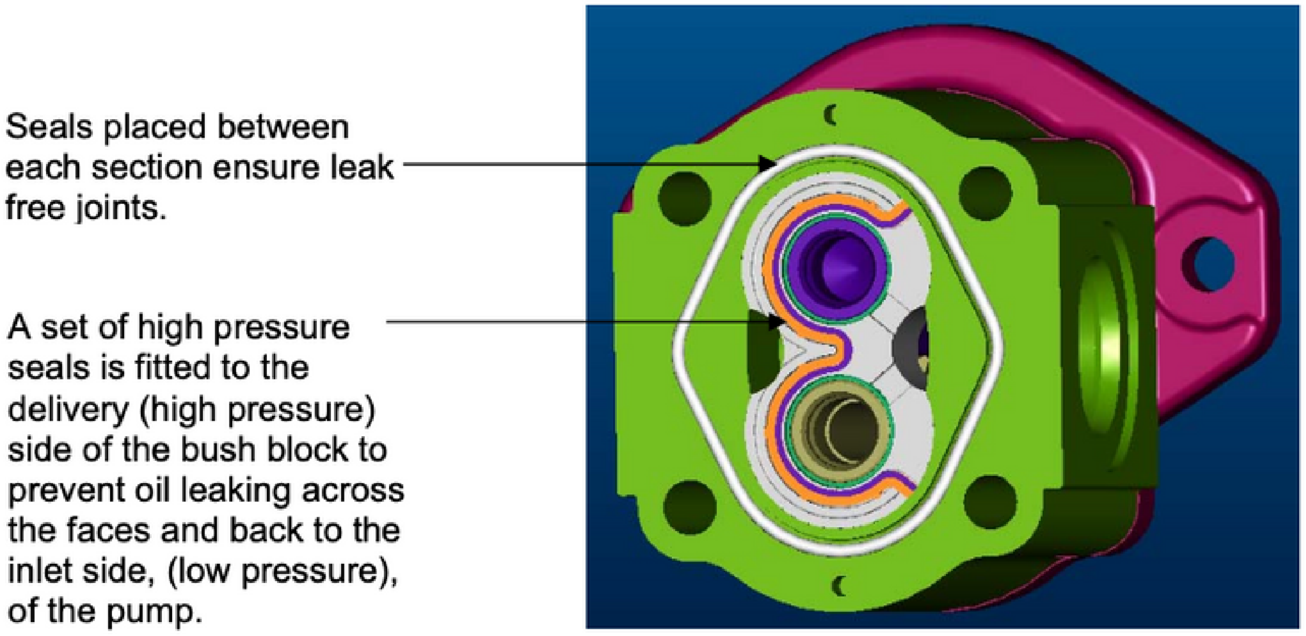
This gear made from high-grade steel is matched in width to the driver gear and has two journals, which are located into the bush block bearings ensuring perfect alignment to the drive gear shaft.

2.2 Gear Sets and Housing Compatibility

For high efficiency gear pumps, as part of the manufacturing process following assembly, the pumps have to be 'cut in'. During this process, the pump is subjected to a pressure equal to the working pressure of the customer's application. The pressure causes the journals to move over in their clearances and the shafts to bend very slightly. This movement causes a small amount of material to be shaved off the inner surface of the gear housing by the tips of the gear teeth. This process produces an excellent seal between the tips of the gear teeth and the inner face of the housing. It should be noted that after this process the pumps have to be thoroughly cleaned.

2.3 Sealing Arrangements

One method of sealing between the various sections of a gear pump is shown in figure 2.3. In this example the end faces of the gear housing are machined to accept the placement of a seal thereby ensuring a leak free joint between the housing face and the end covers. A set of seals is also incorporated into the faces of the bush blocks to prevent the passage of oil from the delivery side of the pump back to the suction side of the pump, by providing an end load to seal between the gear side faces and the bush blocks. As with all hydraulic seals, they have to be compatible with the working fluid and temperatures of the application. . If you compare the two illustrations in fig 2.3, you will see how the seals cover the high pressure area.



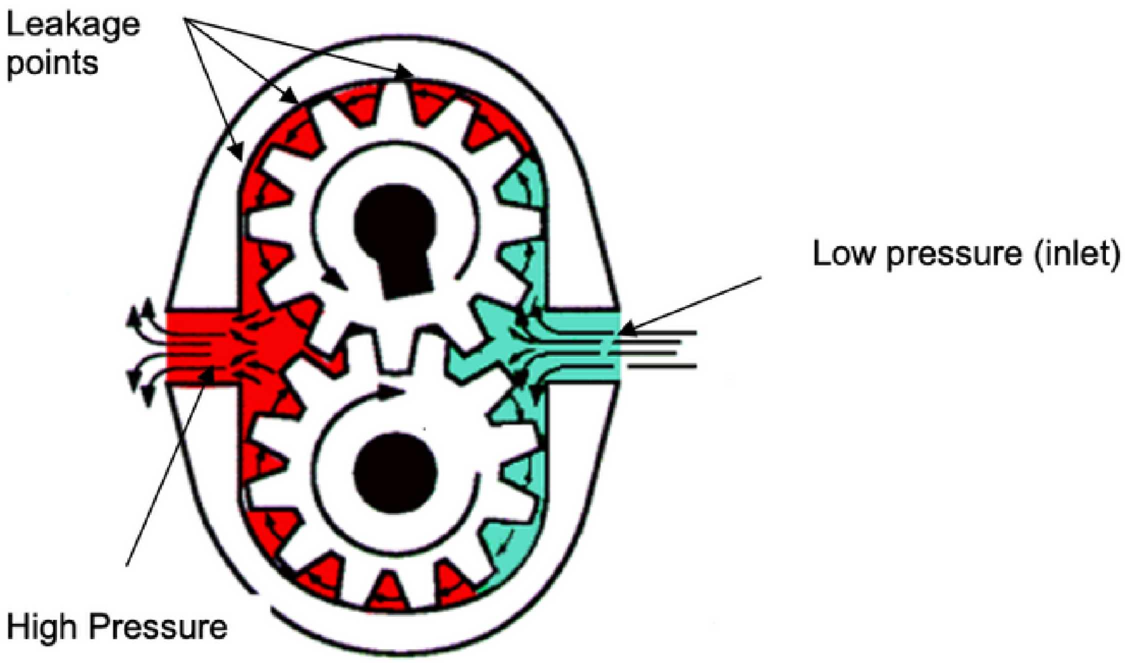


Figure 2.3 Internal seal arrangement. (Parker 500 Series)

3.0 Gear Pump Configurations

So far we have looked at the gear pump as a single unit, that is, only one pump working in a system. This is fine for a small system working at a given pressure and flow rate. There are instances however where the system is more complicated and requires the use of more than one pump. In this case one solution available is to couple a selection of gear pumps together. An example of a multi gear pump arrangement is given below in figure 3.1. The choice of using multi pumps against using a larger or different pump will be covered in the following levels.

3.1 Double Pump or Tandem pump

Generally, multi gear pump arrangements come ready assembled by the manufacturer to the customer's specification. These can be two, three or four unit assemblies depending on the application and size of pump. Some manufacturers provide the ability for customers to add an extra pump, providing the first or primary pump has the necessary facilities to enable this. Additional pumps may be added to the existing unit by removing the end plate and using an appropriate kit. Pumps of the same size or smaller can be added onto the end of a larger primary pump in what is sometimes known as a piggy-back or tandem arrangement, as shown in figure 3.1.

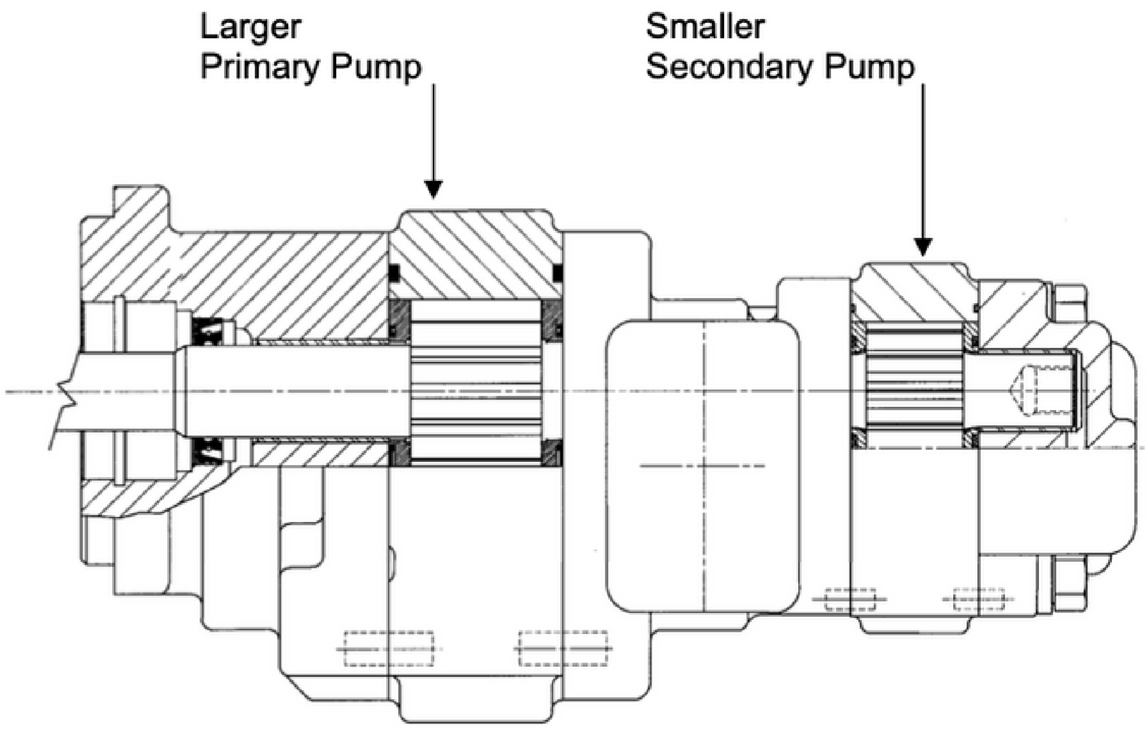


Figure 3.1 Piggy – back arrangement with gear pumps of different sizes

3.2 Porting Arrangements

On multi gear pump assemblies the oil inlet, or supply arrangement, can vary depending on the application and customer desire. Inlet lines can be common or individual to all pumps in a multi pump arrangement. Common inlets generally supply oil to a single port on the multi pump arrangement from where the supply is split internally to each pumping section. This is shown below in figure 3.2, individual inlets are arranged as shown in figure 3.3.

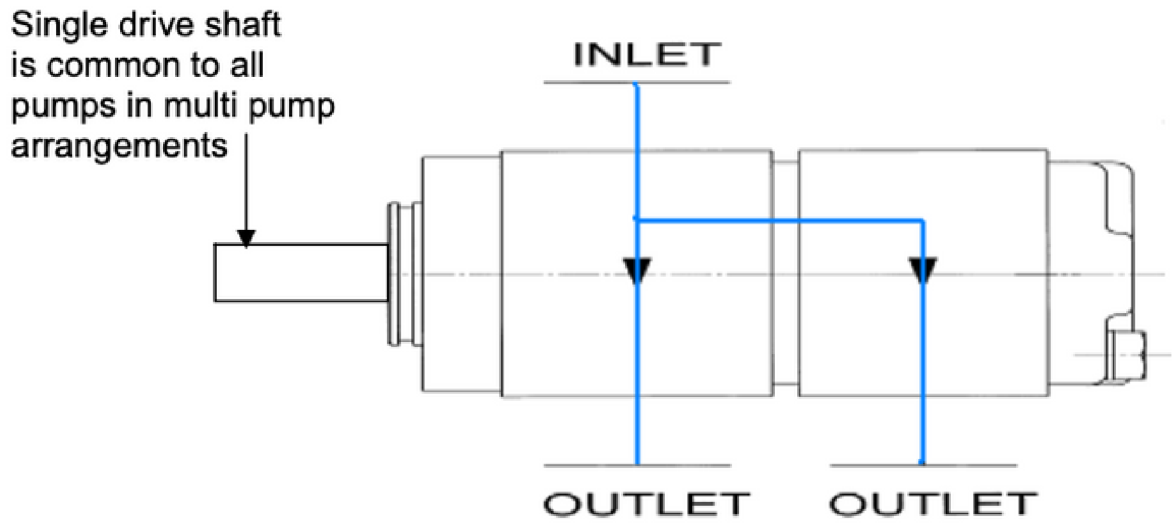


Figure 3.2 Multi pump arrangement showing common inlet

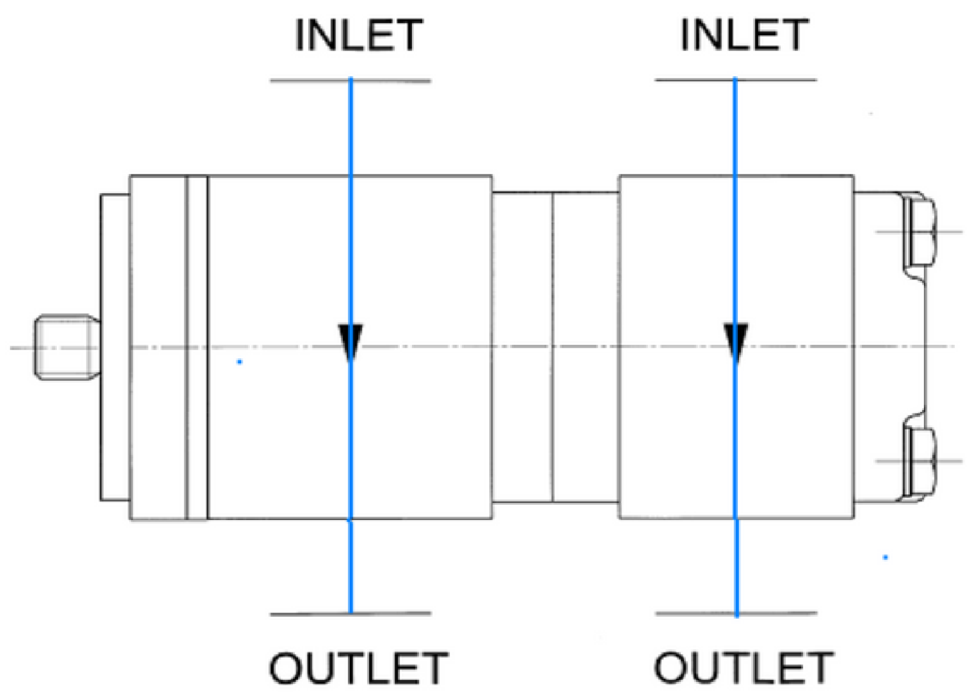


Figure 3.3 Multi pump arrangement showing individual inlets

A further choice is shown in figure 3.4 whereby two separate inlets are used but an open gallery exists between the two pump sections. This arrangement has the advantage of each pump being able to draw extra oil if needed during a higher workload.

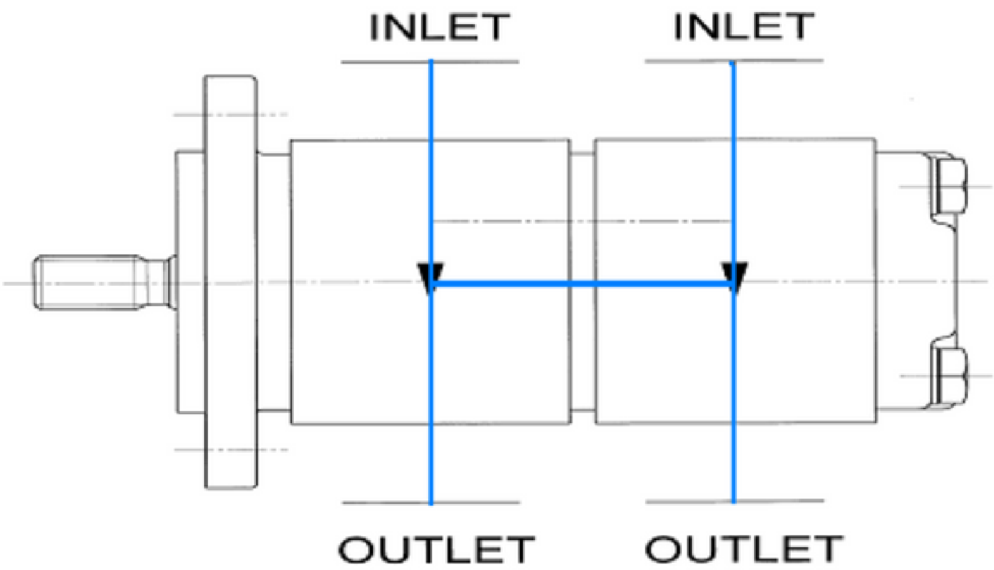


Figure 3.4 showing internal gallery connection between pump sections

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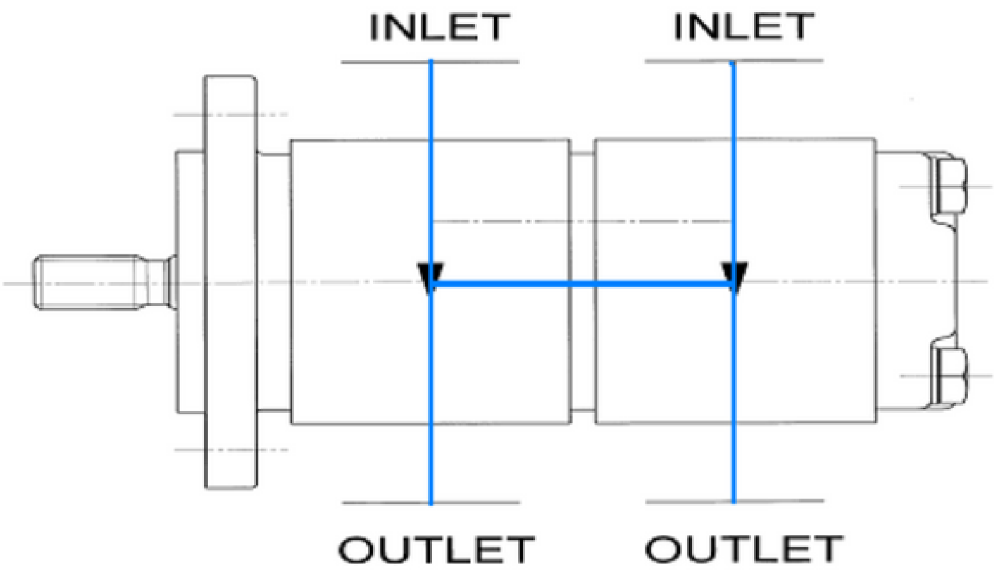


Figure 3.4 showing internal gallery connection between pump sections

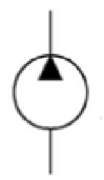
5.0 Applications

The list of applications for the gear pump is wide ranging and they can be found in all areas of hydraulics, below are just a few examples.

Front-end loaders
Excavators
Power units
Harvesters
Cars
Tractors
Fork lift trucks
Mowers
Industrial units

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
- Gear pumps are one of the most common pumps in use
- Displacement of oil from a gear pump is fixed
- Pumps are normally coupled to a prime mover
- Prime movers generally tend to be electric motors or diesel engines
- The two gears inside a gear pump are known as driver and driven
- Gear pumps can be coupled together to form tandem or triple assemblies
- Gear pumps can be made from any suitable material. For hydraulic applications this is normally aluminium or cast iron.
- A fixed displacement pump is represented on a hydraulic schematic diagram by this symbol -



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