CHAPTER EIGHT

POSITIVE DISPLACEMENT PUMPS

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Positive Displacement Pumps are "constant flow machines"; they have an expanding cavity on the suction side and a decreasing cavity on the discharge side. Liquid flows into the pumps as the cavity on the suction side expands and the liquid flows out of the discharge as the cavity collapses. The volume is constant given each cycle of operation.

8.1 Reciprocating Pumps

8.1.1 Introduction

Reciprocating pumps: are positive displacement pumps which divide into three general types; power, controlled volume and steam.

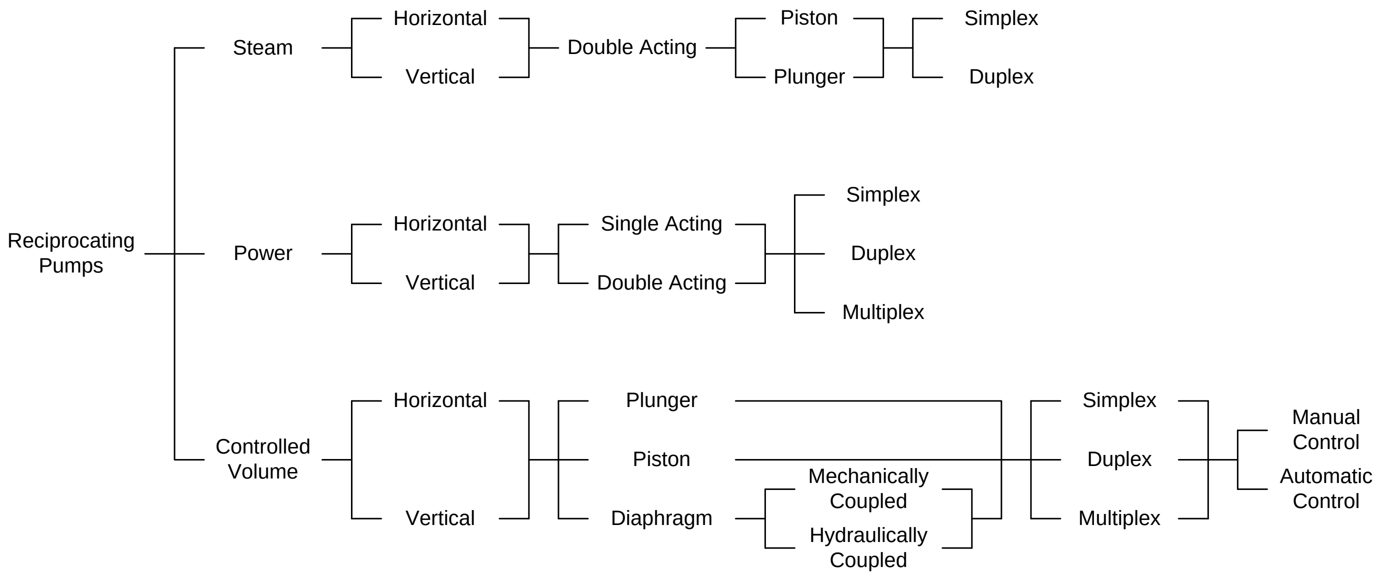

Figure 8.1 – Types of reciprocating pumps

8.1.2 Power Pump

A power pump is a reciprocating pump driven by power from an outside source applied to the crankshaft of the pump. It consists of a liquid end and a power end.

Horizontal Pump: The axial centerline of the cylinder is horizontal.

Vertical Pump: The axial centerline of the cylinder is vertical.

Single-Acting Pump: Liquid is discharged only during the forward stroke of the plunger or piston, that is, during one half of the revolution.

Double-Acting Pump: Liquid is discharged during both the forward and return strokes of the plungers or piston, that is, discharge takes place during the entire revolution.

Piston Pump: The liquid end contains pistons.

Plunger Pump: The liquid end contains plungers.

Simplex Pump: Contains one piston or its equivalent, that is, single or double-acting plunger(s).

Duplex Pump: Contains two pistons or their equivalent, that is, single or double-acting plungers.

Multiplex Pump: Contains more than two pistons or their equivalent, that is, single or double-acting plungers.

Number of power Crossheads	Type pump
1	Simplex
2	Duplex
3	Triplex
5	Quintuplex
7	Septuplex
9	Nonuplex

The following figures show three different examples of power pump:

1. Horizontal single-acting plunger power pump (Figure 8.2)
2. Vertical single-acting plunger power pump (Figure 8.3)
3. Horizontal double-acting piston power pump (Figure 8.4)

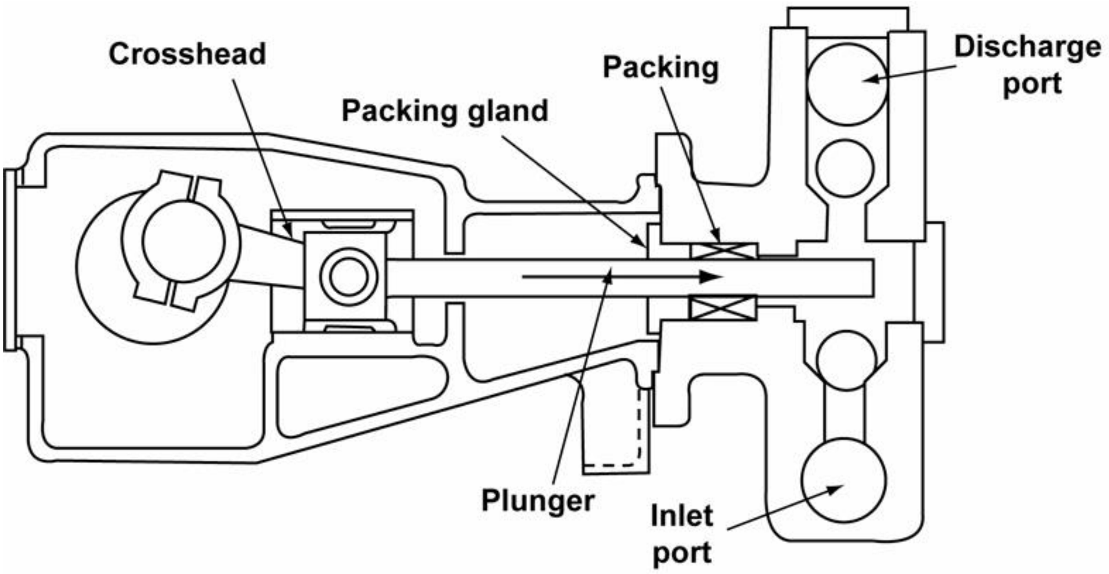

Figure 8.2 – Horizontal single-acting plunger power pump

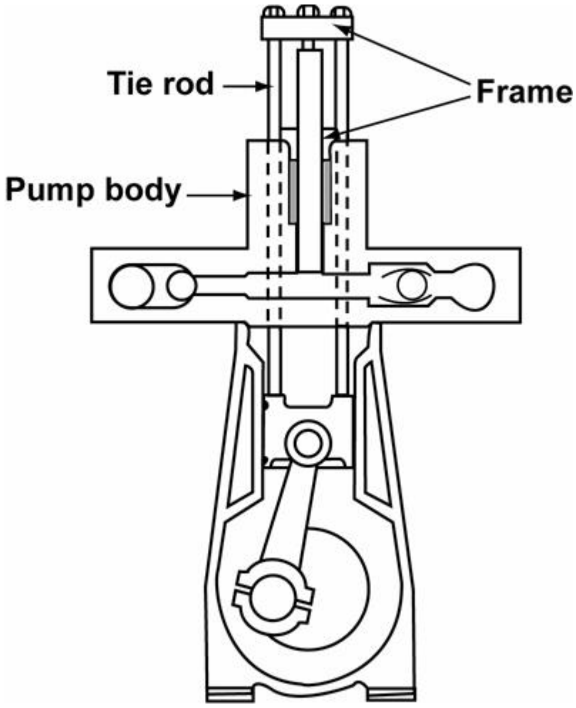

Figure 8.3 – Vertical single-acting plunger power pump

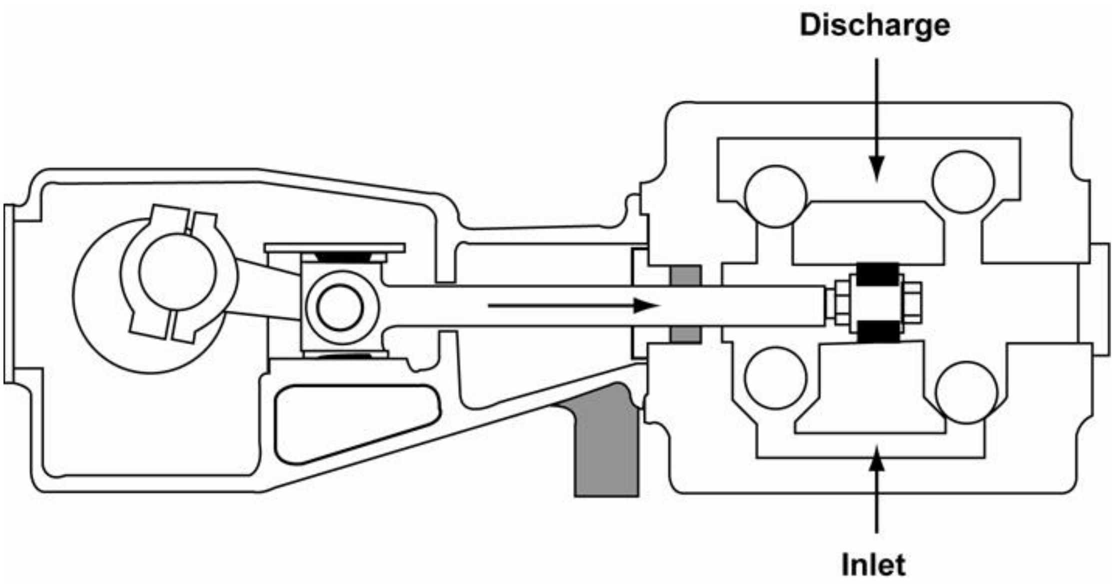

Figure 8.4 – Horizontal single-acting piston power pump

8.2 Rotary Pumps

8.2.1 Introduction

A rotary pump is a positive displacement pump consisting of a chamber containing gears, cams, screws, vanes, plungers or similar elements actuated by relative rotation of the drive shaft or casing, and which has no separate inlet and outlet valves. These pumps are characterized by their close running clearances.

8.2.2 Basic Types

There are seven common basic types of rotary pumps identified by the type of pumping element. Relationships between these types of pumps are illustrated in Figure 8.5.

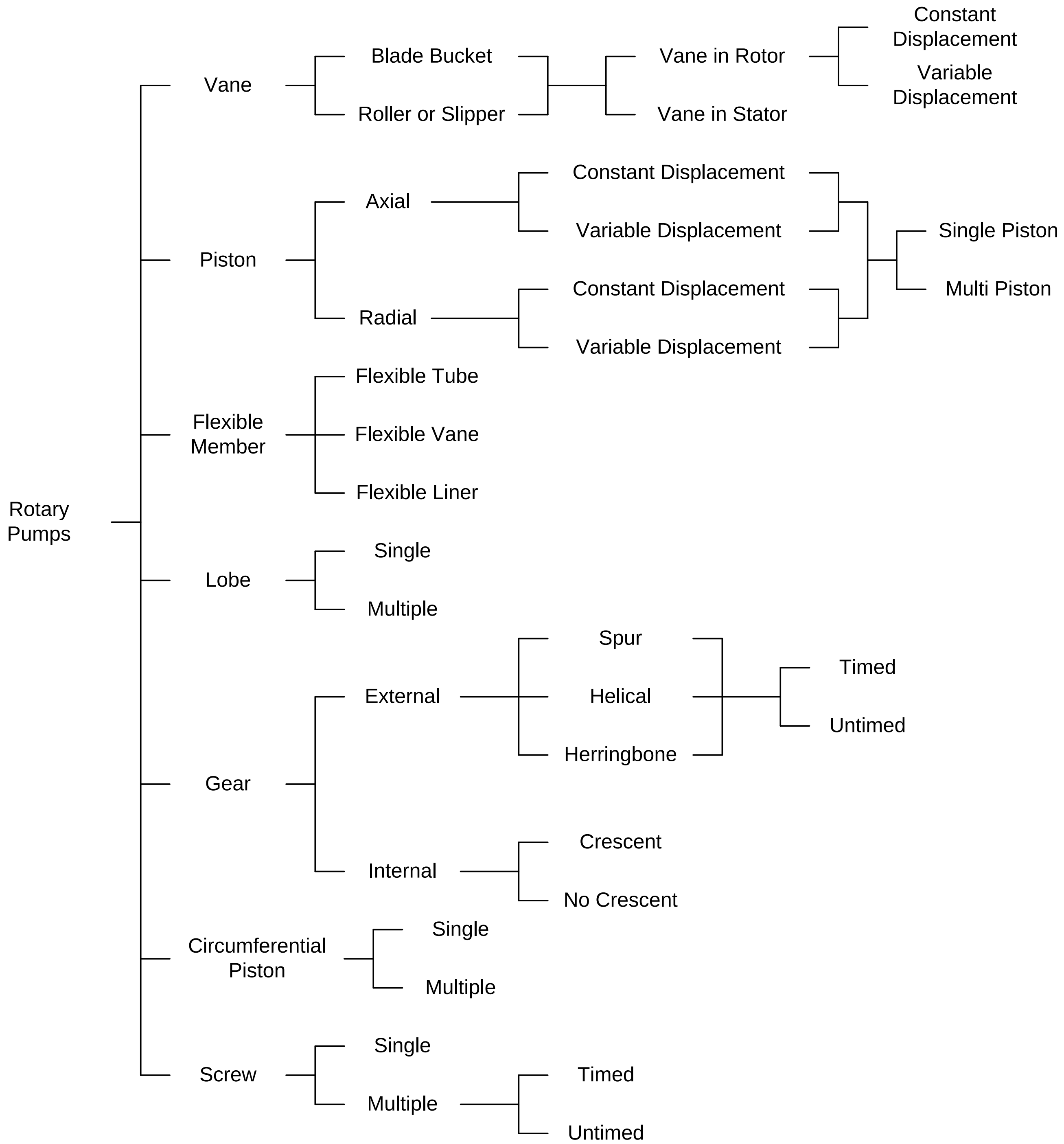

Figure 8.5 – Types of rotary pumps

8.2.2.1 Vane

In this type, the vane or vanes, which may be in the form of blades, buckets, rollers, or slippers, co-operate with a cam to draw fluid into and force it from the pump chamber. These pumps may be made with vanes in either the rotor or stator and with radial hydraulic forces on the rotor balanced or unbalanced. The vane-in-rotor pumps may be made with constant or variable displacement pumping elements. Figure 8.6 illustrates a vane-in-rotor constant displacement unbalanced pump. Figure 8.7 illustrates a vane-in-stator constant displacement unbalanced pump.

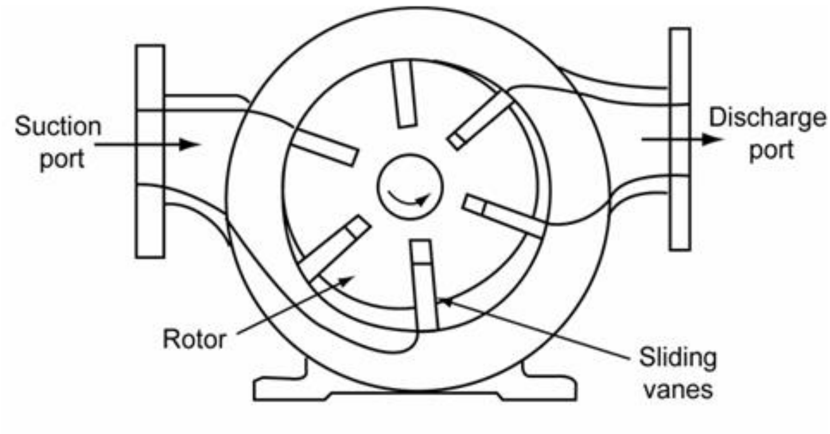

Figure 8.6 – Sliding vane pump

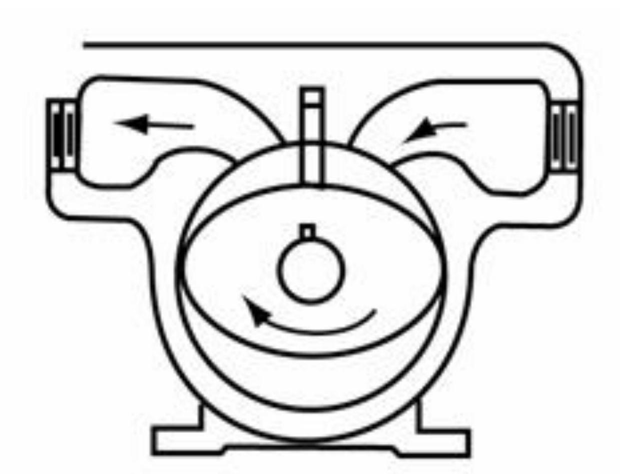

Figure 8.7 – External vane pump

8.2.2.2 Piston

In this type, fluid is drawn in and forced out by pistons which reciprocate within cylinders with the valving accomplished by rotation of the pistons and cylinders relative to the ports. The cylinders may be axially or radially disposed and arranged for either constant or variable displacement pumping. All types are made with multiple pistons except that the constant displacement radial type may be either single or multiple pistons. Figure 8.8 illustrates an axial, constant displacement piston pump.

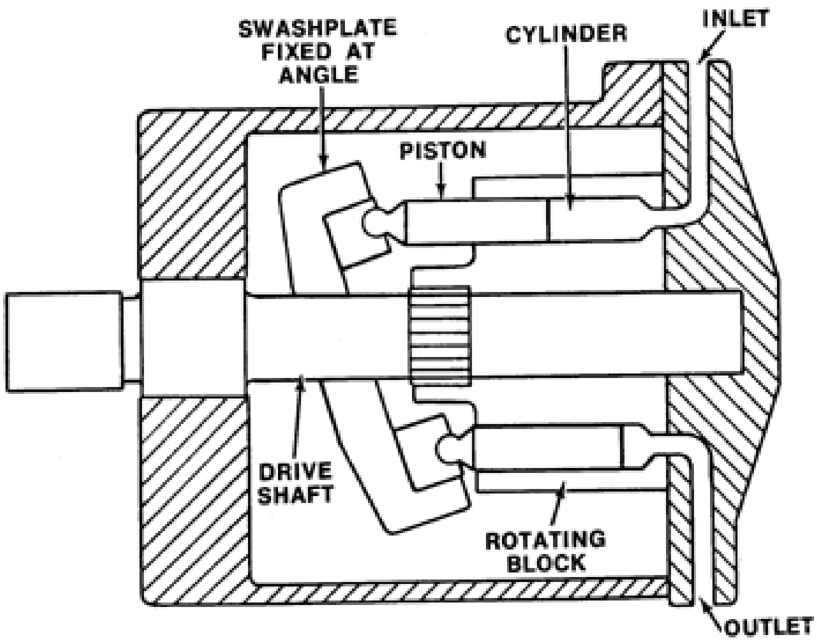

Figure 8.8 – Axial piston pump

8.2.2.3 Flexible Member

In this type, the fluid pumping and sealing action depends on the elasticity of the flexible member (s). The flexible member may be a tube, a vane, or a liner. These types are illustrated in Figures 8.9, 8.10, and 8.11 respectively.

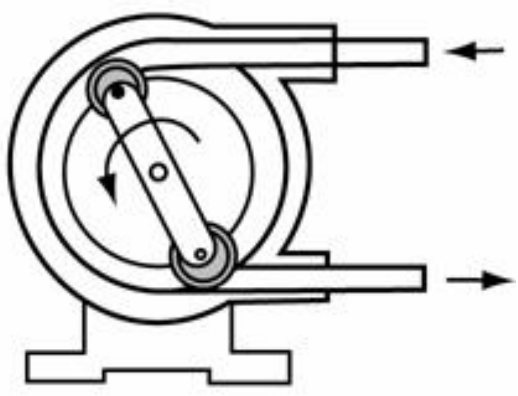

Figure 8.9 – Flexible tube pump

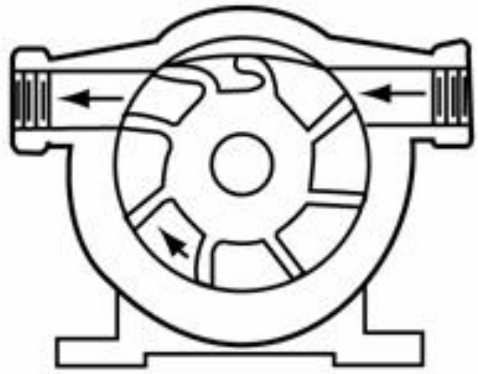

Figure 8.10 – Flexible vane pump

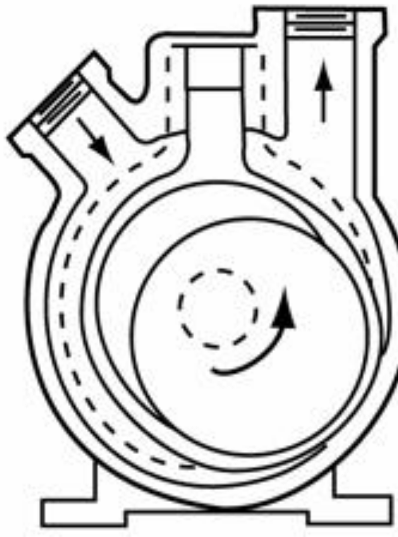

Figure 8.11 – Flexible liner pump

8.2.2.4 Lobe

In this type, fluid is carried between rotor lobe surfaces from the inlet to the outlet. The rotor surfaces cooperate to provide continuous sealing. The rotors must be timed by separate means. Each rotor has one or more lobes. Figures 8.12 and 8.13 illustrate a single and a three-lobe pump, respectively.

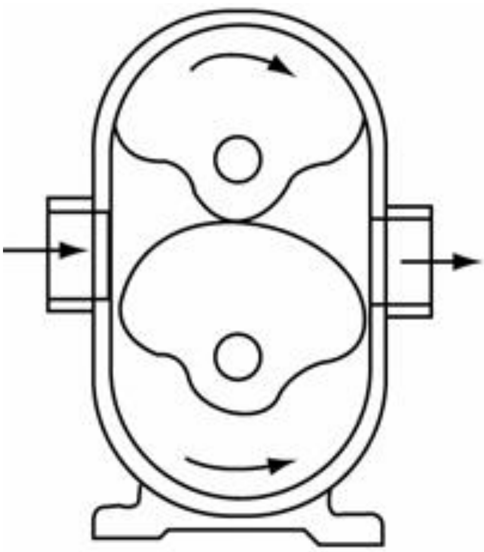

Figure 8.12 – Single lobe pump

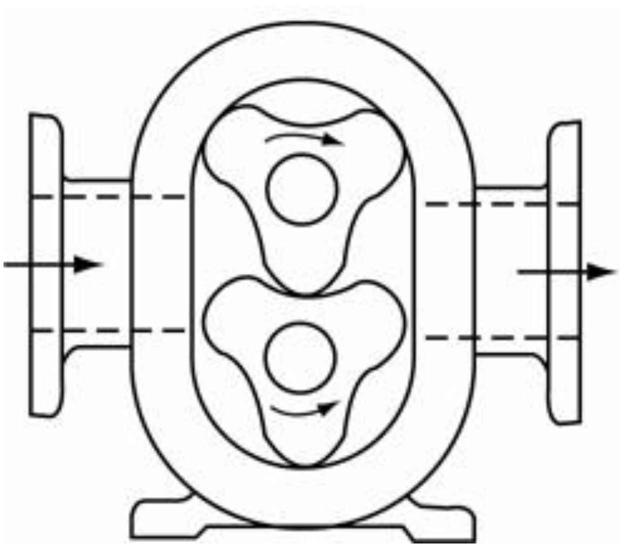

Figure 8.13 – Three lobe pump

8.2.2.5 Gear

In this type, fluid is carried between gear teeth and displaced when they mesh. The surfaces of the rotors cooperate to provide continuous sealing and either rotor is capable of driving the other.

External gear pumps have all gear rotors cut externally. These may have spur, helical, or herring bone gear teeth and may use timing gears.

Internal gear pumps have one rotor with internally cut gear teeth meshing with an externally cut gear. Pumps of this class are made with or without a crescent shaped partition. Figure 8.14 illustrates an external spur gear pump. Figures 8.15 illustrate internal gear pumps with the crescent shaped partition.

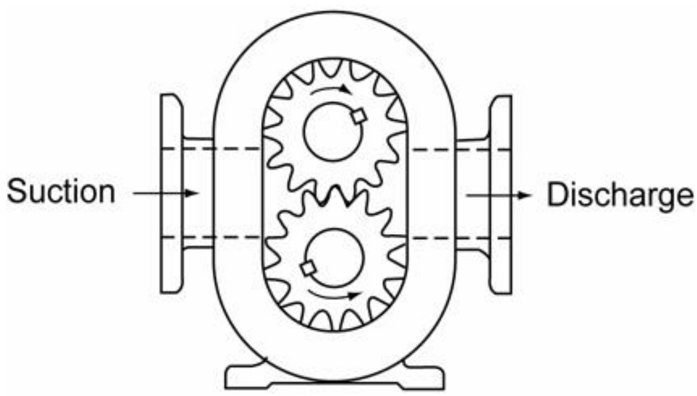

Figure 8.14 – External gear pump

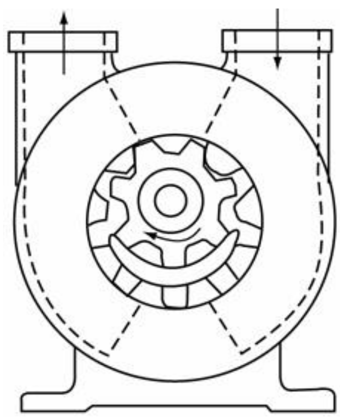

Figure 8.15 – Internal gear pump (with crescent)

8.2.2.6 Circumferential Piston

In this type, fluid is carried from inlet to outlet in spaces between piston surfaces. There are no sealing contacts between rotor surfaces. In the external circumferential piston pump, the rotors must be timed by separate means, and each rotor may have one or more piston elements.

In the internal circumferential piston pump, timing is not required, and each rotor must have two or more piston elements. Figure 8.17 illustrates an external multiple piston type. The grey portions of the figure represent the rotating parts.

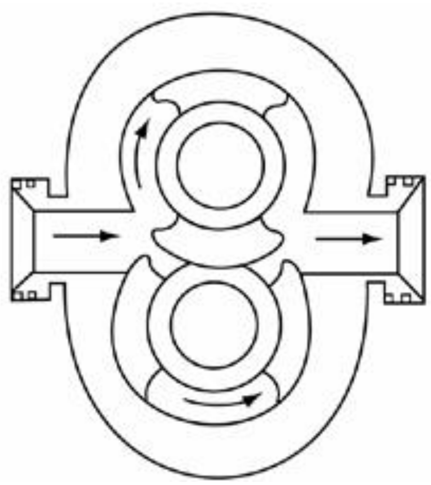

Figure 8.16 – Circumferential piston pump

8.2.2.7 Screw

In this type, fluid is carried in spaces between screw threads and is displaced axially as they mesh.

Single screw pumps, (commonly called progressing cavity pumps) illustrated in Figure 8.17, have: rotor with external threads and a stator with internal threads. The rotor threads are eccentric to the axis of rotation.

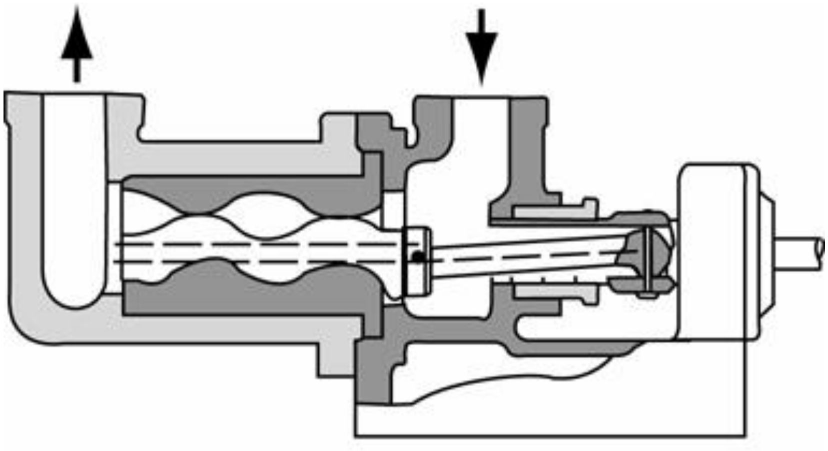

Figure 8.17 – Progressing cavity pumps

Multiple screw pumps have multiple external screw threads. Such pumps may be timed or un-timed. Figure 8.18 illustrates a two screw pump. Figure 8.19 illustrates a three screw pump.

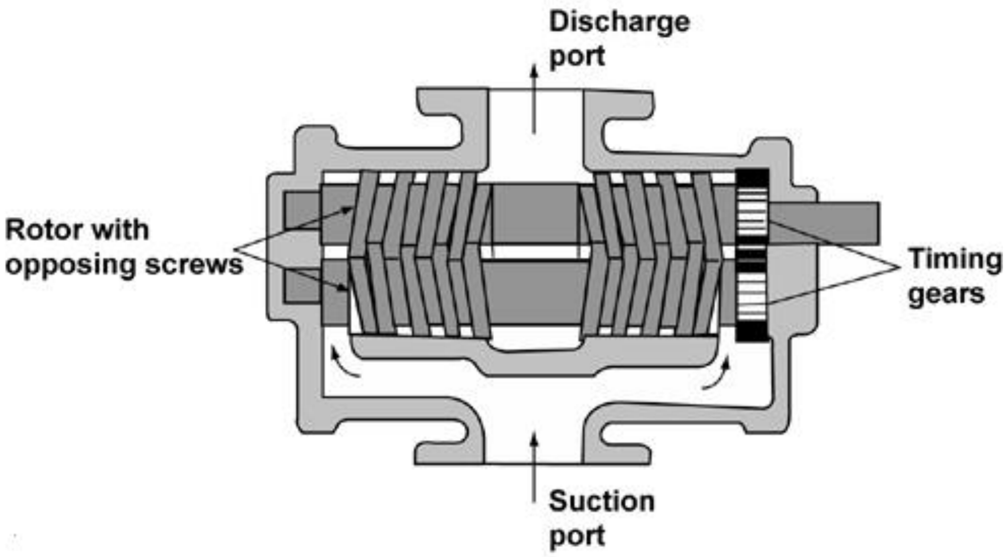

Figure 8.18 – Two screw pump

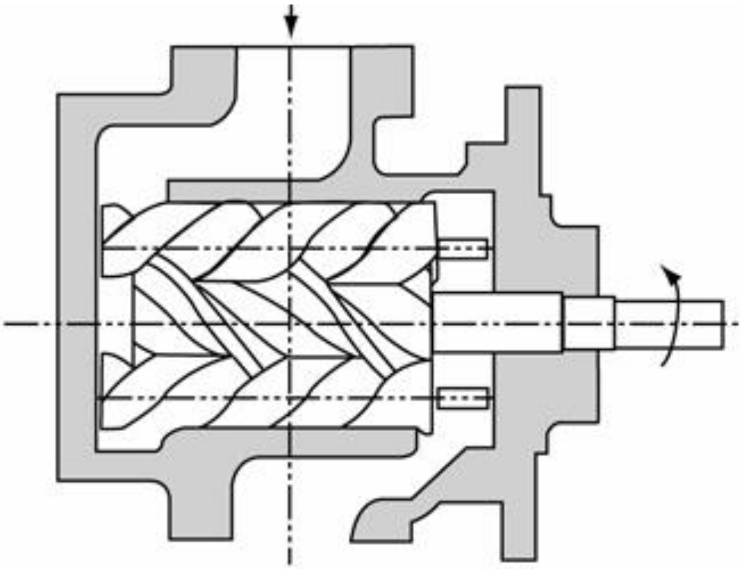

Figure 8.19 – Three screw pump