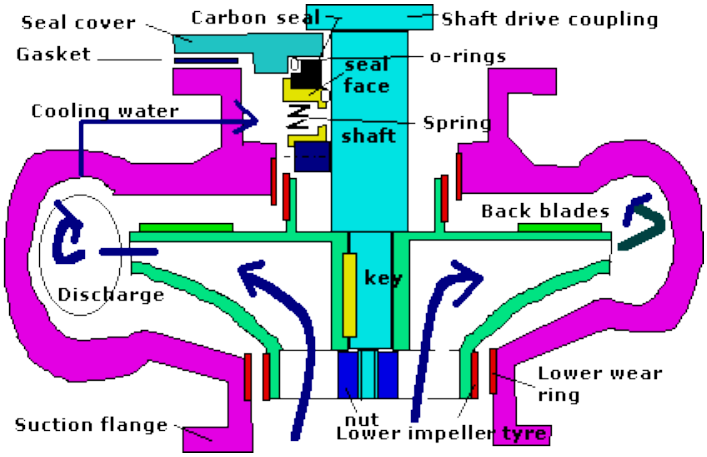
Types of pumps

Centrifugal

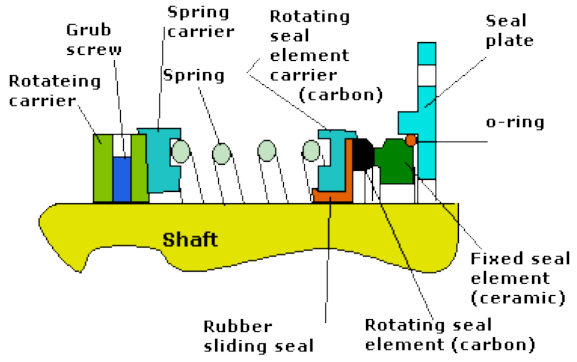


Shown above is a cross section through a vertically mounted centrifugal pump.

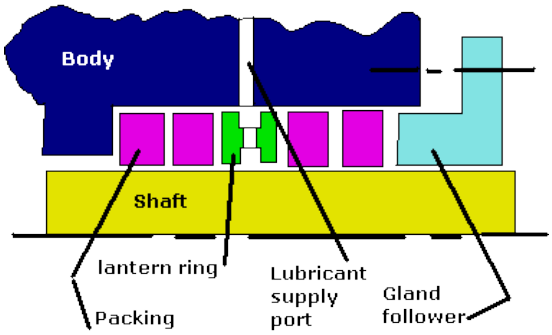
Water is led to the suction eye of the rotating impeller. The water gains energy by the centrifugal action of the pump and is discharged to the volute outlet casing. The volute is created by increasing the area of the outlet port and is greatest at outlet from the pump. By this design the kinetic energy of the water is converted to pressure energy.

Sealing is provided by a mechanical seal (one half of which is shown above and in more detail below) or by packed gland. For the former cooling water is supplied from the discharge side of the pump. For the latter cooling is provided by the allowance of slight leakage, lubrication is by a grease filled manual lubricator.

Mechanical seal

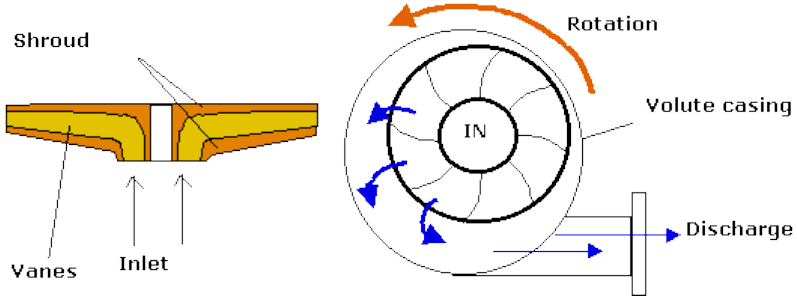


Packed gland seal



The pump unit shown above relies on the driving motor bearings for alignment. For larger pumps a leaded bronze or brass bush may be fitted positioned just below the seal. For the largest pumps, especially those fitted with an inducer the shaft may be extended below the impeller fixing and a second bearing fitted

Impellers



The kinetic energy of the fluid flowing through the impeller is converted to pressure energy by the shape of the volute casing. For high pressure pumps such as boiler feed pumps a diffuser ring is fitted in the casing which converts a greater portion of the pressure energy allowing greater pressures to be generated.

A scroll type inducer may be fitted to the inlet which improves the efficiency of unit and allows the pump to operate with low suction pressures.

Wear rings

For efficient operation it is important to ensure that leakage from the high to low pressure side is kept to a minimum. This is achieved by the use of wearing rings. Traditionally these are fitted to the casing, to increase the longevity of the impeller wear ring tyres may be fitted.

The clearance given for wear rings is often a source of contention especially when dealing with on-ship made rings. A clearance of 1/1000 of the diameter of the bore is often quoted although this may be very difficult to achieve in practice.

Axial force

Without careful design an axial force is created by the action of the impeller. This is due to the low pressure acting on the suction eye whilst the rest of the impeller is subjected to discharge pressure.

One solution is shown above where radial blades are cast into the back (stuffing box side) of the impeller. These blades are commonly called pump-out vanes, and are meant to increase the centrifugal force of the fluid trapped behind the impeller. This causes the fluid to be "thrown" outwards, reducing the pressure behind the impeller for the same reason that the impeller causes a reduction of pressure at the suction eye.

Another method which may be found in conjunction with the pump-out vanes are the balancing holes. These are holes drilled near the center of the impeller, connecting the space in the back of the impeller with the suction eye. This relief the pressure behind the impeller by allowing the high pressure fluid

trapped there to flow to the low pressure region at the suction eye. In order for this to be effective, there must be a tight clearance between the impeller and the casing to reduce the flow of fluid into the back of the impeller.

Alternately dual back to back impellers may be fitted in common with a double casing.

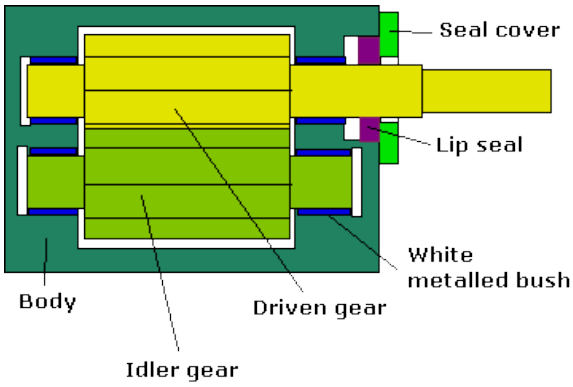
Materials suitable for general service	
Shaft	Stainless steel
Impeller	Aluminium bronze
Casing	Bronze or cast iron
Wear ring	Aluminium bronze or brass

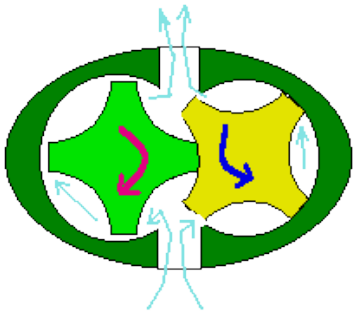
Positive Displacement

This class of pump differs from the centrifugal class by several important factors

- **Generally self priming whereas centrifugal generally require a priming means such as a belt driven priming pump**
- **Require the fitting of a safety valve to limit maximum pressure- this pump cannot be started against a shut discharge valve. Centrifugal pumps may be started against a shut or partially shut discharge valve. This is especially true for larger pumps where the shutting of the discharge reduces starting and running load. It should be noted that the partially shutting of the suction valve on both types of pumps leads to damaging cavitations.**
- **Positive displacement pumps can handle high differential pressures**
- **More suited to low to medium flow rates**
- **May operate with higher viscosity fluids then centrifugal types**

Gear

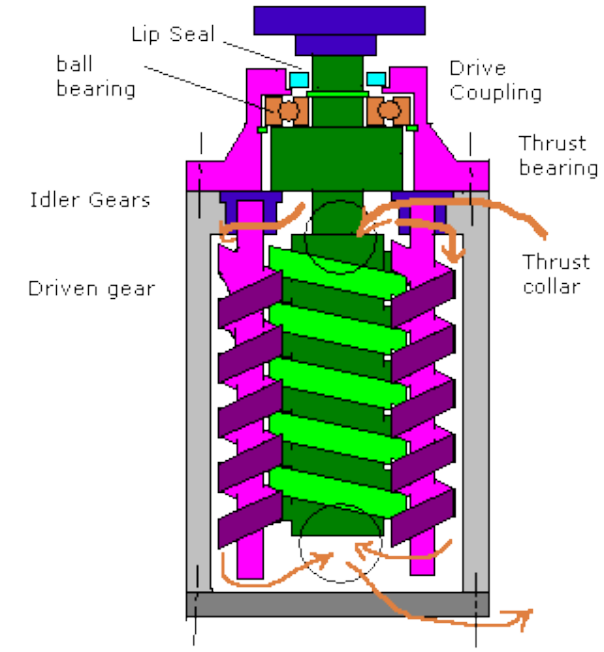


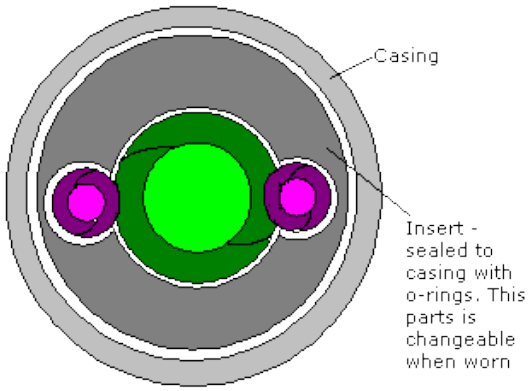


The pump shown above is of very common design. It is used for pumping many types of liquid and gas and is capable of delivering at very high pressures. This makes it suitable for hydraulic supply.

The tooth profile is similar involute gear teeth for liquid pumps. For gas pumps special profiling with very fine tolerances is employed.

Scroll

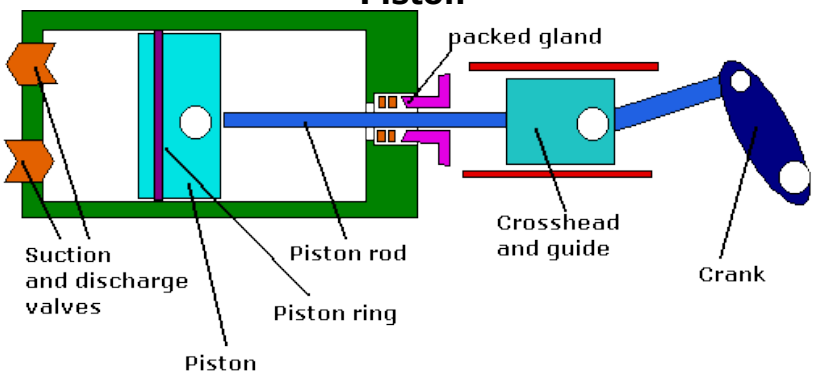




These pumps are seen in many applications and have a higher capacity then double row type. Fluid enters the pump and is screwed by the idler shafts along the outer edge to the discharge port. Axial thrust of the idlers is absorbed by the integral thrust collar of the driven shaft. The axial thrust of the driven shaft is absorbed by the thrust bearing.

The scroll sits in a replaceable insert which is sealed to the outer casing by o-rings.

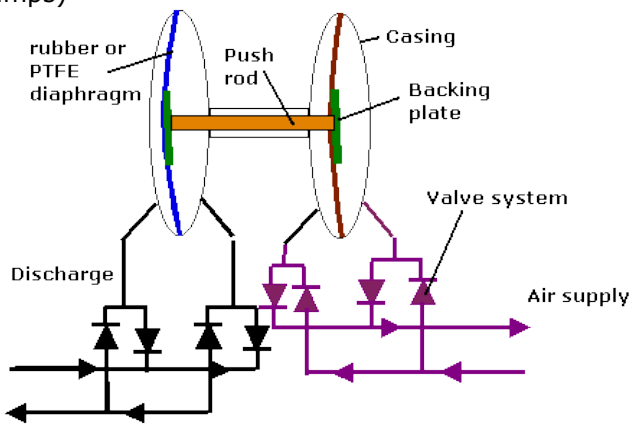
Piston



This type of pump is in common use as a bilge pump or tank stripping pump. For older vessels steam driven varieties served in almost all systems.

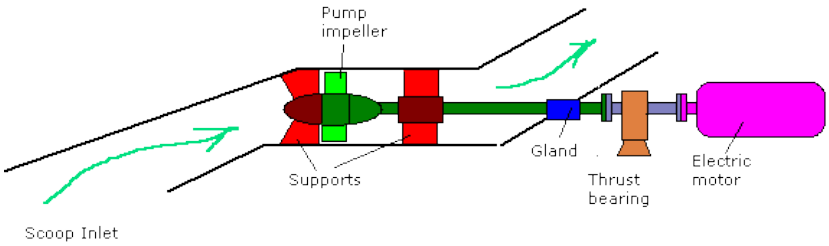
The design is simple, robust and reliable. Materials are very much dependent on the usage but bronze is common for larger parts and stainless steel for piston rods

There are many other forms of positive displacement pump such as rotary vane (often found in use as cooling water pumps, Scroll or Screw pumps were the fluid passes axially along the shaft and Diaphragm Pumps (commonly used as portable salvage pumps)



This air supply valve assembly normally takes the form of a shuttle valve.

Axial Flow



These tend to fit somewhere between postive displacement and centrifugal. They tend to be of the very large capacity type and are oftern seen in use for supply of cooling water for steam ship condensers. This is particularly true where 'scoops' are employed as the axial flow pump offers very little resistance to flow when idling.

During operation considerable end trust occurs and a tilting pad thrust bearing is employed. Guide vanes smooth flow into and out of the impeller.

Inducers

A type of axial flow pump is sometimes attached to the suction side of a centrifugal pump. This is called and inducer and is used where the suction heads are very low or where suction occurs close to the vaporiation pressure of the fluid being pump. Typical examples are the main condenser extraction pumps on steam ships and cargo pumps on LNG and LPG carriers

Cavitation

Disturbances in the water flow cause rapid localised pressure variations. This can lead to instantaneous vaporisation and bubble formation. When these bubbles collapse there is a rapid in rush of water. When this occurs near to a surface this slug of water can strike at speeds of up to 500m/s and lead to destructive erosion and removal of protective oxides thereby increasing rates of corrosion