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DESIGN AND FABRICATION OF PEDAL OPERATOR RECIPOCATING WATER PUMP

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Abstract: *A Water system includes a reciprocating pump operated by pedaling power. The pump set and includes a housing in which a foot pedal and drive shaft rotate an eccentric pin rotating with the drive shaft moves a connecting rod which in turn causes push rod to move linearly. The pushrod extends into a pressure tight chamber formed above the rising main. A pump rod connected to the push-rod extends to the conventional plunger through verified motion.*

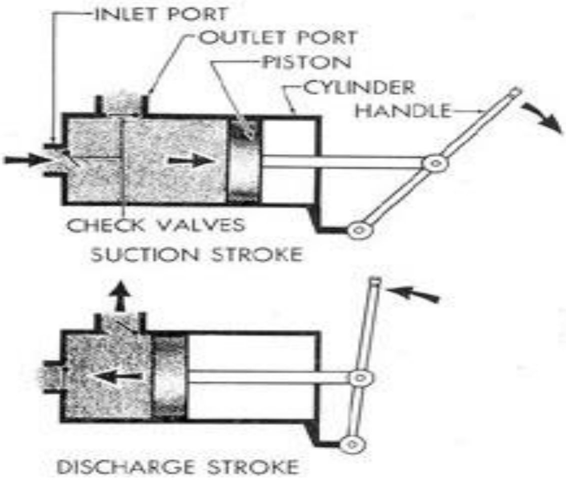
Pumps are a common means of lifting water from a clean ground water source to a useful point of access, but all pumps have moving parts and are therefore destined to break proper selection of a pump will reduce undesirable downtime and will empower the local community to manage their water source.

Here we use the foot pedal pump, powered by our legs instead of arms to lift the water from a depth range of seven meters. Throughout history human, energy has generally been applied through the use of the arms, hands, and back. With minor exceptions, it was only with the invention of the sliding-seat rowing shell, and particularly of the bicycle, that legs also began to be considered as a normal means of developing power from human muscles

A person can generate four times more (1/4 horse power (hp)) by pedaling than by hand –cranking. At the rate of 1/4hp, continuous pedaling can be done for only short periods, about 10 minutes. However, pedaling at half this power (1/8 hp) can be sustained for around 60 minutes.

The main use of pedal power today is still for bicycling at least in the high- power range (75 watts and above of mechanical power). In the lower-power range there are a number of use of pedal power for agriculture, construction, water pumping, and electrical generation that seem to be potentially advantages, at least when electrical or internal-combustion engine power is unavailable or very expensive.

I. LINE DIAGRAM



II. OVER VIEW OF HUMAN POWER MACHINE

Doubts on progress and technology **Home** **About** **All articles** **Obsolete technology** **Ecotech myths** **Low-tech solutions** **No Tech Magazine**

11 posts categorized "Human powered machines"

How to downsize a transport network: the Chinese wheelbarrow

For being such a seemingly ordinary vehicle, the wheelbarrow has a surprisingly exciting history. This is especially true in the East, where it became a universal means of transportation for both passengers and goods, even over long distances.

The Chinese wheelbarrow - which was driven by human labor, beasts of burden and wind power - was of a different design than its European counterpart. By placing a large wheel in the middle of the vehicle instead of a smaller wheel in front, one could easily carry three to six times as much weight than if using a European wheelbarrow.

The one-wheeled vehicle appeared around the time the extensive Ancient Chinese road infrastructure began to disintegrate. Instead of holding on to carts, wagons and wide paved roads, the Chinese turned their focus to a much more easily maintainable network of narrow paths designed for wheelbarrows. The Europeans, faced with similar problems at the time, did not adapt and subsequently lost the option of smooth land transportation for almost one thousand years.

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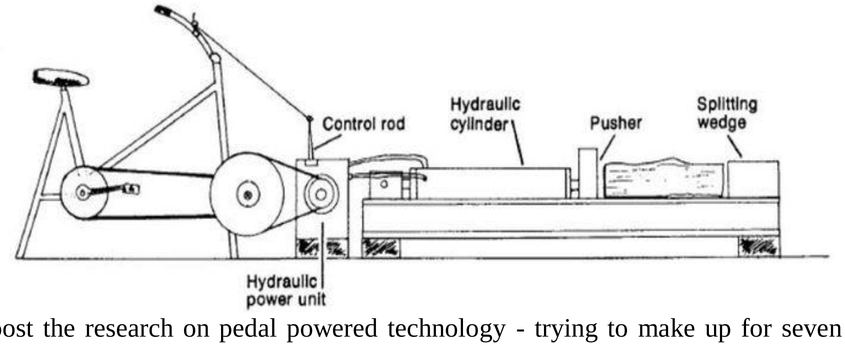
Pedal powered farms and factories: the forgotten future of the stationary bicycle



If we boost the research on pedal powered technology - trying to make up for seven decades of lost opportunities - and steer it in the right direction, pedals and cranks could make an important contribution to running a post-carbon society that maintains many of the comforts of a modern life. The possibilities of pedal power largely exceed the use of the bicycle.

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Bike powered electricity generators are not sustainable

Pedalling a modern stationary bicycle to produce electricity might be a great work-out, but in many cases, it is not sustainable. While humans are rather inefficient engines converting food into work, this is not the problem we want to address here; people have to move in order to stay healthy, so we might as well use that energy to operate machinery. The trouble is that the present approach to pedal power results in highly inefficient machines.

Continue reading "Bike powered electricity generators are not sustainable" »

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The short history of early pedal powered machines

Ever since the arrival of fossil fuels and electricity, human powered tools and machines have been viewed as an obsolete technology. This makes it easy to forget that there has been a great deal of progress in their design, largely improving their productivity.

The most efficient mechanism to harvest human energy appeared in the late 19th century: pedaling. Stationary pedal powered machines went through a boom at the turn of the 20th century, but the arrival of cheap electricity and fossil fuels abruptly stopped all further development.

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Hand powered drilling tools and machines

Hand-powered devices have been used for millennia, but during the last quarter of the 19th century a radically improved generation of tools appeared, taking advantage of modern mass production machinery and processes (like interchangeable parts) and an increased availability in superior material (metal instead of wood).

One of the outcomes included an array of new drilling machines, but their heydays were over fast. These human-powered tools were not only a vast improvement over those that came before them, they also had many advantages in comparison to the power drills that we use today.

A 1922 breast drill (picture credit).

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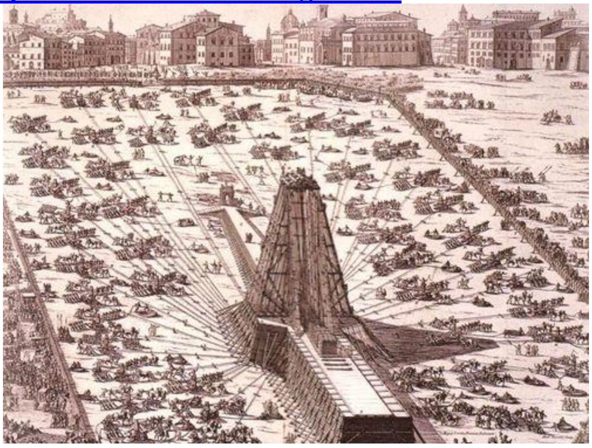
November 24, 2010

The sky is the limit: human powered cranes and lifting devices



From the earliest civilisations right up to the start of the Industrial Revolution, humans used sheer muscle power, organization skills and ingenious mechanics to lift weights that would be impossible to handle by most power cranes in operation today.

Continue reading "The sky is the limit: human powered cranes and lifting devices" »

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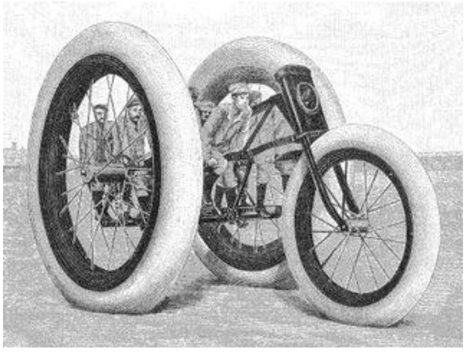
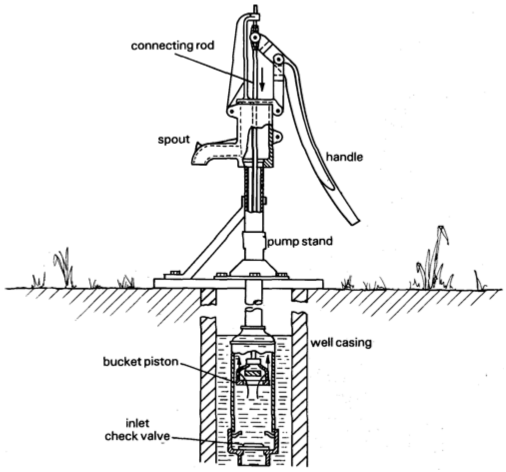
Cars: out of the way



Some readers have observed that we haven't paid any attention to one of the most low-tech innovations ever - the humble bicycle. We noted the sex-appeal of pedal power (and this concerns both men and women), but that's about it. So, since you asked for it, here is our concise but clear point of view on these human powered two-wheelers.

III. OVER VIEW OF HAND OPERATED PUMP



Hand pump

Hand pumps are manually operated pumps; they use human power and mechanical advantage to move fluids or air from one place to another. They are widely used in every country in the world for a variety of industrial, marine, irrigation and leisure activities. There are many different types of hand pump available, mainly operating on a piston, diaphragm or rotary vane principle with a check valve on the entry and exit ports to the chamber operating in opposing directions. Most hand pumps have plungers or reciprocating pistons, and are positive displacement.[1]

Types Suction and lift hand pumps

Suction and lift are important considerations when pumping fluids. Suction is the vertical distance between the fluid to be pumped and the center of the pump, while lift is the vertical distance between the pump and the delivery point. The depth from which a hand pump will suck is limited by atmospheric pressure to an operating depth of less than 7 meters. The height to which a hand pump will lift is governed by the ability of the pump and the operator to lift the weight in the delivery pipe. Thus the same pump and operator will be able to achieve a greater lift with a smaller diameter pipe than they could with a larger diameter pipe.

Siphons

Water will always try to find its lowest level. Using this principle, very simple pumps with plastic or rubber bulb with flap valve at each end are used for emptying fuel or water cans into tanks. Once the bulb is full the fluid will flow without further effort from the higher to the lower container. Many hand pumps will allow the passage of fluid through them in the direction of flow and diaphragm pumps are particularly good at this.

Thus where the levels are correct large volumes of liquid such as swimming pools can be emptied with very little effort and no expensive energy use.

Direct action

Direct action hand pumps have a pumping rod that is moved up and down, directly by the user, discharging water. Direct action hand pumps are easy to install and maintain but are limited to the maximum column of water a person can physically lift of up to 15 m.

Deep wells

Deep well hand pumps are used for high lifts of more than 15 m. The weight of the column of water is too great to be lifted directly and some form of mechanical advantage system such as a lever or flywheel is used. High lift pumps need to be stronger and sturdier to cope with the extra stresses. The installation, maintenance and repair of deep well hand pumps is more complicated than with other hand pumps.

A deep well hand pump theoretically has no limit to which it can extract water. In practice, the depth is limited by the physical power a human being can exert in lifting the column of water, which is around 80 m.

Diaphragm

Diaphragm pumps have the advantage that they pump relatively lightly due to the lack of pulling rods and are corrosion resistant. Their disadvantage is that they need a specific length of tubing and high quality rubber diaphragms, which are costly and are relatively inefficient due to the extra work needed to deform the diaphragm.

Rubber diaphragms will eventually leak and need to be replaced. Because this is usually complicated and costly, diaphragm pumps operating in poor rural areas are often abandoned once the diaphragm wears out.

Progressive cavity

Progressive cavity pumps consist of a single helix rotor inserted into a double helix stator. As the rotor is turned, the voids in the stator are screwed upwards along the axis of rotation. Progressive cavity pumps can have complicated gearing mechanisms and are difficult for local pump technicians to maintain and repair.

A rope and washer pump is a type of progressive cavity hand pump.

Range of lift

The range of lift of different types of hand pumps is given below:[2]

Type	Range
Suction pumps	0 – 7 meters
Low lift pumps	0 – 15 meters
Direct action pumps	0 – 15 meters
Intermediate lift pumps	0 – 25 meters
High lift pumps	0 – 45 meters, or more

Hand pumps and access to clean water

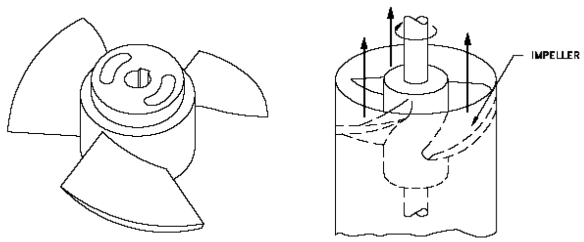
In November 2002, the United Nations Committee on Economic, Social and Cultural Rights asserted that access to clean, safe water goes beyond the classification of water as an economic commodity. The committee stressed the fundamental right of sufficient access to clean water for both domestic and personal use. “The human right to water is indispensable for leading a life in human dignity.” [3] With this in mind, manufacturers of water pumps, like those produced by GOAZ Development in Malaysia, have a wide range of potential customers: governments, non- governmental organizations, women’s groups, community groups and other organizations of various types interested to developing access to groundwater.[2]

However, there is controversy surrounding the sustainability of hand pumps, and the long-term gains from investing in them. A number of difficulties are associated with the use of hand pumps: these include cost, hygiene, maintenance, and availability of spare parts, responsibility of upkeep, community involvement, technology, organization and education. Hand pumps, battered by intense use and conditions in rural areas, have often fallen apart. In addition, unobtainable spare parts impede maintenance.

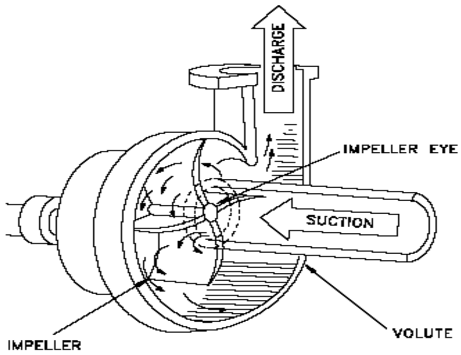
IV. COMMON USED PUMP IN DOMESTIC & INDUSTRIES

CENTRIFUGAL PUMP

A centrifugal pump is one of simplest rotating equipment in any process plant. Centrifugal pump may be single stage (one impeller) or multistage (multiple impeller) and can be horizontal split or barrel type or vertical type. Higher the delivery/discharge pressure required more the number of impellers will be needed. In centrifugal pump energy is imparted to the fluid in form of velocity or kinetic energy and which is then converted into pressure energy of the fluid that is being pumped. This form of energy change occurs by virtue of two main parts of the pump. First the rotating part impeller imparts kinetic energy to the fluids and then the stationary part diffuser or volute converts kinetic energy of the fluid into pressure energy. All the forms of energy involved in a fluid flow system are expressed in terms of Head or height of liquid column discharged by the pumps.



Axial Flow centrifugal pump



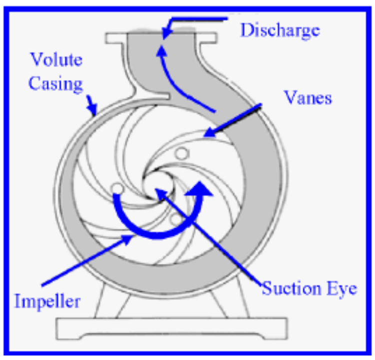
Mix flow Centrifugal pump

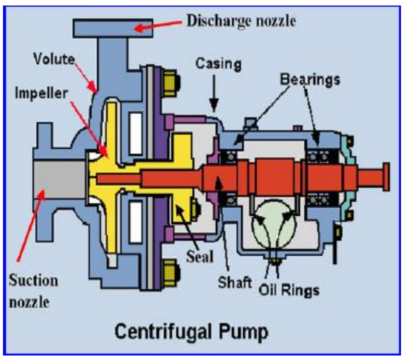
Principle:

The process liquid enters through the suction nozzle of the pump and then into eye (center) of the impeller. When the impeller rotates, it spins the liquid in the space between the vanes and throws outward in the volute and provides centrifugal acceleration. As the liquid leaves the eye of the impeller a low pressure area is created causing more liquid to flow at the inlet. Because the impeller blades/vanes are of curve shape, the liquid is pushed in a tangential and radial direction by the centrifugal force. The energy created by the centrifugal force is kinetic energy and proportional to the velocity at the edge or vane tip of the impeller. The higher the RPM of the impeller or bigger the size of the impeller, higher will be the velocity of the liquid and greater kinetic energy will be imparted to the liquid. This kinetic energy of the liquid leaving the impeller is then harnessed by creating a resistance to the flow.

The pump volute or diffuser creates the first resistance and then in the discharge nozzle where it gets further de-accelerated and the kinetic energy is converted into pressure energy according to Bernoulli's principle. Therefore, the head (pressure in terms of height of liquid column) developed shall be approximately equal to the kinetic energy imparted at the periphery of the impeller.

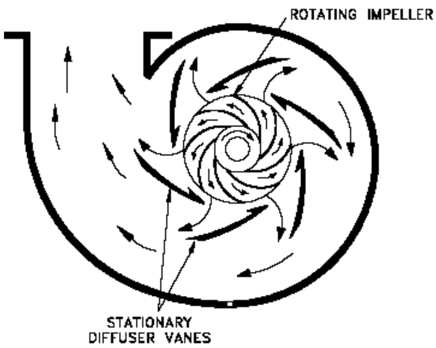
In axial flow pumps the principal of working is different as volute and diffusers are not there, so Kinetic energy imparted by impeller gets converted partially into pressure and partially it remains in same form.



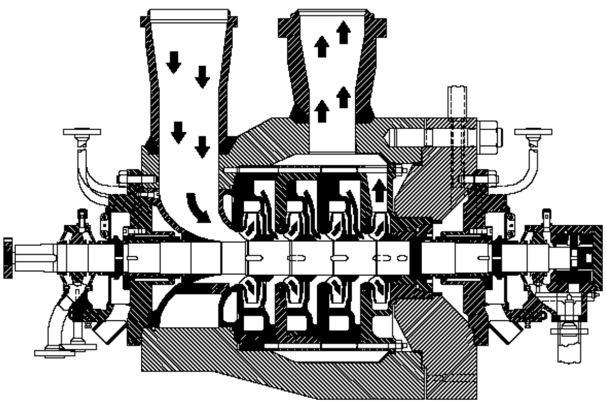


Pump curves related to the flow rate and pressure (head) developed by the pump at different impeller sizes and RPM. The centrifugal pump operation should confirm to the pump curves supplied by the manufacturer.

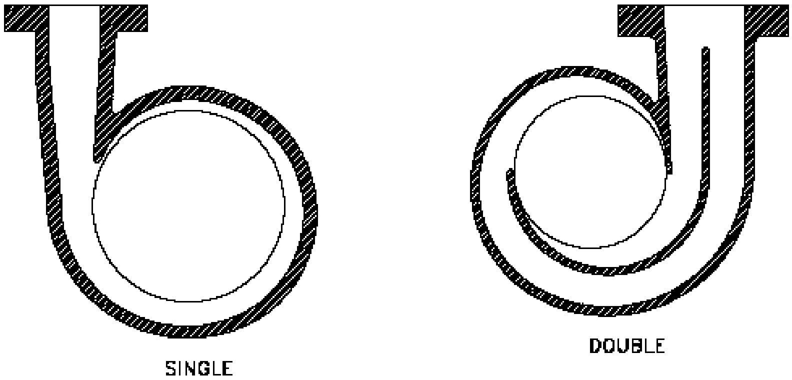
Construction of Centrifugal Pump:
Generally a single stage centrifugal pump consists of the following main parts
-A casing with volute
-An impeller (closed vane or open vane)
-A shaft
-A gland housing with gland packing or Mechanical seal assembly
-Anti friction bearings
-Lantern rings
But in multistage centrifugal pumps there are much more components listed as below:
-Casing (split horizontally or barrel type)
-Shaft with keys
-Impellers for all stages
-Diffuser / diaphragms For all stages
-Shaft sleeves or Impeller sleeves
-Impeller neck rings
-Wearing rings
-Throttle bush or Throat bush
-Diffuser bush
-Drive end (DE) and Non Drive end (NDE) bearing housing
-Bearings thrust and journals,
-Oil seal
-Mechanical seal assemblies
-Oil labyrinths
-Anti rotation devices
-Lip seals
-Balancing device with corresponding bush
- Coupling hub etc.



Sketch showing the functioning of Diffusers in Centrifugal pumps



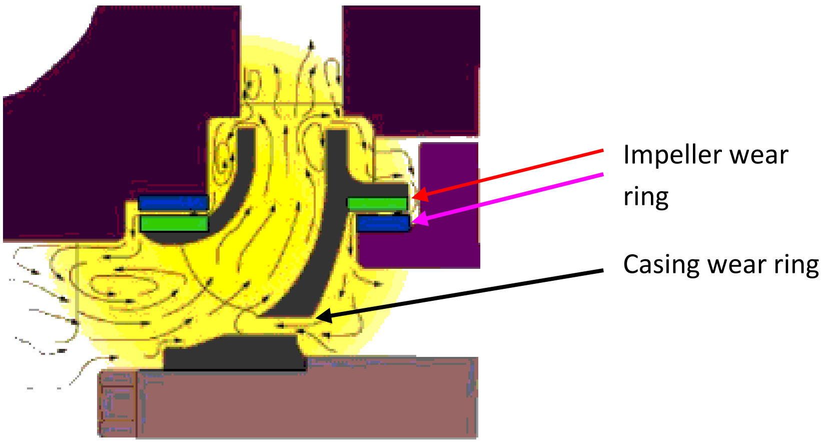
A barrel type multi stage pump



Pump casings with single volute and double volute

Shaft Sleeve/Impeller sleeve:

These are used in single stage pumps. Impeller and sealing gland are not directly mounted on shaft. A sleeve is fitted between the bore of the impeller and OD of the shaft and keyed with the shaft i.e. impeller rotate with the sleeve along with the shaft. The wearable part in this type of assembly is the sleeve, which is far less expensive than the shaft. The function of the impeller sleeves is to protect the shaft from wear and coming in contact with the pumping fluid.



Wear ring / Casing ring:

Wearing ring provide easy and economically renewable relative movement joint between the impeller and the casing and to protect the damage of impeller or casing in that area. OEM generally recommends the clearances between the casing wear ring and impeller wear rings and if these clearances exceeds, pump efficiency will be lowered and abnormal vibration increase will be some of the consequences.

Impeller:

This is the main rotating parts of the pump that imparts the centrifugal acceleration to the fluid. Impellers may be classified in many ways. For example:

-According to the direction of flow in reference to the axis of rotation of the shaft:

i) Axial flow,
ii) Radial flow
iii) Mixed flow

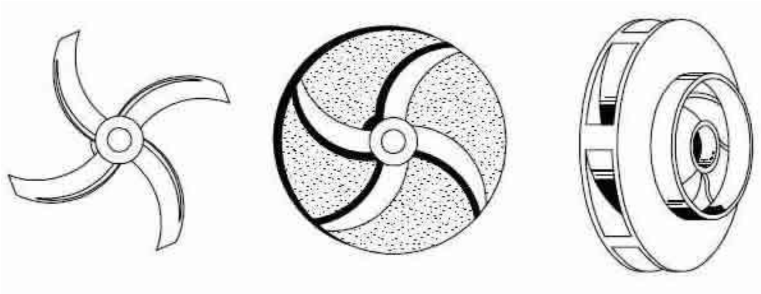
-According on suction type

i) Single suction
ii) Double suction

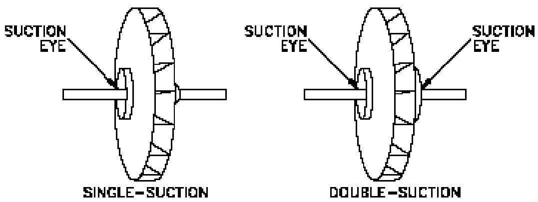
-According to mechanical construction of vanes

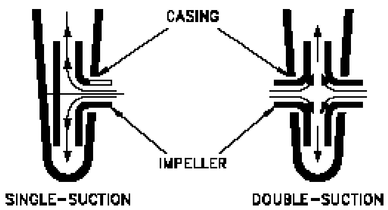
i) Closed vane type

ii) Open vane type
iii) Semi open type.



Open vane Impeller   Semi open Impeller   Closed vane impeller





Gland Housing/Stuffing Box and shaft sealing:

To seal the leakage of fluid from where the shaft penetrates out the pump casing, a gland packing assembly or Mechanical seal assembly is provided and this assembly is fitted in the Gland housing / Stuffing box provided in the pump housing. Specially made asbestos/glass fiber / filled Teflon rings are used for sealing which is mounted between the stuffing box housing and shaft sleeve. Gland packing is very economical to use but this requires renewal at fix interval. Also gland packing do not gives zero leakage assembly by any mean. For cooling of gland ropes small amount of leakage is mandatory to maintain. For non toxic, non critical services gland packing is used in industrial pumps but mechanical seal assembly are used for all hazardous services.

Throttle Bush / throat bushing:

Throttle bush is a stationary device, which forms a restrictive close clearance around the shaft in the pump casing just in front of gland housing. This helps in reducing the fluid flow load on mechanical seals and also helps in maintaining the flushing fluid pressure in the gland boxes.

Lantern ring:

Basically lantern ring are provided in the stuffing box in case of gland packing rings sealing system to give a recess and to cool the gland packing rings/elements with the pump fluid. It is installed between or in the middle of the gland packing elements and a cooling line is connected just above the lantern ring from the pump casing.

Bearing Housing:

The bearing housings are equally critical parts and they encloses the bearings in the drive end and non drive end of the pumps. These housings keeps the shaft or rotor assembly in correct alignment with the stationary parts under radial and axial loads. The bearing housing are built with required oil reservoir for bearing lubrication and water jacket for circulating cooling water for bearing cooling. Now a day’s bearing jackets are avoided as studies shows that oil cooling is more effective than jacket cooling of bearing housings.

Axial thrust of a Centrifugal pump and its balancing:

In centrifugal pumps, the impeller is surrounded by fluid at different pressure at different locations in the casing. This variation in pressure on the surface of the impeller during running condition creates axial hydraulic thrust, which is the summation of unbalanced impeller forces in the axial direction.

In case of multistage pump if all the impeller suction faces are in the same direction the total theoretical axial thrust acting towards the suction end of the pump will be sum of the individual impeller's thrust in that direction. There are various methods which can be employed to counter balance this hydraulic axial thrust in multistage pumps. Some times more than one technique is used to take advantages of these methods. These are as below:

-Provision of balance drum/balance stepped drum
-Provision of balancing disc
-Provision of combination balancing disc-drum
-Provision of impeller back side wearing ring and balancing hole
-Provision of double suction impeller
-Provision of fixing of impellers in back to back configuration

In single stage pumps, additional balancing devices are seldom used. Big single stage pumps are generally designed with double suction impellers and smaller pumps are provided with provision of balancing holes, back side wear rings etc. The residual thrust is taken care by the thrust bearings.

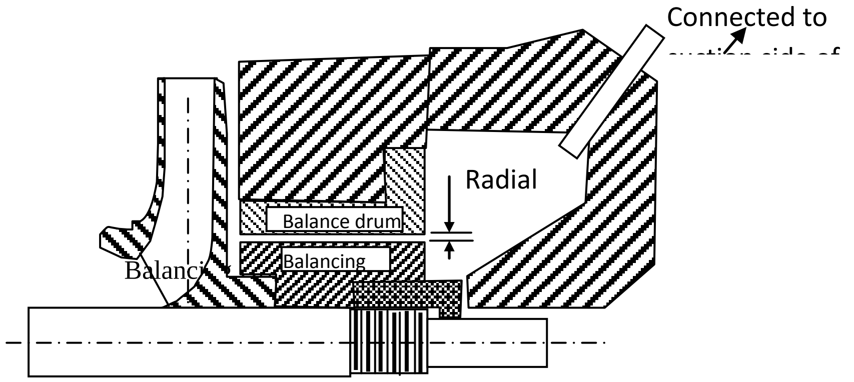
Multistage pumps are generally built with single suction impellers however some manufacturer's uses double suction impeller in first stage of the pump assembly. Single suction impellers may be mounted on shaft and each impeller suction eye facing in the same direction and its stages are arranged one after another in an ascending order of pressure and the total axial thrust is balanced by hydraulic balancing devices. But in this type of assemblies the resultant axial thrust is generally very high and a big size balancing device is needed along with suitably big thrust bearing. However this type of assemblies is easy to make and require lesser grades of skill in maintenance.

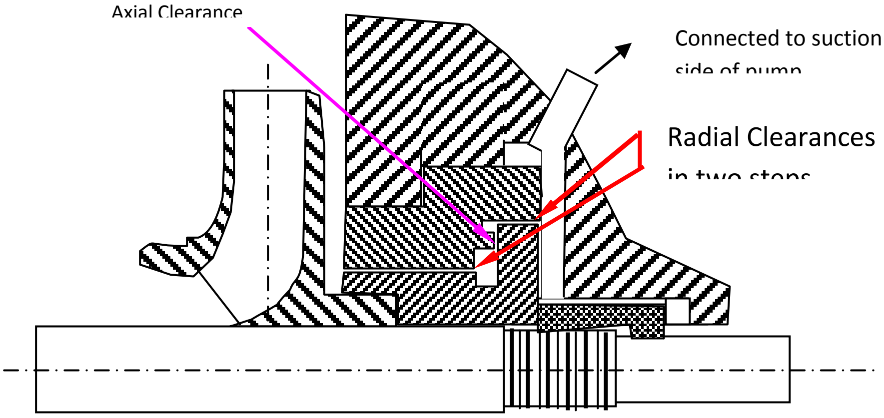
More efficient, more balance multistage pumps are made with impellers fixed in tandem up to middle stage and than in reverse direction again in tandem up to final stage. Combination of two tandems in back to back neutralizes the axial thrust and resultant axial thrust is minimum and can be taken by the nominal size thrust bearing. These types of assemblies are requiring exact calculations and skilled group to assemble. Manufacturer makes arrangement of interstage connections in such a way that no out side lines are required to be connected. Impeller dimensions and weights of each stage is very critical for such type of assemblies and casing designs become very difficult.

Balancing Devices.

Balancing device is an additional part which is fixed in the assembly to neutralize the axial thrust while in operation. In this system a balancing drum is attached with the shaft to rotate with the shaft at the back of the last stage impeller and there is a balancing chamber which is connected to the pump suction. The radial clearance between stationary balancing bush and rotary balancing drum is very critical.

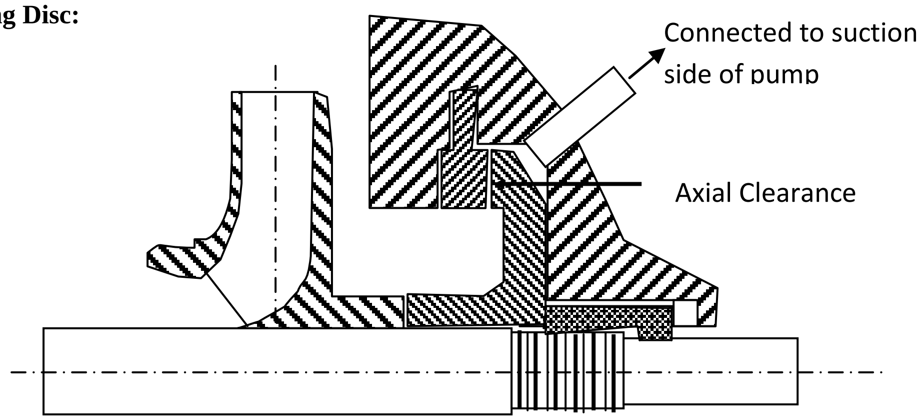
One of the latest developments in this category is the stepped drum design. This type of design is employed on BFW pumps of super thermal power plants where multi stage pumps develop pressures of 200 kg/cm2.





Two forces acting on the balancing drum are:
i) Towards the discharge end which is discharge pressure multiplied by the front balancing area=F1
ii) Towards the suction end which is back pressure or pressure in the balancing chamber multiplied by back balancing area=F2
As the cross section area on two sides is equal but the pressure on impeller side is high, therefore force F1>F2 . Therefore the axial thrust generated in the multistage single suction impeller assembly is counter balanced by the additional balancing device.

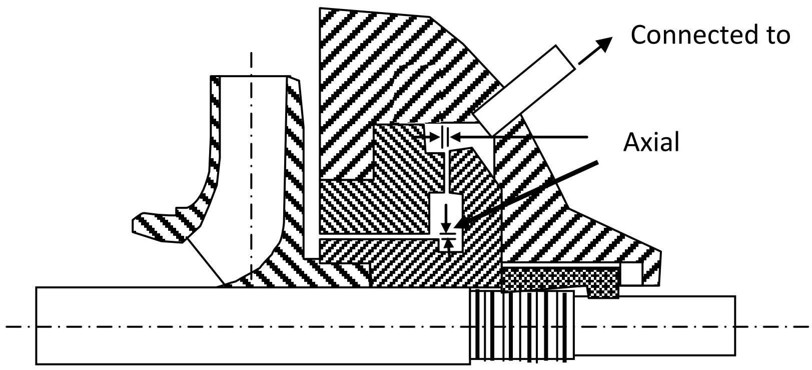
Balancing Disc:



Balancing Disc

The functioning of the balancing disc is same as that of balancing drum. This is a compact device as compared to balancing drum and is employed for comparatively smaller high pressure pumps. In this device a balancing disc is allowed to rotate with the shaft and this disc is separated from the balancing disc head, which is fixed to the pump casing with a small axial clearance. The back of the balancing disc is subject to the balancing chamber backpressure and the disc face is subjected to the discharge pressure of the pump. There is a continuous leakage through the axial clearance between the disc and the disc head, and fluid flows into the balancing chamber. If the axial thrust of the impeller at any moment exceeds the thrust on the disc, the disc assembly moved towards the disc head reducing the axial clearance between the disc and disc head and reduced the leakage which in turn lowers the back pressure in the balancing chamber. This lowering of pressure automatically increase the pressure difference acting on the disc and move it away from the disc head, increasing the clearance until an equilibrium condition is reached.

Combination of Balancing drum and Balancing disc:



Combined Disc

Material of Construction of Pump Components:

Except the mechanical seal mating faces, none of the pump components comes in direct contact with each other, however the service of the pump, in which it has to perform, dictates the material of construction of the pump components. The following criteria should be considered important in the selection of MOC of the pump components

i) Corrosion Resistance
ii) Abrasive Wear Resistance
iii) Cavitations Resistance
iv) Strength
v) Tensile Strength
vi) Endurance Limits
vii) Fatigue Strength
viii) Cost
ix) Maintenance

All components of pump may not be required to fulfill all above mentioned criteria. Depending upon the function it has to perform, different components require meeting some or all the above criteria to be found suitable for selection. e.g. MOC of an impeller is required to meet requirements of corrosion resistance, abrasive wear resistance, cavitations resistance, shall be suitable for casting and machining properties but for shaft of pump it is required to meet only endurance limits, tensile strength, hardness, corrosion resistance and machining properties.

For pump casing material of construction shall have properties equivalent to impeller MOC.

The most widely used materials in pump components are cast iron, bronze, cast steel, austenite steel, and marten site steel and different grades of plastics, selected according to application. During selection of material cost and availability should also be considered. Unnecessary costly material should not be used unless it is required for the service.

Future maintenance shall also be a point to consider for the selection of the material of construction of the components. Some of the components are required to be replaced during the normal operation after normal wear & tear however, major components are designed to perform for the service life but maintenance of all parts shall be considered at the time of selection.

Mechanical seal:

Mechanical seals are the positive sealing devices used for the sealing of fluids at the shaft end of the pumps. Now days in petrochemical industries and refineries, mechanical seals as per API 682 are only approved seal designs which can be used on pumps. Very stringent requirement of API code have forced seal designers and manufactures to innovate newer quality products to enhance the seal efficiencies.

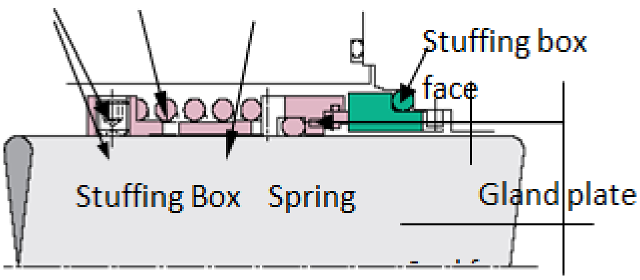
The conventional stuffing box design with gland packing rings is impractical for many service conditions. In the ordinary stuffing box the sealing between the rotating shaft and the stationary gland casing (where the shaft penetrates the casing) is accomplished by means of gland packing ring elements held tightly in the stuffing box around the shaft sleeve and gland follower. After certain time of operation, the gland packing leakages starts due to nominal wearing. Gland follower is further tightened to stop the leakages.

In this way the shaft/sleeve and gland pickings get worn out and the renewal of the parts has to be done for further service. In gland packing, as the sealing is achieved by tightening of the packing rings directly between the rotating and stationary parts, lot of energy or power is lost.

To eliminate this problem and where minimum leakages is required due to expensive or hazardous chemicals, Mechanical seal is required to be installed. In big cooling water pumps, the replacement of gland packing with mechanical seals gives benefit of power up to 7%.

The mechanical seal is a device where two mating surfaces (one is rotating with the shaft and another is stationary) are located in a plane perpendicular to the shaft axis. The two mating surfaces are highly polished and of dissimilar material of which one is keyed to the shaft / shaft sleeve to rotate with the shaft and another one is fixed in the seal chamber/housing which seal the liquid. The basic objective of the mechanical seal assembly is to prevent leakages of fluid. Other than these two main parts there are number of elastomers to prevent path of leakages through sleeve, sealing faces, etc., springs and spring retainer to exert axial force, gaskets, gland plates, sleeve etc. The fundamental principle of mechanical seal operation is the development and maintain of liquid film between the two mating surfaces. This microscopic film of liquids acts as a cushion for the seal faces, preventing and minimizing wear and dissipation of heat generated due to rubbing action. The rotating face may be of carbon graphite, tungsten carbide, silicon carbide and the stationery face may be of one of the above but, if the stationary face is carbon graphite then the rotating face should be of dissimilar material of silicon carbide/tungsten carbide and vice versa i.e. if the stationary face is soft then the rotating face should be hard or vice versa.

This selection of material varies from manufacturer to manufacturer and both have some advantage and disadvantages.



A single spring dual direction seal

Some important maintenance tips during installation of mechanical seal and for its better life are as below:

a) Stuffing box face:

The stuffing box face should be square or perpendicular to the shaft axis otherwise resulting in wrong fixing of stationary element of the seal in gland plate. This will results in seal wobble and not having full face contact in running and rotary head may get elliptical movement against stationary.

b) Concentricity of the stuffing box: The stuffing box should be concentric to the shaft axis within 0.08mm.

c) Lateral or axial movement of shaft (end play): The mechanical seal cannot function satisfactorily with great amount of end play. If the hydraulic condition changes, which happens frequently and if the hydraulic axial balance is not effective, the shaft may float and leading to seal troubles. The total amount of shaft/rotor end play should be within 0.08mm ~ 0.2mm

d) Radial movement of shaft (whip or deflection): Excessive whip or deflection can lead to seal failure and poor sealing performance. The radial movement of shaft should be 0.05mm ~ 0.08mm.
e) Alignment of driver: Driver alignment is by far the most frequent encountered pump problem. The poor alignment causes axial and radial vibrations resulting in failure of seal.

2.1Characteristic of Centrifugal pumps:

The key performance parameters of centrifugal pumps are capacity, head, BEP (Best Efficiency Point) and specific speed. The pump curves provide the operating window within which these parameters can be varied for satisfactorily pump operation.

End user supplies the data of the requirements and manufacturer makes the pump to full fill the requirement of the end user. Basic requirements and manufactured product performances are plotted on the graph and the intersecting points are known as rated capacity. This graph of plots of performance of pump is known as performance curves or characteristic curves of the pump.

Inability to deliver the desired flow and head is one of the most common conditions for making a pump out of service. Many times when the pumps are opened with low or no delivery conditions but on opening no fault is observed.

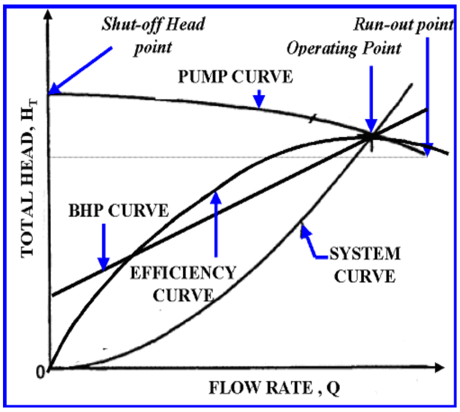
In such conditions, there are three type of problem which mostly encountered are:

-Design error
-Poor process operation
-Poor maintenance practices.

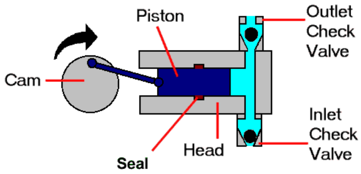
These problems can be identified when the current performance of the pump is judged against the characteristics of the pump. The deteriorated parameter shall be further analyzed and then the problem shall be settled.

The performance of any pumping system can be marked in terms of its capacity or flow (Q) and pressure (head).The variation curves of capacity versus pressure of a particular pump are known as pump performance curve.

The plot starts at zero flow and the head at this point corresponds to the shut off head of the specific pump. The curve then decreases to a point where the flow is maximum and the head is minimum. This point is called run-out point. The pump curve is relatively flat and the head decreases gradually as the flow increases. Beyond the run-out point, the pump cannot operate. The pump's range of operation is from the shut-off head point to the run-out point.



V. RECIPROCATING PUMP



Reciprocating Pumps- classifications-construction and working of single acting and double acting reciprocating pumps-plunger and piston pumps-discharge of a reciprocating pump-theoretical power required-coefficient of discharge-slip-problems-negative slip-indicator diagram-separation-air vessel (functions and working) Special pumps-jet pump-Turbine pump-Submersible pump.

Reciprocating pumps:

These types of pump operate by using a reciprocating piston. The liquid enters a pumping chamber via an inlet valve and is pushed out via a outlet valve by the action of the piston or diaphragm.

Reciprocating pumps are generally very efficient and are suitable for very high heads at low flows. This type of pump is self priming as it can draw liquid from a level below the suction flange even if the suction pipe is not evacuated. The pump delivers reliable discharge flows and is often used for metering duties delivering accurate quantities of fluid.

The reciprocating pump is not tolerant to solid particles and delivers a highly pulsed flow. If a smooth flow is required then the discharge flow system has to include additional features such as accumulators to provide even flows.

Reciprocating pumps designed for delivering high pressures must include methods for releasing excessive fluid pressures. The pumps should include for built in relief valves or relief valves should be included in the fluid circuit which cannot be isolated from the pump. This feature is not required for safety for the air operated diaphragm valve.

VI. MAJOR COMPONETS OF PEDALOPERATED DRILLIING MACHINE

1. **Piston**
2. **Cylinder**
3. **Rod**
4. **Water seal**
5. **pedal link**

1. PISTON

Piston is used to pressure creating component. It is made of steel. It is reciprocating in side the cylinder. Very close tolerance is maintained with cylinder.

1. Cylinder

Cylinder is used to reciprocate the cylinder with close tolerance. Piston will develop the maximum pressure Cylinder is made of mils steel.

2. Rod

It is connect the piston and foot pedal. It is also used push the piston according to the foot pedal action. Rod is used to connect the piston and foot pedal pump link. The maximum pressure is achieved pumping lifting height. It will convert angularity motion to linear motion.

3. Water seal

The primary seal consists of two rings (a primary and mating ring) that are lapped to a high degree of flatness and then loaded against one another by means of a spring. One of these rings will rotate in accordance with the shaft of the pump and rub against the other ring creating a seal for the fluid. The material composition of the primary and mating rings varies depending on duty and life expectancy goals for the application. **The secondary seal** consists of molded rubber components which are held in place via an adhesive or mechanical press. These secondary sealing components form the seal between the rotating faces and the metallic components (spring, retainer, ferrules and sleeve) used to load the faces and to allow the pump builder to install the seal quickly and efficiently.

4. Pedal link

This type link is used to connect the piston rod and foot step mechanism. This link is very sturdy due it will withstand cyclic load.

VII. DESIGN ASPECTS AND OPERATION

PROPERTIES OF MILD STEEL

PHYSICAL PROPERTY

Density - 7860 Kg/m3
Melting point - 1427c
Thermal conductivity - 63 W/ m K

CARBON CONTENT

Low Carbon (or) Mild steel - 0.15% to0.45% carbon

MECHANICAL PROPERTY

- Elasticity
- Ductility
- Toughness
- Weld ability

In our design, screw type clamp, Body of jig have a main part hence the calculations are concentrated on it

VIII. DESIGN CALCULATIONS FOR PUMP

To calculate the volume of the cylinder

Volume=Area*length

Area= (π/4*D$^{2)}$ X L

D=Diameter of the piston,

D=110mm.

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L=.90mm

=855.29m^3.

DESIGN FOR CYLINDER

● The force exerted on in stroke can be expressed as :

$$\mathbf{F = p \; \square \; (d_1^2 - d_2^2) / 4}$$

Where,

P = Initial pressure (N\m²)
d_1 = full bore piston diameter (m)
d_2 = piston rod diameter (m)

For Example:

P = 1 bar (assumed)
π = 3.14
d_1 = 0.11m
d_2 = 0.010m

$F = p\,\pi\,(d_1^2 - d_2^2) / 4$
$F = 1x10^5x3.14x\,(0.11^2 - 0.010^2) / 4$
$F = 1884955.592x2.275x10^{-3} / 4$
$F = 942$ N

IX. OPERATIONS INVOLVED

- Turning (facing, plain turning, step turning , threading etc)
- Facing (flat surface)
- Drilling
- Gas cutting (flat plate, cylindrical rods)
- Shaping
- Welding
- Tapping
- Thread cutting

TURNING

Turning is the operation of reducing a cylindrical surface by removing material from the outside diameter of a work piece. It is done by rotating the work piece about the lathe axis and feeding the tool parallel to the lathe axis. Due to this operation screw rod and head are done by the turning operation to get the required shape.

FACING

Machining the end of the work piece to produce flat surface is called facing. Due to this, the plate can get flat surface have done by the facing operation.

DRILLING

Drilling is the operation of producing cylindrical hole in work piece. It is done by rotating the cutting edge of the cutter known as drill bit. In this Project the jig plates require holes for locating indexing plate and screw rod, drill bush assembly. These holes are done by conventional vertical drilling machine.

THREAD CUTTING

Thread cutting is the operation of forming external thread of required diameter of rod by using a multipoint tool is called thread. This process is used in screw clamp to done on the rod which is used for the movement of the movable plate

FINE GRINDING

It is nothing but the grinding process, which is done as smooth with fine grains. This is done as the each plate and base plate for good surface finish. It is done by conventional grinding machine.

GAS CUTTING

It is used to break are cut the plates. In this project it is used to cut the raw materials such as plates. This done by gas cutting machine.

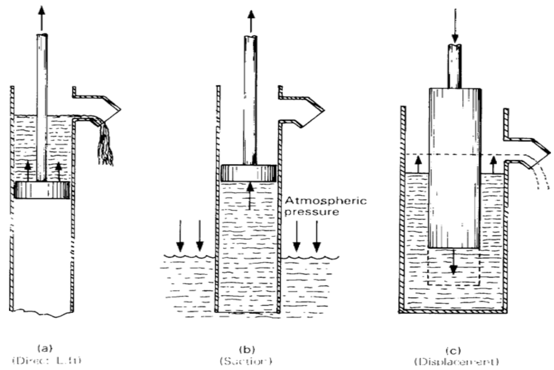
SHAPING

Shaping operation is used to reduce the dimensions of the plates. In this project the plates are in need of shaping process. It is done by shaping machine.

WELDING

It is the process, which is used to join two, is more similar materials as well as dissimilar materials. In this project it is used to join the jig plate one to another. This is done by arc welding machine.

X. WORKING PRINCIPLE



Pumps are a common means of lifting water from a clean ground water source to a useful point of access, but all pumps have moving parts and are therefore destined to break proper selection of a pump will reduce undesirable downtime and will empower the local community to manage their water source.

Here we use the foot pedal pump, powered by our legs instead of arms to lift the water from a depth range of seven meters. Throughout history human, energy has generally been applied through the use of the arms, hands, and back. With minor exceptions, it was only with the invention of the sliding-seat rowing shell, and particularly of the bicycle, that legs also began to be considered as a normal means of developing power from human muscles.

A person can generate four times more (1/4 horse power (hp)) by pedaling than by hand –cranking. At the rate of 1/4hp, continuous pedaling can be done for only short periods, about 10 minutes. However, pedaling at half this power (1/8 hp) can be sustained for around 60 minutes.

The main use of pedal power today is still for bicycling at least in the high- power range (75 watts and above of mechanical power). In the lower-power range there are a number of use of pedal power for agriculture, construction, water pumping, and electrical generation that seem to be potentially advantages, at least when electrical or internal-combustion engine power is unavailable or very expensive.

XI. COST ESTIMATION

TOTAL = 3580.00

S.NO	Name of the part	Weight in kg	Cost RS.
1.	Cylinder arrangement	3	1680
2.	Pedal mechanism		400
3.	Assembly work		1200
4.	Hose accessories		300

LABOUR COST

Lathe, drilling, shaping, welding, riveting, turning, painting, surface grinding and gas cutting.

Cost = Rs 1800.00

TOTAL COST

Total cost = material cost + Labour cost
= 3580 + 1800
= 5380.00

Total cost for this project = Rs 5580.00

XII. ADVANTAGES AND APPLICATIONS

ADVANTAGES

- It is used for to achieve manual operated water pumping non automated by simple mechanism.
- Its operation and maintenance is very simple.
- It is compact and portable.
- It is simple and rigid in construction.
- Manufacturing cost is lesser than modern water pumping machine.
- It provides better speed changes method on the driving unit.
- Power saved and good exercise for all people.

APPLICATIONS

This device find place in almost all industries.

DISADVANTAGES

1. Continuous pedaling action is required for system operation so that lot of work can not executed.

XIII. CONCLUSION

This project focused on modeling, design and control of pedal operated water pumping, with emphasis on lightweight, portable appliances. . An innovative method of minimizing manual stress and thus reliably stabilizing the pumping was also presented. The project carried out by us made an impressing task in the industrial purpose. It is very useful for the small scale works

This project has been designed to perform the entire requirement task, which has also been provided.