"DESIGN & FABRICATION OF PEDAL POWERED WASHING MACHINE"

A Project Report

Submitted in partial fulfillment for the

Award of the degree of

BACHELOR OF TECHONOLOGY

IN

MECHANICAL ENGINEERING

Submitted by

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(2015-2016)

DECLARATION

We hereby declare that we are **Student of Mechanical Engineering, IIMT, Ghaziabad.** We are working on project under the guidance of **Mr. M. K.PODDAR** Further, this work has been submitted in full to obtained degree of the Bachelor of Technology that the studies described in this report entitled "**DESIGN & FABRICATION OF PEDAL POWERED WASHING MACHINE"** in subject Mechanical engineering is carried out by us

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CERTIFICATE

This is to certify that project report entitled "**DESIGN & FABRICATION OF PEDAL POWERED WASHING MACHINE"** which is being submitted by **Dhananjay Kumar Gupta, Saurabh Dixit , Rishabh Dixit, Himanshu Pratap Singh** , **Ashish Kumar** in partial fulfillment for the requirement for the award of the degree of Bachelor of Technology in department of Mechanical Engineering of Ideal Institute of Management and

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ABSTRACT

Pedal power is the transfer of energy from a human source through the use of a foot pedal and gear system. This technology is most commonly used for transportation and has been used to propel bicycles for over a hundred years. Less commonly pedal power is used to power agricultural and hand tools and even to generate electricity. Some applications include pedal powered laptops, pedal powered grinders and pedal powered water wells. This project concentrates on pedal powered washing machine. The basic Principle of this machine is compound gear system; the concept of this Mechanism is that the pedaling is converted into rotary motion.

Cloth washing is one of the essential parts of the life but it is considered undesirable because of the involvement of efforts, time, energy and cost. Nowadays a wide variety of washing machines are available in the market. All of the washing machines available in the market are electric power driven and basic principle of their operation depends upon creation of the turbulent flow of detergent around the dirty clothes. In our country where approximately 70% population is living with very poor economic status, those people cannot have a washing machine because of cost constraints and unavailability of electricity due to any reason.

The present work is an attempt to develop a concept to make a cloth washing mechanism which can meet out the requirements of above mentioned 70% population of the nation. Working principle of this concept is no more different from available similar type of machine with a difference driving mechanism of the machine. The objective of bringing down the initial cost and operating cost of washing machine is almost achieved in present work within the limitation of work as mentioned.

The main aim is to reduce the human effort for provides the light washing in the rural and dark areas which are very far from the electricity and development. In our country where approximately 70% population is living with very poor economic status, those people cannot have a washing machine because of cost constraints and unavailability of electricity due to any reason according to survey 2013-2014, there are approximate 25722 villages are still not electrified, where 400 million people are suffering from this problem.

NOMENCLATURE

S.NO.	SYMBOL	DESCRIPTION
1.	**rpm**	**Rotation Per Minute**
2.	**mm**	**Milimeter**
3.	**HP**	**Horse Power**
4.	**min**	**Minute**
5.	**W**	**Watt**
6.	**T**	**Teeth of gear**
7.	**lb**	**Pounds**
8.	**Kg**	**Kilogram**
9.	**F**	**Fehrenheit**
10.	**ac**	**Alternating current**
11.	**dc**	**Direct current**
12.	**Rs**	**Rupees**
13.	**$**	**Dollar**
14.	**°C**	**Celsius**
15.	**B\W**	**Between**
16.	**m**	**Module of gear**
17.	**I/P**	**Input**

18.	**O/P**	**Output**
19.	**Appx.**	**Approximate**
20.	**i.e.**	**That is**

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CHAPTER: 1 INTRODUCTION

1. 1: THEORY

Pedal power washing machine is the transfer of energy from a human source through the use of a foot pedal and Gear system. This technology is most commonly used for transportation and has been used to propel bicycles for over a hundred years. Some third world development projects currently transform used bicycles into pedal powered tools for sustainable development.

An individual can generate four times more power (1/4 HP) by pedaling than by hand-cranking. At the rate of ¼ HP, continuous pedaling can be served for only short periods, approximately 10 minutes. However, pedaling at half this power (1/8 HP) can be sustained for close to 60 minutes but power capability can depend upon age. As a consequence of the brainstorming exercise, it was apparent that the primary function of pedal power one specific product was particularly useful the bicycle.

Fig 1.1 **Pedal Powered Washing Machine (PPWM)**

A pedal-powered washing machine would allow women to wash clothes faster and with less strain. When asked what they would do with their free time, women said that they would try to generate income by making crafts or food to sell. Young daughters who help their mothers with domestic chores may also have the opportunity to concentrate more on their studies. Laundromat micro-enterprises may even arise if our washing machines are successful. Conditions vary in developing countries, but women in many regions are washing clothes manually while they could be doing more profitable or rewarding work elsewhere.

Several local organizations across Central America and Africa have already expressed an interest in pedal-powered technology. It is an affordable, environmentally-friendly alternative to devices powered by electricity or fossil fuels. Since it is based on bicycle components, the machines can be manufactured locally and repair parts are affordable and readily available. We are hoping that designed to be produced and maintained in any culture where bicycle technology exists, will help to bring appropriate technology and opportunities to women in developing nations across the world and pave the way for other pedal-powered or appropriate technologies that would help women.

1. 2: Innovation

Pedal powered washing is a machine which does not require electricity for several operations like washing, drying, rinsing etc. This is a human powered machine runs on gear drives mainly with human efforts. It has some special attachment so use both human power as well as electric power. The design is ideal for use in the developing world because it doesn't require electricity and can be built using metal base, chain, pulley ,rubber belt, bearing, foot pedal (for operated by human).

Washing the clothes is very specific to particular cultures, but most cultures perform the task in the same way. In almost all underdeveloped rural areas, due to the lack of money problem. Women wash clothes by hand, using cold or lukewarm water that they carry from a river or pull up from a well which is a very difficult task. Existing technologies for washing clothes do not work well in underdeveloped rural areas.

Lack of electricity make powered machines unusable. Difficult transportation due to poor road conditions or just geographical distances create problems with imported devices that might need replacement parts or maintenance repairs.

clothes washing problem in an efficient, affordable and practical way. To our knowledge, no one has successfully built a pedal powered washing machine (multi utility drum) with these goals in mind.

1. 2: Ease of Use

It will be easy to use by younger and older person. After loading the machine, washing requires three cycles. Between each cycle, the drum spins quickly to draw the water out of the clothing, as it drains out of the drum. In the first cycle, water and detergent are added to the drum. The operator pedals the machine for roughly 25 minutes, spins, and drains the water.The next two cycles are rinse cycles. In each rinse cycle, the operator pours clean water into the machine, pedals for 10 minutes, spins, and drains the drum. After the last rinse cycle, the operator spins the clothes dry and saves the slightly soapy water for the next wash cycle.

Our research into existing washers and our earlier prototypes indicate that the power required for washing, drying and spinning is relatively low. We demonstrated that it is not difficult to spin a perforated plastic drum up to extraction speeds with clothes inside. For these experiments, we used a geared transmission from a bicycle. Both younger and older women can generate enough power for the wash and spin cycles. We estimate this power to be 50-75 watts. While familiarity with pedaling in general and the machine in particular will reduce the effort expended by the user, no prior experience will be necessary for its operation. The ability to change gearing ratios will allow some level of tuning to individual users and also allow for shorter wash times with more power input or conversely less strenuous operation if the user can pedal for a longer amount of time.

1.4: NEED

In developing countries, rural women are among the least privileged. Women are both essential to the family unit and integral to the economy,. One factor behind the inequality is the long list of responsibilities that traditionally fall to women. Not only do women perform agricultural duties and care for livestock alongside men, but women are also responsible for many domestic chores. Usually, new technology improves people's efficiency, but women benefit less from new technology for several reasons. First, women's duties are neglected by technological improvement efforts because domestic

chores are often seen as cultural obligations for women so little effort is expended to diminish them. Second, foreign aid in the form of appropriate technologies is unevenly distributed because women are often considered less technically competent than men. Factors like these tend to prevent the development of improved technology for women's uncompensated, time-consuming, and laborious

Fig 1.2 Women Washing Laundry in Guatemala. Currently, Women Wash and rinsing out each Clothing Item Individually By Hand. They Must Bend Over The Tanks And Submerge Their Hands In Washing Solution For 8 Hours Each Week (ref. 9)

CHAPTER: 2 LITERATURE SURVEY

2.1: Literature survey of the pedal powered washing machine

The Pedal Powered washing machine is working on compound gear system. The PPWM is used to washing, drying, rinsing. PPWM helps to obtain a less effort uniform sinning and washing. It can be used in places where Electricity is not available. It is designed as portable one which can be used for rising and washing in various Places. By pedaling the bicycle the pedaling motion rotates the drum, the washing machine will be moving with the crank & rotate the multi utility drum for the washing. Thus the light material can be also washing the clothes without any external energy like fuel or current. Since this uses no electric power and fuel, this is very cheap and best.

The surveys of the literature regarding the **PPWM** are listed

2.1.1 Dharwa chaitanya kirtikumar [2] designed and developed a multipurpose machine which does not require electricity for several operations like washing. This is a human powered machine runs on gear drives mainly with human efforts. But if you wanted to operate this machine by electric power this machine can also does that. It has some special attachment so use both human power as well as electric power. The design is ideal for use in the developing world because it doesn't require electricity and can be built using metal base, chain, pulley ,rubber belt, bearing, foot pedal (for operated by human) , chain socket.

2.1.2 S.G.bahaley, Dr. Ague, Awate, S.V. saharkar [3] designed and fabricated a pedal powered multipurpose machine. It is a human powered machine which is developed for lifting the water to a height 10 meter and generates 14 Volt, 4 ampere of electricity in most effective way. Power required for pedaling is well below the capacity of an average healthy human being. The system is also useful for the work out purpose because pedaling will act as a health exercise and also doing a useful work.

2.1.3 Linxu, Weinan bai, Jingyu rue, and Qiang li [4] designed and developed an pedal driven washing machine, The main objective is to provide a product with an alternative

way to wash clothes when there is no electricity. It has to be understood that in rural areas, it is a very stressful and laborious task. So the machine which is a pedal driven machine, it satisfies the need of rural people by giving them an alternative way of washing clothes which is quick, cost-effective and eco-friendly. The product designed has zero operating cost, cost-effective, and it can be used with minimal.

This study aims to design and fabricate a pedal driven washing machine to obtain a less effort uniform washing and sinning and to have a comparison between hand driven and pedal driven washing machine.

Fig 2.1 **Pedal Operated Washing Machine**

2.2: Project Objectives:

The title of this project work is "Design & fabrication of pedal powered washing machine". The objectives of the present work are:

- Study on washing machines on the basis of design & construction, performance, economy and applications.
- Design & construction a working unit of low cost washing machine made up of easily and readily available scrap parts in daily life. It generates power through human pedalling and with the drive mechanism, to perform all the functions such as Washing, Rinsing, and Spinning.
- Cost analysis of a unit of pedal powered washing machine

CHAPTER: 3 DESIGN & CONSTRUCTION OF PPWM

3.1 Components and their technical Features

3.1.1: Seat

A seat is place to sit, often referring to the area one sits upon as opposed to other elements like armrests. Seat is a arrangement in any bicycle on which a person can sit comfortably. In seating arrangement the design factor is always consider according to their use in any vehicle. Seat may be made of plastic, rubber, metal etc material. In some seating arrangement suspension is also consider.

Fig3.1 **Seat**

3.1.2: PEDAL ARRANGEMENT

A bicycle pedal is the part of a bicycle that the rider pushes with their foot to propel the bicycle. It provides the connection between the cyclist's foot or shoe and the crank allowing the leg to turn the bottom bracket spindle and propel the bicycle's wheels. Pedals

usually consist of a spindle that threads into the end of the crank and a body, on which the foot rests or is attached, that is free to rotate on bearings with respect to the spindle.

Pedals were initially attached to cranks connecting directly to the driven (usually front) wheel. The safety bicycle, as it is known today, came into being when the pedals were attached to a crank driving a sprocket that transmitted power to the driven wheel by means of a roller chain.

Fig 3.2 **Pedal Arrangement**

3.1.3: GEAR

Bicycle gearing is the aspect of bicycle drive train that determines the relation between the cadence, the rate at which the rider pedals, and the rate at which the drive wheel turns.

On some bicycles, there is only one gear and the gear ratio is fixed. Many contemporary bicycles have multiple gears and thus multiple gear ratios. A shifting mechanism allows selection of the appropriate gear ratio for efficiency or comfort under the prevailing circumstances: for example, it may be comfortable to use a high gear when cycling downhill, a medium gear when cycling on a flat road, and a low gear when cycling uphill. Different gear ratios and gear ranges are appropriate for different people and styles of cycling.

A cyclist's legs produce power optimally within a narrow pedaling speed range, or cadence. Gearing is optimized to use this narrow range as best as possible. As in other types of transmissions, the gear ratio is closely related to the mechanical advantage of the drive train of the bicycle. On single-speed bicycles and multi-speed bicycles using derailleur gears, the gear ratio depends on the ratio of the number of teeth on the chain ring to the number of teeth on the rear sprocket (cog). For bicycles equipped with hub gears, the gear ratio also depends on the internal planetary gears within the hub. For a shaft-driven bicycle the gear ratio depends on the bevel gears used at each end of the shaft.

For a bicycle to travel at the same speed, using a lower gear (larger mechanical advantage) requires the rider to pedal at a faster cadence, but with less force. Conversely, a higher gear (smaller mechanical advantage) provides a higher speed for a given cadence, but requires the rider to exert greater force. Different cyclists may have different preferences for cadence and pedaling force. Prolonged exertion of too much force in too high a gear at too low a cadence can increase the chance of knee damage; cadence above 100 rpm becomes less effective after short bursts, as during a sprint.

Fig 3.4 **Pedal & sprocket**

3.1.4: BEARING:

A bearing is a machine element that constrains relative motion between moving parts to only the desired motion. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may *prevent* a motion by controlling the vectors. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts.

Fig 3.5 **Bearings [8]**

The term "bearing" is derived from the verb "to bear" a bearing being a machine element that allows one part to bear (i.e., to support) another. The simplest bearings are bearing surfaces, cut or formed into a part, with varying degrees of control over the form, size, roughness and location of the surface. Other bearings are separate devices installed into a machine or machine part. The most sophisticated bearings for the most demanding applications are very precise.

3.1.5: CHAIN AND SPROCKET

When creating your own human powered vehicles, a chain drive will likely be your chosen power transfer system, as it is an inexpensive, easy-to-install and highly efficient drive mechanism. Bicycle chains are fairly simple, requiring only one inexpensive tool to remove and attach links. Since a recumbent cycle will often require a chain that is one and a half to 3 times the length of a regular upright bicycle chain, some basics should be known, as you will probably need to create the chain for your vehicle.

Fig 3.6 **Chain [8]**

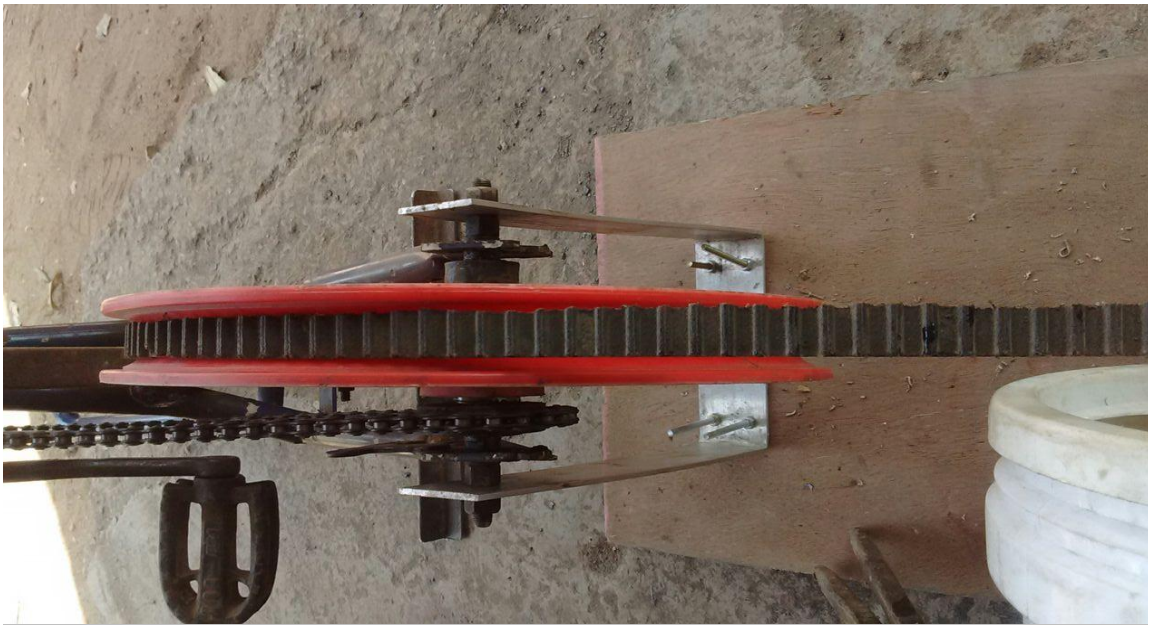

Fig 3.7 **Chain arrangement**

There are two basic types of bicycle chain: single speed chain and multi-speed chain. Single speed chain is mainly used on kids' bikes, BMX bikes, coaster brake cruisers, and

heavy cargo bikes. Multi-speed chain is used on standard speed bikes and mountain bikes that require the use of a front and rear derailleur to change gears. Both types of bicycle chain have a pitch of 1/2 inch (ANSI standard #40). This measurement indicates the length of the links. Although every type of bicycle chain and freewheel have a 1/2 in pitch, the width of chain varies quite a bit, from 3/32" to 1/8". Single speed bicycle chain is wider, having a width of 1/8 inch. This type of chain will not fit a multi-speed freewheel nor will it fit properly through a derailleur cage. Multi-speed chain comes in variouswidths, with 3/32" being the most common size. Multi-speed chain is designed with a lot more side-to-side flex to allow it to function properly with a derailleur system. Flexibility is very important in a multi-speed system as the alignment of front and rear chain rings could be off by as much as 3 inches, depending on which gears are being used. Figure 1 shows the two common sizes of bicycle chain; 1/8" on the top and 3/32" on the bottom. At this angle, both chain types look very similar since you can only see the pitch, not the width.

Fig 3.8 **Single speed (top) and multi-speed (bottom)[11]**

Figure 3.8 gives you a much clearer view of the difference between a 1/8" single speed chain (top) and a 3/32" multi-sped chain (bottom). The multi-speed chain is obviously narrower to fit the narrower chain rings on a multi-speed freewheel, and it also includes a beveled edge on the inner link to allow for better meshing with the teeth when switching gears.

When bicycle building becomes your hobby, one of those "must have" tools will be a chain link tool as shown in Figure. For under $20, this small tool will give you a lifetime

of service, able to break and rejoin any size of bicycle chain in a few seconds. The other method involves using a punch, a hammer, and a finishing nail, but I assure you, the chain link tool is so much easier and makes a worthwhile investment. To open a link, place the chain into the holder as shown in Figure 3, and then turn the vice handle clockwise to press out the link pin.

The link pin pushed out by the chain link tool after turning the handle around a few times. This tool makes adjusting a chain pretty much effortless which is a good thing since you may have to adjust a long recumbent chain on a new project several times to get it right.

Fig 3.9 **Separated Chain[11]**

After breaking a chain with the link tool, it will look like the one shown in Figure , with the link pin pressed through the roller to the outer plate. The pin only needs to be pressed far enough out so that the roller can be released. Notice that the pin has been slightly flattened at the end. This helps to ensure that it does not slip out of the plate hole, which is only holding it there by friction. I have broken many chains over the years, but it has always been a plate that has snapped, never a pin that has fail.

The two outer plates, pins, and rollers with inner plates are shown in Figure 6. Normally, you would not need to pull a chain apart like this, as there are no wear parts that can be replaced. When a chain fails or stretches, the damage is always throughout the entire chain, which needs to be replaced. For this reason, you should never join together chains that are from different manufacturers or may be years apart in wear. Often, the outer plates will have the manufacturers' code stamped on them.

After pressing a link back into a chain, the pin will have forced the plates together,

causing a stiff link as shown in Figure 7. This stiff link will cause a skip or jump every time it passes through the rear derailleur, and must be fixed before use. A stiff link will always be created when first joining a chain, but it can easily be relaxed.

To fix a stiff link, hold the chain so you can work the links side to side as shown in Figure 8. Press your thumbs against the plates on each side of the stiff link and force it back and forth until it no longer sticks when you bend the chain. Once the link has been relaxed, it will act like every other link without causing the problem. A common 6 speed freewheel and the 3/32" chain that fits into it. Although the larger single speed (1/8") chain will also fit into the teeth, it will be too wide to fit properly through the rear derailleur. You could get away with the larger chain on a multi-sped freewheel if you plan to make your bike single speed (fixed gear).

The 3/32" multi-speed chain is not only designed to fit properly between the rear derailleur cage as shown in Figure, but it is also designed to flex side-to-side, allowing some misalignment between opposing chain rings at the front and rear of a bicycle.

Fig 3.10 **This chain is too thin for the teeth[11]**

Multi-speed chain will not fit into the teeth of a single speed free hub or coaster hub as shown in Figure 11, so you don't ever have to worry that you may have the wrong chain there. The width of the teeth makes it impossible to seat the rollers properly. The 1/8" single speed chain is shown meshing with a BMX freewheel in Figure 12. A coaster hub

will have the same width of chain ring, requiring the 1/8" wide chain. Sometimes, you may require a very long chain when making a long cargo trike or even a very tall bike. The chain shown in Figure 13 is standard 1/8" single speed chain, but was taken from a discarded garage door opener, a good source for a very long length of single speed chain. When working on recumbent cycles and creative human powered vehicles, you will likely need to join together two or more bicycle chains, so consider purchasing an inexpensive chain link tool, and be mindful of the different widths of bicycle chain. Rusty chain should always be discarded. Oiling a chain is a matter of choice. I have never oiled a bicycle chain, and the current school of thought is that an oiled chain is less efficient and will wear out sooner due to trapping dirt between the links. Maybe if your bike lives outdoors and is exposed to alot of moisture, then a light brushing of light oil may be a good thing.

3.1.6: CATCHER

Catcher is a part of rickshaw on which sprocket could be mount. on it threaded design is made .by using it sprocket could be tighten.

Fig 3.11 **Catcher & sprocket[12]**

3.1.7 SHAFT

Shaft is a mechanical component for transmitting torque and rotation, usually used to connect other components of a drive train that cannot be connected directly because of distance or the need to allow for relative movement between them. Drive shafts are carriers of torque: they are subject to torsion and shear stress, equivalent to the difference between the input torque and the load. They must therefore be strong enough to bear the

stress, whilst avoiding too much additional weight as that would in turn increase their inertia. To allow for variations in the alignment and distance between the driving and driven components, drive shafts frequently incorporate one or more universal joints, jaw couplings, or rag joints, and sometimes a splined joint or prismatic joint.

Fig 3.12 **Shaft [9]**

3.1.8: SHAFT COLLAR

The shaft collar is a simple, yet important, machine component found in many power transmission applications, most notably motors and gearboxes. The collars are used as mechanical stops, locating components, and bearing faces. The simple design lends itself to easy installation. Many people will be familiar with shaft collars through using Meccano.

3.1.9: DRUM AS A WASHING CHAMBER

It is just a chamber in which water is filled with detergent further cloth is put inside it for rinse. In this type of machine, there are two drum are used: inner & outer.

Inner drum: This drum consists of clothes & it is less in diameter as compared to outer drum. Inner drum is blanked throughout its body. It rotates with the help of compound gear & chain arrangement in the desired speed with respect to the purpose.

Outer drum: Outer drum is used to store water used for washing the clothes.

Fig 3.13 **Inner drum**

Fig 3.14 **Drum as a washing chamber (OUTER)**

DESING ANALYSIS:

Cleaning:

Machine-washed clothes must be as clean as those hand-washed for 5 minutes

Gentleness:

Must wear clothes at slower rate than hand-washing [hole/tear growth]

Capacity:

Minimum 5lb of clothes/load – should be easy to re-size.

Water:

Effective washing must occur in soft and hard water at temperatures from 70-120_F

Water usage:

Maximum 5L water / .5kg clothes

Active pedaling time for effective washing:

Maximum 20 minutes each for wash and rinse cycles

Total operation time:

Maximum 1 hours, including fetching water, filling, washing, draining, and cleaning machine

Power:

Maximum 100W (comfortable level of human-power output)

Cost:

Rs. 7000 (comparable to cost of other MP machine)

Lifetime of structure:

5 years, assuming daily use

Manufacturing location:

local market

Weight:

Maximum 10kg, or 25kg if it has wheels (1 woman can move it indoors so it can't be stolen or damaged).

Culturally acceptable:

Suitable appearance, user position and motion such that most women are willing to use the machine.

Table 3.1. Dimensions of different components of the model

S. NO.	PARAMETERS	DIMENSION (mm)
1.	Inner drum diameter	180
2.	Outer drum diameter	300
3.	Length of inner drum	230
4.	Height of shaft	690
5.	Distance between shaft & cycle	380
6.	Height of base above ground	18
7.	Length of base	670
8.	Width of base	380
9.	Height of seat	810
10.	Height of handle	1067
11.	Total volume of inner drum	19782000
12.	Total volume of outer drum	5849820
13.	Length of outer drum	280
14.	Distance B\W Sprocket & pedal	360

3.1.10: CYCLE FRAME ARRANGEMENT

A bicycle frame is the main component of a bicycle, on to which wheels and other components are fitted. The modern and most common frame design for an upright bicycle is based on the safety bicycle, and consists of two triangles, a main triangle and a paired rear triangle. This is known as the diamond frame. Frames are required to be strong, stiff and light, which they do by combining different materials and shapes.

Fig 3.15 **Cycle frame arrangement**

3.2 FABRICATION PROCESS USED IN THE PROJECT:

3.2.1 WELDING

Cast iron can be welded perfectly well using a stick welder and nickel rods, or with preheating by a gas welder using cast iron rod**.** Welding cast iron is a precision task that requires high heat, and often expensive equipment. You should not attempt it on the strength of reading a brief Internet article, no matter how informative. However, understanding the basics can help you prepare for a qualification course, or to make better decisions for welding projects run by qualified personnel under your supervision.

TIPS

- Always preheat or precool cast iron using the same method throughout. Changing

methods can cause stress and fractures in the cast iron. These may ruin your project, or be small enough to go unnoticed until the iron fails catastrophically during normal operation.

Cast iron is typically higher in carbon than steel. This makes the iron brittle, and more difficult to weld than other industrial metals.

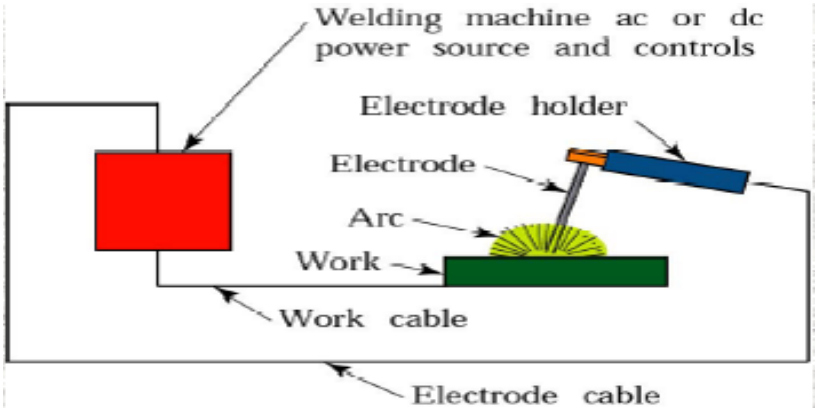

Fig 3.16 **Welding [10]**

- **DIMENSION OF THE BASE FRAME**
- Length:- 670 mm
- Width:- 379mm
- Thickness:- 18mm
- Material used: Wood

Fig 3.17 **Wooden base frame**

3.2 BASIC LAYOUT, WORKING & ASSEMBLY:

3.2.1 LAYOUT OF PPWM:

PPWM consist of no. of components such as Drum, gear, shaft, chain, paddle, sprocket, seat etc .Each & every component has its specific work.

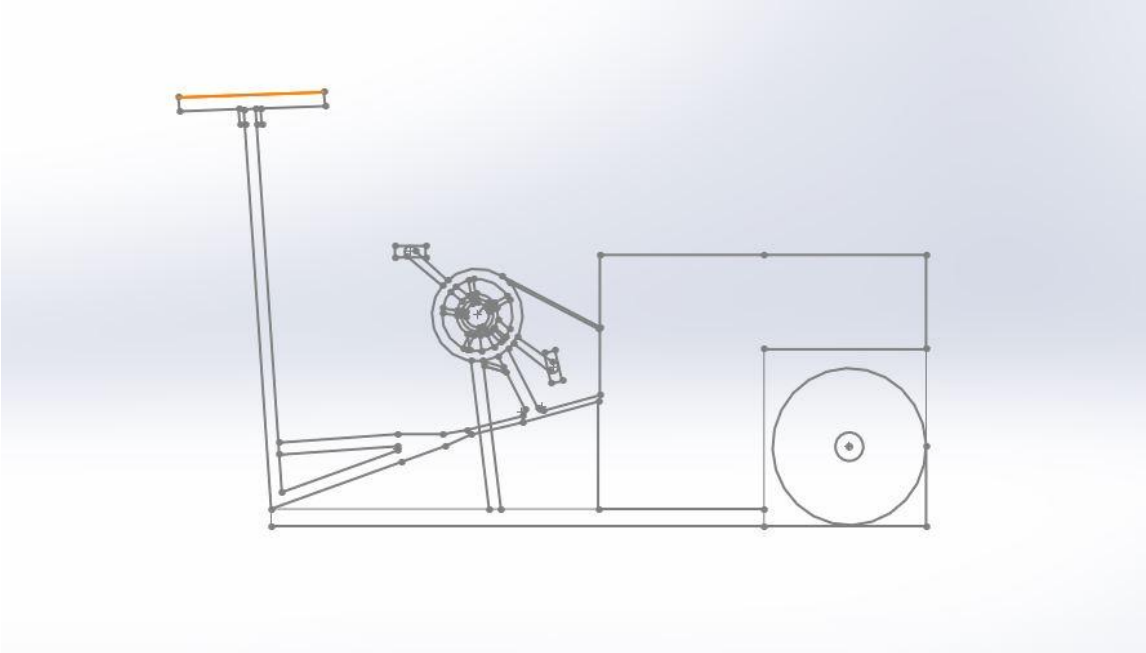

Fig. 3.18 **Layout of PPWM**

PRINCIPLE: It is a machine which generates power through human pedaling and with the drive mechanism, converts the pedaling motion into required rotary motion of the drum. Its innovation lies in its simple design, use of inexpensive parts. With the help of compound gear system, the machine achieves the desire speed for different purposes like rinsing, drying etc.

3.2.2 Operating Parameter

Operating Parameter for a normal human being **,** These are the operating parameter:

Process	Time Taken	RPM Required
1. Washing	30 min	20 rpm
2. Rinsing	5 min	500 rpm
3. Drying	15 min	1000 rpm

3.3 ASSEMBLY: The assembly of PPWM involves number of steps, these are started from the frame of cycle which is the initial part of the structure:

STEP 1: The cycle frame consist of sprocket, chain, catcher, pedal, etc. With the help of Gas welding, the stand & seat is welded to the frame of cycle. The seat & stand are made of mild steel. The pedaling gear is connected to the sprocket with the help of chain.

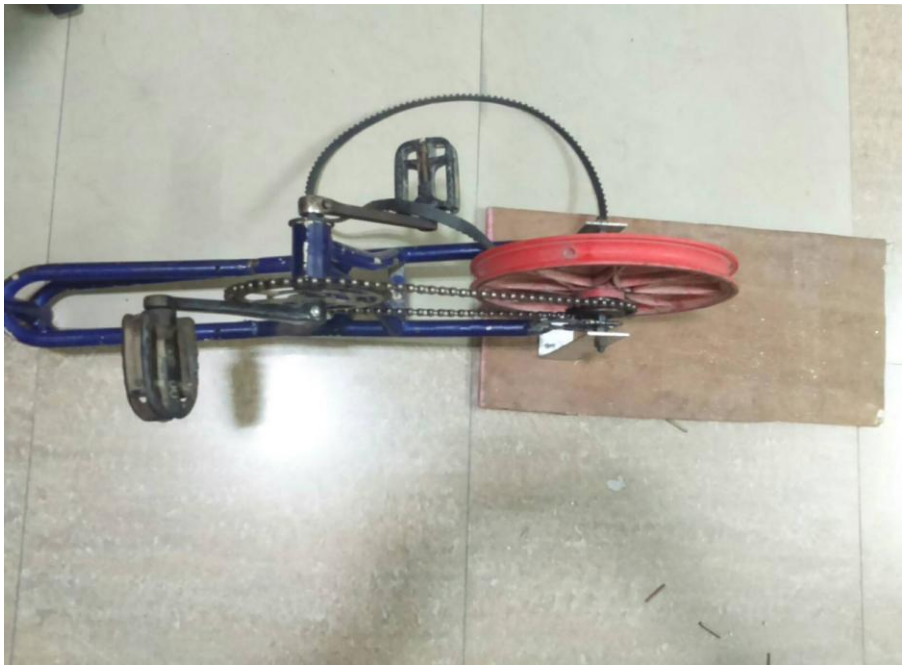

Fig 3.19 **Cycle frame**

STEP 2: The catcher contains one more gear (i.e. freewheel) of bigger diameter. The sprocket & freewheel are mounted on the same shaft, So the speed of sprocket & freewheel are same. This big gear transfer this rotary motion to the another gear which is much smaller than this gear.

STEP 3: This assembly of 4 gear with chain is known as COMPOUND GEAR SYSTEM. This small gear is coupled with washing chamber (i.e. drum) by using fasteners. In this type of arrangement, the output is much larger than the input given in the form of pedaling motion. For this PPWM, there is the ratio of I/p & O/p is **1:9.**

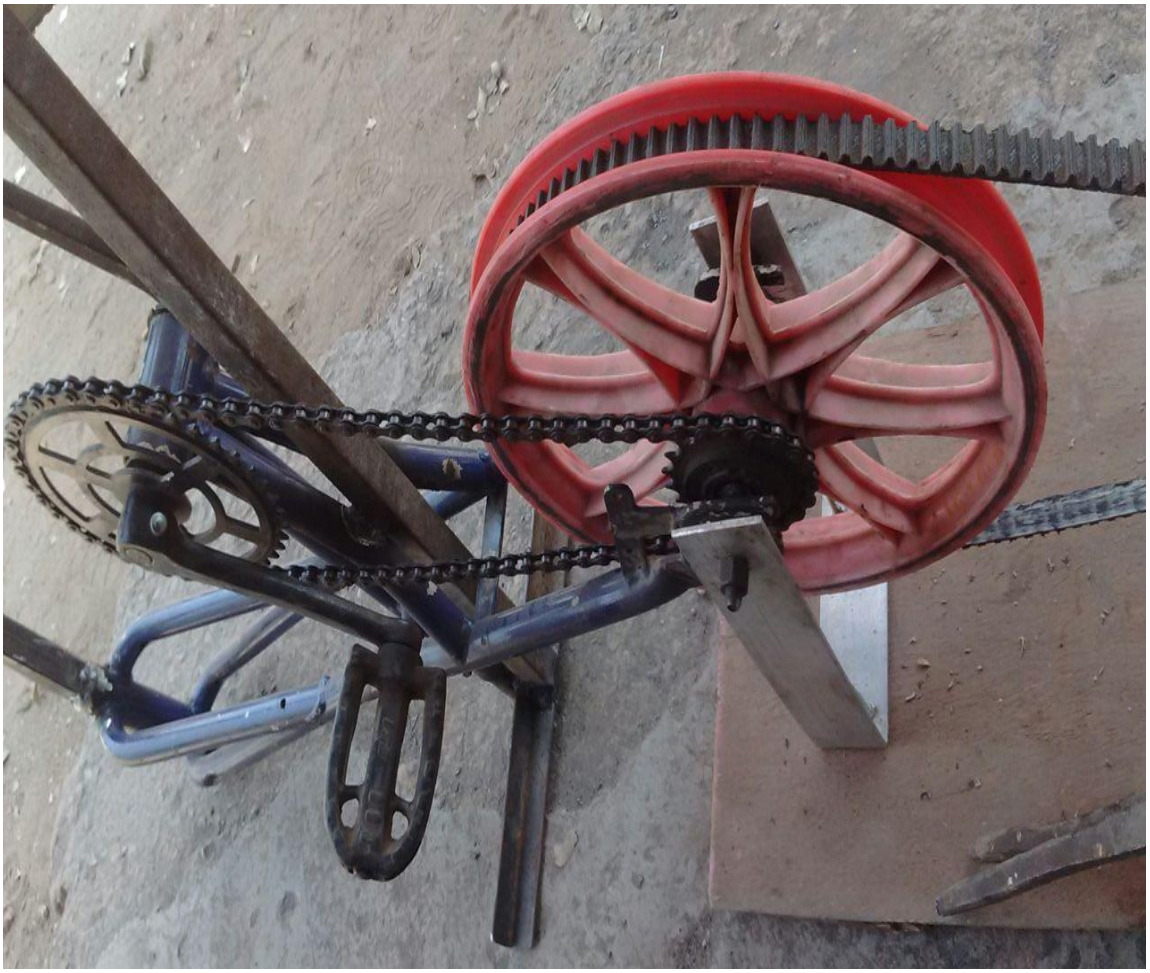

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Fig 3.20 **Compound gear system**

STEP 4: There are two drums are mounted on that output shaft; outer & inner drum. The inner drum contains clothes and water & it rotates in the same speed that of gear. The outer drum consists of water only & it is stationary. The inner drum rotates freely without any obstacle.

STEP 5: The wooden base frame comprises of this whole arrangement. The nuts & bolts are used to fix this assembly and it gives the rigidity to the whole structure.

STEP 6: To give the aesthetic appearance to the machine, the wooden ply board is used to make the housing. This housing protects the outer drum perils of outsiders.

Fig 3.21 **Housing of PPWM**

For washing, the speed is quite low i.e. 30-40rpm & for drying, the higher speed i.e.800-900 rpm is required. This speed can be attaining by a normal woman & men.

CHAPTER: 4 WORKING OF PPWM

WORKING:

A washing machine (laundry machine, clothes washer, or washer) is a machine to wash laundry, such as clothing and sheets. The term is mostly applied only to machines that use water as opposed to dry cleaning (which uses alternative cleaning fluids, and is performed by specialist businesses) or ultrasonic cleaners. Washing entails immersing, dipping, rubbing, or scrubbing in water usually accompanied by detergent, or bleach. The simplest machines may simply agitate clothes in water while switched on; automatic machines may fill, empty, wash, spin, and heat in a cycle. Most washing machines remove substantial amounts of water from the laundry at the end of a wash cycle, but do not completely dry it.

In our project the rotation of drum is possible through wheel rotation .Wheel is rotated by chain drive. When a person start peddling, the gear connected through sprocket by chain start to transmit power, the rotation of drum is dependent on man power. In our project the complete process is depend on compound gear system. Gear drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles.

Most often, the power is conveyed by a roller chain, known as the drive chain or transmission chain, passing over a sprocket gear, with the teeth of the gear meshing with the holes in the links of the chain. The gear is turned, and this pulls the chain putting mechanical force into the system. Another type of drive chain is the Morse chain, invented by the Morse Chain Company of Ithaca, New York, USA. This has inverted teeth.

Sometimes the power is output by simply rotating the chain, which is used as input for the washing drum. In other situations, a second gear is placed and the power is recovered by attaching shafts or hubs to this gear. Though drive chains are often simple oval loops, they can also go around corners by placing more than two gears along the chain; gears that put power into the system or transmit. By varying the diameter of the input and

output gears with respect to each other, the gear ratio can be altered, so that, for example, the pedals of a bicycle can spin all the way around more than once for every rotation of the gear that drives the wheels.

4.1: WASH CYCLES

A stand-alone spin dryer used for extracting water from laundry The earliest washing machines simply carried out a washing action when loaded with clothes and soap, filled with hot water, and started. Over time machines became more and more automated, first with very complex electromechanical controllers, then fully electronic controllers; users put clothes into the machine, select a suitable program via a switch, start the machine, and come back to remove clean and slightly damp clothes at the end of the cycle. The controller starts and stops many different processes including pumps and valves to fill and empty the drum with water and rotating at different speeds, with different combinations of settings for different fabrics.

Fig 4.1 **Washing of clothes**

4.2: WASHING:

Many front loading machines have internal electrical heating elements to heat the wash water, to near boiling if desired. Chemical cleaning action of the detergent and other

laundry chemicals increases greatly with temperature. Washing machine with internal heaters can use special detergents formulated to release different chemical ingredients at different temperatures, allowing different type of stains and soils to be cleaned from the clothes as the wash water is heated up by the electrical heater. Higher-temperature washing uses more energy, and many fabrics are damaged at higher temperatures. Temperatures exceeding 40 °C have the undesirable effect of inactivating the enzymes when using biological detergent.

Many machines are cold-fill, connected to cold water only, which they heat to operating temperature. Where water can be heated more cheaply or with less carbon dioxide emission than by electricity, cold-fill operation is inefficient.

Front loaders need to use low-sudsing detergents because the tumbling action of the drum folds air into the clothes load that can cause over-sudsing and overflows. However, due to efficient use of water and detergent, the sudsing issue with front-loaders can be controlled by simply using less detergent, without lessening cleaning action.

4.3: RINSING

Washing machines perform several rinses after the main wash to remove most of the detergent. Modern washing machines use less water due to environmental concerns; however, this has led to the problem of poor rinsing on many washing machines on the market, which can be a problem to people who are sensitive to detergents. The Allergy UK website suggests re-running the rinse cycle, or rerunning the entire wash cycle without detergent. In response to complaints, many washing machines allow the user to select additional rinse cycles, at the expense of higher water usage and longer cycle time.

4.4: SPINNING

Higher spin speeds remove more water, leading to faster drying. If a heated clothes-drier is used after the wash and spin, energy use is reduced if more water has been removed from clothes. However, faster spinning can crease clothes more. Also, mechanical wear on bearings increases rapidly with rotational speed, reducing life. Early machines would spin at only 300 RPM and, because of lack of any mechanical suspension, would often shake and vibrate.

Many modern machines are equipped with an automatic clothes load balancer, using a sealed ring of viscous liquid, that helps to counteract any out-of-balance distribution. Better machines may include internal suspension and shock systems to reduce noise, and sensors and software to detect and correct an out-of-balance load.

Separate spin-driers, without washing functionality, are available for specialised applications. For example, a small high-speed centrifuge machine may be provided in locker rooms of communal swimming pools to allow wet bathing costumes to be substantially dried to a slightly damp condition after daily use.

Fig 4.2 **Washing chamber**

CHAPTER 5: COST ANALYSIS

The cost estimation cannot be done 100% certainty because price of different material used in the washing machine are highly fluctuating. In this work, a rough estimation of the cost is being reported on the basis of market survey. Approximate cost of different components are given in table 5.1:

Table 5.1: Cost estimation

S. NO.	NAME OF THE COMPONENT	QUANTITY	ESTIMATED (Rs.)
1.	Wooden board	1	500
2.	Drum	2	400
3.	Iron pipe & stand	1	1500
4.	Cycle frame	1	1200
5.	Gear set	2	1000
6.	Pedal set	1	500
7.	Chain set	2	800
8.	Flywheel	1	500
9.	Nut bolts	As per need	100
10.	Pipe , socket, bracket		500
11.	Overhead		1000
12.	Total cost		8000

CHAPTER 6: CONCLUSIONS

A pedal-powered washing machine would allow women to wash clothes faster and with less strain. It can be use by man, woman, old people etc. When asked what they would do with their free time, women said that they would try to generate income by making crafts or food to sell. Young daughters who help their mothers with domestic chores may also have the opportunity to concentrate more on their studies. Laundromat microenterprises may even arise if pedal powered washing machines are successful. Conditions vary in developing countries, but women in many regions are washing clothes manually while they could be doing more profitable or rewarding work elsewhere. It is also helpful for maintaining fitness.

We hope through our research and analysis we have designed or at least help clarify the design - concept of a pedal-powered washing machine. Hopefully in the near future, such helpful tools become a common addition to Cambodia villages and Third world countries.

FUTURE DEVELOPMENT

A. USE OF CHAIR IN PLACE OF CYCLE FRAME

For making perfect washing of clothes more comfortable, the cycle frame can be replaced with a chair. Use of chair will be more convenient for women as well.

B. COMPOSITE STRUCTURE

To reduce the assembly time and prevent others from tampering with it in public areas, the structure will be made out of welded angle iron. Welding fixtures may be designed to make it easier to weld several structures with proper alignment of components. The welded structure will add to the weight of the machine, making it inherently less likely to vibrate. The steel structure may also be cemented into the ground to ensure stability and security of the machine from theft.

C. TECHNOLOGY FOR THE POOR

With the help of this Pedal powered washing machine, there are number of other technologies are used such as :

C.1 Operating a wood working lathe: The pedaling motion is used to rotate the wooden work piece & the tool is stationary. In the villages, the small work shop & shops are run with this low cost machine. It does not required any electricity, so it is one time investment.

Fig A **Operating a wood working lathe[5]**

Fig B **Operating a circular saw[6]**

These are the some application of pedal powered machine**,** in which the rotational motion of cycle is used for cutting the work piece of different materials wood & metal & non metal .

Fig C **Water pumping from a shallow well[6]**

It is also used for pumping water from shallow well. The water is pumped to the ground with the help of pedaling motion. This machine can be used by anyone i.e. men, women, children etc.

Fig D **Corn shelling[5]**

Corn shellor is a piece of machinery to shell corn kernels of the cob for feeding to livestock or for other uses.

Fig E **Winnowing[7]**

These are the some application of pedal powered machine**,** in which the rotational motion of cycle is used for cutting the work piece of different materials wood & metal & non metal. There are many developments can be made in future.

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