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Review On Crank Pedal Operated Washing Machine

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ABSTRACT

Pedal powered washing machine (PPWM) is a low-cost washing machine made up of easily and readily available scrap parts in daily life. It is a machine which generates power through pedaling and with a drive mechanism, converts the pedaling motion into required rotary motion of the drum, innovation lies in simple design, without use of inexpensive parts. We intends to directly address the problems faced in washing clothes, and thus have developed a new design for easy effort in washing, rinsing and drying clothes. In our country where approximately 70% of population is living with very poor economic status those people cannot have a washing machine because of cost constraints. The present work is an attempt to develop a concept to make a cloth washing mechanism which can meet our requirement of above mentioned 70% population. PPWM is completely new concept, which in its one laundry cycle does washing, rinsing and partial drying of cloths similar to that of automatic washing machine available in market

Key words: Laundry cycle, Washing, Rinsing, Drying.

1.INTRODUCTION

We all wash clothes either by our hands or use power driven washing machines. Traditionally and even in today's India, washing clothes by hand is a common practice. Over the years, this has been either a very strenuous and time consuming or an expensive process. Although electricity is widely available, the ability to effectively utilize human power is invaluable. For efficiency purposes and availability, the bicycle is a great union of person and machine. In the rural areas where electric supply is unavailable,

powered washing machines becomes almost impractical. Several attempts have been made to develop a solution for these areas and to solve these problems, but either the project in itself becomes very expensive, or the repair and maintenance of the machines require a lot of money and imported parts to replace. So our intention to provide low cost washing machine and also to save electricity

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 task.

Figure 1.1 Village side women washing clothes near river side

Washing machine is a device which imparts mechanical energy to clothes by rotating the agitator water in top loaded washing machine. This project covers one of the daily house-hold activities washing clothes. The machine entitled -Horizontal drum pedal powered washing machine, it works on the principle of rotating impeller by paddling and causes to washing clothes. The basic idea is to use a stationary bicycle pedal as the power source, and use an assembly of chain drive to connect it to washing machine drum.

The washing machine has a separate spinning drum for removing excess water after the clothes have gone through the wash and rinse cycles.

- Uniqueness
- Simplicity of using a single drum instead of inner and outer drums.
- Ease of transportability.
- By using such a pedal operated machine less water and no energy usage.
- Cost will be less as compared to washing machine.

- In rural areas electricity is scare so great advantage of such machine.
- By attaching bicycle to such device it can use for exercise purpose.
- Importance of mobility structure.

Comparison between Electric powered washing machine (EPWM) and Pedal powered washing machine (PPWM)

ELECTRIC POWERED WASHING MACHINE	PEDAL POWERED WASHING MACHINE
1) Electric motor is used to drive the drum	1) Human pedaling force is used to drive the drum
2) EPWM can drive load from 5kg-8kg	2) PPWM can drive the load from 3kg-6kg
3) Initial investment is more when compared to PPWM	3) Initial investment is less when compared to EPWM
4) Maintenance cost is more due to costly sensors and electric motor	4) Maintenance cost is less because of simple gear and bearing mechanisms
5) In automated EPWM, sensors will take care of all rinsing, washing, drying timings	5) In PPWM, because of no sensors the one who operating has to take care of all rinsing, washing, drying timings
6) No exercise for human	6) PPWM is a good equipment for exercise our body
7) Comparatively less in weight	7) It is heavy in weight
8) Everyone can easily use it	8) Children can't use it
9) Ease of transportability	9) Transpiring of PPWM is quite difficult

2. LITERATURE SURVEY

This project started with the study of washing machine and to overcome disadvantages, drawbacks and to reduce the usage of electrical supply taking into consideration of rural areas. By the usage of man powered machine we can avoid cost of maintenance and can save electricity.

Pal Pandianet.al [1] in their paper has explained Washing machine is a device which imparts mechanical energy to clothes by rotating the agitator water in top loaded washing machine. This project covers one of the daily house-hold activities washing clothes. We all wash clothes either by our hands or use power driven washing machines. This is a very strenuous, time consuming and expensive process. In our developing country, women are among the least privileged. One factor only do women perform agriculture duties and care for livestock alongside men, but women are also responsible for many domestic works. Usually new technology improves people's efficiency but women benefit less from new technology as women are often considered less technically competent than men

The most important aspect in the design of the machine is its ability to perform as a device that eases the task of washing clothes. In order to be a viable solution in rural areas, the machine should be able to deliver the same quality of washing without adding excessive overheads. Thus the design and operation of the machine should be firmly grounded in the physics of clothes washing, with a special emphasis on the mechanical aspects (since water temperature and detergent composition are likely to vary).We also identified a number of secondary goals with varying degrees of importance that could help make the machine more useful and thus more successful. The ability to spin-dry clothes would increase water economy by requiring fewer wash cycles, and could relieve the strenuous task of manually wringing the clothes before they are hung to dry. If the layout of the machine allowed the user to perform manual work while pedaling, we could further reduce the amount of time consumed by washing. A number of safety features should also to be included in order to mitigate the inherent safety issues involved in a chain-driven machine. If the machine was to be used in a home, ensuring its portability of would allow it to be shared among families, transported close to a water source for operation, or used in households where space is limited.

Gitin M Maitra[2] has briefed Construction a cylindrical drum using metal of require dimension. Present the bicycle and make the bicycle carriers using tube, angles or other flat irons available. All elements are together to the bicycle. Slots are drilled into the plates, which allow for the adjustment of the voltage belt. Place the bicycle on the chassis, measuring using a string the length of the belt if necessary. Drill hour holes into the flame and secure. Use chain to transmit power from pedal to pulley putting it in place, tighten tender and the machine is ready effectively. Clean your clothes, the rotation of the tank should not be too fast about 70- 80 rpm. Manufacture, use and maintenance of the pedal powered washing machine is available. The machine uses a regular mountain bicycle transmission which can provide gar ratios between 1:1. The user is expected to turn the pedal of the machine about 70 rpm the wash cycle and a higher 80 rpm during the dry cycle, where the lack of resistance from makes pedaling easier. With an inner drum diameter of 19in, at a 1:1 gear ratio, pedaling at 70rpm results in a centripetal acceleration

on the clothing of about 0.87g, which results in efficient clothing tumbling. For the spin cycle, the user would which switch to the highest available gear, and a pedal speed of 80 rpm in an acceleration of 20 kg. This has been shown to extract 50% of water from wet cotton clothing; remaining water weight in clothing is approximately 90% of the dry fabric weight comparable to commercial vertical axis washing machine.

G.S.Jagushte, [3] mentioned Some General Assumption in Design of Machine were made with respect to this paper. The machine must be inexpensive and easily build so that the community will accept it. We consider the need of the people living in the rural area and consider the shortage of electric supply we made this project start with low-cost mind set. The components uses in this project are easily available in rural area. The machine uses the bicycle parts which are available everywhere. Pedal powered washing machine is different from people washing their clothes in rural areas. We achieved what we desired i.e. to build the manually driven pedal powered washing machine using the easily available component and material. The main advantage of washing machine is that it does not consume the electricity. By using this people can wash clothes during their workout and exercise. If the production of this washing machine is done at the commercial scale, then the total production cost of the machine will reduced to 40% of the estimated cost and there will saving in the electric power supply.

Junaid Baig, [4] in his publication has elaborated the three basic principles in a washing machine.

Washing: The mechanism of washing is based on the tumbling action of the drum. The clothes in the drum rub against each other like in the washing machine and the resulting friction loosens the dirt. Water turmoil removes dirt away from within folds of clothes. Brushes incorporated along spindle ensure brushing of the clothes thus imitating the action used in hand washing. Since the brushes are not fixed on the rotating shaft, there is relative motion between the brush spindle and the rotating shaft that enables efficient brushing. The net, a new feature of this machine provides friction from the outer side ensuring brushing from all directions. Paddles provided in the inner cage ensure proper tumbling movement of clothes inside the drum. These together constitute the mechanism of washing.

Rinsing: The process of rinsing is similar to that of washing. No detergent is added in the rinsing process. The water turmoil ensures that the clothes are free from soap and lather. The rinsing process is carried out at a slightly higher rpm than washing so that the clothes are lather free. Now there might be a problem of clothes tangling with the brushes and themselves. However due to the design itself pedaling at a faster speed will detangle the clothes automatically due to the added centrifugal force.

Spinning: The mechanism of spinning is based on centrifugal force. When the drum is rotated at higher speeds, the centrifugal action takes the water droplets away from the clothes. The faster the speed greater will be the drying efficiency.

Adarsh Ranjan, [5] in his work discussed about Pedal Power Levels: The power levels that a human being can produce through pedaling depend on how strong the pedaling person is and on how long he or she needs to pedal. If the task to be powered will continue for hours at a time, 75 watts mechanical power is generally considered the limit for a larger healthy non-athlete. A healthy athletic person of the same build might produce up to twice this amount. A person who is smaller and less well nourished, but not ill, would produce less; the estimate for such a person should probably be 50 antipeddling Rate: Human beings are very adaptable and can produce power over a wide range of pedaling speeds. However, people can produce more power--or the same amount of power for a longer time--if they pedal at a certain rate. This rate varies from person to person depending on their physical condition, but for each individual there is a pedaling speed somewhere between straining and flailing that is the most comfortable, and the most efficient in terms of power production. A simple rule is that most people engaged in delivering power continuously for an hour or more will be most efficient when pedaling in the range of 50 to 70 revolutions per minute (rpm). For simplicity's sake, we will use 60 rpm, or one revolution of the pedal cranks per second, as an easy reference value for estimates of the gear ratios required to drive a given load.

3. OBJECTIVE OF PROJECT

The project started with the following objective

- A machine which can be manually operated
- Must have all the mechanisms- washing, rinsing and drying
- Should be easily to operated
- It should have readily available components and should be economically efficient.
- A machine which does not run on electric power
- It encourages pedaling which is a good physical exercise and keeps oneself fit.
- It would help to reduce the physical stress which is applied on the hands during washing clothes.
- The spin dry mechanism provides drying of clothes that is not possible with hand washing.
- Should be easy to operate. Less tiring than conventional washing techniques by hand and hence eases the effort.
- Eco friendly and non-polluting in every way.

4. METHODOLOGY

Methodology is the systematic, theoretical analysis of the methods applied to a field of study. It comprises the theoretical analysis of the body of methods and principles associated with a branch of knowledge. Typical, it encompasses concept such as theoretical model, phases and quantitative or qualitative techniques.

The methodology of the project as follows:

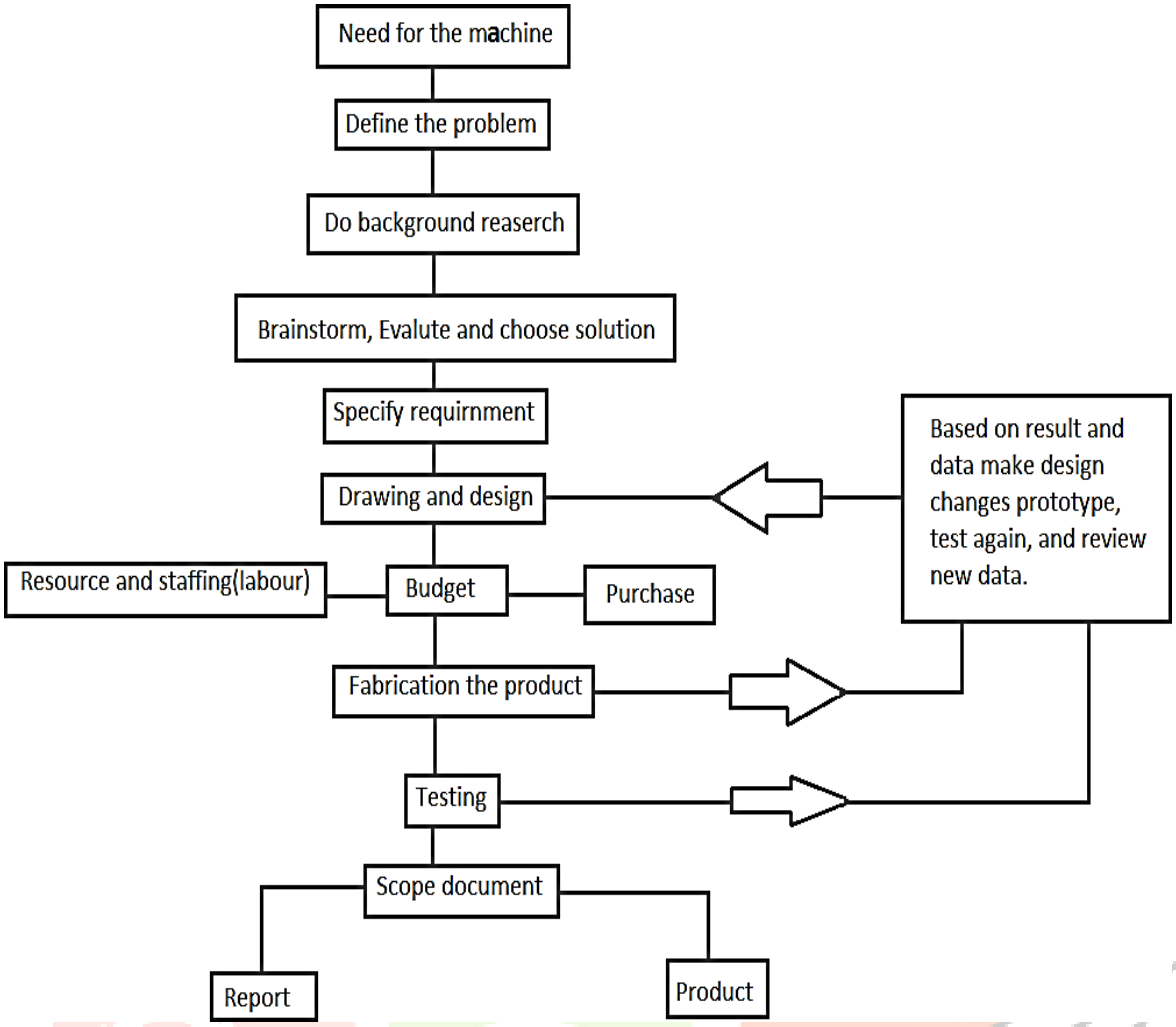

Figure 4.1 Methodology

4.1 PRINCIPAL AND OPERATION

The machine entitled –HORIZONTAL DRUM PEDAL POWERED WASHING MACHINE, it works on the principle of rotating impeller by paddling and causes to washing clothes. The basic idea is to use a stationary bicycle pedal as the power source, and use an assembly of chain drive to connect it to washing machine drum.

4.2 WORKING PROCEDURE

Pedal is connected to a flywheel by means of a chain drive, a set of chain is connected to the washing drum shaft when the pedal is rotated the thrust generated will be transferred to the flywheel. The flywheel enhance the energy and transferred it to washing drum. In working when the flywheel rotates the washing drum in clockwise and the water splashes in opposite direction of drum rotation. By this mechanism effective washing of the cloth takes place. The cloths to be washed is first rinsed with water, and then have to put in the washing drum. The drum is filled with sufficient water .When the drum rotates the

cloth starts removing dust particle present on it by centrifugal force. After pedaling for a particular time we will get cleaned dirt-free cloth.

Pedaling rate

Human beings are very adaptable and can produce power over a wide range of pedaling speeds. However, people can produce more power or the same amount of power for a longer time, if they pedal at a certain rate. This rate varies from person to person depending on their physical condition, but for each individual there is a pedaling speed somewhere between straining and flailing that is the most comfortable, and the most efficient in terms of power production. A simple rule is that most people engaged in delivering power continuously for an hour or more will be most efficient when pedaling in the range of 80 to 100 revolutions per minute (rpm). For simplicity's sake, we will use 100 rpm, or one revolution of the pedal cranks per second, as an easy reference value for estimates of the gear ratios required to drive a given load.

CALCULATIONS

With the reference of design data handbook by K. Mahadevan

Theoretical calculation on V-belt drive aspect:

To find the unknown speed Speed ratio $N_1D_1=N_2D_2$ Known parameter

D_1=230mm (diameter of the flywheel)

D_2= 100mm (diameter of the smaller pulley) N_1= speed of flywheel

N_2= speed of pulley

Let us assume the value of N_1 as 100, 150, 200, 300, and 400.

I. N_1=100

$N_1D_1=N_2D_2$ $100*230=N_2*100$

N_2=230rpm

Similarly by substituting other values for N_1

N_1 in rpm	N_2 in rpm
100	230
150	345
200	460
300	690
400	920

Velocity calculation

$V = \pi D_1 N_1 / 60000$

$V = \pi 230 * 100 / 60000$

$V = 1.2 m/s$

Similarly by substituting other values to fine V

N_1 in rpm	Velocity in m/s
100	1.2
150	1.8
200	2.4
300	3.61
400	4.81

velocity

$N1/N2 = 100/230$

$= 0.434$

Arc of contact

$\theta=2\cos^{-1}(D2-D1/2C)$

$\theta=2\cos^{-1}(100-230/770)$

$\theta=199.43°$

Pitch lenth of the belt V-belt

$L= 2C + 1.57 (D2+D1) + (D2-D1)^2 / 4C$

$L= 770 + 1.57 (100+230) + (100-230)^2 / 4*770$ L=2063.58mm

To find equivalent pitch diameter

$de=D1*kd$

$kd=1$

$de=230$

Power transmitting capacity

$kW= [1.08v^{-0.099}-69.68/de-1.78*10^{-4}v^2] *0.7355v$

$kW= [1.08(1.2)^{-0.099}-69.68/230-1.78*10^{-4}(1.2)^2]*0.7355(1.2)$ kW = 0.6700kW

Or

kW= 670.07W

DESING AND FABRICATION

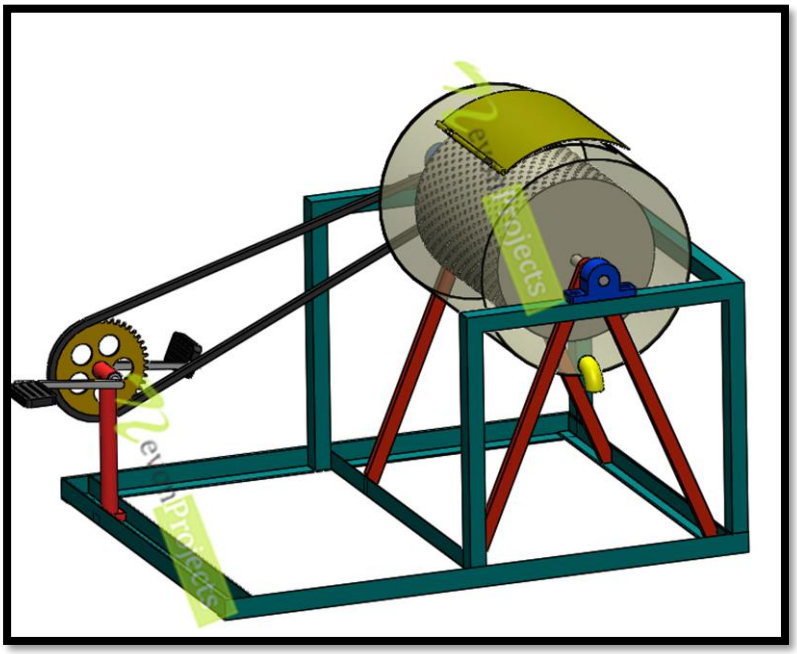

Figure 4.2 2D Model of horizontal drum pedal powered washing machine (Front view)

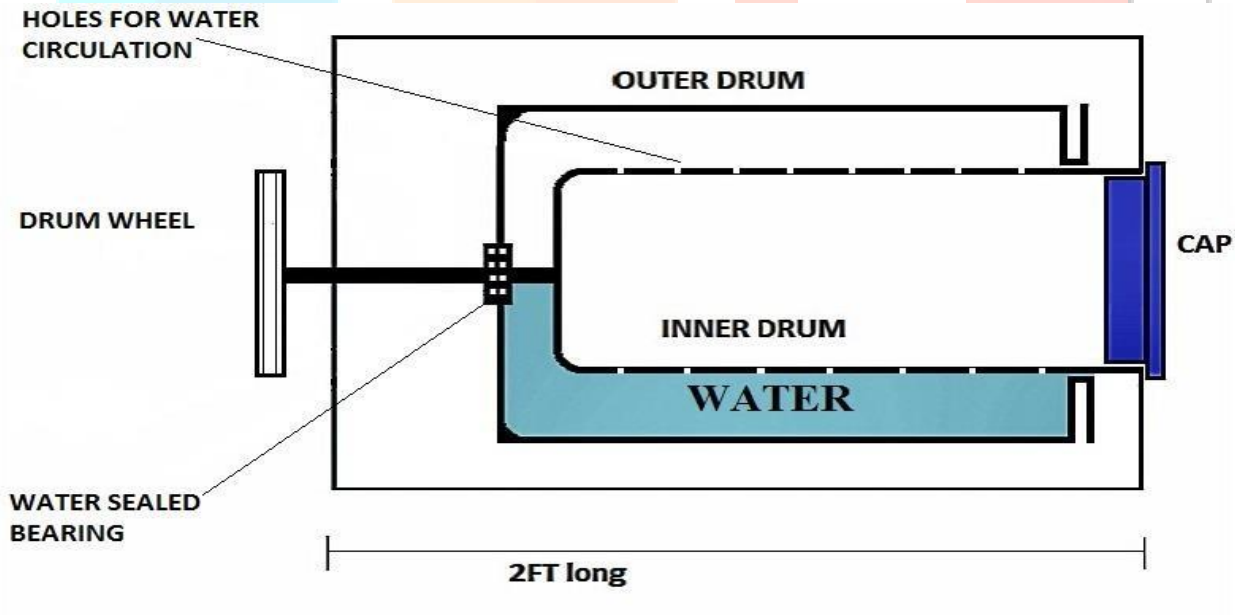

Figure 4.3 Drum design of pedal powered washing machine (Sectional Side view)

FABRICATION

A working model of PPWM was fabricated using the selected scrap components as mentioned in the design. The machine was fabricated to study the design feasibility and the efficiency of the working model. It was found that PPWM can be easily manufactured in a workshop using scrap components and conventional manufacturing processes. Manual Metal Arc Welding (MMAW) was key manufacturing process used. Other operations such as lathe works, press fitting, cutting and grinding of scrap metals etc. were also done.

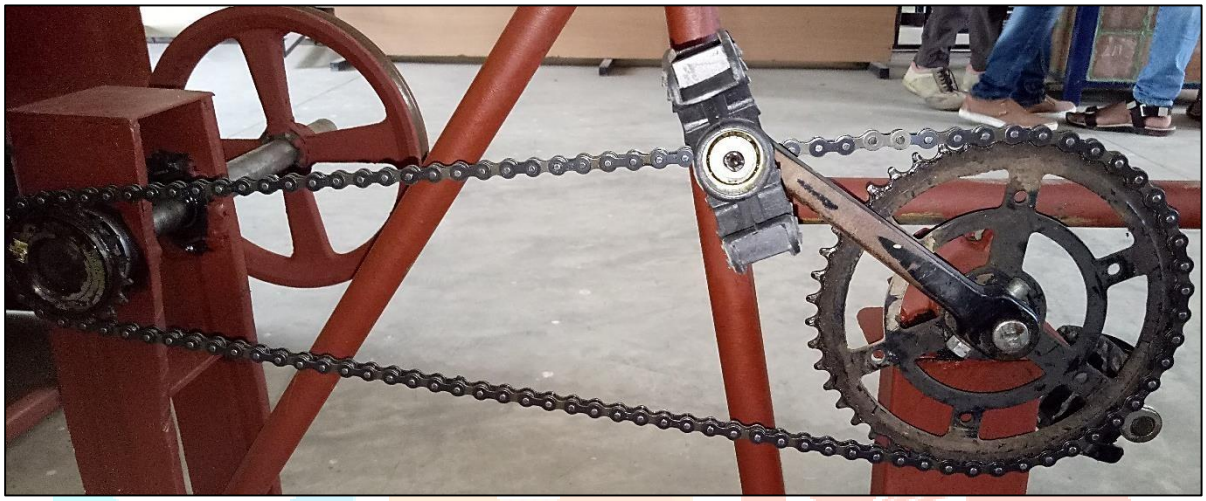

Figure 4.4 Chain drive

ADVANTAGES

- **Efficiancy** :It is much more efficient to wash clothes using the pedal washing machine than to use the manual washing tanks. The machine washes and dries many clothes concurrently whereas each item must be washed individually in the wash tank.
- **Affordability:**A natural location to install a Washing machine is at the public washing stations. The women already use the washing stations and they will be able to share the washing machine among the entire community.
- **Easy Build and Maintain:**Unlike any of the other alternatives, the Washing machine uses locally available materials or recycled bicycle parts. It can be produced in any area that has prevalent bicycle technology and things like plastic buckets.

DISADVANTAGES

- Need much human effort.
- It is heavy in weight.
- Structure is complex.
- Children can't use it

APPLICATION

- It is very useful into the local rural areas
- PPWM can be used to wash the clothes.
- This whole arrangement will be used as an exercise equipment
- Use it at the dark areas where there is no any electricity.
- Saving in detergent the water.
- Better wash quality, scale free tub
- Easy to operate and less effect of chemical on the women hand

FUTURE DEVELOPMENTS

- **Improve the gear drive mechanism**

As we all know that the washing of the cloths in actual washing machine can be successfully achieved by rotating the drum in both clockwise and anticlockwise direction in regular interval of time. In pedal powered washing machine we cannot rotate the drum in both direction because of freewheel is constrained in only one direction. So by improving gear mechanism we can achieve both direction of washing. And even the drying also effectively done if we improve the gear mechanism.

- **Optimize the size of PPWM**

The size of the PPWM layout must be optimized, in a minimal area the layout must fit with all gear drive, drum mechanism. With a suitable length of chain and belt drive which is very much required for transmission of power PPWM can be run, so the selection of belt and chain drive will optimize the layout size of PPWM.

- **Increasing capacity**

The capacity of washing can be increased so that more clothes can be washed, thus utilizing the wasted energy. It has a disadvantage that all the clothes would not be rinsed and dried simultaneously in the same cycle. The capacity of rinsing and drying is low as compared to washing. Thus, increasing the washing capacity would require the rinsing and drying of the clothes to be done in turns. The machine would then no longer complete the entire laundry process in one cycle

- **Designing and Implementing the Drain Valve mechanically**

A normal washing machine uses an electronic control valve in the drainage system to control the flow of waste water out. This valve can be designed mechanically using bicycle brakes. The brakes would block the rubber outlet pipe when the clothes are being washed, rinsed or dried. The blockage would open to make the waste water flow out after a washing cycle or during drying.

CONCLUSION

The machine must be inexpensive and easy to build if it will be adopted into the community. We recognized this need and designed the machine from the start with low cost in mind. The machine will only contain parts that are readily available in rural areas. This eliminates the need to order or import components just for the washing machine. The machine also uses bicycle parts for all the precision parts. These parts are very inexpensive because rural areas have a surplus of unused bicycle parts. The pedal-powered washing machine is quite different from the community's current method of washing clothes; the community may be reluctant to try the new machine. To help encourage the adoption of the washing machine, we will run multiple trials with local women so we can adjust the design to meet their needs. We will run the trial periods with groups like the women's cooperative who are already familiar with pedal powered machines; they have already proved they are willing to try new technologies. If women in the cooperative accept and use the machines, then they will serve as spokes-people for the new machine in their local community. Their support will greatly increase the credibility of the machine so that local people will be willing to try it. We achieved what we desired i.e. to build a manually driven pedal powered low cost washing machine using locally available materials and performing necessary function of washing and rinsing with ease. Our washing machine doesn't consume electricity. The washing machine can be used by the urban people also while workout and exercises. It can serve dual purposes. While cycling, the clothes can be washed utilizing the pedaling of the human being. If the production of this washing machine is done at commercial scale, then the total production cost of the machine can be reduced to 40% of estimated cost.

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