IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 10, Issue 1, January 2020, ||Series -IV|| PP 11-18

Development and Modification of Potter's Wheel by Using Sewing Machine Pedal Mechanism and Chain Sprocket

Nandkishor M. Sawai, Dr. V. G. Arajpure, Dr. C. C. Handa
Assistant Professor, Dattakala Faculty of Engineering, Swami-Chincholi (Bhigwan), Pune, India
Principal, Dattakala Faculty of Engineering, Swami-Chincholi (Bhigwan), Pune, India
Professor and Head of Department, Mechanical Engineering, K.D.K.C.E, Nagpur, India
Received 02January 2020; Accepted 16 January 2020

Abstract: Potter's wheel is increasingly being recognized as highly sustainable for making clay or earthen pot. Unfortunately, the traditional pottery making industry is on the verge of extinction. There is a growing concern to revive this dying industry. Different processes and techniques used in pottery making are understood by carrying surveys and field visits. The electric potter's wheel is used in rural areas as an alternative to human powered potter's wheel, but it is economically not feasible. The author introduces a conceptual model to minimize the efforts and overcome problems in pottery makings. The present work deals with design and development of human powered potter's wheel, providing a solution to cater economic, ergonomically and operational problems. Sewing machine pedal mechanism has many low powered applications, which can be used to minimize human efforts and increase efficiency. The proposed design enable researchers to provide economical and user friendly potter's wheel, which rotates efficiently utilizing the mechanical energy of the sewing machine pedal.
Keywords: Potter's Wheel, Sewing Machine Pedal Mechanism, Sprocket, freewheel, Ergonomic design

I. INTRODUCTION

Many models of potter's wheel have been introduced every year around the world by the pottery making companies. Potter's wheels for instant are mostly preferred for making of an earthen pot or clay pot and other applications. Throughout the human history, before the advent of mechanization, energy has generally been applied through the use of the arms, hands, and back. Legs were also being considered as the 'normal' means of generating power from human muscles since the invention of the sliding-seat rowing shell, particular to the bicycle.

In some machines, the required power input is so far below that of which human beings are capable of producing. Such application of sewing machine pedal power came to known as very-low-power applications of sewing machine pedal power. Sewing machines pedal mechanism is generally limited to less than optimum value to allow the potter's wheel table to be placed at a convenient height. The user provides a wide range of potter's wheel speeds without gear-change mechanisms. Reciprocating motion is converted into rotary motion by sewing machine pedal mechanism. The flywheel used in the sewing machine pedal mechanism and the other end of shaft is used for the sprocket. The sprocket wheel drive uses chains to transmit power from bevel gear to the sprocket wheel. But their applications are limited. The load carrying capacity and climbing capacity are limited as there is torque only at the sprocket wheel. The potter's wheel would be using chains to transmit power from the bevel gear mounted on the flywheel of sewing machine pedal mechanism to sprocket wheels so as to make the system simpler. A freewheel is used to make the engagement of the potter's wheel drive automatic. Power is given to the potter's wheel and flywheel is used for storage of energy to continuously rotate potter's wheel. A mechanism where pedal-driven and single-track wheels are attached to a frame one behind the other is known as potter's wheel which is often known as pottery wheel too. The development of potter's wheel has had an enormous effect on the development of the clay pots or earthen pots and pottery industries.

1.1 TYPES OF POTTER'S WHEEL

Potter's wheel can be categorized into different ways: like manual power driven, and by electric power driver.

1.1.1 MANUALLY ROTATED POTTER'S WHEELS

A kick wheel is a potter's heavy wheel which works by kicking the flywheel in a specific rhythm. It utilizes flywheel that stores energy as it speeds up when propelled by foot. Some beginners find it easier to control the speed of a kick wheel as compared to the speed of an electric wheel. Kick wheels are very heavy as well as extremely durable and long lasting. They are probably best suited for a dedicated ceramics studio as they remain in one location. Operating this wheel is convenient as a pot could be turned around much more easily and quickly. In Mesopotamia during the third millennium BC, the pot making technique underwent gradual changes as the potters adopted the turntable for making and decorating. Hand turned wheels were considered adjunct as the speed of the potter's wheel was slow thus eventually resulting in the invention of kick wheel which was rotated by foot kicking. The wheel was turned by the apprentices the potters had at the time of 18th century. However, since the 19th century the pottery wheel has been turned into a mechanical wheel and the need for another person was reduce the motive power was mechanical.

While using the foot-operated kick-wheel, it allows the potter to insert energy while continuing the throwing activity. Given skilled potter's capacity to effectively separate foot and hand movements, one may reasonably expect the regulation of rotation speed to be close to optimal for reasons of energy efficiency. Though the manual wheel is heavy, it is easier to control and more comfortable learning how to throw with. Generally in a developing society the electric power is usually scarce, one would expect that the manual wheels should be put more into practice both for professionals and beginners for optimum production. There are basically two types of foot-powered wheels, Kick wheels and Treadle wheels.[1]

1.1.1.1 Kick Wheel

The kick wheel is rotated by foot kicking the flywheel in a specific rhythm which powers the head. The energy is stored in heavy flywheel thus making it to rotate by more speed when kicked by foot. The treadle wheel utilizes a lever and a cam mechanism to rotate the shaft by foot kicking the heavy flywheel. For rotation of the kick wheel a perfect hand and foot coordination is required, which can be achieved by regular practice.

1.1.1.2 Treadle Wheels

The treadle potter's wheel is recently developed for pottery. The wheel in a treadle is rotated by rocking the pedal back and forth by left foot. Compared to the kick wheel the treadle wheel operation is easier as the treadle is moved back and forth easily. In American potteries treadle wheels were commonly used and were mass produced for both school and private studios. In the beginning of 20th century, Bernard leach designed a treadle wheel which was further commonly used as a sit-down version as stated. The potters that prefer manual wheels more over electric wheels used this legendary wheel which is popularly known as leach wheel. It was used more by people due to the increased comfort. The manual wheels were preferred by most of the professional potters as the feel of the pottery was great using manual wheels than using the electric wheels. By applying pressure, the potter has to tip the pedal in back and forth motion with both of his feet. Through the pedal, the pushrod turns the leather belt which then makes the potter's wheel turn. It is important to rock the pedal in the needed direction, i.e. clockwise or anticlockwise. The factory made frame can be used to build the wheel to turn it through foot power. It can be build up with metal strips or parts. If it is build through scraps, it is important to position the gear and axle perfectly as it has more weight on its turning mechanisms. All the gears included should make the wheel turn smooth which would make it store the rotation power due to the weight of the wheel.

1.1.1.3 Electrically rotated potter's wheels

The manual interference is not required as the wheel is powered by an electric motor. The use of electric wheel doesn't need any hands and foot coordination like a kick wheel or treadle wheel. The potter can focus on his hands only while shaping a clay piece. It is convenient for the experienced potter to use kick wheel or treadle wheel as there's no issue with the coordination of hands and feet; and the speed of the manual wheel is easily controlled than the electric wheel. Some electric wheels have the setting of two specific speed units while, others have the function to control its speed through the foot usually in a specific range of 0 to 240 rpm. Electric wheels are portable due to its light weight than the kick wheel or treadle wheel. This wheel is the most efficient wheel as it conveniently allows the potter to control the speed and concentrate on moulding the clay rather than focusing on the working mechanisms of the potter's wheel. The power that you need to centre clay depends upon the torque produced by the motor which gives the machine more cantering power. The 1/3 hp motors provides more torque to the wheel than 1/2 hp motors. The industry made motor is used in all the wheels that are able to provide constant torque through different speed ranges. The electric wheels are the best choice in the society. Motorized wheel is the combination of electric wheel and a kick wheel. Motorized wheel boasts the fine control by kicking the wheel and the electric power to centre the clay which would be the most efficient wheel used in modern day.

II. METHODOLOGY

The average work rate of a man working continuously is equivalent to 75W (Alexandrove, 1981). Thus, only continuous manufacturing process requiring less than 75W can be man powered. Any manufacturing process requiring more than 75W and which can be operated intermittently without affecting end product can also be man powered. Such man powered manufacturing process is based on the following concept. The source of power used in this process is a flywheel. To energize the flywheel, manpower is used at an energy input rate, which is convenient for a man. After maximum possible energy is stored in flywheel it is supplied through suitable clutch (Gupta, 1997) and gearing system to a shaft, which operates the process unit. The flywheel's deceleration will begin at a rate considering the load torque. The higher the load torque is the higher will be the rate of deceleration. Thus this man-flywheel machine can abolish the load torque of infinite immensity. Same principle lies behind the Pedal driven potter's wheel .If such machine is developed it will be a great help to potters of rural areas because it does not need conventional energy. It is environment friendly machine.

Based on the previous techniques which are meant for the development of potter's wheel and its evolution we started a new innovation among manual potter's wheels which will be an alternate to electrical motor potter's wheel consumes electricity. The main objective of our project is to maintain the speed of potter's wheel. In order to maintain the speed certain changes in its design are made. The main change we did is sewing machine pedal mechanism, bevel gear, sprocket, free wheel and required length of chain.

In our project we have used sewing machine pedal mechanism to fix the bevel gear on the wheel of the mechanism. The other bevel gear fix on the shaft with 12 mm diameter of one end and other end fix the sprocket. The sprocket is connected to freewheel with the chain, freewheel is fix on the other shaft with 12 mm diameter. This shaft one end fixes flywheel and other end fix potter's wheel; these shafts are mounted on the frame with the help of bearing to freely rotate.

III. WORKING

Working of manual potter's wheel machine as shown in fig.1, and fig.2 the potter inputs mechanical energy during pedalling, each potter accelerates the flywheel use in sewing machine pedal mechanism for about one minute. This flywheel is accelerated to the speed of 60 rpm in a minute time. In this machine, initial energy is stored in the flywheel by accelerating it to a desired speed by pedal. The torque amplification gearing mechanism comes into play after the flywheel has achieved the desired speed. The torque amplification gear works by engaging the bevel gear.

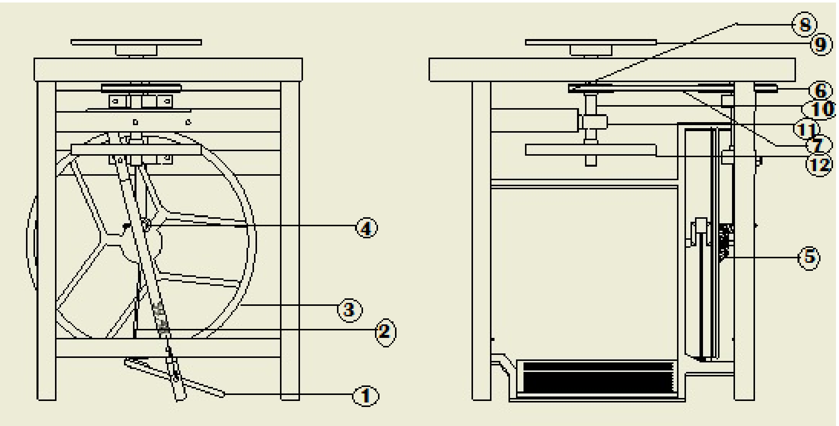

Fig. No. 1: Schematic View of the Potter's Wheel

1. Pedal, 2. Link, 3.Wheel, 4. Mechanism which converts linear motion to rotary motion,
5. Bevel gear, 6. Sprocket, 7.Chain, 8. Freewheel, 9. Potter's wheel, 10. Shafts,
11. bearing with pedestal, 12. Flywheel

Fig. No. 2: Potter's Wheel Machine

The force applied on the pedal is transformed to bevel gear pair; the bevel gear pair transfers the motion to sprocket. As the sprocket is mounted on the shaft the motion from bevel gear pair is transformed to the sprocket. Here as we are using sprocket and free wheel the rpm is going to be improved based on the gear ratios.

IV. PARTS OF POTTER'S WHEEL

Parts potter's wheel can be categorized in the following ways:

4.1 WHEEL HEAD

Throughout the different stages of pottery, wheel and clay relate and interact with one another. As the potter attempts to centre the lump of clay on the wheel, the hands grasp the clay. The fingers, bent slightly following the surface curvature, sense the clay and exchange vital tactile information necessary for a number of crucial decisions that are about to follow in the next few seconds.

Fig. No. 3: Wheel Head with Flywheel and freewheel

4.2 BEARING

A bearing is a device that is used to enable rotational or linear movement, while reducing friction and handling stress. Resembling wheels, bearings literally enable devices to roll, which reduces the friction between the surface of the bearing and the surface it's rolling over.

4.3 FLYWHEEL

Flywheels are designed to store and release kinetic energy. A Flywheel is disc-shaped, and true to its weight on all sides and locations of the disk. The flywheel is designed to provide a more steady flow of momentum. The size and weight of the flywheel will determine the amount of energy that can be produced from peddling. The mechanical advantages of using a flywheel is that its energy output is consistent and, depending on the size of the flywheel, it is able to store and release great amounts of energy even after the peddling has ceased.

4.4 SHAFT

A mechanical component used for transmitting torque, usually used to connect other components of drive train that cannot be connected directly because of distance or the need to allow for relative movement between them.

4.5 BEVEL GEAR

To obtain optimum load distribution between gears and to ensure smooth running, the bevel gears must be assembled in a specific way. Setting up a pair of bevel gear is a very complicated than setting up a pair of spur gear. But by following the correct procedure, the 'setting up' can be a much easier task. The bevel gears cannot perform well if installed in the same manner as spur gear and helical gears. For any two bevel gears to perform smoothly without binding or excessive backlash, the gears must be positioned together. The bevel gears can include straight, spiral, zerol, hypoid and spiroid. As these bevel gears are conical in shape, they all have an optimum position for best performance. The manufacturer of these bevel gears usually determines the optimum position by running tests, but the responsibility for incorporating this optimum position is shared by the designer and the assembly technician. In order to help the technician to assemble the overall gearbox, the designer must provide shimming dimensions that are easy to measure.

Fig. No. 4: Bevel Gear

4.6 PEDAL POWER

The transfer of energy generated by the human source by the use of foot pedal and crank system is known as the Pedal Power. This technology is commonly being used for transportation and propelling bicycles for over a hundred years. Human beings are very adaptable and can produce power over a wide range of pedalling speeds. However, pedalling at a certain rate allows people to generate more or the same amount of power for a long amount of time. But, the rate changes depending on each person's physical ability. Still the most efficient way of power production would be to pedal in speed somewhere between straining and fumbling. The pedalling speed in range between 50 to 70 revolutions per minute would be the ideal pedalling rate for most people who are engaged in pedalling for an hour or more.

4.7 SEWING MACHINE PEDAL MECHANISM

To combat with the above-mentioned problems hand operated driving mechanism is now replaced by the foot operated mechanism. In this improved mechanism, power input is given through treadles. The mechanism is advantageous as comparatively stronger foot muscles are used to give input. By providing treadles not only effort is minimized but also one can operate this for a longer period. The idea of treadle pump has been skilfully adapted to this model. All parts used in this model are of standard hand pump and are easily available in the market. Parts are made detachable so that they can be replaced as per the need. As compared to the previous models the current modification is much smoother. Though providing the driving force by feet and leg made the operation easy, yet it is not a fully optimized solution. This motivated us to look for an improved design for providing continuous power by reciprocating motion through treadles. There are some very-low-power applications of pedal power, in which the required power output is so far below that of which human beings are capable that maximum efficiency is not a concern. Ex-For the sewing table to be placed at a convenient height, sewing machines are generally restricted to less than the optimum value. This mechanism allows the peddler to provide a range of sewing speeds changing with the will of the peddler without using the gear-change mechanisms.

Fig. No. 5: Sewing Machine Pedal Mechanism with Bevel Gear

4.8 SPROCKET

A wheel with tooth, cogs, or sprocket that is meshed with the chain, track or other notched materials is called a sprocket-wheel. Sprocket is the term generally applies to a wheel that has indented projections upon it where a chain can be meshed together. The gears and pulleys are totally different terms than sprocket. Gear is a mechanism where identical gears with different/same sizes are meshed together directly, whereas pulley doesn't have teeth, it is smooth. The sprockets are used to transmit gyratory motion between two shafts where gears cannot be used, or to provide linear motion. The sprockets are generally used in bicycles, motorcycles, tracked vehicles and other machines. The most common use of sprocket would be found in bicycles where a large sprocket wheel is fixed on the pedal shaft, which drives a chain to the rear smaller sprocket wheel attached on the rear axle. In early period, sprockets and chain mechanisms were used to drive automobiles which had a mechanism identical to that of the bicycle. Sprockets are available in various designs, each originator has claimed for maximum of efficiency. Sprockets typically do not have a flange. Some sprockets used with timing belts have flanges to keep the timing belt centred. Sprockets and chains are also used for power transmission from one shaft to another where slippage is not admissible, sprocket chains being used instead of belts or ropes and sprocket-wheels instead of pulleys. They can run at high speed and so constructed as to be noiseless even at high speed.

Fig. No. 6: Sprocket with Bevel Gear and Bearing

4.9 GEAR RATIO

The gear ratio is the relationship between the rotating speed of whatever is being driven and the pedalling rate (both expressed in revolutions per minute).Typically there are several gears available on the rear sprocket assembly, attached to the rear wheel. A few more sprockets are usually added to the front assembly as well. The number of sprocket gears added to the front to that of rear is known as the number of gear ratios which are often called as "speeds". The most practical applications of pedal power gear ratio would be the bicycle chain-drives. The ratio of the chain-drives of bicycle is 1:1 for high gears.

V. CALCULATION

5.1 DESIGN FOR GEAR RATIO

Design has to be such that power is to be transmitted to the potter's wheel when the pedalling is stop. To obtain this we use freewheel and a gear ratio and then the bevel gear ratio. The calculation for gear ratio is done with the following considerations:

1. Freewheel used is that of bicycle having pitch 12.7mm and number of teeth 18. Freewheel was considered as the driven sprocket.
2. Sprocket is mounted on the shaft one end and on the other end mounted the Bevel Gear.

Pitch of the sprocket is 12.7mm and contained 52 teeth.

Design of gear ratio is done in the following stages:

Stage 1: From Potter's wheel side to freewheel.

The pitch and number of teeth were fixed as the used freewheel was that of the bicycle which is generally available in the market.

Pitch = 12.7mm

Number of teeth on driven sprocket = 52

To obtain higher gear ratio choose driving sprocket such that

Pitch = 12.7 mm

Number of teeth on driver sprocket = 18

Gear ratio = 52/18

i1 = 2.888: 1

Stage 2: Power transmission from sewing machine mechanism joint shaft mounted bevel gear on it and another Bevel Gear mounted on joint shaft (Bevel Gear Pair), commonly available in the market.

Bevel Gear of pitch Diameter 70 mm, Pressure Angle 200 and Number of teeth 25 we choose driver such that

Pitch Diameter = 50 mm

Pressure Angle 200

Number of teeth on driven Bevel Gear = 20

Gear ratio = 25/20

i2 = 1.25: 1

Stage 3: Resultant gear ratio

Resultant gear ratio I = i1 * i2

= 2.888 * 1.25

I = 3.61: 1

5.2 DESIGN OF FREEWHEEL

A free wheel is used in order to make the two wheel engagement automatic. The free wheel used is the commonly available one for bicycles.

Specifications:
Pitch = 12.7 mm
Number of teeth = 18
Weight = 175 g.
Material: Steel.

5.3 SPROCKET

Sprocket and chain is used to transmit power from sewing pedal mechanism output to the potter's wheel.
Sprocket: The sprocket is coupled to the sewing pedal mechanism output shaft and delivers power to freewheel.

Specifications:
Pitch = 12.7 mm
Number of teeth = 52.
Material: Steel C45

5.4 CHAIN

Chain play an important role as all the power transmission is using sprocket and chain. Chain:

Pitch =12.7 mm
Design for number of links:
Pitch, p = 12.7 mm
Centre distance between sprockets X = 300 mm
Number of teeth on driven sprocket T1 = 18
Number of teeth on driver sprocket T2 = 52

Number of links K $= (T_1 + T_2)/2 + (2X/p) + (p/X)*[(T_2 - T_1)/(2\pi)]^2$

$= (18+52)/2 + [(2 * 300)/12.7] + (12.7/300) * [(52-18)^2/4\pi^2]$

$= 35 + 47.24 + 1.24$

K = 83 links

VI. CONCLUSION

The work is done to reduce the human power by producing more number of rotations to the same torque. The transmission capacity of the potter's wheel using new mechanism has calculated the speed of the potter's wheel. Sewing machine pedal mechanism, sprocket, and freewheel are used instead of kick or treadle potter's wheel. This new mechanism increases the speed of potter's wheel with less effort. This work also deals with the comfort to the potter as compared to the kick wheel or treadle wheel. The results obtained from this work is a useful approximation to help in the earlier stages of the development and helping in the decision making process to optimize a design. This new mechanism has served as an alternative to a treadle wheel for the future.

REFERENCES

[1]. Okewu Ebute Jonathan, "Manual Potter's Wheel Efficiency in Ceramics Production in Nigeria" IOSR Journal of Humanities and Social Science (IOSR-JHSS) Volume 19, Issue 2, Ver. V (Feb. 2014), PP 01-05 e-ISSN: 2279-0837, p-ISSN: 2279-0845.
[2]. Sanjeey Reddy K Hudgikar and S.M.Saleemuddin, "Design and Modification of Bicycle by Using Additional Sprockets" International Journal of Advance Research and Innovative Ideas in Education(IJARIIE), Vol-3 Issue-4 2017, ISSN(O)-2395-4396, pp 2422-2431.
[3]. Nandkishor M. Sawai, Dr. V. G. Arajpure, Dr. C. C. Handa, "Design And Fabrication Of A Manually Operated Potter Wheel By Using Sewing Machine Pedal Mechanism", Journal of Emerging Technologies and Innovative Research, Volume 6, Issue 5 (ISSN-2349-5162), May 2019,
[4]. Morie Kaneko, "Variations in Pottery Making in Southwestern Ethiopia", Proceedings of the 16th International Conference of Ethiopian Studies, ed. by Svein Ege, Harald Aspen, Birhanu Teferra and Shiferaw Bekele, Trondheim 2009.
[5]. Nandkishor M. Sawai, Dr. V. G. Arajpure, Dr. C. C. Handa, "Potter's Wheel Efficiency in Clay Pot Production in Rural Area: A Critical Review", International Journal of Advance Electronics & Communication System Approved by CSIR NISCAIR ISSN No. 2277-7318 Proceeding of National

Conference on Current Trends in Engineering, Science, Technology and Management (NACCTESTM-2017), 21st March 2017, Godavari College of Engineering, Jalgaon.
[6]. K.S. Zakiuddin And J.P. Modak, "Application of pedal operated flywheel motor as an energy source for fodder chopper", International Journal of Agriculture Engineering Vol-3 Issue-2 October, 2010, pp ss251-256
[7]. Afuye E.K., and Ejiko S.O., "Development of an Interchangeable Throwing Wheel", Scholarly Journal of Engineering Research Vol. 3(1), pp. 11-21, January, 2017, Available online at http:// www.scholarly-journals.com/SJER, ISSN 2276-8955 c 2017 Scholarly-Journals.
[8]. Nandkishor M. Sawai, Dr. V. G. Arajpure, Dr. C. C. Handa," Throwing Profile and Tools on the Potter's Wheel for The Production in the Pottery: A Critical Review", International Journal of Innovations in Engineering and Science, Special Conference Issue, 2018
[9]. Philip Kwesiga,1 and Willian K. Kayamba, "Experiments in design process and productdevelopment in Uganda's ceramics", Net Journal of Social Sciences, Vol. 2(4), pp. 92-99, October 2014, ISSN: 2315-9774.
[10]. OkewuEbute Jonathan, "Manual Potter's Wheel Efficiency in Ceramics Production in Nigeria" IOSR Journal of Humanities

Nandkishor M. Sawai, et.al. "Development and Modification of Potter's Wheel by Using Sewing Machine Pedal Mechanism and Chain Sprocket". *IOSR Journal of Engineering (IOSRJEN)*, 10(1), 2020, pp. 11-18.