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# Design and Fabrication of Tandem Drive Human Power Flywheel Motor for Application of Seed Oil Extraction

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**Abstract:** The biggest Aim of This Paper Design and Fabrication of Human power flywheel motor (HPFM) is to get maximum energy with minimum amount of your time. Tandem drive means double pedal in machine. The main component of this machine is hopper, chain sprocket, shaft, flywheel, pedal, freewheel, gear, The machine is very simple and comfortable, it can be easily operated either male or female. The machine is economically viable and it often is operated skilled and unskilled people. In India most of people suffering from electricity. So overcome this problem our group select HPFM, which operated manually. In today scenario farmers need electricity in the agricultural areas. Our team works on HPFM for application of seed oil extraction. This energy uses so many applications like water purification, seed oil extraction, Bio-ethanol plant (ethanol made from rise, made ethanol from waste material). The agricultural products are oil-seeds (cotton, castor, sunflower, etc), nuts (coconut, groundnut, shea-nut, etc), oil made from sunflowers and fruits (oil palm).

**Keywords:** HPFM, Flywheel, Shaft, Gear, Seed Oil.

## I. INTRODUCTION

In today developing world so many challenges ahead of humans like electricity, unemployment, loss in farming etc. in today scenario farmers need electricity in the agricultural areas, Our team work on HPFM for application of seed oil extraction. This energy use so many applications like water purification, seed oil extraction, Bio-ethanol plant (ethanol made from rise, made ethanol from waste material). The agricultural products are oil-seeds (cotton, castor, sunflower, etc), nuts (coconut, groundnut, shea-nut, etc), oil made from sunflowers and fruits (oil palm). It is simple that extraction of oil from the seed, nuts, sunflowers. This machine is simple and comfortable, low cost, easy to operate either male or female, easy to operate unskilled and semiskilled peoples. This machine use farmer and people business point of view.

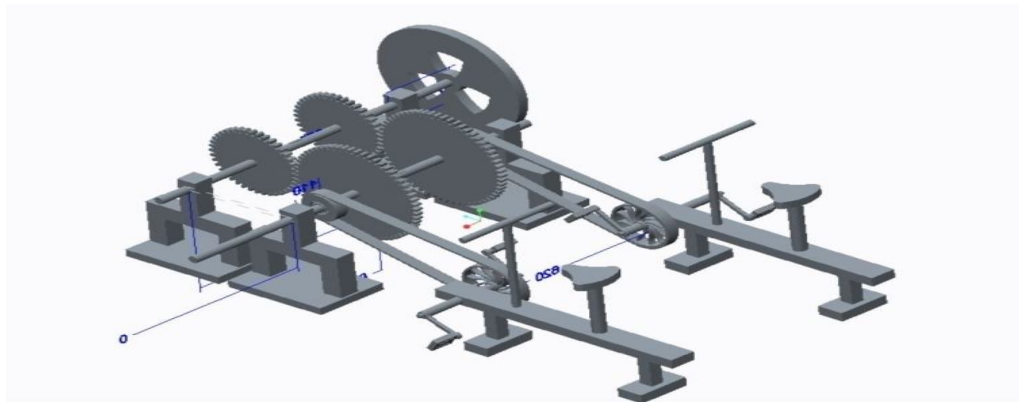


Fig - 1 CAD model of tandem drive human power flywheel motor

The Main Problem In India there is no electricity in Rural, Semi-rural and agricultural areas that's why poor people, farmers face big problems and income of farmers and poor people does not grow. Death of farmers is maximum. People are going to leave the villages and migrate to the city. Our team works on HPFM machine. This machine works to generate electricity manually. The maximum output of this machine is 13 HP. When you pedal, the machine chain sprocket is connected to the shaft. In this shaft, rotating gear pinion arrangement is connected to another rotating shaft and flywheel mounted on it. This rotating flywheel's rotational energy is stored on it.

This Rotational Energy Converted Into Electrical Energy. This energy use application of seed oil extraction firstly the inputs i.e. the seed are fed to the machine through the hopper. Then seed come in contact with the two members, one is semicircular net and another is roll shaft. Semicircular net be a stationary member while the roll shaft is rotating member. When the seed comes in contact with these two members then the shearing action takes place here. Due to shearing action (crushing) the seed gets shelled and extract oil.

You can locate this machine in rural, semirural, urban, agricultural areas. If you have use this machine to purify water then locate in pond, river, drain. But our team use this machine in agricultural area because of extraction of seed oil. The seeds that come out of farmers farm, that seed will take in the HPFM machine and oil come out this machine use farmers in our agricultural farm and rectify our all problems.

## II. DESIGN AND ANALYSIS

### A. Design of Flywheel



Fig - Reference by Google images

Where,  $E$  = kinetic energy of flywheel in (Joule)

$I$  = moment of inertia ( $\text{kg m}^2$ )

$\omega$  = angular velocity (rad/s)

$k$  = constant inertial - depend on shape of flywheel

$m$  = mass of flywheel (kg)

$r$  = radius (m)

Thickness of the rim= 0.06, width of the rim= 0.08

Density =  $7200 \text{ kg/m}^3$

$E = \frac{1}{2} I \omega^2$

$I = mk^2$

$m = 0.06 * 0.08 * 2 * \pi * 0.5 * 7200$

$m = 108.58 \text{ kg}$

$K = D/2 = 1/2 = 0.5 \text{ m}$ ,

**$I = 27.14 \text{ kgm}^2$**

**For  $N = 2000 \text{ rpm}$**

$\omega = 2\pi N/60 = 2\pi * 2000/60$

$\omega = 209.46 \text{ rad/sec}$

$E = 0.5 * 27.14 * (209.46)^2$

$E = 595363.28 \text{ Joule}$

Power =  $E/60 = 9922.72 \text{ J/sec}$

Power = 9922.72

**Power = 12.9 HP**

**For N=1200 rpm**

$$\omega = 2\pi N/60$$

$$\omega = 125.68 \text{ rad/sec}$$

$$E = 0.5 \times 27.14 \times (125.68)^2$$

$$E = 214344.42 \text{ Joule}$$

$$\text{Power} = 3572.40 \text{ J/sec}$$

**Power= 4.64 HP**

**For N=1500 rpm**

$$\omega = 157.1 \text{ rad/sec}$$

$$E = 0.5 \times 27.14 \times (157.1)^2$$

$$E = 334913.16 \text{ Joule}$$

$$\text{Power} = 5581.88 \text{ J/sec}$$

**Power= 7.25 HP**

### B. Design of Shaft



Fig : Reference by Google images

**For 1200 rpm**

Where, N= speed of the shaft in rpm

T= twisting moment in N-mm

J= polar moment of inertia for solid shaft

$\tau$  = shear stress

$$\text{Power} = (2 \times \pi \times N \times T) / 60$$

$$\text{Power} = 3572.40 \text{ watt}$$

**N= 1200 rpm**

$$T = 60 \times P / 2\pi \times N$$

**T= 28420 N-mm**

$$T = \tau \times r / j$$

$$J = \pi / 32 \times d^4$$

$$r = d / 2$$

$$\tau = S_{ut} / FOS = 91.75$$

**d= 14.6 mm**

**For 1500 rpm**

Power= 5581.88 watt

**T= 35530 N-mm**

**d= 15.8mm**

**For 2000 rpm**

Power= 9922.72 watt

**T= 47.37 N-mm**

**d= 17.4 mm**

### C. Design of Gear

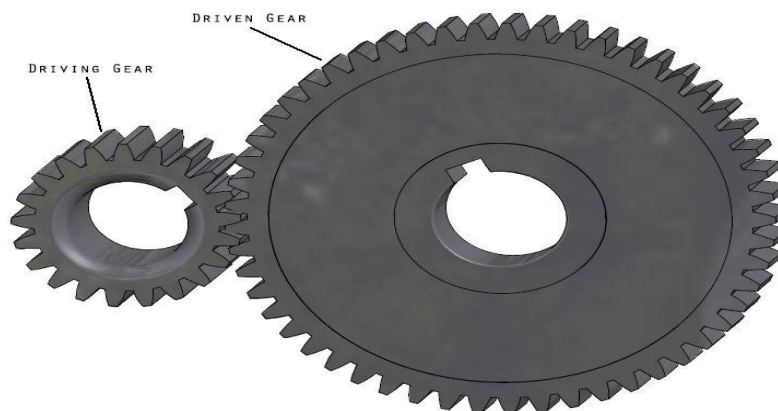


Fig - Reference by Google images (<http://thereviewstories.com>)

**For N= 2000 rpm**

Power= 9.92272 KW

N = Pinion =2000 rpm

Velocity Ratio = 8

Static Stress =  $\sigma_v = 120$  Mpa

Static Stress =  $\sigma_v = 100$  Mpa

Pinion Teeth = 20

Face width =14m

y= 0.154 -0.192/20

y = 0.1084

Given,

P= 9.92272 KW = 9922.72 watt

N = 2000 rpm

V.R. = TG/TP =8

$\sigma_{op} = 120$  Mpa = 120 N/mm<sup>2</sup>

$\sigma_{og} = 100$  Mpa = 100 N/mm<sup>2</sup>

T<sub>P</sub> = 20

b = 14m

m= module in mm





$D_p$  = diameter of pitch circle pinion in mm

Pitch Line Velocity

$$\begin{aligned} V &= \pi * D_p * N / 60 = \pi * m * T_p * N / 60 \\ &= \pi * m * 20 * 2000 / 60 \\ V &= 2.0946 \text{ m/s} \end{aligned}$$

The service factor ( $C_s$ ) is given in table

Tangential tooth load

$$\begin{aligned} W_T &= P / V * C_s \\ W_T &= 9922.72 / 2.0946 \text{ m} * 1 \\ W_T &= 4737.1506 / \text{m N} \end{aligned}$$

Velocity Factor

$$\begin{aligned} C_v &= 3 / (3 + V) = 3 / (3 + 2.0946 \text{ m}) \\ C_v &= 0.5888 \end{aligned}$$

Tooth from Factor (Pinion)

$$\begin{aligned} Y_p &= 0.154 - 0.912 / 20 \\ Y_p &= 0.1084 \end{aligned}$$

Tooth from Factor (Gear)

$$\begin{aligned} Y_G &= 0.154 - 0.912 / T_G \\ &= 0.154 - 0.912 / 8 * 20 \\ Y_G &= 0.1483 \\ \sigma_{op} * Y_p &= 120 * 0.1084 \\ &= 13.008 \\ \sigma_{og} * Y_G &= 100 * 0.1483 \\ &= 14.83 \\ \sigma_{op} * Y_p &< \sigma_{og} * Y_G \end{aligned}$$

Pinion is weaker

Using Lewis equation to the pinion

$$\begin{aligned} W_T &= \sigma_{wp} * b * \pi * m * Y_p \\ &= (\sigma_{op} * C_v) * \pi * m * Y_p \\ 4737.1506 / \text{m} &= 120 (3 / (3 + 2.0946 \text{ m})) * 14 \text{ m} * \pi * m * 0.1084 \\ 3 + 2.0946 \text{ m} &= 0.04512 \text{ m}^3 \end{aligned}$$

Solving this equation by hit and trial method

$$\begin{aligned} m &= 7.44 \text{ mm} \\ \mathbf{m} &= \mathbf{8 \text{ mm}} \end{aligned}$$

Face width

$$\begin{aligned} b &= 14 \text{ m} = 14 * 8 \text{ mm} \\ b &= 112 \text{ mm} \end{aligned}$$

Pitch Circle Diameter of pinion

$$\begin{aligned} D_p &= m * T_p \\ &= 8 * 20 \\ \mathbf{D_p} &= \mathbf{160 \text{ mm}} \end{aligned}$$

Pitch Circle diameter of gear

$$\begin{aligned} D_G &= m * T_G = 8 * 160 \\ \mathbf{D_G} &= \mathbf{1280 \text{ mm}} \end{aligned}$$

$$N = 1200 \text{ rpm}$$

$$V = 1.2568 * m \text{ m/s}$$

$$W_T = 2842.45 / m \text{ N}$$

Velocity factor,

$$C_V = 0.7047m$$

$$Y_P = 0.1084$$

$$Y_G = 0.1483$$

Using Levis equation,

$$m = 2.65 \text{ mm}$$

$$m = 2 \text{ mm}$$

Face width (b) = 28 mm

Pitch circle diameter for pinion

$$D_P = 40 \text{ mm}$$

Pitch circle diameter for gear

$$D_G = 320 \text{ mm}$$

$$N = 1500 \text{ rpm}$$

$$V = 1.571 * m \text{ m/s}$$

$$W_T = 3553.07 / m \text{ N}$$

Velocity Factor,

$$C_V = 0.6563m$$

$$Y_P = 0.1084$$

$$Y_G = 0.1483$$

$$3 + 1.571 m = 0.4831 m^3$$

$$m = 3.076 \text{ mm}$$

$$m = 4 \text{ mm}$$

Face width (b) = 56 mm

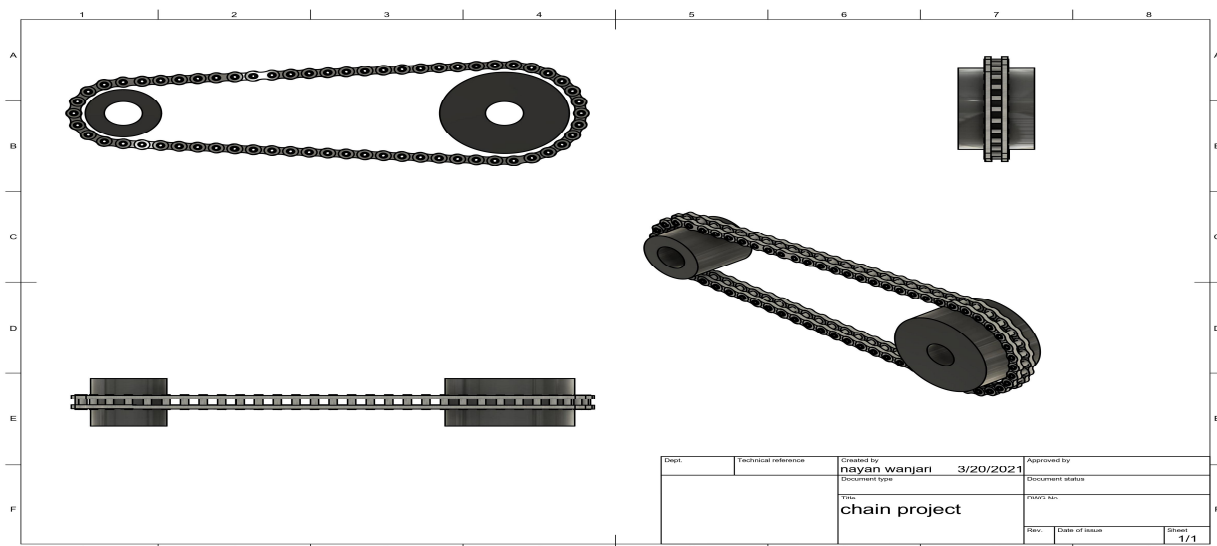
Pitch circle diameter for pinion

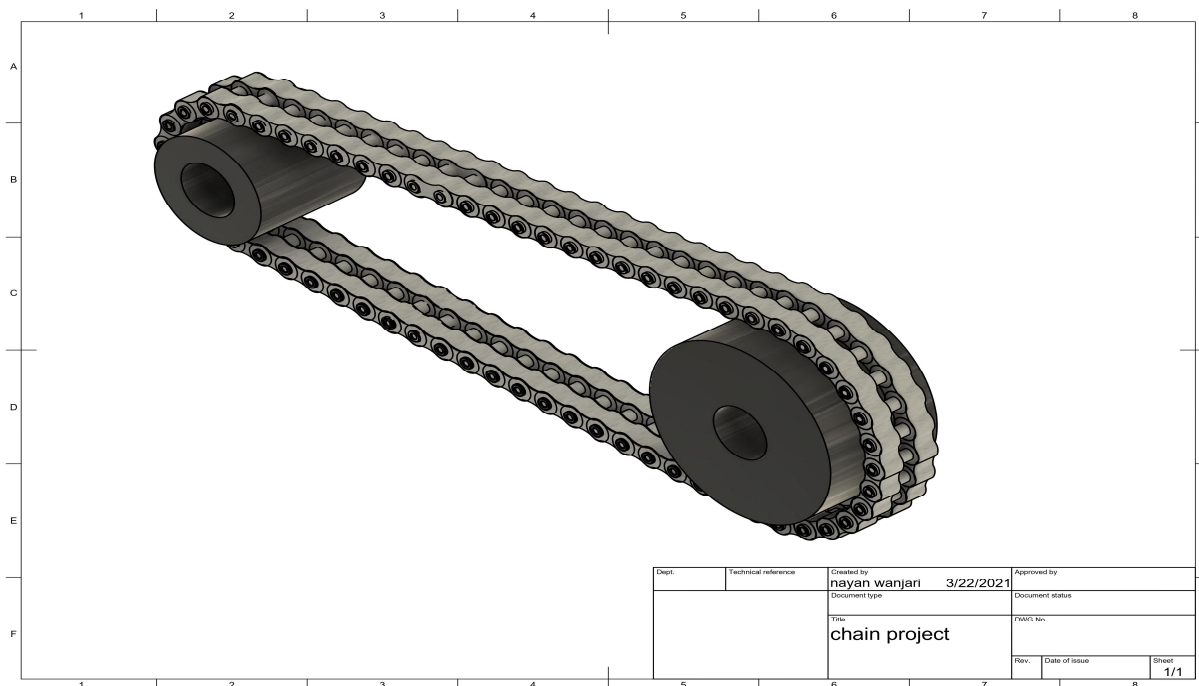
$$D_P = 80 \text{ mm}$$

Pitch circle diameter for gear

$$D_G = 640 \text{ mm}$$

#### D. Design of Chain





Module = 8 mm

$T_P = 20$

$T_G = 160$

$D_P = 160$  mm

Pitch of the chain,

$D_P = P \operatorname{cosec} (180/20)$

$160 = P \operatorname{cosec} (180/20)$

$P = 25.02$  mm

Therefore, the minima centre distance between the smaller and bigger sprockets should be 30 to 50 times the pitch.

Therefore,

Centre distance between the sprockets =  $30 P = 30 \times 25.02 = 750.6 \approx 751$  mm

In order to accommodate initial slag within the chain .

The value of centre distance is decrease by 215 mm.

$X = 751 - 3 = 748$  mm

Therefore,

Number of chain links,

$K = T_1 + T_2 / 2 + 2x / P + [ T_2 - T_1 / 2\pi ]^2 \times T / x$

$= 20 + 160 / 2 + 2 \times 748 / 25.02 + [ 160 - 20 / 2\pi ]^2 \times 25.02 / 748$

$K = 166.30$

$K = 167$  mm

Link of chain,

$L = P \times K$

$= 25.02 \times 167$

$= 4178.34$  mm



$$L = 4.178 \text{ m}$$

Pitch line velocity of small sprocket,

$$V1 = \pi \text{ dp } N / 60 = \pi \times 160 \times 2000 / 60$$

$$V1 = 16.755$$

**Find the value of torque**

$$T_{\text{mean}} = \text{total area} / 2\pi$$

$$= (1/2 * b * h) + (1/2 * b * h)$$

$$= (1/2 * 6 * 10.4) + (1/2 * 6 * 1.7) / 2\pi$$

$$= 5.77 * 20$$

$$T_{\text{mean}} = 115 \text{ N-m}$$

Sr.no/Ang	d	F	$\theta$	$F \cos \theta$	r	T
1	0°	240N	0	0	0	0
2	30°	240N	60	$240 \cos 60^\circ$	0.18	21.6N-M
3	60°	240N	30	$240 \cos 30^\circ$	0.18	37.41N-M
4	90°	240N	90	0	0.18	43.2N-M
5	120°	240N	30	$240 \cos 30^\circ$	0.18	207.84N-M
6	150°	240N	60	$240 \cos 60^\circ$	0.18	21.6N-M
7	180°	240N	90	0	0.18	0
8	210°	240N	120	$240 \cos 120^\circ$	0.18	-21.6N-M
9	240°	240N	150	$240 \cos 150^\circ$	0.18	-37.41N-M
10	270°	240N	270	0	0.18	-43.2N-M
11	300°	240N	150	$240 \cos 300^\circ$	0.18	-37.41N-M
12	330°	240N	240	$240 \cos 330^\circ$	0.18	-21.6N-M

Table-1 - Pedalling force at 30° each (Thesis Design of Human Powered Vehicle by Ashwin Kubde and Guided by G. D. Mehta. as a reference.

### III. LITERATURE REVIEW

A. Dr. R. A. Kubde, Shahajad Khan, Swapnil Bodade, Showbuddinmulla, Roshan Ughade, Shubham Lonkar, Vitthal Bangar(2017) Design and fabrication of manually operative wood working machine.

In this paper we are studied mainly for small wood factory, The machine operated by human peddling so no any other extra energy it's needed. Power required for pedalling is above the capacity of an average healthy human being. But with the Help of pulley we supply the more power this is used to increase the communication with workpiece which is away from the machine us multipurpose machine makes the machining operation like grinding and wooden cutting operation etc. Very easy without electricity. In this machine one alternator is attached to flywheel which transmits to mechanical power into electrical power.

B. M. P. Mohurle, D. S. Deshmukh, P. D. Patil (2016)

Human power Using Bicycle Mechanism as an Alternative Energy sources -A Critical Review

In This paper importance of human power as an alternative energy sources is investigated, to present state and its future scope. In bicycle technology operator uses mostly pedal to operate machine and transmits power through crank, chain and freewheel to the working unit. In the paper, a method of harnessing the power of children play in playground and public places, on devices such as seesaw, marry-go-round and swing is proposed Owing to the linear dependence of energy with IG, the generated, current can be used as a measured of the energy produced by the system.

C. D. Mohammed Rafi, Mr.B.Raja kumar, G.S.R. Nagamalleswar A ram(2016)

Design and development of gear box for multipurpose Milling Machine (5 pm)

The concept of purpose of a gear reduction system is to convert input an speed and torque into a different output speed and torque. This paper is a partial ful fillment to the present market needs to understand the variation in machine design accessories. The progress in non-linear dynamics of gear driven system is received, especially the gear dynamic behaviour by considering the backlash and time-varying mesh stiffness of teeth. The method of introducing the frictional torque between teeth into the dynamic equation is given in his paper.

D. Prof. Vivek padole laxminarayan m. Patorkar

Design and fabrication of pedal operated thresher machine.

In this paper we learn the process of machine less bulky and the ergonomic consideration in the design would allow for its comfortable use for it can easily be operated by either male or female. The thresher can help to sub substantial reduce the human labour involved in threshing at an affordable cost 8e also reduces the time used for threshing operation on small farms.

E. S. G. Bahale, Dr. A. U. Awate, S. V. Saharkar (2012) :

Performance analysis of pedal power multipurpose machine

In this paper we learn process of the conventional energy sources are being source, so alternative energy sources are found which must be cheap. Easily available and must satisfy the technical requirements. This system of pedalling will act as a health exercise and also during a useful work. A healthy male can only reliable maintain the high power range. This energy needs by method will be great way to improve human health in busy life.

F. Gaurang Bhatawadekar, Budye Salman, Nilesh Chiplunkar, Swapnil Devrukhakar, Singh Akashdup(2015)

Design and fabrication of pedal powered washing machine.

As we know HPFM machine can be used in various applications. In this experiment the human power is utilizing for washing machine. This machine is developed because of the lack of electrical energy in rural as well as urban areas. This machine doesn't require power supply or diesel supply and it is portable as it is low in weight. This experiment works on the principle of rotating impeller by peddling and cause to washing cloth. The outlet grey water from machine can be recycled for filling toilet tanks or for watering plants.

G. P. B. Khope, j. P. Modak(2013)

Design of experimental set up for establishing empirical relationship for chaff cutter energized by human powered flywheel motor

In this research paper we learn the process of system for pumping using muscular energy in the flywheel is feasible and then the energy stored in flywheel can used for different application. The design of experimental set up for carrying out the experimental ion to establish empirical relationship for chaff cutter energized by human power flywheel motor.This human energy out put is in the low range and the process could be operated intermittently can be considered for utilization.

H. A. D. Dhole, J. P. Modak (September 2012)

Formulation of experimental data based model for oil press using human power flywheel motor as energy sources.

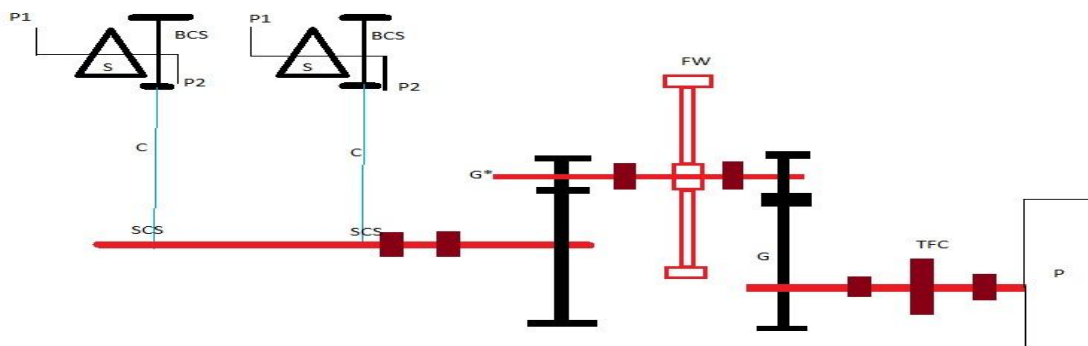
For extraction of oil from the oil seed we use electric power but from this experimental research we can also use the human power for this extraction. As in rural areas, especially in Maharashtra (India) there are 10 to 12 hours load shedding of electricity hence this experimental research is very useful to farmers small scale entrepreneurs in rural areas to enhancement of technology for low profile farmers in view of human power mechanization of agriculture operation.

I. K. S. Zakiuddin, H. V. Sondawale, J. P. Modak ( March 2012)

Human power an earliest source of energy and it's efficient use.

The concept of paper is the importance of human power from the earliest times to the present and it's future scope. For development of industries we use the natural fuels as a source hence now we need to come with alternate source of energy, i. e., non conventional energy. There are many applications of this machine such as domestic use, commercial and industrial use, agricultural use, transportation, electrical generator, physical fitness etc.

#### IV. WORKING PRINCIPLE



When You Pedal Machine Chain Sprocket Is Connected To Shaft. In this shaft Rotating Gear Pinion Arrangement Connected to Another Rotating Shaft and Flywheel Mount On it, This Rotating Flywheel Rotational Energy Stored On It. This Rotational Energy Converted Into Electrical Energy. This energy use application of seed oil extraction. The agricultural products are oil-seeds (cotton, castor, sunflower, etc), nuts (coconut, groundnut, sheanut, etc), oil made from sunflowers and fruits (oil palm). It is simple that extraction of oil from the seed, nuts, sunflowers Firstly the inputs i.e. the seed are fed to the machine through the hopper. The seed are available contact with the 2 members, one is semicircular net and another is roll shaft. Semicircular net be a stationary member while the roll shaft is rotating member. When the seed comes in contact with these two members then the shearing action takes place here. Due to shearing action (crushing) the seed gets shelled and extract oil. . This machine is simple and comfortable, low cost, easy to operate either male or female, easy to operate unskilled and semiskilled peoples. This machine use farmer and peoples business point of view.

#### V. CONCLUSIONS

- The HPFM is study and design model is formed for different variables or values similarly find the value of power, shaft diameter, module of gear, diameter of gear and pinion.
- By using HPFM design model determine the values of machine parts for various different rpm that's 1200 rpm, 1500 rpm and 2000 rpm.
- The utmost power output for 2000 rpm is 12.9 hp.
- Module of gear is 8 for 2000 rpm is

#### VI. ACKNOWLEDGMENT

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