DESIGN AND FABRICATION OF PEDAL OPERATED POWER GENERATION

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Abstract – Resources consumed for generating considerable amount of power has been a major concern in present times and due to limited availability of such fuels, some precautionary measure must be undertaken. Besides this, there is already ample of devices that can convert simple rotary motion into required power output, but there is hardly any device that convert reciprocating motion into electrical output and this is the major reason of wastage of mechanical efforts produced through reciprocating motion. The major purpose of this project is to take initiative of preserving perishable resources as well as effectively utilizing the reciprocating energy for generating electricity with help of mechanical energy or human efforts and utilizing it for charging some small accessories which have input lower or similar to all phones. For producing optimal output in the form of power, this device converts human pedal effort into electrical output by means of one-way mechanism which is used to produce single direction motion to generator shaft through, pedal movement is reciprocating. In order to get a smooth output, stabilizing circuit is being used. Being user friendly and compact in design, this device can be accessed by any age groups and can be carried to multiple locations.

IndexTerms – Foot-pedal Mechanism, Generator, Power generation, Electrical Equipment.

I. INTRODUCTION

The fourth need after food, water and shelter is electricity now-a-days. There are plenty of ways in which the same is produced, but the most effective way still is from a thermal power plant. It can generate huge amount of energy just by burning a fossil fuel – "coal". As we know resources are no longer in abundance, they are depleting day by day. In this paper we have established a new eco-friendly way of generation of power, which is not only more dependable but also our first step towards conservation of fuel.

We have designed and fabricated a model which will be able to produce power up to 5-6W using mechanical energy as an input. We have focused on 2 main parameters as follows:

1- Foot-pedal mechanism[1] - It is a device which operated through our foot and gives a linear motion to us which can further be used by attaching a set of rack and pinion to it as per Fredrik smith[2]. Also, if the input will be though pedal it can also add to individual's health in a form of muscle exercise.

2- Two-way to one-way mechanism- This is the main part of our model where the linear motion given by the foot pedal will be converted into rotary motion by the rack attached to a linear guide[3] and pinion and since the rotary motion will be in two direction that is, while coming down if a pedal is giving clockwise motion, then while going up again it will generate an anticlockwise motion, it is necessary to convert this motion into one-way before feeding it to the next part which is generator shaft.

Also bevel gearing is used in between which increases the gear ratio and amplifies the input rotation to generator shaft. The generator shaft then gives the output which then is stabilised and used for various applications for example mobile charging, trimmer charging, gym equipment, hydraulic doors etc.

This is a portable device also taken care for rough weather conditions and this can be the source of small amount of power for some villages who are still are waiting for the government to give electricity to them.

II. WORKING

In this model, the working takes place in the following sequence:

- Here, working load is applied on the foot-pedal mechanism (as shown below in figure no.1).
- The helical compression spring[4] helps to bring the pedal plate back to its initial position once the load is removed.
- The movement of pedal results into reciprocation of rack which is precisely supported by linear guide.
- By using a pinion meshing with the rack, the linear motion is converted into rotary motion which rotates the input shaft of the mechanism (as shown below in figure no.2). This mechanism consists of 3 bevel gears and 2 one-way bearing that are connected in opposite direction thereby producing single direction rotary motion at the bevel pinion.
- The bevel pinion is connected with the input shaft of the generator.
- Then after the produced electrical power is stabilized by using a filter circuit which regulates the fluctuation of the generated output.

- Finally, the constant electrical output from the circuit can be used to operate various devices having low or similar input up to 5-6 watts.

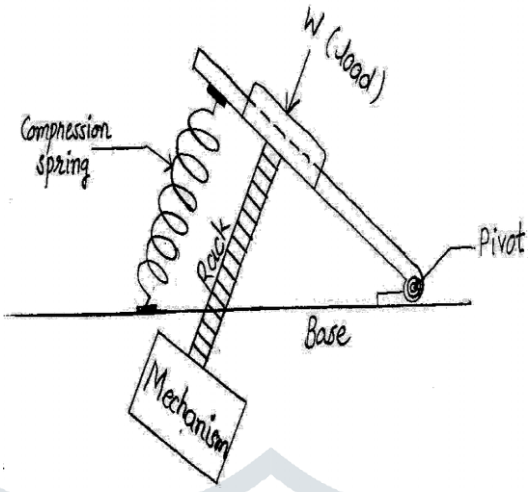

Fig 1

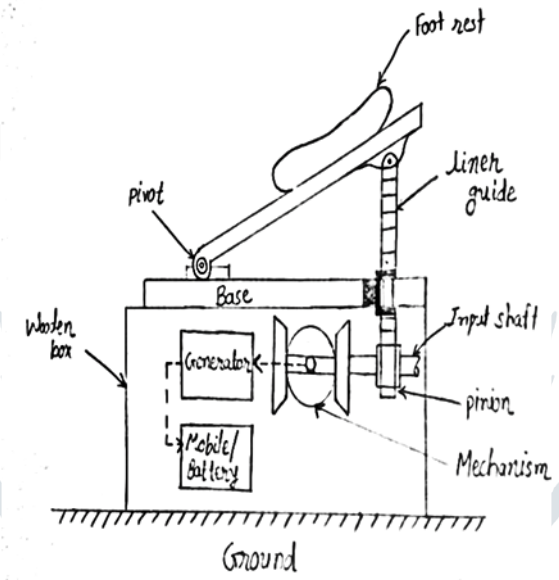

Fig 2

III. DESIGN

We made different part of this unit as per the perfect dimension and then assembled them in CREO. We used surface as well as solid modelling for the same, also we have done a motion analysis check on the device which shows it is safe as per design.

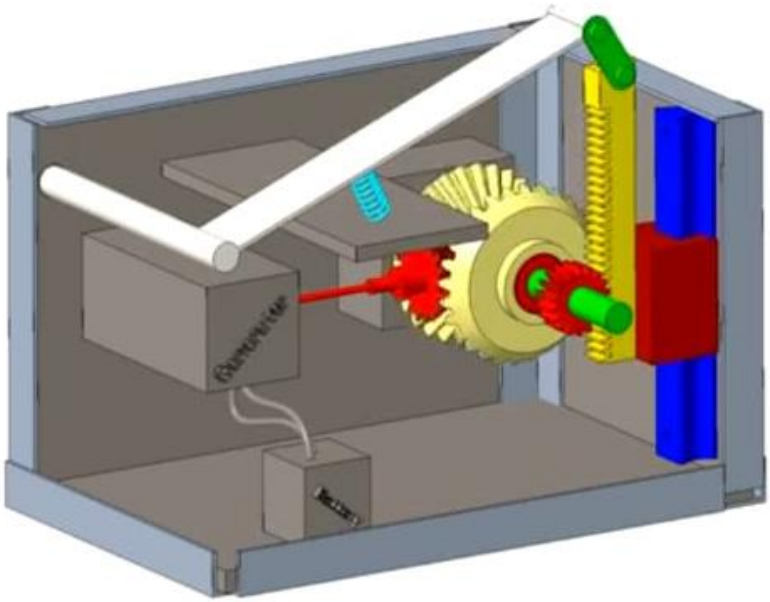

Fig 3 Proposed model

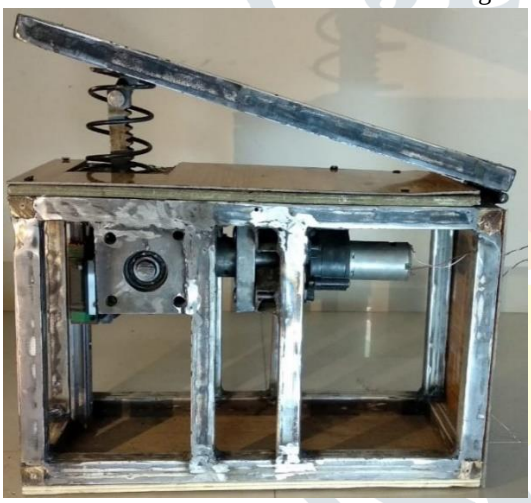

Fig 4 Side view of actual model

Fig 5 Isometric view of actual model

IV. DEVICE BUILDING

Sr no.	Name of component	Material	Specification	Process used to manufacture	Cost (in Rs)
1	Structure	Mild steel	Length 400mm Width 160mm Height 250mm	Welding	1600
2	Rack & pinion	Rack-Mild steel Pinion- Caste Iron	Rack 160*19mm Teeth - 16 m = 2 Pinion D= 45mm Teeth - 20	Rack- Milling Pinion-Casting	700
3	Linear Guideways	Hardened steel	Length 220mm Width 30mm		1200
3	Helical spring	Oil tempered steel wire	d = 3.5mm D = 53.5mm K - 15 No of turns - 5		300

4	Bevel gears	Grey caste iron	Bevel gear DP - 13 m - 1.95 Teeth - 28 Bevel pinion Teeth - 15	Casting	700
5	Single direction Bearings	-	D = 40mm d = 20mm		200
6	DC Generator	-	Max V – 40V Max A –1500mA D of shaft – 8mm		1000
	TOTAL				**5700**

V. CALCULATION

Bevel Gearing

Pinion diameter – Dp = 40 mm
Gear diameter – Dg = 70 mm
Face width – b = 20 mm
Pitch angle for both pinion and gear – $\theta = 45°$
Slant height – $L = [(Dg/2)^2 + (Dp/2)^2]^{1/2} = 40.31$ mm
Teeth of pinion – Tp = 15
Teeth of gear – Tg = 28
Equivalent teeth = Tep = $Tp\sec\theta p = 39.5$
Module = Dp/Tp = 2.6
Peripheral speed = $V = \pi DpNp / 60 = 0.125$ m/s

Velocity Factor,
Cv = 3/(3+V) =0.96 [as the gears are cut by form cutter]
Tooth form factor, [Levis factor]
$y'p = 0.124-0.686 /Tep = 0.0916$
Deformation factor for Cast-Iron, C = 22 N/mm
Ratio factor,
Q = 2 Teg/ (Teg +Tep)
= 1.30
For caste iron load stress factor – K = 1.68
Modulus of elasticity – $E = 84$ KN/mm^2
Endurance limit – $\sigma e = 630$ MPa
Allowable static stress – $\sigma o = 70$ N/mm
Tangential load,
$Wt = \sigma.Cv.b.\pi.m.y' [(L-b)/L] = 518.36$ N
Dynamic load,
$Wd = Wt + [21V(bc + Wt) / 21V + (bc + Wt)^{1/2}] = 695.81$ N

Wear load,
$Ww = DpbQK/\cos\theta p = 2481.2$ N

Static tooth load,
$Ws = \sigma e .b.\pi.m.y'[(L-b)/L] = 4859.65$ N

- As, Ws and Ww are both greater than Wd, the design is safe.
- L/b ratio is approximately 2 which is less than 3. Hence, bevel gear will work satisfactorily.
- As face width is 7.5 times module which is between 6.3 to 9.5 times module, thus bevel gears will work properly.

RPM of Generator

According to practical performed, we are able to pedal 170 times in a minute. One pedal is equal to one rotation of bevel gear, hence bevel gear rotates with 170 rpm.

For rotation of bevel pinion,
Rpm of bevel gear/rpm of bevel pinion = Teeth on bevel pinion/Teeth on bevel gear
170/rpm of bevel pinion = 15/28

Rpm of bevel pinion = 315
That is same as the input shaft of generator.

VI. RESULT

Sr no	R (ohm)	I max (mA)	I min (mA)	V max (Volt)	V min (Volt)	P max (Watt)	P min (Watt)
1	360	106	77	36	30	3.816	2.31
2	300	130	99	36	30	4.68	2.7
3	270	135	100	36	30	4.8	3
4	240	170	130	36	30	6.12	3.51
5	210	210	180	36	30	8.19	5.4
6	180	230	180	36	30	8.28	5.4
7	150	260	220	36	30	9.36	6.6
8	120	320	280	36	30	11.5	8.4
9	90	375	320	30	27	11.25	8.64
10	60	565	450	30	27	16.95	12.15
11	30	750	640	24	18	18	11.52
12	20	1000	800	18	12	18	9.6
P avg						**10.0**	**6.6**

Thus, the average power generated through the device is equal to (10 + 6.6) /2 = **8.3 Watt.**

VII. CONCLUSION

The objective of producing necessary power out from reciprocating mechanical energy has been achieved. This has been possible by means of pre-designed mechanism and necessary components as all the relevant properties were incorporated into the design process. Though, metal is used to fabricate the device which makes it cheap but heavier, using more diversified material during fabrication can significantly help to make the device as light as possible.

VIII. FUTURE SCOPE

Future scope of work will be: -

1. To make the model more cost effective.
2. To explore the ways of amplifying input in order to generate more output.
3. To make the model more compact and light-weight.
4. To consider this idea as an initiative towards preservation of precious natural resources that are used to generate electricity and to conceive this as a productive step towards reduction in pollution level.

IX. REFERENCES

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