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CONCEPTUAL CAD MODELLING OF HUMAN POWERED FLYWHEEL MOTOR WITH DOUBLE LEVER INVERSION PEDALLING MECHANISM

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Abstract: - The Human powered flywheel motor (HPFM) is the primary part of the diverse manually energized machines such as chaff cutter, brick making machine, pedal operated flour mill etc . Since its invention continuous efforts are being prepared for its optimization with intent of the efficient energy utilization of human energy. In an attempt this paper presents the development of flywheel motor with modified double lever inversion pedalling mechanism as till now conventional bicycle pedalling system has been used. The gear ratio required for modified system is also discussed in this paper. Further the CAD modelling of this system is developed by using the CAD software CREO**.**

Keywords: CAD, HPFM (Human Powered Flywheel Motor), CREO, Double Lever Inversion Mechanism

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INTRODUCTION

The ever increasing demand, non availability of electricity in rural areas of developing countries like India; Increased wakefulness of people in the direction of the improvement of humanly powered machines. These machines includes manually powered brick making machine, chaff cutter, pedal operated flour mill etc.

During 1979-99, Modak J.P. developed a human powered brick making machine for the manufacturing of bricks (Modak J.P. J.P. 1982, 1994, 1997, 1998) [**1**]. And since then various processes are powered by the human energy such as wood turning, cloth washing, chaff cutter [**2**], potter's wheel, flour mill etc. All these machines are initiated by the human power with one common mechanism amongst them- The Flywheel Motor.

Flywheel motor is a mechanical arrangement used to accumulate the human energy and consequently uses it to drive the relevant process. The Machine consists of flywheel motor driven bicycle mechanism with speed increasing gearing, which drives the shaft of process unit through clutch and torque amplification unit (Gupta 1977)[**1**].

Since invention, constant efforts are being continuously made to optimize a variety of parameters of these machines so as to provide the ease for the operator and accordingly make optimum use of human energy. Hence in attempt the present paper proposes the modification of HPFM with coupling double lever inversion mechanism which haven't been done so far. Further the CAD based modelling of the system using CREO is done. This CAD model in future can be used for the various purposes such as simulation various analysis such as stress analysis, ergonomic analysis etc.

II. HUMAN POWERED FLYWHEEL MOTORS

Whichever is the machine, to power it by human effort, the utmost power requirement should be 75Watts. Any machine or process needing further than 75 Watts and if process is sporadic without disturbing and product can also be operated by human energy (Alexandrove 1981)[**3**]. This is possible with the provision of intermediate energy storing element which stores the energy of human and supply intermittently at necessary rate to process unit, this is called as "human powered flywheel motor." Fundamentally the flywheel motor consists of flywheel, which is being driven by a human through a simple bicycle mechanism and couple of pace increasing gears[**3**]. The schematic of flywheel motor is as shown in Fig1

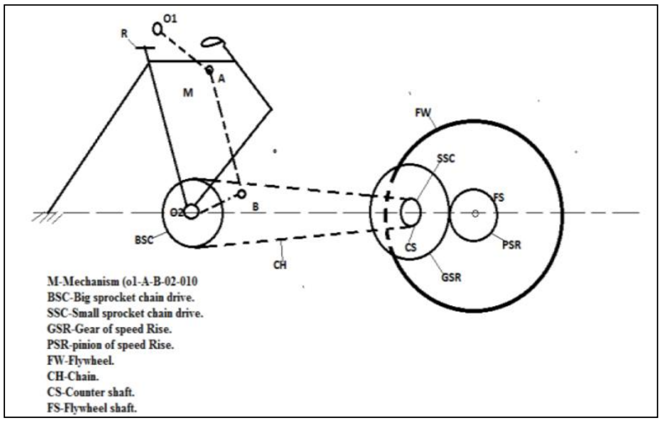

Figure 1: Schematic of HPFM(Human Powered Flywheel Motor)

An operator pedals the device 'M' converting the oscillatory movement of thighs into rotational motion of counter shaft 'C'. This countershaft 'C' coupled to flywheel shaft 'FS' with speed growing transmission consisting of couple of speed gears [**4**]. Driver injects the energy in flywheel at energy pace suitable to him [**4**]. In this way, the muscular energy of human is transformed into kinetic energy of flywheel by this man machine and for its efficient use it is necessary to optimize its parameters [**4**].

III. MODIFIED PEDALLING MECHANISM

Modak J.P (1985) has established the correlation between the valuable torque developed at the crank as function of crank position throughout its revolution [**5**]. Modak J.P. also observed that out of 360° rotation of pedal crank, only from 30°-115° of crank position from top dead centre is useful. The rest of the period of crank position i.e. 0°-30° and 115°-162° is not efficiently utilised and from 162°-360° is absolutely idle. Even when both the cranks are considered the valuable driving angle is found to be 154°.[**5**]. Therefore for maximum utilization of operators energy Modak J.P. suggested three customized mechanisms namely Quick return ratio one, Double lever inversion and Elliptical sprocket[**5**].Based on his mathematical modelling he concluded improvement of 17%,38%, and 18% in human energy utilization for Quick return ratio one, Double lever inversion and Elliptical sprocket respectively. This performance of various bicycle drives then was experimentally established by Modak J.P., Chandurkar K.C. et,al (1987) and found nearly matching with theoretical values[**6**].

III.a. DOUBLE LEVER INVERSION MECHANISM

From Fig.2, O_2A is a crank which does not rotate completely but oscillates. Therefore O_2A is chosen to give adequate angular displacement and better transmission angle. The lever centre or crank centre O_2 is located on the perpendicular bisector of A_1A_8 so as to give an oscillation angle $A_1O_2A_8$ of 70^0.

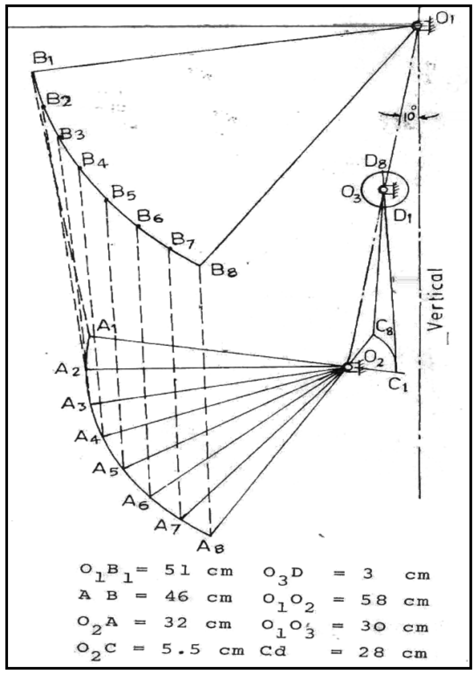

Figure 2: Schematic of Double Lever Inversion Pedalling Mechanism

In double lever mechanism, lever O_2A is 32cm long and frame O_1O_2 is 58cm at an angle of 10^0 to vertical. Another four bar chain O_2CDO_3 is provided in series. This auxiliary four bar chain is crank lever inversion with crank O_3D rotating and lever O_2C oscillating along with O2A. In addition to timing the lever oscillates in position O_2A_1 to O_2A_8. The auxiliary mechanism serves an additional purpose, when lever(oscillating crank) for one leg is moving down, lever for another leg moves up. The crank O_3D for both the levers is kept 180^0 out of phase. So instead of using conventional bicycle pedalling system it could be advantageous to use modified version of double lever inversion mechanism. Which may increase the efficiency of the HPFM to some extent even by reducing human effort.

III.b. **FLYWHEEL**

Modak J.P(1987) in the duration of testing has observed the maximum thigh oscillation for the average individual of 165 cm stature from age set 20-22 years is 40^0. [**7**]. With the existing chain drive for existing 22" bicycle frame the flywheel velocity of 240 rpm was reasonably enough from point of total speed ascend from pedals to flywheel shaft [**7**]. Further with computation Modak J.P.(1987) has determined the dimension of flywheel with the intention to store the maximum energy irrespective of velocity fluctuations (180-240 rpm)[**7**]. Flywheel rim diameter is established to 82cm which results the weight of flywheel as 150Kg and 266 Kg for 240 rpm and 180 rpm respectively. Hence Modak J.P.(1987) recommended the flywheel with 150 Kg @240 rpm[**7**]. Moreover Modak J.P.(1987) has also found that driving torque of pedal is unaltered by increasing flywheel moment of inertia and stores unchanged energy for same rate of thigh oscillation [**7**].

III.c. **GEAR RATIO**

Modak J.P. (1987) suggested (for conventional pedalling system) the value of gear ratio as 4:1 so as to reduce the upshot of jerk generated in process unit shaft as outcome of energy or momentum exchange during the clutch engagement. If inferior value of gear ratio is to be used then flywheel speed should be maintained higher than 240 rpm[**7**]. But 4:1 gear ratio system could not be feasible for the double lever inversion mechanism as the effective rotation obtained by the input is merely 70^0. Thus for drawing same output from crank shaft the gear ratio is to be modified i.e. 360/70=5.14 and made accordingly.

IV. CAD MODEL

The CAD model of the proposed system for HPFM with double lever inversion in, the flywheel and gear ratio discussed in this paper is also considered Fig.3, and developed using software CREO 2.0. This CAD model can be used for further virtual modifications, simulation, stress analysis, ergonomic studies as well and consequently contributes in performance optimisation of Human Powered Flywheel Motor.

In the CAD model shown the gearing arrangement is made inside customised bicycle frame. Which is used as transmission system to the flywheel. The pedal crank is also a modified version with an extension after pivot. The pedalling system is oscillating. the pedal crank is attached to the shaft through the freewheel which takes the motion of pedal in one direction only. The big yellow gear is keyed with the pedalling shaft, which later transmits the power to the flywheel through transmission system. The connecting rod attached at the other end of pedal crank is again attached to rotary crank as shown. The complete mechanism of extension, connecting rod and the rotary crank becomes a four bar chain mechanism. In which, the pedal crank extension is oscillating and rotary crank is rotating. The other side of rotary crank is 180^0 out of phase. Which makes the other side of pedal to move up while front side comes down. So accordingly, as the front side pedal comes down the freewheel gets locked and power is transmitted to the gear through the shaft. The power is not wasted for getting pedal back to the top position as it is taken care by double lever mechanism.

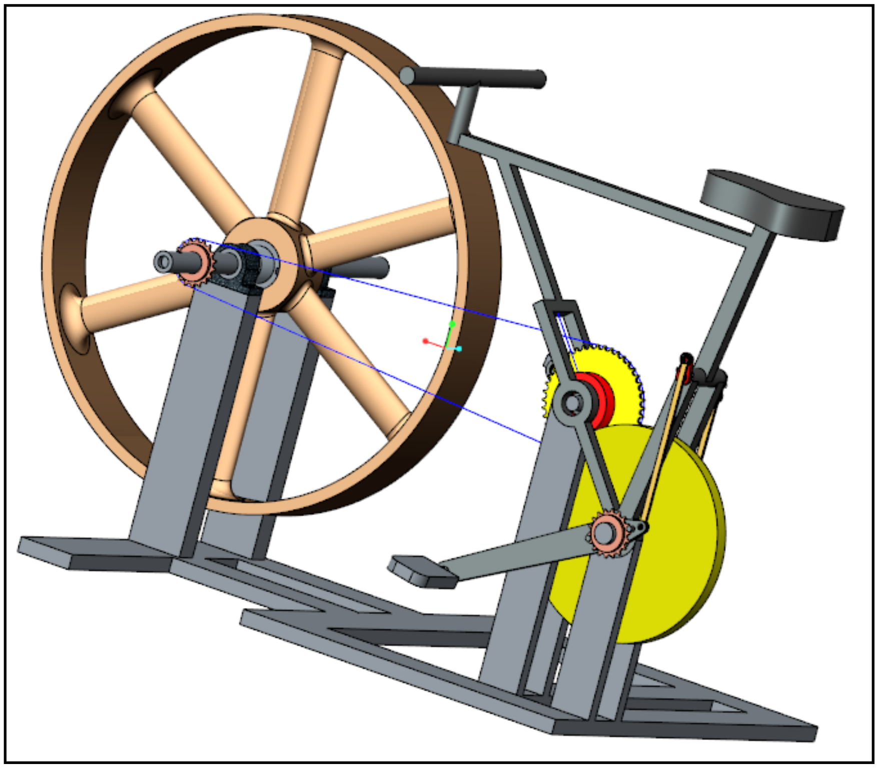

Figure 3: Modified HPFM, *CAD MODEL*

V. CONCLUSION AND FUTURE WORK

Due to ever-increasing energy crises the need of human powered machines are increasing daily. The advantages are associated with this machine at unavailability of electric power specifically in rural areas of developing India. In this paper human powered machine with modified double lever inversion pedalling mechanism is proposed which can be seen as further advancement in HPFM. The virtual CAD model using CREO is developed for inexpensive virtual modifications for further modifications in view of increasing efficiency of the system. Further addition of tandem drive system alongside is proposed for reducing efforts of single driver.

REFERANCES:

1. Modak J.P, Bapat A.R. “Various efficiencies of human powered flywheel motor” Human power number volume 54;pp21-23

2. Modak J.P, Kazi Z S “design and development of human energised chaff cutter” [New York Science Journal 2010; 3 (4):104-108].(ISSN:1554-0200)..

3. Modak J.P, Moghe S.D “Design and development of human powered machine for the manufacture of lime fly ash sand bricks” Human power; volume 13 num-ber2; 1998; pp3-7.

4. Modak J.P, Bapat A.R. “Improvement in experimental setup for establishing generalized experimental model of various dynamic responses for A manually energised flywheel motor”

5. Modak J.P, Bapat A.R. “Formulation of generalized experimental model for manually driven flywheel motor and its optimization” Applied ergonomics; 1994; volume 25; number2; pp 119-122.

6. Modak J.P “Bicycle and its kinematics and modifications”. National conference mach Mech; February 1985;pp5-11.

7. Modak J.P. , Chandurkar K.C., Singh M.P, Yadpanawar A.G “Experimental verification of various bi-cycle drive mechanism part1” Proceedings of AMSE conference modeling and simulation Karisurhe west Germeny, july 20-22 1987;pp139-160.

8. Modak J.P “General consideration of mechanical design of A manually driven process machine” NA-COMM; 1987;p 13-17.