Design, Development of Dual Mass Flywheel and Comparative Study with Conventional Flywheel

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Abstract— The Duel Mass Flywheel (DMF) is primarily used for damping of oscillations in automotive power trains and to prevent gearbox rattling. We explain the DMF machines along with its applications and components. Afterwards a detailed initial model of the DMF dynamics is presented. This mainly includes a model for two stage arc spring in the DMF and their behavior. Both centrifugal effects and redirection forces act radially on the arc spring which induces friction. An experimental DMF model is compared to a measurement to model validation. Finally the observability of the engine torque using the DMF is discussed. For this purpose the DMF is manufactured and done experiment or testing to see the result. And then results are compared with the conventional flywheel. The objective when developing the DMF was therefore to isolate the tensional vibration from the drive train as much as possible caused by the engine's rotating mass. Owing to its internal damping spring the DMF almost entirely absorbs these tensional vibrations. The result is very good vibration damping. Flywheel inertia is stored when you rev the engine slightly before letting the clutch out –this small amount of extra power helps in getting the motorcycle with minimum effort. By "borrowing" the power for a few seconds engine has to develop less to move from the standing start. Once the clutch is completely engaged, inertia can no longer be borrowed the motorcycle can only be used what it products in "real time".

Keywords: Dual Mass Flywheel, Arc Spring, Torsional Resonance and Torsional Frequency

I. INTRODUCTION

A flywheel is a rotating mechanical device that is used to store rotational energy. Flywheel has significant moment of inertia and thus resists changes in rotational speed. The amount of energy stored in a flywheel is proportional to the square of its rotational speed. Energy is transferred to a flywheel by applying torque to it, thereby increasing its rotational speed, and hence its stored energy. Conversely, a flywheel releases stored energy by applying torque to a mechanical load, thereby decreasing its rotational speed. Flywheels are often used to provide continuous energy in systems where the energy source is not continuous. In such cases, the flywheel stores energy when torque is applied by the energy source (here 2 stroke-engine), and it releases stored energy when the energy source is not applying torque to it. For example, a flywheel is used to maintain constant angular velocity of the crankshaft in a reciprocating engine. In this case, the flywheel which is mounted on the crankshaft stores energy when torque is exerted on it by a firing piston, and it releases energy to its mechanical loads when no piston is exerting torque on it. Other examples of this are friction motors, which use flywheel energy to power devices such as toy cars.[3]

A. Principles of Dual Mass Flywheel.

In a DMF design, the flywheel inertia is split up into two parts: the primary mass is still attached to the crankshaft while the secondary is belongs to the clutch. Both mass have two small stoppers, each one able to pick up two are springs. As the springs are defiected within the arc channel, they transfer torque from one flywheel to other. When the arc springs slides through their channel, friction adds damping characteristics to the DMF.

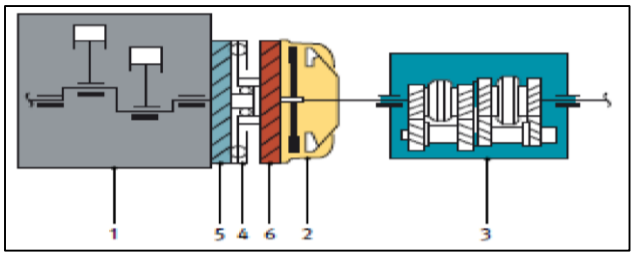

Fig. 1: Principles of Dual Mass Flywheel.
1.Engine,2.Clutch,3.Transmission,4.Torsion damper,5.Primary mass,6.Secondary mass,7.Flywheel

B. Two Spring Two Mass Models

The model is a two spring two mass model graphically represented as below: The figure shows the free un-damped vibration set up of two mass tow spring system. As Shown in the figure the input to the system is in the form of the low energy intermittent input from any power source (excitation), this results in free un-damped vibrations are set up in the system resulting in the free to and fro motion of the mass (m1) and (m2), this motion is assisted by gravity and will continue until the resonance occurs, i.e., the system will continue to work long after the input (which is intermittent) has ceased. Hence the term free energy is used.

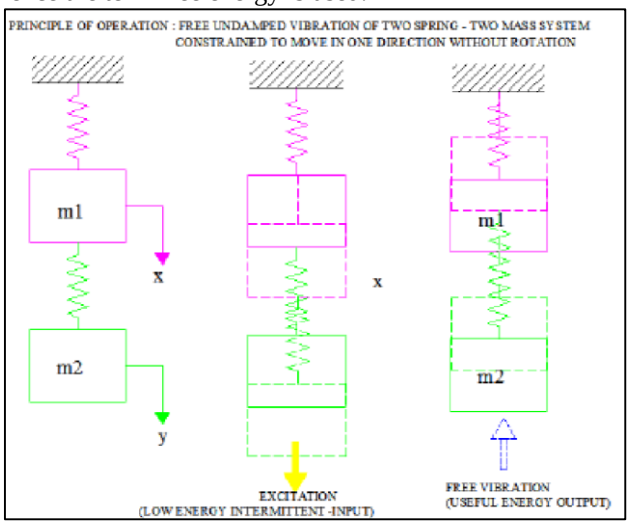

Fig. 2: Two Spring Two Mass Models

C. Objective

After studying all the research papers and previous work done by other others ,1 found some lack of characteristics properties like power ,torque , efflciency , weight in case Of conventional flywheel. So this work is done to improve these properties using DMF instead of using conventional flywheel. And hence the objectives of my work are:

1) Evaluation of effectiveness of modified flywheel over conventional flywheel in terms of maximum fluctuation of energy.
2) To improve the efficiency of the system.
3) To increase the torque of the system
4) To increase Power Output.

D. Problem Defination

The engine's ignition induced rotational speed irregularity causes torsional vibration in vehicle's drive line. At a given speed the ignition frequency is equal to the natural frequency of the drive line so that extremely high vibrations amplitudes occur that causes transmission rattle and body boom. Also more mass increases the coast of DMF

II. LITERATURE REVIEW

There has been a great deal of research on gear analysis, and a large body of literature on energy storage system has been published. The origins and use of flywheel technology for mechanical energy storage started several hundred years ago and developed throughout the Industrial Revolution. One of the first modern dissertations on the theoretical stress limitations of rotational disks is the work by Dr. A. Stodola whose first translation to English was made in 1917. Development of advanced flywheel started in the 1970s. [2] Generally various studies have been made on flywheels. According to the periodic combustion cycles of a 4-stroke engine produce torque fluctuations which excite torsional vibration to be passed down the drive train. The resulting noise and vibration, such as gear rattle, body boom and load change vibration, result in poor noise behavior and driving comfort. The basic concept for this paper is taken from United States Patent Document of Lee et al. The main concept of work is started by studying the problems with conventional flywheel. Torque estimation of dual mass flywheel is explained by Ulf Schaper et al which has been useful for this paper. Effect of dual mass flywheel in case of noise in vehicular power train system has been discussed by S Theodossiades et al. According to their research dual mass flywheel has best impact on noise reduction as compare to conventional flywheel. [3]

A. Literature Summery

From the above discussed literatures, it is concluded that most of the work had been done on study the performance of flywheel, dual mass flywheel act as vibration isolators in engine energy storage of flywheel etc. now a days requirement of energy storage of flywheel is more in small size, because of the space constraint in engines. This paper describes the improvement of energy storage capability by using dual mass flywheel with same size as compared to conventional flywheel.

III. SPECIFICATIONS

Bore diameter: 35 mm
Stroke: 35 mm
Capacity: 34 cc Power output : 1.2 BHP at 5500 rpm
Torque: 1.36 N-m @ 5000 rpm
Dry weight: 4.3 kg
Ignition: Magneto ignition
Direction of rotation: Clockwise .looking from driving end
Carburettor: "B" type
Cooling: Air Cooled engine[2]

IV. EXPERIMENTAL SETUP OF DUAL MASS FLYWHEEL

The experimental test rig consist of two stroke petrol engine is paired with the planetary dual mass flywheel mounted on flywheel of the shaft, by love joy coupling. The flywheel shaft is mounted on base plate with the help of deep groove ball bearing. The torsional vibration damper is incorporated into the flywheel as a two arc spring as well as two masses on the conventional flywheel. For this reason the flywheel is divided into a primary and a secondary mass hence the name exists "dual mass flywheel". The unidirectional ball bearing called as unidirectional clutch is mounted on flywheel shaft with bearing mounting to avoid opposite side rotation of dyno brake pulley. The dyno brake pulley is paired with unidirectional clutch. The rope is rapped on dyno brake pulley with one end is tie on base plate, and another end is tie on weighing pan.

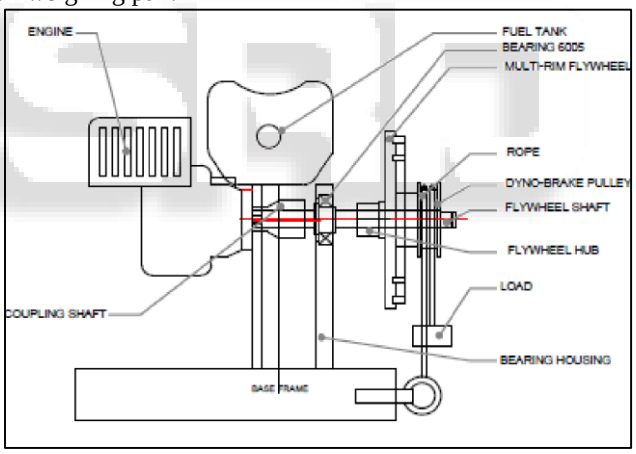

Fig. 3: Schematic of conventional flywheel test rig

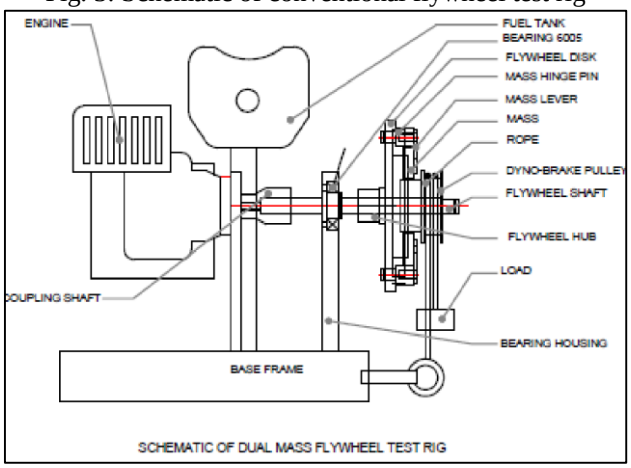

Fig. 4: Schematic of dual mass flywheel test rig

Fig. 5: Experimental Setup

V. PROCEDURE

1) Start engine by turning
2) Let mechanism run & stabilize at certain speed (say 1300 rpm)
3) Place the pulley cord on dynamo brake pulley and add 500 gm weight into, the pan, note down the output speed for this load by means of tachometer.
4) Add another 500 gm cut & note down the output speed for this load by means of tachometer.
5) Take data of speed up to adding 5 kg weight.
6) Repeat above process with removing weight.
7) Tabulate the readings in the observation table for conventional and dual mass flywheel system.
8) Plot torque Vs speed, Efficiency Vs speed & Power Vs speed characteristics.[2]

VI. CONCLUSION

Since we have concluded that modern automobile industry expect better performance of engine and transmission system, our project spring mass flywheel tries its best to fit their requirements.

The main advantages of Dual mass flywheel improves flywheel effectiveness and it has turn improves Engine performance characteristics such as speed, torque, power and efficiency. With refers of the research papers we have concluded that power output of engine is increased by implementing the dual mass flywheel system. We also come to know that torsional vibrations are minimized. Hence preventing gear box components knocking. Moreover the fuel consumption can also be reduced. Also the power output increases.

VII. SCOPE

1) Lowered weight of flywheel system will reduce system weight thereby leading to better fuel economy of vehicle and also reduce overall material cost.
2) Compact size: The size of the flywheel will lead to better cabin space of vehicle.
3) Engine life increases due to balanced power output.

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