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THEORETICAL DEVELOPMENT OF MECHANISM FOR SAVING FUEL IN FOUR STROKE ENGINE WHILE GOING DOWNHILL WITHOUT COASTING

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ABSTRACT
As most of our needs of energy nowadays are satisfied by nonrenewable fuels. So mankind is now in the fear of those fuels getting exhausted in near future. We are in search of new fuels and also of the methods of converting energy into useful work in the most efficient way. Efforts are being made to save even a small quantity of fuel.
In this paper a mechanism for saving fuel while going down hill without coasting is developed theoretically. The paper discusses various linkages of the mechanim along with their relative positions. The relative motion between various links while normal conditions and while going downhill is explained. As this mechanism consists of a force closed pair the method of providing the necessary force along with its required magnitude is explained.

KEYWORDS: Fuel, Four Stroke Engine**,** Mechanism, Force analysis.

INTRODUCTION
Fuels which we use in automobiles nowadays are nonrenewable and are soon going to get exhausted. Thereby efforts are being made to save them. Developments are being made to increase efficiency of various equipments. Researches are carried out for increasing economy of vehicles.
On level roads engine drive the wheels. But while going downhill because of the slope wheels drive the engine and it increases our vehicle's speed. Many people because of the misconception for saving fuel and money and thereby to increase economy of vehicle turn ignition key of their vehicle off. But this doesn't save any fuel. It only keeps fuel away from getting burnt and the unburnt fuel gets out of engine during exhaust stroke.
The fuel can be saved by shifting the vehicle under neutral. But this leads to loss of engine braking and speed of vehicle increases rigorously thus making the vehicle out of control and it may even lead to accidents and thus it is not advisable.
This paper introduces a mechanism to save fuel by controlling opening of inlet valve. Under any conditions driver can stop opening of inlet valve thus stopping entry of fuel on combustion chamber. While doing this engine can be kept engaged with gear box thus not loosing the benefit of engine braking and maintaining vehicle under control of driver.
In this paper various linkages of the mechanism are explained. Analysis of relative position of various links and the forces acting on them is carried out. Suggestions for optimising dimensions and geometry of various links of the mechanism are also provided.

SYSTEM DESCRIPTION
1. Inlet Valve
Inlet valve serves the purpose of opening the inlet manifold prior to suction stroke of engine and allows entry of fuel in combustion chamber for combustion purpose[1]. The inlet valve is usually kept in closed position with the help of spring force of a valve spring.
2. Rocker Arm
Rocker arm serves to work a valve and is operated by a follower from camshaft. The rocker arm of existing engines is broken in two parts and is joined by an hinge. Also some modifications are done in shape of arm. Like part OA is added which has a hinge at its end A.

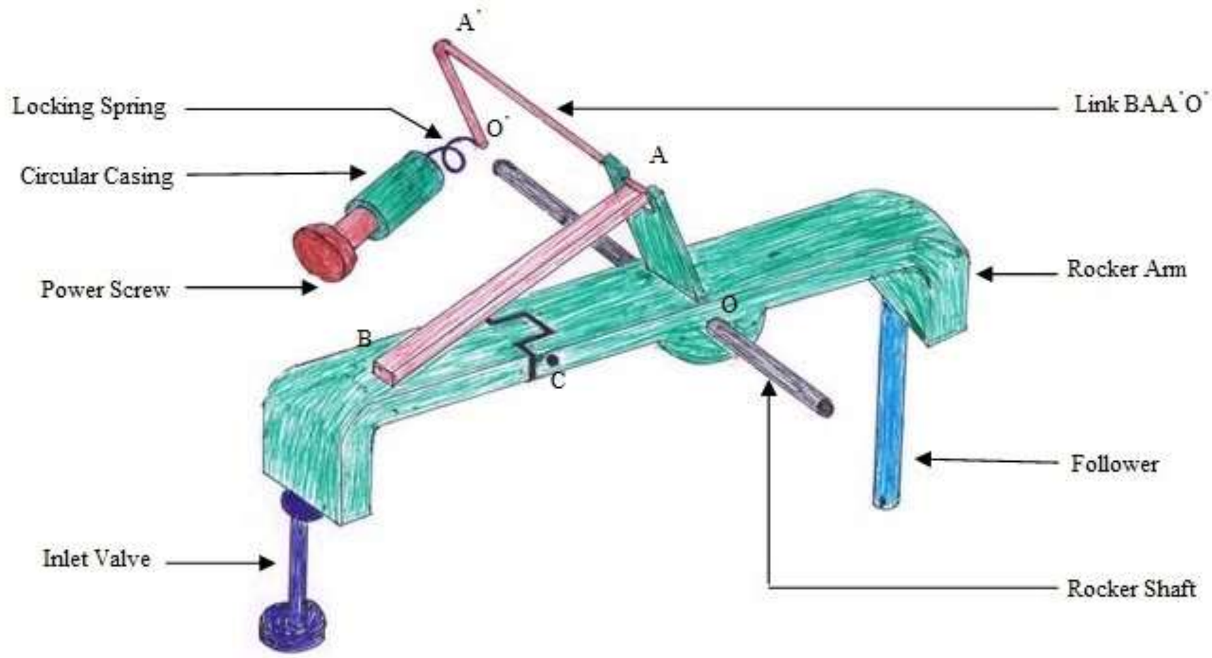

Fig. 1 Fuel Saving Mechanism

3. Semi Circular Hinge At C

Semi circular hinge is used to join two parts of the rocker arm. The hinge is fixed to part CO of rocker arm and restricts the rotation of part BC of rocker arm across the lower semicircle and allows rotation of part CB of rocker arm across upper semicircle only.

4. Link BAA'O'

Link BAA'O' is used to transfer the locking force. Locking force is applied on the link at point O'. This link is supported by the hinge provided at end A of part OA of rocker arm. If needed additional similar hinge supports can also be provided.

5. Locking Force Arrangment

Locking force can be applied by a spring keprt in compression. The compression spring is placed in a circular casing consisting of threads on internal surface which makes casing similar to a nut. A power screw can form a screw pair with the casing. One end of the compression spring is fixed to the power screw while the other end is fixed to the pont O' of link BAA'O'. The casing is kept fixed so that by turning the power screw it can move forward and backward and the compression force of the spring acting on link BAA'O' can be varied and locking force can be adjusted. Stoppers can be used for limiting forward and backward movement of the power screw and thereby limiting maximum and minimum value of the locking force. While going downhill inlet valve is to be kept closed so there should not be any locking force. So minimum value of locking force is zero.

In normal conditions whole mechanism behaves as a structure not allowing any relative movement between any parts of the mechanism. Whereas while going down hill at the will of driver by operating the power screw locking spring can be brought to free condition thus not exerting any locking force because of which the part CB of the rocker arm starts oscillating across the semi circular hinge and the inlet valve does not open and supply of fuel to the engine stops completely and instantaneously. By again compressing the locking spring by turning the power screw and thereby exerting the locking force the mechanism again acts like a structure and the rocker arm serves to work the inlet valve.

DISPLACEMENT ANALYSIS

Prior to suction stroke as inlet valve is to be opened the follower pushes the rocker arm and its other end pushesh the valve thereby opening the inlet manifold. The rocker arm along with the entire mechanism oscillates about axis OO'. Thus even if entire mechanism is oscillating the points O and O' are stationary. As we want to keep the

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locking force act at a fixed point we will apply the locking force to act at point O'. Thus OAA'O' lies in a plane and form a rectangle.

$$OA = O'A' = a$$

In the further discussion it will be seen that required locking force is proportional to spring force acting on the valve which is maximum when inlet valve is fully open.

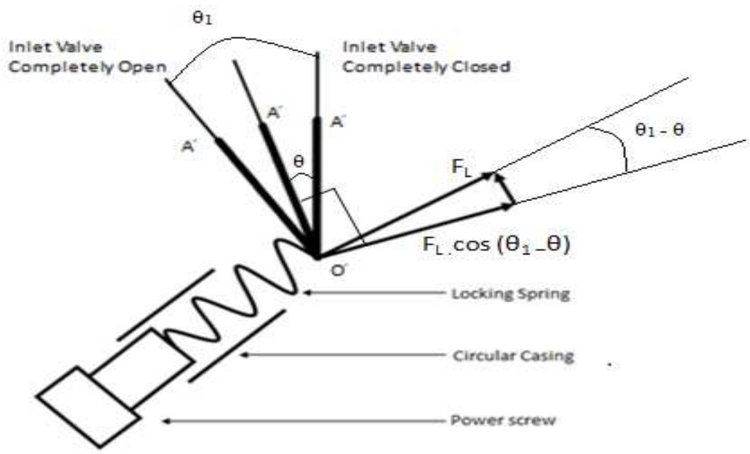

Fig. 2 Line Diagram Representing Position And Forces Acting On O'A'

The component of compression force of the locking spring which is normal to O'A' provides the necessary locking force. As the link O'A' is oscillating about point O' the locking force varies in magnitude. When the inlet valve is opened completely locking force needed is maximum thus locking spring is kept perpendicular to the position of link O'A' obtained when valve is opened completely.The locking force arrangement alongwith the casing and locking spring is to be fixed so that it will be perpendicular to position of link O'A' obtained when valve is opened completely.

FOECE ANALYSIS

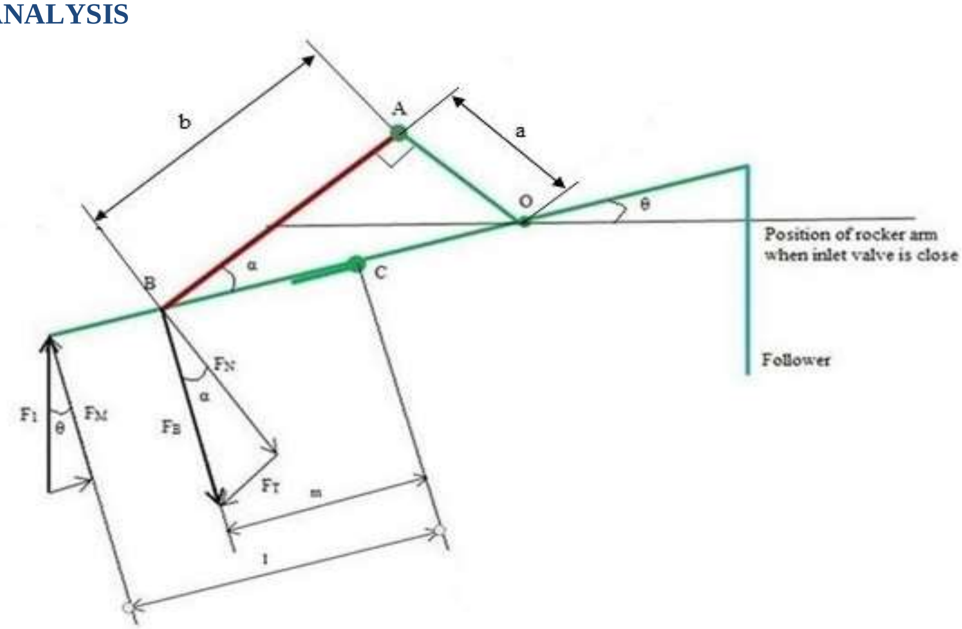

Fig. 3 Forces Acting On Rocker Arm

When the inlet valve is to be opened the follower pushesh the rocker arm and the rocker arm pushesh the inlet valve down. The downward movement of the inlet valve is opposed by the valve spring . Thus a force F_1 acts on the rocker arm and is given by

$$F_1 = k\,.\,x \qquad \text{……………...(1)}$$

Normal force acting on rocker arm because of valve spring is

$$F_M = F_1.\ \cos\theta \qquad \text{……………...(2)}$$

The locking force acting at point O' causes a force F_B to act on the rocker .\
Moment at an internal hinge is always zero [2].

Thus

$$F_M.l = F_B.m \qquad \text{……………...(3)}$$

Component of force F_B along link AB is the thrust force F_T and is given by

$$F_T = F_B\,.\sin\alpha$$

This thrust force acts at point A of the link OA which behaves like a cantilever. The thrust force causes a bending moment at point O which causes bending stresses on the normal section at point O. This bending moment is given by

$$M = F_B\,.\sin\alpha\ .a \qquad \text{……………...(4)}$$

Thus if we want to minimize the bending moment acting at point O we will have to decrease length of link OA i.e. a and < ABO i.e. α. As perpendicular distance is minimum distance of a point from a line < BAO must be 90^0.

Component of force F_B normal to link AB is F_N and is given by

$$F_N = F_B\,.\cos\alpha \qquad \text{……………...(5)}$$

The locking force is given by F_L.

For equilibrium moment at hinge A is zero [3].

Thus

$$F_N\,.b = F_L\,.a\,.\ \cos(\theta_1 - \theta) \qquad \text{……………...(6)}$$

By rearranging the terms we get

$$F_L = \frac{F_1.\ \cos\theta\,.\cos\alpha\,.\,l\,.\,b}{m\,.\ a\,.\ \cos(\theta_1 - \theta)}$$

As

$$\tan\alpha = \frac{a}{b}$$

$$F_L = F_1 \frac{\cos\theta}{\cos(\theta_1 - \theta)}\,\frac{l}{m}\,\frac{cos^2\alpha}{sin\alpha}$$

Maximum locking force is needed when inlet valve is completely open i.e. $\theta_1 = \theta$. Thus maximum locking force is

$$F_{L_{Max}} = F_1 \cos\theta\ \frac{l}{m}\,\frac{cos^2\alpha}{\sin\alpha}$$

Thus as α increases the required locking force decreases. But as α increases the bending moment at point O increases. Thus α must be selected carefully.

ADVANTAGES

- From the time of operating the power screw entire fuel can be saved because of monitoring opening of inlet valve unlike turning fuel tank cock off.
- This mechanism saves fuel without coasting and without loosing the benefit of engine braking.
- No need of external power neither it extracts any power from engine.

CONCLUSION

This paper discusses about a mechanism which can be used for saving fuel while going downhill in an automobile which uses a four stroke engine. This mechanism under normal condition behaves like a structure not allowing any relative movement among any links and allows inlet valve to open prior to suction stroke and fuel enters the combustion chamber. While going down hill at the will of driver by operating a power screw opening of inlet valve can be prevented and supply of fuel to combustion chamber can be stopped. Eventhough by using this mechanism only few times we can save small quantity of fuel in one vehicle. But commulatively using this mechanism many times in many vehicles we can save significantly large quantity of fuel.

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Suggestions for future work include design of links of the mechanism on strength basis. Analysis of the mechanism can be done taking into consideration the stiffness of valve spring and leverage ratio of rocker arm of an actual specific engine.

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