Automatic Clutch Engagement Mechanism using Variable Speed One Way Damper

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Abstract: ***So far, irrespective of all the advancements made in the automobile industry, there still persist a drawback in every Motor powered vehicles which comprises of a Clutch Unit. On a broader aspect, in order to get any geared vehicle moving in the 1st Gear from rest, the Clutch pedal must be slowly released so as to reach the Friction Point, where the clutch plate gradually engages with the flywheel and Pressure Plate simultaneously. If this point is not maintained for a set time duration and let the vehicle to traverse forward or if the clutch pedal is released with a jerk, the Inertia of Rest of the Clutch disk dominates over the applied Rotational torque of the flywheel. And this leads the flywheel to immediately stop, giving away the reactive rotational jerk to the clutch plate, and through the drive train, the whole vehicle. The following article will suggest possible improvements in the above mentioned problem of clutch engagement, and their Pros and Cons respectively***

Keywords: Clutch, Engagement, Rotational jerk,Damper

1. Introduction

The basic function of the clutch is to control the flow of mechanical power a machine (Figure 1). It must be capable of transmitting specified amount of torsional moment. The clutch is called upon to convert potential or kinetic energy into internal energy and to dissipate it in the form of heat, transferred from the clutch to the atmosphere.

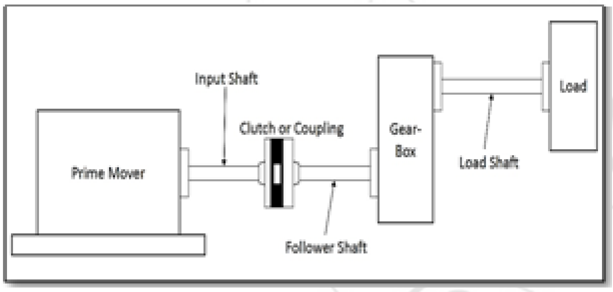

Figure 1: Power Flow diagram

2. Classification of clutch

2.1. Positive contact clutch

These clutches operate by machine jaws or teeth of the driving member with corresponding elements of the driven member. Such a clutch is used when a positive drive is required and when a gradual engagement between the driving and the driven member is not a must.

2.2. Friction clutches

The design and operation of friction clutches is based on the forces developed by surface in direct contact. Friction clutches have generally two or more rotating concentric surfaces which can be forced firmly into contact with one another so that the tangential friction force transmits torque from the input to the output shaft. When engaged the clutch members tend to rotate as a single unit, but they are free to slip as long as they are not in equilibrium. As a rule, at least one surface is lined with a material having high co-efficient of friction.

3. Actuation mechanism

3.1. Mechanical actuation

A type of actuation mechanism where driver's foot effort is transmitted to the clutch through a set of levers and links.

3.2. Cable clutch

In this type of actuation mechanism the driver's foot effort is transmitted to the clutch through a cable, connected between the clutch pedal and the lever operating the thrust bearing.

3.3. Hydraulic clutch

This is the most commonly used type of clutch actuation mechanism because this incorporates the minimum amount of effort applied by the driver. Here, the driver's foot effort is transferred to a hydraulic oil medium, which in turn operates the clutch through master cylinder and slave cylinder. The pedal efforts are lower and does not require clutch pedal free play adjustments.

4. Target problem:

Of all the actuation mechanisms involved in clutch engagement and disengagement process, the main problem area relates to the process of engagement of the clutch plate with the flywheel and pressure plate, as the clutch pedal is released.

The engagement of clutch is totally dependent on driver's reflexes, the rate at which the clutch plate engages with the flywheel is proportional to the rate by which the driver releases the clutch pedal. Now, consider for instance the clutch pedal is released suddenly, the clutch plate abruptly engages with the flywheel forcing the engine to quickly accelerate the vehicle. And this whole process has a number of drawbacks, such as:

1. The stationary clutch forces the rotating flywheel to come to rest all of a sudden. Since the engine doesn't have enough power to accelerate the car so suddenly, hence it stalls.
2. The other possibility involves sudden rotation of the clutch plate, which leads to an uncomfortable ride to the passengers.
3. In the above mentioned case, the sudden jerk is transferred to gear operated drive-train, and add up to the sudden failure of drive-train components.
4. The sudden engagement of a rotating component "flywheel" with a non-rotating component "Clutch Plate"also increases the rate of wear of the friction lining.
5. As mentioned above, due to high wear of the clutch plate, repeated such engagements may heat up the clutch plate to higher temperature values.
6. As the temperature of clutch plate increases, the rate of wear further increases by a greater difference.

This concept finds itself useful in today's affordable car segment where the engagement of clutch is totally in the control of the driver. This increases stress on the ankle joint and degrade the driver ergonomics, also in long term use may cause cramp and chronic pain to novice drivers.

5. Proposed solutions

5.1. Solution 1

One of the solution to the target problem is, the use of a one way damper.

In general, a one way damper is a device that consists of a fixed link, a movable link with a prescribed motion along one axis, and a damping mechanism. The damping mechanism allows the free motion of the movable link in one direction, and generates a damping force when the link moves in the prescribed direction "opposite direction". Hence the link is forced to move at a very low set speed in one direction and freely moves in the opposite direction. Keeping the direction of free motion of damper as same as the direction of lever motion that leads to disengagement of clutch, simultaneously the direction of damped motion of clutch lever leading to the engagement of clutch, will solve the problem of rapid engagement and will ensure a longer life of clutch plate.

5.2. Solution 2

Other solution involves the invention of a Variable-Speed Damper.

It incorporates the design and fabrication of a new kind of damper. The damper consists of a fixed link, a movable link with a prescribed motion along one axis, and a damping mechanism just like a one-way damper. The only difference is in the damping mechanism. The mechanism is designed as such, when the movable link travels in one direction, there is no resistance to motion while as the movable link strokes in the opposite direction the damping mechanism provides resistance to motion and reduces the speed of stroke only in the region of Slippage. This introduces a situation known as a "slipping clutch", in which the "engine plate" slipping against the non-moving plate of the drive shaft. This results in part of the engine torque being transferred to the drive shaft, while the rest is lost due to the slippage. The more the plates get connected, the more engine torque gets transferred, until the two plates are fully connected and you have full engine power available to drive.As a result, during the region, starting from slipping of clutch till the point of full engagement of clutch, the damping force reduces the speed of retraction of movable link. Rest of the stroke i.e. before and after the slippage region, there is no hindrance in the motion of retraction and the pedal moves with the same speed as foot displacement.

5.2.1. Explanation

The outer casing consists of two holes present diametrically opposite to each other (Figure 2), providing maximum air flow in and out, resulting in increased speed of piston travel right before and after the engagement process of clutch.

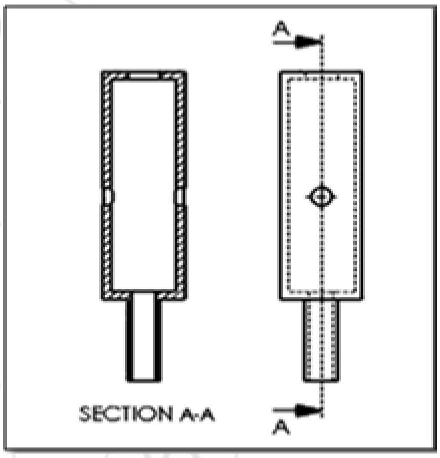

Figure 2: Outer Section of proposed Damper

The inner rod involves two sections of piston, A and B respectively (Figure 3). The section A-A provides restriction to the air flow across the holes present in the outer casing, during the time of engagement (Figure 4). The section B-B on the other hand contains holes such that it allows unrestricted passage of air only in one direction, the direction in which the clutch is allowed to disengage. The movement in other direction is restricted via holes with smaller diameter so as to provide reduced piston speed at the time of clutch engagement (Figure 5), resulting in gradual and smooth engagement of clutch assembly.

Figure 3: Inner piston of proposed Damper

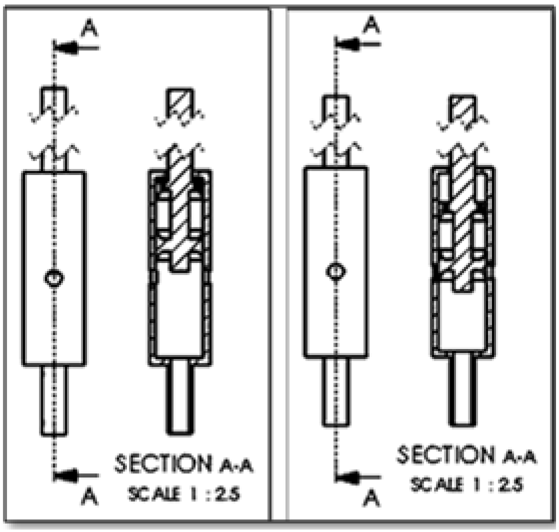

Figure 4: Piston position (a) Before engagement (b) Start of Engagement

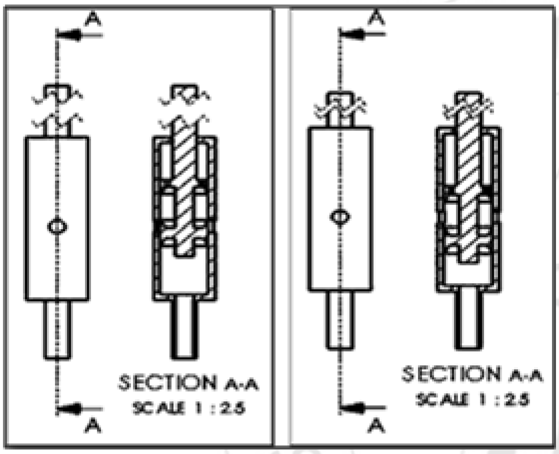

Figure 5: Piston position (a) End of Engagement (b) After Engagement

6. Limitations

As the limitations are concerned, the main limitation is that in the above mentioned system, the risk factor significantly increases when oil is used as a fluid medium in order to actuate the mechanism. This is because continuous repeated loading of such system may lead to the leakage of fluid from small crevices of the damper assembly. Apart from this if any such leakage occurs, there is no such mechanism which indicates the failure of mechanism.

Also, as the solution requires the addition of new components, this will lead to increase in weight and increase in cost of the whole clutch linkage mechanism.

7. Summary

This article targets on the problem of sudden engagement of clutch that dominates over a wide range of 4 – wheelers. The first solution offers the use of a One – Way Damper which damps the engagement process of clutch while releasing the clutch pedal. The second solution offers the use of self – proposed, Variable – Speed Damper where the damping action only takes place during the period of Clutch engagement while the speed of clutch pedal for theduration before and after engagement is in full control of the driver. This will not only reduce the driver strain in ankle but also increase the life of clutch plate and other components due to eliminated jerk on rotating engine, pressure plate, clutch plate and connected linkages.

Author Profile

Rishu Sharma is an engineering student in University of Petroleum and Energy Studies, Dehradun, Uttarakhand, India pursuing B. Tech in Automotive Design Engineering (2013-17).