Design & Fabrication of Pneumatically Operated Clutch in Heavy Vehicles

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Abstract— In automobiles, clutch is used to transmit the power from driving shaft to drive shaft by engaging and disengaging the clutch plate and flywheel of vehicle. In clutch, one shaft is connected to an engine and other shaft provides output power or work. Now a days, due to improvement in technologies there were lots of new updates in new vehicles. New vehicles were introduced with new features like automatic brake system, power steering system etc. This project is proposed to reduce the efforts required to press the clutch and to disengage the clutch in less time. This clutch operates with the help of direction control valve and double acting cylinders. Due to use of two double acting cylinder, smooth engagement and disengagement of clutch takes place. Due to this project, driver will experience more comfort while driving the vehicle. Thus this project will be more comfortable in heavy vehicles.

Key words: Double Acting Pneumatic Cylinder, Foot Operated Direction Control Valve, Pneumatic Source

I. INTRODUCTION

Automobiles are the main source of transportation. So, developments in automobile industry are very important. As we know that, clutch is very important part in automobile. So improvements in technologies related to clutch system are also important. In simple words, clutch is mechanical device which connect and disconnect the driving and driven shaft in the automobile for power transmission from driving shaft to driven shaft. In this project, 5/2 direction control valve and double acting cylinders are used for engagement and disengagement of the clutch. Two pneumatically operated double acting cylinders attached to the release lever are used for forward or reverse moment of the clutch plate automatically. The pressurized air is used from compressor or air tank available in air brake system of heavy vehicles. The project mainly concentrates on designing a suitable pneumatic control unit for engaging and disengaging the clutch. As the three pedal system is complicated to use with two legs in vehicles. We can implement this pneumatic clutch system with hand operated directional control valve to eliminate the clutch pedal in the vehicles. This clutch system is not completely automatic system but we can say that it is semi-automatic clutch system with the use of pneumatic system.

II. CONSTRUCTIONAL DETAILS

The fabricated model of the pneumatically operated clutch is as shown below in the photograph. The main components of the pneumatic clutch system are as follows:

- Double acting pneumatic cylinders
- 5/2 foot operated direction control valve
- Needle valve
- Air compressor

A. Double Acting Cylinders

Double acting cylinders are the mechanical devices which uses the compressed air from the air compressor to produce a force in reciprocating linear motion. In this project, the piston rods of the double acting cylinders are connect to plate or lever of the clutch plate for forward and reverse movement of the clutch plate.

B. 5/2 foot Operated Direction Control Valve

Direction control valve is used to allow the compressed air to flow into different paths from one or more sources. When the foot pedal is pressed, it allows the compressed air to flow from compressor to the double acting cylinder.

C. Needle Valve

Needle valve allows the required flow of compressed air in or out of the double acting cylinder. It is used to control the engagement speed of the clutch system.

D. Air Compressor

An air compressor is a device used for supplying the compressed air to the pneumatic clutch system for automatic operation of clutch system.

III. WORKING OF SYSTEM

The diaphragm type of clutch is most common type of clutch which is used in heavy vehicles. The diaphragm type of clutch uses a diaphragm or conical spring instead of coil spring to produce adequate pressure for disengaging the clutch. The clutch cover is secured to the engine flywheel. The outer rim of the diaphragm spring is in contact with the pressure plate. In engaged position, the diaphragm spring keeps the pressure plate in firm contact with the flywheel. To disengage the clutch, direction control valve is used with the help of double acting pneumatic cylinder attached to the release lever for pushing/pulling of the clutch automatically and the pressurized air is used from the engine compressor or air tank available in the air brake system of the vehicle which cause the linkages pressed and to move the throw out bearing forward. When the foot operated direction control valve is released then again flywheel and clutch plate of diaphragm clutch comes in contact with each other and rotate together for transmission of power from driving shaft to the driven shaft.

A. Photographs of the Fabricated Model

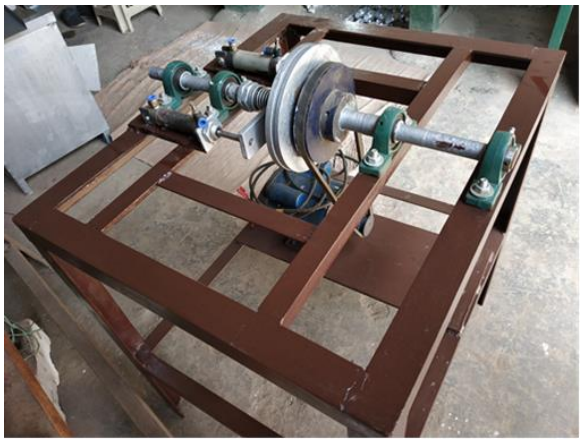

Fig. 1:

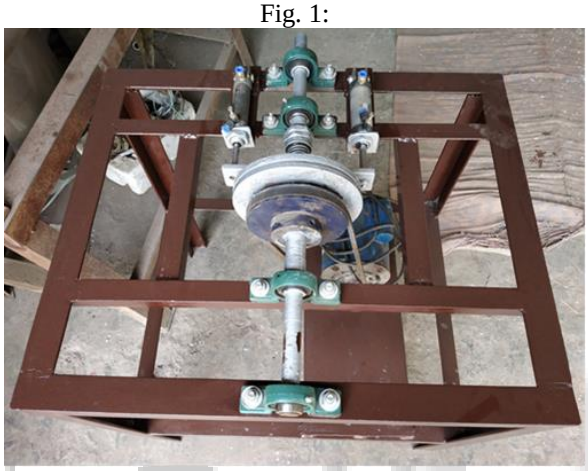

Fig. 2:

IV. OBSERVATIONS & CALCULATIONS

We are considering Ashok Layland 3116i vehicle for application of pneumatically operated clutch. The specifications related to heavy Vehicle is as follows

Vehicle name	Ashok Leyland 3116 il
Engine	H series, turbocharged, intercooled with inline
Engine cylinders	6
Displacement (cc)	5660 cc
Max power	160bhp @2400 rpm
Max torque	550 Nm @1500-1700rpm
Transmission	Manual
Clutch	Single plate dry plate with clutch booster, 381 mm facing diameter

For single plate clutch,
According to uniform wear theory,
$T = (\mu F/2)\,(R_o + R_i) \times N$
$T = (\mu/2)\,[2\pi \times P_i \times R_i\,(R_o - R_i)] \times (R_o + R_i) \times N$
$550 = 0.25[\pi \times 85000 \times Ri\,(0.1905 - R_i)]\,(0.1905 + R_i) \times 2$
Ri = 0.1162 m
Ri = 116.2 mm
Now, force required to disengage the clutch is given by
$F = 2\pi \times P_i \times Ri \times (R_o - R_i) \times N$
$F = 2\pi \times 85000 \times 0.1162\,(0.1905\text{-}0.1162) \times 2$
F = 9221.97 N

Thus, actual force required to engage the clutch is 9221N approximately. So the cylinder have to provide that much amount of force for engagement of clutch and compressor have a capacity approximately 150 psi in heavy vehicles.
We know that,
150 psi = 1.03 N/mm^2
D = diameter of cylinder
A = area of cylinder
F = force in N
P = pressure in N/mm^2
Pressure = Force/Area
$1.03 = 9221/(\pi/4 \times D^2)$
D = 106.75 mm
Say D = 110 mm
Thus, the diameter of the cylinder required for engagement and disengagement of the clutch is 110 mm.

V. CONCLUSIONS

The experimental details shows that it is possible to come up with a pneumatically operated clutch with the use of double acting cylinder and foot operated direction control valve. This project provides the desired output for engagement and disengagement of the clutch at less cost. It can be operated by using hand, so it will eliminate clutch pedal from tri pedal system. As the system is pneumatically operated. Thus it is neat and clean system as compared to hydraulic system. It is based on the compressed air available in the air tank of air brake system. So there is no need of extra compressor for working of this pneumatically operated clutch.

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