ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Issue 4, April 2016

Design and Development of Hydroelectric Gear Shifter

S. Biju, R.Byju, A.Bergin, A.Binish Mon
Student, Mechanical Department, Bethlahem Institute of Engg, Karungal, Tamilnadu
Student, Mechanical Department, Bethlahem Institute of Engg, Karungal, Tamilnadu
Student, Mechanical Department, Bethlahem Institute of Engg, Karungal, Tamilnadu
Student, Mechanical Department, Bethlahem Institute of Engg, Karungal, Tamilnadu

Abstract*:* Main objective of this project is to provide an improved hydro-electric gear shifting mechanism which will overcome the shortcomings of conventional gear changing mechanism. In conventional gear shifting mechanism, cables and mechanical linkages are used. In the proposed project, we are using solenoid valves and hydraulic cylinders so jamming and slipping is not possible. This proposed method is specially designed for rear engine vehicles or in vehicles in which gear box is placed a bit away from the driver. The arrangement of switches in the gear shifting switch panel is as follows: R (Reverse) –N (Neutral) – 1 – 2 – 3 – 4 –5(Top). This mechanism shifts the gear in straight manner i.e. to increase gear make the lever one step reverse and for decreasing one step forward. Neutral is placed before the first gear and reverse is placed before neutral. In this method, the three shafts that control the synchronizer unit are coupled with piston rods of three hydraulic cylinders. Each one of these hydraulic cylinders are connected with their respective solenoid valves and these solenoid valves are connected with gear shifting switch panel.

Keyword: Gearshifter, Hydroelectric, Hydraulic cylinder, Reverse motion linkage, Solenoid valves**.**

I. INTRODUCTION

In modern world vehicles have become important machine in human's daily life because it saves the time of travel by reaching the target place very faster. Since the invention of automobiles many new feature are introduced in order to improve the user satisfaction. This project is designed in order to overcome the shortcomings in the conventional gear transmission system. Here conventional gear transmission system is replaced by a hydroelectric gear transmission. The name of this project is "HYDROELECTRIC GEAR SHIFTER". Nowadays each family has their own automobiles to make transportation easier and faster. Gear transmission is one of the major mechanisms present in the automobiles but there are lots of shortcomings available in the conventional gear transmission system that is used in most of the automobiles today. Today's conventional system uses mostly mechanical linkages and cables to transmit the motion from leaves to the gear shifting shafts. But these systems have many shortcomings. When using cables shipping in the gear transmission is possible and also frequent application of lubricant is required and when using mechanical linkages jamming during the gear transmission is possible and periodic replacement of bush is required .Also both of these methods are noisy . In order to overcome the shortcoming in these methods hydroelectric gear shifter is designed.

II. LITERATURE REVIEW

A. P.MasoomBasha, P.Nithesh Reddy (2014) "Fabrication of Pneumatic Gear Changer"

According to suggested gear shifting method the control unit chooses optimum gear shifting ratio for an automobile without operating it manually using relays.

The two solenoid valves are connected to a compressor with the help of hoses of Ø6mm from which pressurized air is extracted. The solenoid valves are followed by two pneumatic cylinders with the help of air hoses. The cylinders are followed by a clutch pedal. Next to the clutch pedal gear box and a motor arrangement is present. The construction also includes a proximity sensor which senses the speed of the wheel. The precise signals are sent to the solenoid valves by the control unit through the relays. Therefore the input is speed of the wheel sensed by a sensor and the output is shifting of gear accordingly. The power to the control unit is supplied from the 12V battery. On the other hand the shifting of gear can be monitored on an LCD. It also consists of DC motor, ATMEGA Development board, speed regulator (accelerator), transformer etc.

The compressor sends the pressurized air to the solenoid valves through the hoses of 6mm diameter whereas the solenoid valve acts as temporary storage of air and acts as passage. The air from the solenoid valves passes to the pneumatic cylinders which act as working medium for actuating cylinders. When air enter into the cylinders the pistons starts

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Issue 4, April 2016

reciprocating that is extraction and retraction. The retraction is done manually by operating switches on the solenoid valves by closing the air inlet. On the other hand the relays send the precise signals to the solenoid valves. The input for these relays is the speed of the wheel or vehicle which is sensed by sensor proximate to the wheel. The shifting of gear is done by altering the speeds by rotating the rotor in the speed regulating board i.e., accelerator in case of automobile.

B. Tadashi Ichida, Akira Tsumiyama (2006) "Hydraulic Gear Shift Mechanism"

A hydraulic gear shift mechanism for a bicycle having a positioning mechanism for controlling the motion of the piston of a master cylinder assembly is disclosed, wherein in the master cylinder assembly is in communication with a slave cylinder for operation of derailleur. The positioning mechanism preferably includes a pivot soft spaced apart from the handle bar, a rotating member rotatable about the pivot shaft, a push mechanism for rotating the rotating member in a first direction and a return mechanism for rotating the rotating member in a second direction point in a more preferred embodiment of the invention, an adjuster piston is threading the engaged with the master cylinder assembly for adjusting the initial position of the slave cylinder.

C. Ken Gilbert (2003) "Electrohydraulic control system"

The electrohydraulic control system for the transmission and transfer consists of various sensors and switches, a transmission control module (TCM) and the hydraulic controlling units including solenoid valves. The system controls the automatic transmission operation, including gear shifting, lockup clutch operation, line pressure, automatic control pattern selection (Base and Power), and gear-shift timing. It also controls the operation of the transfer clutch. The TCM determines vehicle operating conditions from various input signals and controls a total of eight solenoids by sending appropriate signals to them.

III. EXISTING METHOD

Since the invention of automobiles many changers and new features are introduce in order to make them more efficient and user friendly. Gear transmission system is one of those systems that will periodically undergo changes to improve the driver's satisfaction. Shifting the gears manually is the common method available in the automobiles. But nowadays automatic gear transmission systems, semi-automatic gear transmission systems and electronically controlled gear transmission systems are introduced in the automobiles to improve the gear shift quality. Commonly in gear transmission systems the following two methods are used to carry motion from lever to gear box.

- Cables
- Rod Linkages

But there are many disadvantages are present in both of these methods that are making them difficult to use.

A. Cables

These cables are designed to replace the maintenance prone rod linkages commonly used in cab over trucks and rear engine buses. Cables in manual transmission is introduced to make the gear shifting easier for both the vehicle builder and operator. This system provides cost effective and less maintenance manual transmission shifting. This system is commonly used in tractors, loaders, agricultural sprayers. But this *system also have some shortcomings.*

B. Rod Linkages

There are two types of shift linkages used on manual transmissions. They are the external rod and the internal shift rails. They both perform the same function. They connect the shift lever with the shift fork mechanism. The transmission shift lever assembly can be moved to cause movement of the shift linkage, shift forks, and synchronizers. The shift lever may be either floor mounted or column mounted, depending upon the manufacturer. Floor-mounted shift levers are generally used with an internal shift rail linkage, whereas column-mounted shift levers are generally used with an external rod linkage.

IV. CURRENT PROJECT

In our project we have introduced combined electronic and hydraulic system for gear transmission instead of mechanical linkages and cables. This decreases the wear and tear produced by the linkages and hence the life of the system gets increased.

a) Hydraulic circuit

In the hydraulic system, the hydraulic flow starts with reservoir and ends with hydraulic cylinder. In the reservoir non-compressible hydraulic fluid is stored at atmospheric pressure. The pump sucks the fluid from the reservoir. The fluid from the reservoir is filtered before it is entered into the pump through filter. The pump increases the pressure of the fluid to 150 bar. The variable Pressure relief valve send back the fluid to the reservoir when the pressure of the fluid goes beyond 150 bar. The function of splitter is, it gets a single input and produce multiple outputs. These outputs are with same pressure and it is given as the input for DC solenoid valves.The 4/3 DC solenoid valve controls the flow direction of the fluid to the cylinder. The DC solenoid valve consists of four ports and three directions. To

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Issue 4, April 2016

bring back the piston to normal position, a spring is welded inside the cylinder and it will retard automatically to make the neutral gear.

b) Electric circuit

In the electric circuit 240v ac power source is used in this system to run the motor. A step down transformer is used to convert the 240v ac to 110v ac current. This 110v power source is given to the switch. Each solenoid valves are controlled by the output from the switch. The switch is controlled by gear lever.

V. CALCULATION

1. Calculation of load and pressure

Load due to gear lever and fork=3 kg
Load given to the spring to deflect 2 cm =15 kg
Total load= 15+3=18 kg
=18×9.81
=176.58 N

Pressure=$\frac{Load}{Area}$

Area of cylinder= $\frac{\pi}{4}\times d^2$

$= \frac{\pi}{4}\times(5\times10^{-2})^2$

Area of cylinder= $1.963\times10^{-3} m^2$

Pressure= $\frac{176.58}{1.96\times10^{-3}}$

$= 89931.45$ N/m^2

$= 0.89931\times10^{-5}$ N/m^2

= 0.899 bar

Take factor of safety as 20
Maximum pressure = 0.899×20
= 17.98 bar

2. Design of spring

Load P = 15 kg
= 147.15 N
Deflection δ = 20 mm
Material = High carbon steel
Working stress τ = 430 N/mm^2
Modulus of elasticity E = 2.0×10^5 N/mm^2
Modulus of rigidity G = 0.85×10^5 N/mm^2
Spring index C = 15
Stress $\tau = \frac{8\,KPC}{\pi d^2}$

$d^2 = \frac{8\,KPC}{\pi\times\tau}$

$d \geq (\frac{8\,KPC}{\pi\tau})^{1/2}$

K – Wahl's shear stress factor

$K = \frac{4C-1}{4C-4} + \frac{0.615}{C}$

$K = \frac{4\times15-1}{4\times15-4} + \frac{0.615}{15}$

K = 1.0902

$d \geq (\frac{8\times1.09\times15\times15}{\pi\times430})$

d ≥ 1.458 mm

The standard diameter above 1.458 mm is d= 1.63
Standard wire gauge number is SWG16

C= 15 = $\frac{D}{d}$

D= 15×1.63
D= 24.45 mm
Mean diameter of coil= 24.45 mm
Outer diameter of coil= D + d
= 24.45+1.63= 26.08 mm
Inner diameter of coil = D – d
=24.45 – 1.63 = 22.82 mm

Deflection $\delta = \frac{8PC^3n}{Gd}$

$n = \frac{\delta Gd}{8PC^3}$

$n = \frac{20\times0.83\times10^5\times1.63}{8\times15\times15^3}$

n = 6.84
n = 7 turns

Free length of spring L_f = n d + (n-1) ×gap btw adj coil
Assuming gap between adjacent coil = 5

$L_f = 7\times1.63 + (7-1)\times5$

L_f = 41.41 mm

Pitch = $\frac{free\ length\ L_f}{n-1}$

$= \frac{41.41}{7-1}$

Pitch = 6.96 mm
Type: open coil helical spring
Wire diameter d = 1.63 mm
Wire gauge number = SWG16
Diameter of coil = 24.45 mm
Number of turns = 7 nos
Free length = 41.41 mm
Pitch = 6.96 mm

3. Design of hydraulic cylinder

Free length of spring = 41.41 mm
Number of spring = 2
Total length of spring = 41.41 × 2
= 82.82 mm
Length of cylinder = 100 mm
Piston thickness = 30 mm
Stroke length = length of cylinder – piston thickness
= 100 – 30

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Issue 4, April 2016

Stroke length = 70 mm
Maximum pressure = 0.899 bar
Load = 18 kg = 176.58 N

Pressure = $\frac{load}{area}$

Area = $\frac{176.58}{0.899\times10^5}$

$= 1.957 \times 10^{-3}$

$\frac{\pi}{4}\times d^2 = 1.957 \times 10^{-3}$

$d^2 = \frac{1.957 \times 10^{-3} \times 4}{\pi}$

$d^2 = 2.492 \times 10^{-3}$

d = 0.0499 = 49.9 m

Diameter of cylinder = 49.9 mm
Stroke length of cylinder = 70 mm

4. Frame calculation

Length of frame = length of (cylinder+ valves+ pump+ gearbox+ clearance)
Length of cylinder with piston rod = 25 cm
Length of valve 20 cm
Length of pump = 20 cm
Length of gearbox = 35 cm

Clearance = $\frac{length\ of\ (cylinder+\ valves+\ pump+\ gearbox)}{2}$

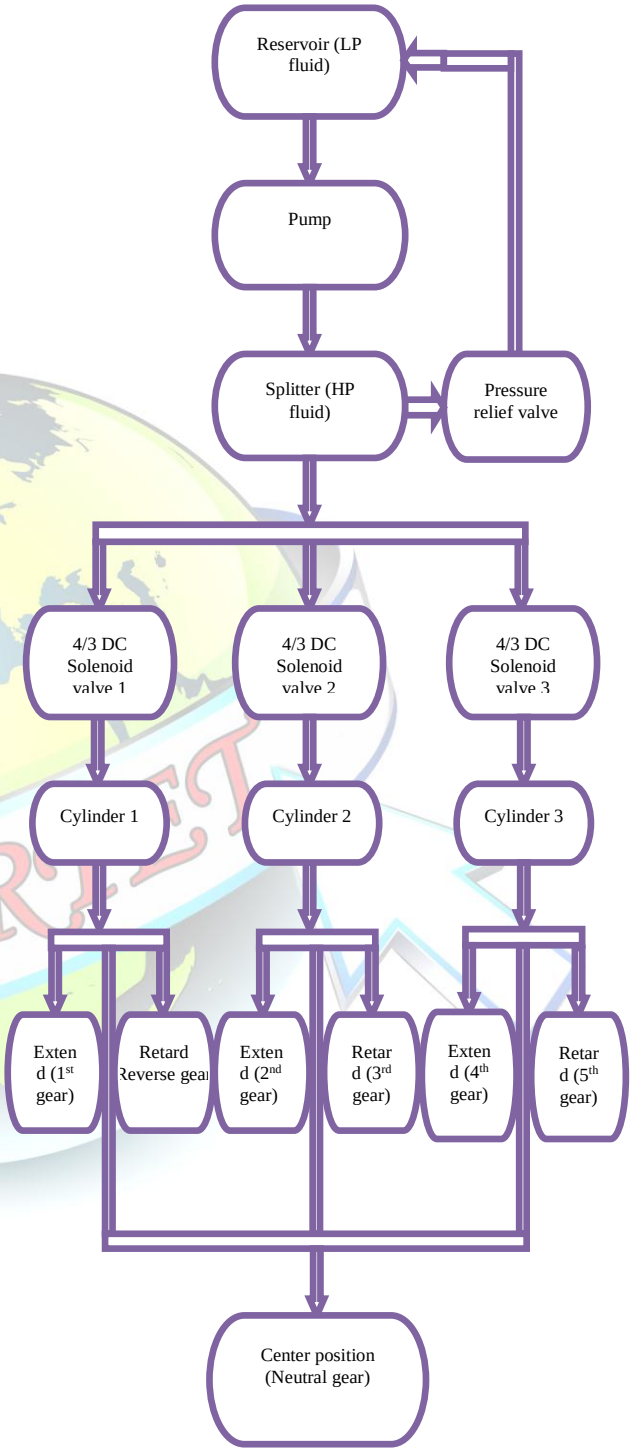
$= \frac{25+20+20+35}{2}$

Length of frame = 25+20+20+35+50
=150 cm = 1.5 m

Width of frame = width of 3 cylinder + clearance
= 10×3+15
= 45 cm

VI. WORKING

The working of hydroelectric gear shifter is given through the flowchart below. A 240v AC current is given to the motor which runs the pump. Pump converts the uncompressed fluid that stored in the reservoir to the highly compressed liquid. These compressed liquid is transmitted towards the three solenoid valves by using splitter. These solenoid valves are operated at the power range of 110v ac current. For using solenoid valve 240v ac should be converted into 110v dc, for this purpose step down transformer is used. These solenoid valves are controlled by switches placed in the switching panel. Switching panel consists of 7 switches, each solenoid valves are controlled by two switches and one is for neutral.



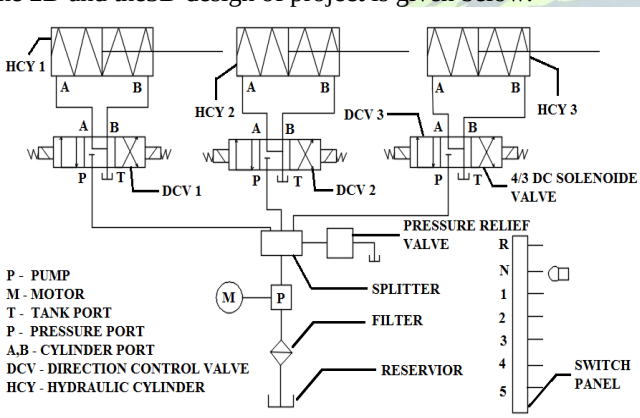
ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

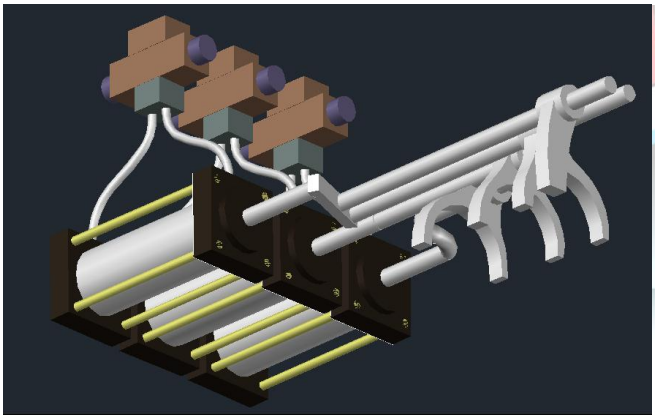
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Issue 4, April 2016

Solenoid valve consists of four ports, they are

1) Pressure port
2) Tank port
3) Cylinder port A
4) Cylinder port B

The pressure port is connected to the splitter; tank port is connected to the reservoir. Both the cylinder ports are connected to the respective positions in the cylinder. Gear box consists of four gear shifting shafts to change the gear. 2nd and 3rd gears are controlled by one shaft and 4th and 5th gears are controlled by another shaft. Both the first and the reverse gears have independent shafts and share the same hydraulic cylinder. The 2D and the3D design of project is given below.





VII. CONCLUSION

Thus the design and assembling of "Hydroelectric gear shifter" is successfully done. This project is particularly implemented for rear engine vehicles and the result was found to be positive. This proposed method is capable of shifting the gear in straight manner thus increases the quality of gear shift and operator satisfaction. In conventional gear shifting method many shortcomings are present due to the use of cables and rod linkages. In this proposed system we are not using rod linkages or cables. So the gear shifting process can be performed much smoother. Also this project can be implemented without the presence of mechanical linkages in case of commercial usage, thereby avoiding friction that occurs due to mechanical linkages. This proposed method is complex when comparing with conventional methods that uses cables and rod linkages. But this proposed system produces significant amount of advantages such as no slipping, no jamming over the conventional gear shifting methods.

REFERENCE

[1]. Frank Owen (2008) "Electronic Transmission Control"

[2]. Mustafa, Rashad (2010) "Modelling and Analysis of the Electrohydraulic and Driveline Control of a Dual Clutch Transmission"

[3]. Roshan.S.Hubly (2009) "Development of Push Button Operated Shifting Lever Mechanism"

[4]. P.Masoom Basha, P.Nithesh Reddy (2014) "Fabrication of Pneumatic Gear Changer"

[5]. M.S.Kumbhar (2014) "A Literature Review on Automated Manual Transmission"

[6]. Kei-Lin Kuo (2011) "Simulation and Analysis of the Shift Process for an Automatic Transmission"

[7]. James.E.Erickson (2006) "Hydraulically Assisted Gear Shift Mechanism for a Marine Propulsion Device"

[8]. Tadashi Ichida, Akira Tsumiyama (2006) "Hydraulic Gear Shift Mechanism"

[9]. Ken Gilbert (2003) "Electrohydraulic control system"

[10]. Maurizio Uberti (2010) "Electro-hydraulic control system for a motor-vehicle dual-clutch transmission"

[11]. Michinobu Suzuki, Masahiko Hayashi (2003) "Gear Change Device"

[12]. Yong Zheng, Xinghui Lian (2011) "Gear Shifting Mechanism for the Vehicle Automatic Transmission"

[13]. Yasushi Yamamoto (2004) "Gear Change Device"

[14]. Robert A Dejonge, Stephen D Wexall (2001) "External electronic transmission shift system"

[15]. Norbert Esly, Jens Benndorf (2003) "Motor vehicle with gearbox