Design and Fabrication of Hydraulic Gear Shifter

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***Abstract* : - This is disclosed an auto gear change control apparatus for an automobile and a method of controlling such apparatus. A rotational output of an internal combustion motor is connected to drive wheels of the automobile and a load device. When a gear shifting-up of an automatic transmission is to be effected, the load applied by the load device is increased, or the load is connected to an output rotation shaft of the motor via a selectively- connecting device, thereby reducing the rotational speed of the output rotation shaft of the motor to a required level. It consists of two units of hydraulic power system and Actuator system. We introduced a power pack in this project. This unit provides high pressurized fluid, which is used in cylinder assemblies of lever for effective work. It is a heavy construction. It provides more power compared to other methods. Compact in size. It replaces a large amount of human effort.**

INTRODUCTION

A method of controlling a gear change of an automobile, the automobile comprising an internal combustion motor; an automatic transmission connected to an output rotation shaft of the motor so as to transmit the rotational output of the motor to drive wheels of the automobile through any selected one of a polarity of gear ratios. A load device selectively connectable to the output rotation shaft of the motor via selectively-connecting and means for generating a gear change control signal for selecting one of the automobile and the motor the method comprising the steps of controlling the selectively- connecting means when the gear change signal generating means generates the control signal for shifting up the gear in the automatic transmission, in such a manner that the selectively-connecting means connects the load device to the output rotation shaft of the motor.

INTRODUCTION TO GEARS

In engineering and technology the term “gear” is defined as machine equipment used to transmit motion and power between rotating shafts by means of progressive engagement of projections called “the teeth”. Gears operate in pairs, the smaller in the pairs is called the pinion and the larger is named as the gear. Usually the pinion drives the gear the system acts as a speed reducer and torque converter. The various types of gears are helical gears, Bevel gears, spur and worm gearwheels. Among all the kinds of gears, the spur gear is given first preference for the checking of their precision.

MAJOR CLASSIFICATION OF GEARSSPUR GEARS

Spur gears are cylindrical in form and operate on parallel axis. The teeth are straight and parallel to the axis. They are mounted on shafts parallel to each other.

HELICAL GEARS

Helical gears are cylindrical in form and the teeth traces are helical. It may be left-handed or right-handed.

.BEVEL GEARS

Bevel gears are conical in form and operate on intersecting axis, which are usually at right angles.

WORM GEARS

Worm gears include worm and their mating gears. Their axis is usually at right angles. We are interested in handling external spur gears.

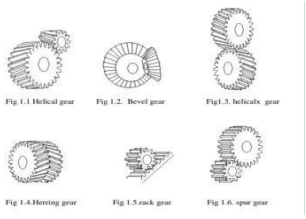
EXTERNAL SPUR GEARS

Spur gears are used to transmit power between parallel shafts. They impose only radial loads on their bearings. The tooth profiles are ordinarily curved in the shape of an involute. Variations in centre distance do not affect the trueness of the gear in action unless the change is so great as to other jam the teeth into the root of the mating member or withdraw almost out of action. Spur-gear teeth may be hobbed, shaped, milled, drawn, sintered, cast, and shear-cut. They may be given a finishing operation such as grinding, shaving, lapping, rolling, and burnishing. Generally, there are more kinds of machine tools and processes available to make spur gears than to make any other gear type.

DETAILED STUDY OF GEARS

Gears are used to transmit power between shafts rotating usually at different speeds. Some of the many types of gears are illustrated below. A pairs of spur gears for mounting on parallel shafts. The 10 teeth of the smaller pinion and the 20 teeth of the wheel lie parallel to the shaft axes A rack and pinion. The straight

rack translates rectilinearly and may be regarded as part of a wheel of infinite diameter. Like spur gears helical gears connect parallel shafts, however the teeth are not parallel to the shaft axes but lie along helices about the axes.



Straight bevel gears for shafts whose axes intersect. Hypoid gears - one of a number of gear types for offset shafts. A worm and worm wheel gives a large speed ratio but with significant sliding. In order to demonstrate briefly the development of gear drives, from first principles through to safety implications, we consider here only spur gears. Knowledge of these is fundamental to understanding the behaviour of geometrically more complex types, including helical gears which are generally preferred to spurs since they are more compact and smoother in operation, thus permitting higher speed. There are three stages here - the first spiral bevel pairsare followed by two helical pairs.

A couple of features of the box are immediately apparent

- compactness - shafts are short and simply supported where practicable, with gears located as close as possible to bearings in order to minimise shaft bending
- sturdiness increasing from input through output
- the sizes of input & output shafts, and second & third stage gear teeth, should be compared.

A pairs of meshing gears is a power transformer, a coupler or interface which varies the speed and torque characteristics of a power source and a power sink/load. A single pairs may be inadequate for certain sources and loads, in such case more complex combinations such as the above gearbox, known as gear trains, are necessary. In the vast majority of applications such a device acts as a speed reducer in which the power source drives the device through the high speed low torque input shaft, while power is fed from the device to the load through the low speed high torque output shaft. Speed reducers are much more common than speed
-up drives not so much because they reduce speed, but rather because they amplify torque. Thus gears are used to accelerate a car from rest, not to provide the initial low speeds (which could be accomplished by easing up on the accelerator pedal) but to increase the torque at the wheels which is necessary to accelerate the vehicle. Torque amplification is the reason for the gearbox's increasing sturdiness mentioned above.

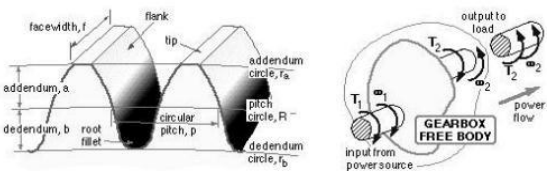


Fig 1.7.Graphical representation of gear teeth

These will consider the following aspects of spur gearing

- Overall kinetics of a gear pairs (for cases only ofsteady speeds and loads)
- Tooth geometry requirements for a constantvelocity ratio (eg. size and conjugate action)
- Detailed geometry of the involute tooth andmeshing gears
- The consequences of power transfer on the fatiguelife of the components, and hence
- The essentials of gear design.

Some of the main features of spur gear teeth are illustrated. The teeth extend from the root, or dedendum cylinder (or colloquially, "circle") to the tip, or addendum circle: both these circles can be measured. The useful portion of the tooth is the flank (or face), it is this surface which contacts the mating gear. The fillet in the root region is kinematically irrelevant since there is no contact there, but it is important insofar as fatigue is concerned.

Overall kinetics of a gear coil

Analysis of gears follows along familiar lines in that we consider kinetics of the overall assembly first, before examining internal details such as individual gear teeth. The free body diagram of a typical single stage gearbox is shown. The power source applies the torque T1 to the input shaft, driving it at speed ω1 in the sense of the torque (clockwise here). For a single pairs of gears the output shaft rotates at speed ω2 in the opposite sense to the input shaft, and the torque T2 supplied by the gearbox drives the load in the sense of ω2. The reaction to this latter torque is shown on the free body diagram of the gearbox - apparently the output torque T2must act on the gearbox in the same sense as that ofthe input torque T1.

The gears appear in more detail in Fig below. O1 and O2 are the centres of the pinion and wheel respectively. We may regard the gears as equivalent pitch cylinders which roll together without slip - the requirements for preventing slip due to the positive drive provided by the meshing teeth is examined below. Unlike the ddendum and dedendum cylinders, pitch cylinders cannot be measured directly; they are notional and must be inferred from other measurements.

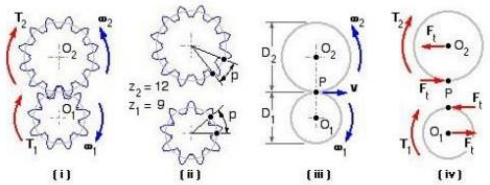


Fig 1.8. pitch circle Fig 1.9. pitch diameter

One essential for correct meshing of the gears is that the size of the teeth on the pinion is the same as the size of teeth on the wheel. One measure of size is the circular pitch, p, the distance

between adjacent teeth around the pitch circle (ii); thus p = πD/z where z is the number of teeth on a gear of pitch diameter D. The SI measure of size is the module, m
= p/π - which should not be confused with the SI abbreviation for metre. So the geometry of pinion 1 and wheel 2 must be such that: D1 / z1 = D2 / z2 = p
/π = m that is the module must be common to both gears. For the rack illustrated above, both the diameter and tooth number tend to infinity, but their quotient remains the finite module.

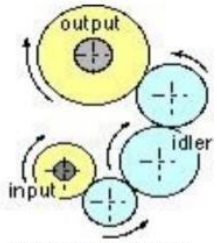


Fig 1.10. pitch point

The pitch circles contact one another at the pitch point, P which is also notional. Since the positive drive precludes slip between the pitch cylinders, the pinion's pitch line velocity, v, must be identical to the wheel's pitch line velocity: v = ω1 R1 = ω2 R2; where pitch circle radius R =D/2 Separate free body diagram of pinion and wheel appear in (iv). Ft is the tangential component of action -reaction at the pitch point due to contact between the gears. The corresponding radial component plays no part in power transfer and is therefore not shown on the bodies. Ideal gears only are considered initially, so the friction force due to sliding contact is omitted also. The free bodies show that the magnitude of the shaft reactions must be Ft, and that for equilibrium: Ft= T1 / R1 = T2 / R2 in the absence of friction. The preceding concepts may be combined conveniently into :-(1) ω1 / ω2 = T2 / T1 = D2 / D1 = z2 / z1; D
= mz

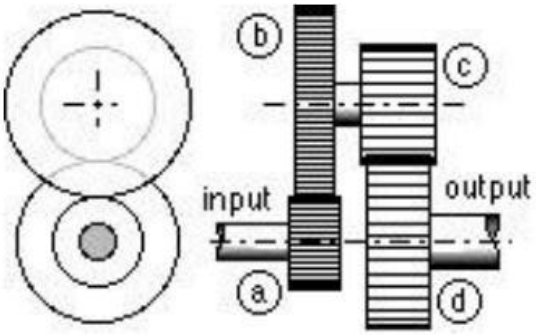


Fig 1.11. Gear transmission.

That is, gears reduce speed and amplify torque in proportion to their teeth numbers. In practice, rotational speed is described by N (rev/min or Hz) rather than by ω (rad/s). The only way that the input and output shafts of a gear pairs can be made to rotate in the same sense is by interposition of an odd number of intermediate gears as shown - these do not affect the speed ratio between input and output shafts. Such a gear train is called a simple train. If there is no power flow through the shaft of an intermediate gear then it is an idler gear. A gear train comprising two or more pairs is termed compound when the wheel of one stage is mounted on the same shaft as the pinion of the next stage. A compound train as in the above gearbox is used when the desired speed ratio cannot be achieved

economically by a single pairs. Applying (1) to each stage in turn, the overall speed ratio for a compound train is found to be the product of the speed ratios for the individual stages. Selecting suitable integral tooth numbers to provide a specified speed ratio can be awkward if the speed tolerance is tight and the range of available tooth numbers is limited. Until the advent of computers allowed such problems to be solved by iterative trials, techniques based on continued fractions were used.

GEARTRONICS

Sequential gearboxes contain a cam drum or barrel as part of the selector mechanism. The action of the gearstick rotates this drum to a unique position corresponding to the selected gear. The sensor of the Geartronics display unit measures this position and allows the control unit to calculate which gear is selected and display accordingly. The common sensor is a special potentiometer (variable resistor) which is able to rotate continuously through 360 degrees. We can supply sensors, usually from stock, from Penny & Giles, Active Sensors or Novotechnik. Although not cheap, you can be assured of the highest accuracy & reliability. Occasionally we have seen a linear, plunger type, potentiometer used, particularly on Hewland gearboxes. This type of display is based on there being a fixed ratio between road speed & motor speed. Whilst it might work under some conditions, the times when you REALLY need to know what gear you're in, this type of display will let you down. It will not work at all when the clutch is disengaged and will not work reliably at low vehicle speeds. The Geartronics unit measures the absolute position of the selector barrel within the gearbox and will always give an instant and accurate indication of the selected gear. But depending upon the type of gearbox you have it may not be possible to display reverse. However, because a proper 'alpha-numeric' display is used the Neutral and Reverse positions (where applicable) are correctly displayed instead of showing a 'dash' or lower case 'n' for neutral. Additionally, a 12v output is provided when neutral or reverse is selected. The following parts are the main section for our project,

1. Oil compressor
2. Push button
3. Cylinder
4. Gear assembly

LITERATURE SURVEY

A. P.MasoomBasha, P.Nithesh Reddy (2014) "Fabrication of Hydraulic 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 6mm from which pressurized oil is extracted. The solenoid valves are followed by two hydraulic cylinders with the help of oil 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 oil to the solenoid valves through the hoses of 6mm diameter whereas the solenoid valve acts as temporary storage of oil and acts as passage. The oil from the solenoid valves passes to the hydraulic cylinders which act as working medium for actuating cylinders.

When oil enter into the cylinders the pistons starts reciprocating that is extraction and retraction. The retraction is done manually by operating switches on the solenoid valves by closing the oil 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 caseof 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 a total of eight solenoids by sending appropriate signals to them.

HYDRAULIC CYCLINDER

Introduction

A hydraulic cylinder simply converts oil pressure into linear motion. When selecting a hydraulic cylinder, you must pay attention to:

- how far the piston extends when activated, known as "stroke" surface area of the piston face, known as "bore size"
- action type
- pressure rating, such as "50 PSI"
- type of connection to each port, such as "1/4" NPT"
- must be rated for compressed oil use
- mounting method

Action Types

By "action type", we mean how the cylinder acts when pressure is applied and removed.

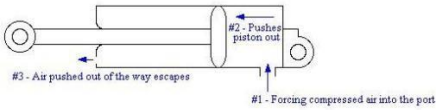


Fig: when pressure applied

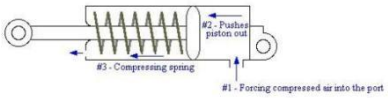


Fig 4.2. when pressure removed

A "single-acting" cylinder has a single port for compressed oil. When oil pressure is removed, the cylinder does nothing to retract the piston. Whatever the piston pushed out must push the piston back in. A cylinder that is "single-acting with spring return" has hook ups like the "single-acting" cylinder. When oil pressure is

the reservoir to the highly compressed liquid. These compressed liquid is transmitted towards the hand lever 5/3DC valves and using splitter. The rotation of the motor is driven to the main shaft through Belt drive, attached in motor with pulley. There are four gears with 60 teeth and 40 teeth-2nos attached in the main shaft 2 nos. and the engaging shaft. The gears are placed properly in the shafts. It is arranged perfectly to engage in one another, when the

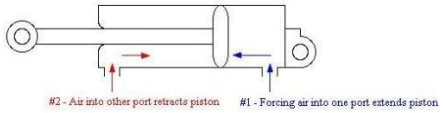


Fig 4.3. spring action

removed, the spring pushes the piston back into the resting position.

In some cases the cylinder is sealed and the trapped oil performs as an "oil spring". A single-acting cylinder with spring return requires more oil pressure to activate because you are pushing against both the load and the spring. A "double-acting" cylinder has two ports for compressed oil. Note that a double- acting cylinder requires a more complex solenoid valve. When you want to return the piston to its resting position, you must not only apply pressure to the second port, but also open up the first port so that the gas in it can be expelled. A double-acting cylinder consumes more oil than the equivalent single acting cylinder, because you need oil to push the cylinder in each direction.

Commercial Hydraulic Cylinders

Hydraulic cylinders are available commercially in a wide range of sizes and designs.

Using a commercial hydraulic cylinder is not a guarantee of safety -you can still do bad things with good parts - but it does provide additional safety margins that improvised hydraulic cylinders simply cannot provide.

EXPERIMENTALSETUP, PROCEDURES WORKING PRINCIPLE

An automatic transmission connected to an output rotation shaft of the motor so as to transmit the rotational output of the motor to drive wheels of the automobile through any selected one of a polarity of gear ratios. The machine comprising a load device for applying a load; means for connecting the load device to the output rotation shaft of the motor and for generating a gear change control signal for selecting one of the gear ratios of the automatic transmission in accordance with one of operational conditions of the automobile and the motor; and load control means for increasing the load of the load device when the gear change signal-generating means generates the control signal for shifting up the gear in the automatic transmission. The working of hydroelectric gear shifter is given through the flowchart below. A 230v AC current is given to the motor which runs the pump. Pump converts the uncompressed fluid that stored in

lever is operated. Here we are having hydraulic cylinder and flow control valve to made the above operation successfully. When the hydraulic piston is hitted to lever, it will engage the gears. These operations are made only when the motor is in off condition. Compressed oil is must to operate this principle. We are designed this project for automobile field.

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

ADVANTAGES & APPLICATIONSADVANTAGES

It requires simple maintenance cares The safety system for automobile

- Checking and cleaning are easy, because of the main parts are screwed.
- Easy to Handle
- Low cost automation project
- Repairing is easy
- Replacement of parts is easy

APPLICATIONS

It is very much useful for car owners & Auto- garages. Thus it

can be useful for the two wheeler application.

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 advantagessuch as no slipping, no jamming over theconventional gear shifting methods.

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