CHAPTER 1

INTRODUCTION

1.1 Introduction to Electrical Steering Mechanism:

Steering is the term applied to the collection of components, linkages, etc. which will allow a vessel (ship, boat) or vehicle (car, motorcycle, and bicycle) to follow the desired course. An exception is the case of rail transport by which rail tracks combined together with railroad switches (and also known as 'points' in British English) provide the steering function. The arrangement for converting a conventional manual steering system of an on-road vehicle to automatic steering system utilizable electric microcontroller and ultrasonic sensor. A DC motor is direct connected to rack and pinion drive to a drive mounted on the steering shaft (Refer fig 1). In this project we work on the pre notification which helps in the reduction of the extreme impacts of the vehicle collision. This pre notification is calculated in concern with both the distinct on the steering as well as the vehicle. This paper can play an important role in the advancement of the intelligent system of the chore automotive. In this project, we propose a safety only in terms on the road.The DC motor is connected to a electrical control unit (ECU) and moves with the steering shaft in both a manual steering mode and an automatic steering mode. An encoder provides a signal to a electrical control unit (ECU) that changes operation to the manual mode if the number of steps reported by the encoder is different than What is expected. An assembly including alternate steering Wheel, shaft pulley, adapter fit and DC motor is easily connected to the steering column. This type of design structure work both on manually and automatic. Elsewhere on this site you can learn about all the other stuff that makes a car go and stop, so this page is where you'll learn about how it goes around corners. More specifically, how the various steering mechanisms work.

Like most things in a car, the concept of steering is simple - you turn the steering wheel, the front wheels turn accordingly, and the car changes direction. Though this is not so simple. It was used to be back in the days when cars were called horseless carriages, but nowadays, not so much.

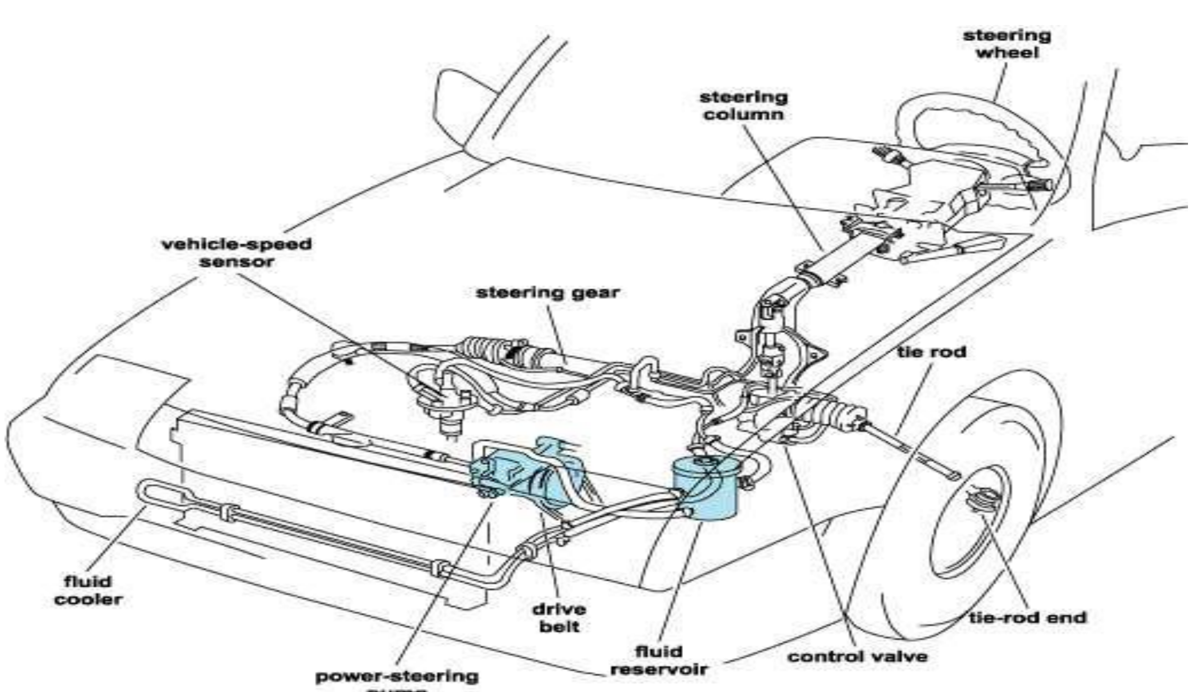

Fig.1 Steering Mechanism in Vehicle

The steering system is the key interface between the driver and the vehicle. The main requirement is that the steering should be precise, with no play. In addition, the steering system should be smooth, compact and light. It must also provide the driver with a perfect feel for the road surface and help the wheels return to the straight-ahead position. The standard steering arrangement is to turn the front wheels using a hand-operated steering wheel via the steering column. The steering column may contain several joints to allow it to deviate somewhat from a straight line. These joints may also be part of the collapsible steering column design to protect the driver in frontal crash situations. For safety reasons all modern cars feature a collapsible steering column (energy absorbing steering column) which will collapse in the event of a heavy frontal impact to
avoid excessive injuries to the driver. Airbags are also generally fitted as standard. Noncollapsible steering columns fitted to older vehicles very often impaled drivers in frontal crashes, particularly when the steering box

or rack was mounted in front of the front axle line, at the front of the crumple zone. This was particularly a problem on vehicles that had a rigid separate chassis frame, with no crumple zone.

Most modern vehicle steering boxes/racks are mounted behind the front axle on the front bulkhead, at the rear of the front crumple zone. Collapsible steering columns were invented by Bela Barenyi and were introduced in the 1959 Mercedes-Benz W111 Fintail, along with crumple zones. This safety feature first appeared [when?] on cars built by General Motors after an extensive and very public lobbying campaign enacted by Ralph Nader. Ford started to install collapsible steering columns in 1968. Audi used a retractable steering wheel and seat belt tensioning system called procon-ten, but it has since been discontinued in favor of airbags and pyrotechnic seat belt pre-tensioners.

Nowadays almost all the automobile vehicle is being atomized in order to product the human being.

The automobile vehicle is being automated for the following reasons.

- To achieve high safety.
- To reduce man power.
- To increase the efficiency of the vehicle.
- To reduce the work load.
- To reduce the vehicle accident.
- To reduce the fatigue of workers.
- To high responsibility.
- Less Maintenance cost.

1.2 History of different steering mechanisms & various types of vehicle steering system.

1.2.1 Basic geometry: Ackermann steering geometry:

Caster angle θ indicates kingpin pivot line and gray area indicates vehicle's tire with the wheel moving from right to left. A positive caster angle aids in directional stability, as the wheel tends to trail, but a large angle makes steering more difficult. The basic aim of steering is to ensure that the wheels are pointing in the desired directions. This is typically achieved by a series of linkages, rods, pivots and gears. One of the fundamental concepts is that of caster angle - each wheel is steered with a pivot point ahead of the wheel; this makes the steering tend to be self-centering towards the direction travel. The steering linkages connecting the steering box and the wheels usually conforms to a variation of Ackermann steering geometry, to account for the fact that in a turn, the inner wheel is actually travelling a path of smaller radius than the outer wheel, so that the degree of toe suitable for driving in a straight path is not suitable for turns (Refer fig. 2) The angle the wheels make with the vertical plane also influences steering dynamics,see camber angle as do the tires.

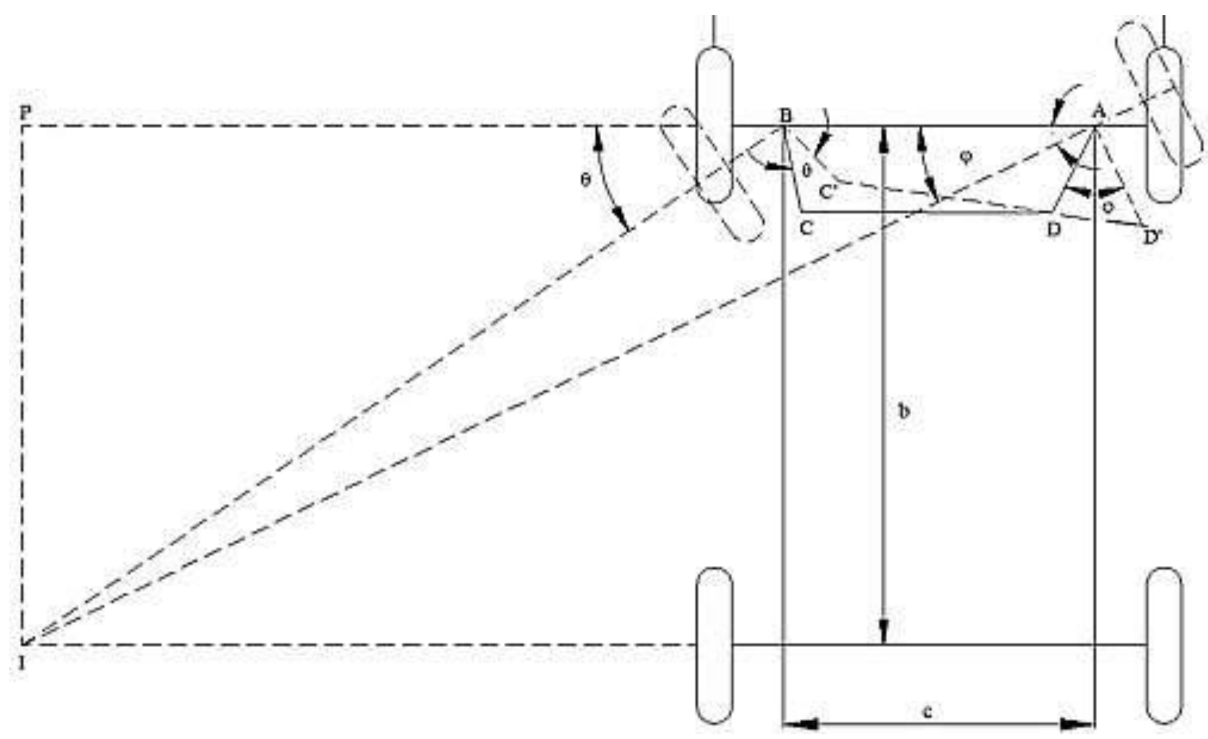

Fig.2 Ackermann Steering Geometry

1.2.2 Rack and pinion

Rack and pinion steering mechanism includes Steering wheel, Steering column, Rack and pinion, tie rod, kingpin. Rack and pinion unit mounted in the cockpit of an Ariel Atom sports car chassis. For most high volume production, this is usually mounted on the other side of this panel. Many modern cars use rack and pinion steering mechanisms, where the steering wheel turns the pinion gear; the pinion moves the rack, which is a linear gear that meshes with the pinion, converting circular motion into linear motion along the transverse axis of the car (side to side motion). This motion applies steering torque to the swivel pin ball joints that replaced previously used kingpins of the stub axle of the steered wheels via tie rods and a short lever arm called the steering arm (Refer fig 3) The rack and pinion design has the advantages of a large degree of feedback and direct steering "feel". A disadvantage is that it is not adjustable, so that when it does wear and develop lash, the only cure is replacement.

A rack and pinion is a type of linear actuator that comprises a pair of gears which convert rotational motion into linear motion. A circular gear called "the pinion" engages teeth on a linear "gear" bar called "the rack"; rotational motion applied to the pinion causes the rack to move, thereby translating the rotational motion of the pinion into the linear motion of the rack.For example, in a rack railway, the rotation of a pinion mounted on a locomotive or a railcar engages a rack between the rails and pulls a train along a steep slope.

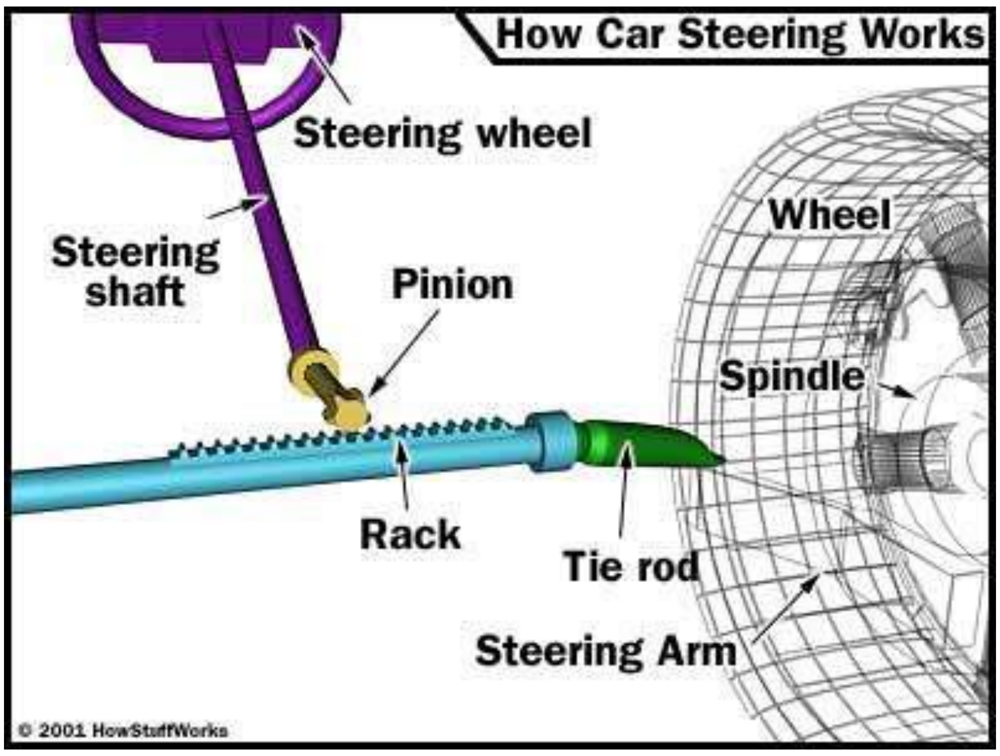

Fig.3. Rack and Pinion Steering Mechanism

The rack and pinion arrangement is commonly found in the steering mechanism of cars or other wheeled, steered vehicles. This arrangement provides a lesser mechanical advantage than other mechanisms such as recirculating ball, but much less backlash and greater feedback, or steering "feel". The use of a variable rack (still using a normal pinion) was invented by Arthur Ernest Bishop, so as to improve vehicle response and steering "feel" especially at high speeds, and that has been fitted to many new vehicles, after he created a specialized version of a net-shape warm press forging process to manufacture the racks to their final form, thus eliminating any subsequent need to machine the gear teeth enclosed steering rack in an automobile.

1.2.2 Recirculating ball

Older designs often use the recirculating ball mechanism, which is still found on trucks and utility vehicles. This is a variation on the older worm and sector design; the steering column turns a large screw (the "worm gear") which meshes with a sector of a gear, causing it to rotate about its axis as the worm gear is turned; an arm attached to the axis of the sector moves the Pitman arm, which is connected to the steering linkage and thus steers the wheels. The recirculating ball version of this apparatus reduces the considerable friction by placing large ball bearings between the teeth of the worm and those of the screw; at either end of the apparatus the balls exit from between the two pieces into a channel internal to the box which connects them with the other end of the apparatus, thus they are "recirculated" (Refer fig 4) .

The recirculating ball mechanism has the advantage of a much greater mechanical advantage, so that it was found on larger, heavier vehicles while the rack and pinion was originally limited to smaller and lighter ones; due to the almost universal adoption of power steering, however, this is no longer an important advantage, leading to the increasing use of rack and pinion on newer cars. The recirculating ball design also has a perceptible lash, or "dead spot" on center, where a minute turn of the steering wheel in either direction does not move the steering apparatus; this is easily adjustable via a screw on the end of the steering box to account for wear, but it cannot be entirely eliminated because it will create excessive internal forces at other positions and the mechanism will wear very rapidly. This design is still in use in trucks and other large vehicles, where rapidity of steering and direct feel are less important than robustness, maintainability, a mechanical advantage.

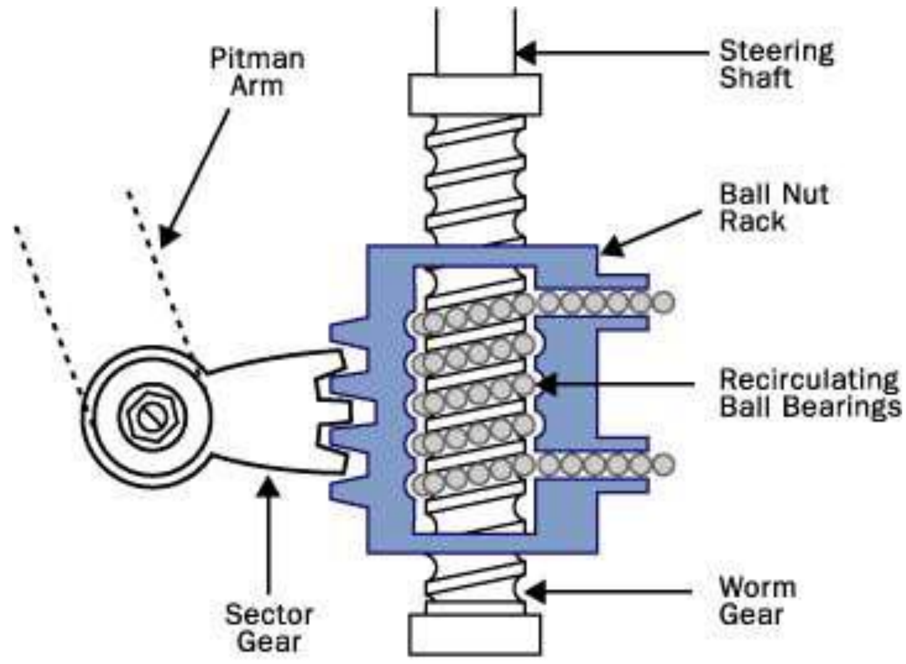

Fig.4 Recirculating Ball Mechanism

1.2.3 Worms and Sector

The worm and sector was an older design, used for example in Willys and Chrysler vehicles, and the Ford Falcon (Refer fig 5) Other systems for steering exist, but are uncommon on road vehicles. Children's toys and go-karts often use a very direct linkage in the form of a bell crank (also commonly known as a Pitman arm) attached directly between the steering column and the steering arms, and the use of cable-operated steering linkages (e.g. the Capstan and Bowstring mechanism) is also found on some home-built vehicles such as soapbox cars and recumbent tricycles.

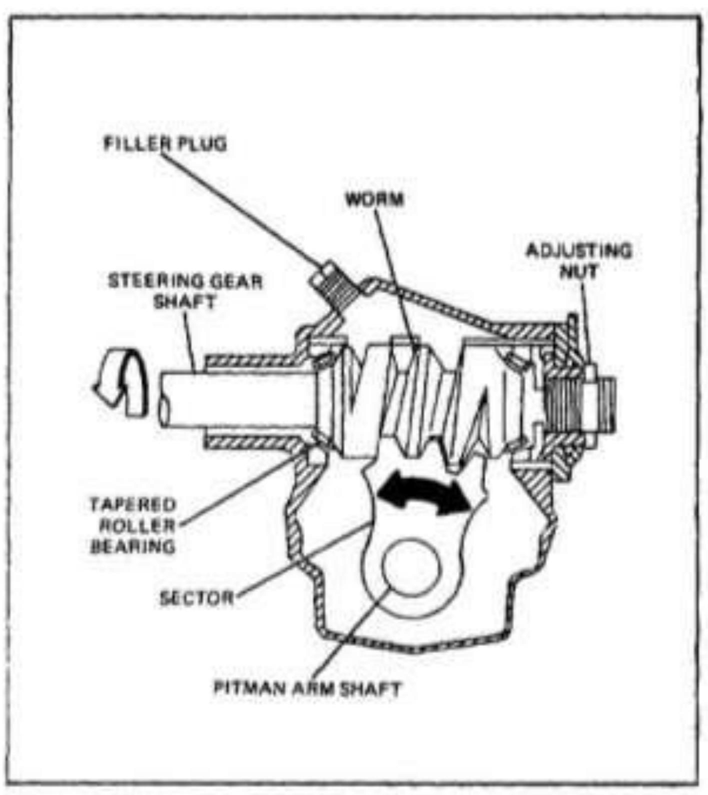

Fig.5 Worm & Worm Sector

1.2.4 Power steering

Power steering helps the driver of a vehicle to steer by directing some of the it's power to assist in swivelling the steered road wheels about their steering axes. As vehicles have become heavier and switched to front wheel drive, particularly using negative offset geometry, along with increases in tire width and diameter, the effort needed to turn the wheels about their steering axis has increased, often to the point where major physical exertion would be needed were it not for power assistance (Refer fig 6). To alleviate this auto makers have developed power steering systems: or more correctly powerassisted steering on road going vehicles there has to be a mechanical linkage as a fail safe. There are two types of power steering systems; hydraulic and electric/electronic. A hydraulic-electric hybrid system is also possible. A hydraulic power steering (HPS) uses hydraulic pressure supplied by an engine-driven pump to assist the motion of turning the steering wheel

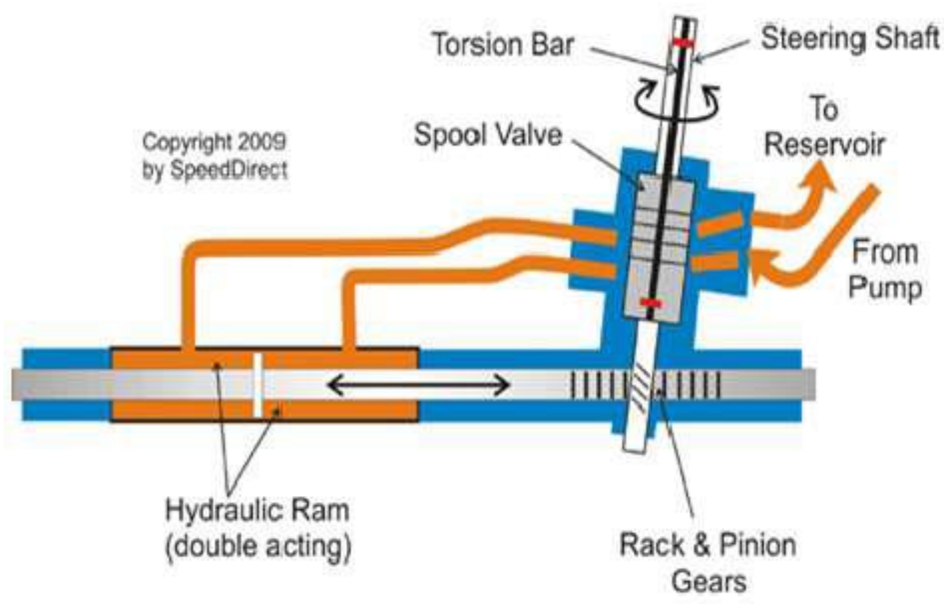

Fig.6 Power Steering Mechanism

1.2.5 Speed Sensitive Steering

An outgrowth of power steering is speed sensitive steering, where the steering is heavily assisted at low speed and lightly assisted at high speed. The auto makers perceive that motorists might need to make large steering inputs while manoeuvering for parking, but not while traveling at high speed.Modern speed-sensitive power steering systems reduce the mechanical or electrical assistance as the vehicle speed increases, giving a more direct feel. This feature is gradually becoming more common.

1.2.6 Four-wheel steering

Four-wheel steering (or all-wheel steering) is a system employed by some vehicles to improve steering response, increase vehicle stability while maneuvering at high speed, or to decrease turning radius at low speed.(Refer fig 7)

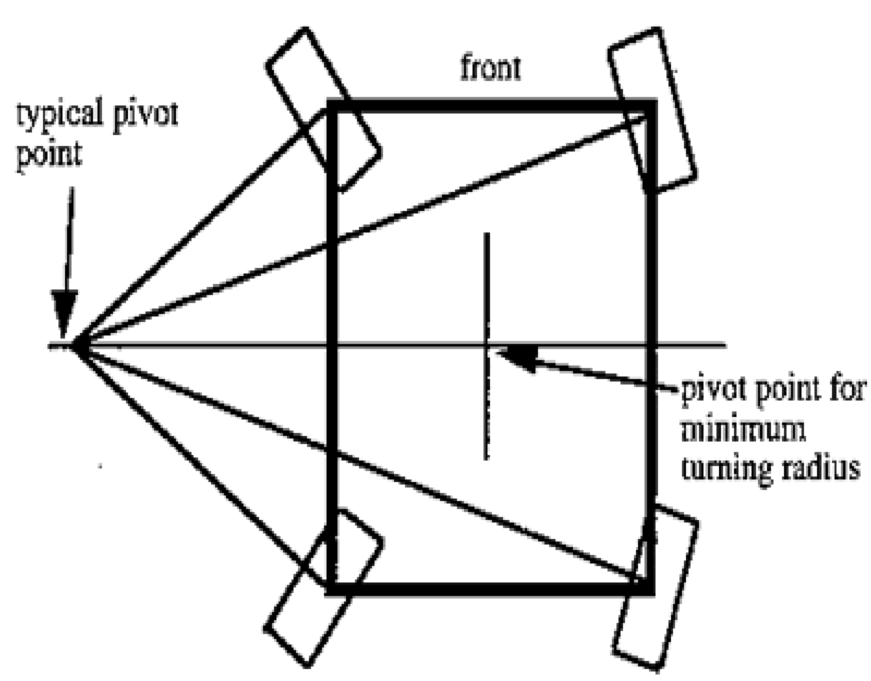

Fig.7 All Wheel Steering Mechanism

1.2.7 Active four-wheel steering

In an active four-wheel steering system, all four wheels turn at the same time when the driver steers. In most active four-wheel steering systems, the rear wheels are steered by a computer and actuators. The rear wheels generally cannot turn as far as the front wheels. There can be controls to switch off the rear steer and options to steer only the rear wheel independent of the front wheels. At low speed (e.g. parking) the rear wheels turn opposite of the front wheels, reducing the turning radius by up to twenty-five percent, sometimes critical for large trucks or tractors and vehicles with trailers, while at higher speeds both front and rear wheels turn alike (electronically controlled), so that the vehicle may change position with less yaw, enhancing straight-line stability.

Crab steering

Crab steering is a special type of active four-wheel steering. It operates by steering all wheels in the same direction and at the same angle. Crab steering is used when the vehicle needs to proceed in a straight line but under an angle i.e. when moving loads with a reach truck, or during filming with a camera dolly,or when the rear wheels may not follow the front wheel tracks i.e. to reduce soil compaction when using rolling farm equipment.

1.2.8 Passive rear wheel steering

Many modern vehicles offer a form of passive rear steering to counteract normal vehicle tendencies.For example,generally passive steering system is used to correct for the rear wheel's tendency to toe-out. On many vehicles, when cornering, the rear wheels tend to steer slightly to the outside of a turn, which can reduce stability. The passive steering system uses the lateral forces generated in a turn (through suspension geometry) and the bushings to correct this tendency and steer the wheels slightly to the inside of the corner. This improves the stability of the car, through the turn. This effect is called compliance understeer and it, or its opposite, is present on all suspensions.

1.2.9 Articulated steering

Articulated steering is a system by which a four-wheel drive vehicle is split into front and rear halves which are connected by a vertical hinge. The front and rear halves are connected with one or more hydraulic cylinders that change the angle between the halves including the front and rear axles and wheels, thus steering the vehicle. This system does not use steering arms, kingpins, tie rods, etc. as does four-wheel steering. If the vertical hinge is placed equidistant between the two axles, it also eliminates the need for a central differential, as both front and rear axles will follow the same path, and thus rotate at the same speed.

1.2.10 Rear wheel steering

A few types of vehicle use only rear wheel steering, notably fork lift trucks, camera dollies, early pay loaders, Buckminster Fuller's Dymaxion car, and the Thrust SSC. Rear wheel steering tends to be unstable because in turns the steering geometry changes hence decreasing the turn radius (over steer), rather than increase it (under steer). A rear wheel steered automobile exhibits non-minimum phase behavior. It turns in the direction opposite of how it is initially steered. A rapid steering input will cause two accelerations, first in the direction that the wheel is steered, and then in the opposite direction: a "reverse response." This makes it harder to steer a rear wheel steered vehicle at high speed than a front wheel steered vehicle.

1.2.11 Watercraft steering

Ships and boats are usually steered with a rudder. Depending on the size of the vessel, rudders can be manually actuated, or operated using a servomechanism, or a trim tab/servo tab system. Boats using outboard motors steer by rotating the entire drive unit. Boats with inboard motors sometimes steer by rotating the propeller pod only (i.e. Volvo Penta IPS drive). Modern ships with diesel-electric drive use azimuth thrusters. Boats driven by oars (i.e. rowing boats, including gondolas) or paddles (i.e. canoes, kayaks, rafts) are steered by generating a higher propulsion force on the side of the boat opposite of the direction of turn. Jet skis are steered by weight-shift induced roll and water jet thrust vectoring. Water skis and surfboards are steered by weight-shift induced roll only.

1.3 Steering System Designs:

1.3.1Pitman arm type

There really are only two basic categories of steering system today; those that have pitman arms with a steering 'box' and those that don't. Older cars and some current trucks use pitman arms, so for the sake of completeness, I've documented some common types. Newer cars and unibody light-duty trucks typically all use some derivative of rack and pinion steering(Refer fig 8). Pitman arm mechanisms have a steering 'box' where the shaft from the steering wheel comes in and a lever arm comes out - the pitman arm. This pitman arm is linked to the track rod or centre link, which is supported by idler arms. The tie rods connect to the track rod. There are a large number of variations of the actual mechanical linkage from direct-link where the pitman arm is connected directly to the track rod, to compound linkages where it is connected to one end of the steering system or the track rod via other rods. The example here shows a compound link (left). Most of the steering box mechanisms that drive the pitman arm have a 'dead spot' in the centre of the steering where you can turn the steering wheel a slight amount before the front wheels start to turn. This slack can normally be adjusted with a screw mechanism but it can't ever be eliminated. The traditional advantage of these systems is that they give bigger mechanical advantage and thus work well on heavier vehicles. With the advent of power steering, that has become a moot point and the steering system design is now more to do with mechanical design, price and weight. The following are the four basic types of steering box used in pitman arm systems.

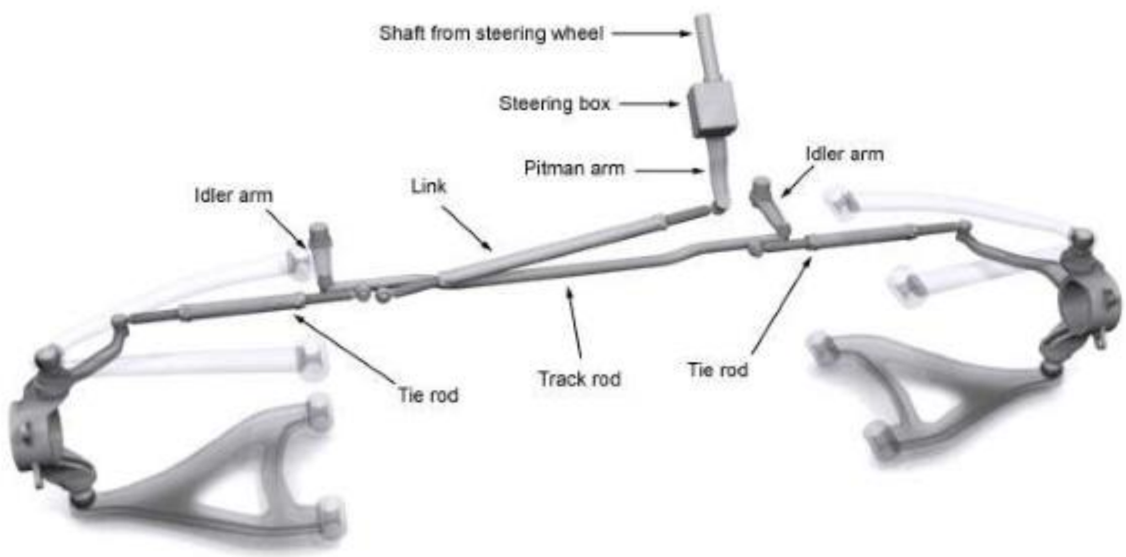

Fig.8 Pitman Arm Types Steering System

1.3.1 Worm and sector

In this type of steering box, the end of the shaft from the steering wheel has a worm gear attached to it. It meshes directly with a sector gear (so called because it's a section of a full gear wheel). When the steering wheel is turned, the shaft turns the worm gear, and the sector gear pivots around its axis as its teeth are moved along the worm gear. The 1sector gear is mounted on the cross shaft which passes through the steering box and out the bottom where it is splined, and the the pitman arm is attached to the splines. When the sector gear turns, it turns the cross shaft, which turns the pitman arm, giving the output motion that is fed into the mechanical linkage on the track rod.(Refer fig 9).The box itself is sealed and filled with grease.

Fig.9 Worm And Sector

1.3.2 Worm and roller

Fig.10. Worm And Roller

The worm and roller steering box is similar in design to the worm and sector box. The difference here is that instead of having a sector gear that meshes with the worm gear, there is a roller instead. The roller is mounted on a roller bearing shaft and is held captive on the end of the cross shaft. As the worm gear turns, the roller is forced to move along it but because it is held captive on the cross shaft, it twists the cross shaft. (Refer fig 10) Typically in these designs, the worm gear is actually an hourglass shape so that it is wider at the ends. Without the hourglass shape, the roller might disengage from it at the extents of its travel.

1.3.3 Worm and nut or recirculating ball

This is by far the most common type of steering box for pitman arm systems. In a recirculating ball steering box, the worm drive has many more turns on it with a finer pitch. A box or nut is clamped over the worm drive that contains dozens of ball bearings. These loop around the worm drive and then out into a recirculating channel within the nut where they are fed back into the worm drive again hence recirculating. (Refer fig 11) As the steering wheel is turned, the worm drive turns and forces the ball bearings to press against the channel inside the nut. This forces the nut to move along the worm drive. The nut itself has a couple of gear teeth cast into the outside of it and these mesh with the teeth on a sector gear which is attached to the cross shaft just like in the worm and sector mechanism. This system has much less free play or slack in it than the other designs, hence why it's used the most. The example below shows a recirculating ball mechanism with the nut shown in cutaway so you can see the ball bearings and the recirculation channel.

Fig 11. Recirculating Ball

1.3.4 Cam and lever

Cam and lever steering boxes are very similar to worm and sector steering boxes. The worm drive is known as a cam and has a much shallower pitch and the sector gear is replaced with two studs that sit in the cam channels(Refer fig 12). As the worm gear is turned, the studs slide along the cam channels which forces the cross shaft to rotate, turning the pitman arm. One of the design features of this style is that it turns the cross shaft 90° to the normal so it exits through the side of the steering box instead of the bottom. This can result in a very compact design when necessary.

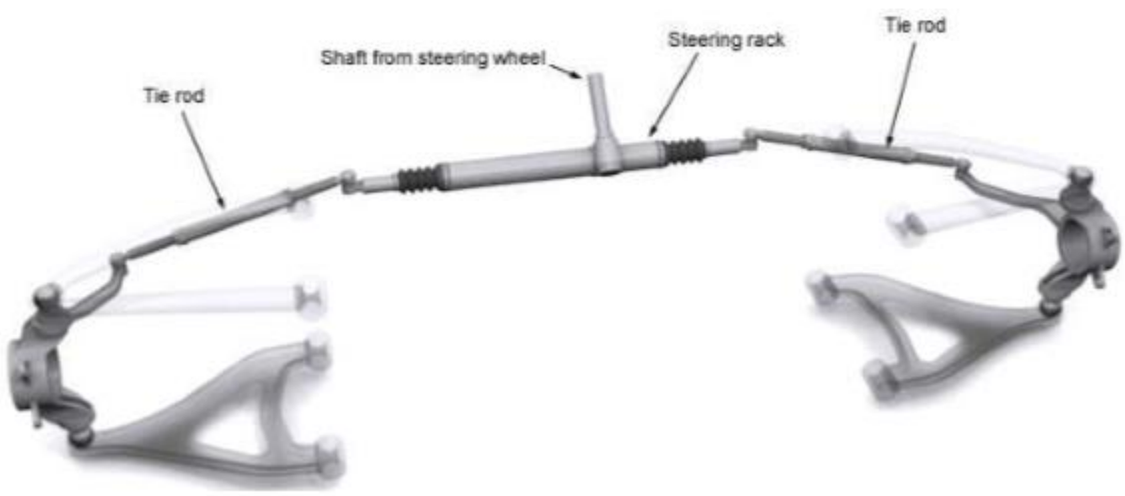

Fig.12.Cam, Lever and Steering Components

CHAPTER 2

LITERATURE SURVEY:-

Vishal N. Sulakhe, Mayur A. Ghodeswar, Meghsham D. Gite (2013), ELECTRIC POWER ASSISTED STEERING (EPAS) is a new power steering technology that will define the future of vehicle steering.It is the function of the steering wheel torque and vehicle velocity.It is set by control software, which is one of the key issues of EPAS. The straight-line type assist characteristic has been used in some current EPAS products, but its influence on the steering maneuverability and road feel hasn't been explicitly studied in theory. In this paper, the straight-line type assist characteristic is analyzed theoretically. then a whole vehicle dynamic model used to study the straight-line type assist characteristic is built with car and validated with driver control files mode of car based on the whole vehicle dynamic model, the straight-line type assist characteristic's influence on the steering maneuverability and road feel is investigated. based on the driver's request for the ideal relationship between steering wheel torque and vehicle velocity, the vehicle speed proportional coefficient of the assist characteristic can be determined by making steering wheel torque at different vehicle lateral acceleration agree with the request of the driver at a certain velocity.

The target of this paper is analyzing the influence of the straight-line type assist characteristic on the steering maneuverability and road feel, and studying how to apply simulation method to determine the straight-line type assist characteristic of EPAS, which will direct and benefit the adjustment of the assist characteristic during the road test. Design options are one of the biggest advantages to the electric power steering. With no pump, mounting bracket, hose or pulley or belt, a lot of under-hood space is liberated for other uses, especially when the servo motor is mounted on the column inside the car. The steering control unit needs a lot of information to get the boost level and timing just right. Along with vehicle speed and charging system output level, most of the other data is already available from several onboard-computers. The control unit can be, mounted anywhere on the vehicle, and it can vary the boost level infinitely over a wider range of conditions. Boost level can even become a driver-adjustable feature, and of course boost is available even when engine isn’t running. The electronic principle is simple, but it relies on to features developed just for this application. First is the very advanced algorithm in the computer program that calculates steering wheel position and torque, essentially giving the machine the ability to interpret the human driver’s intensions? After that, the control unit simply chooses and appropriate output from a look-up table, similar to the way engine computers control ignition timing. Electric power steering technology most likely will start from the bottom a move up to the larger, more expensive cars. Two basic reasons are cited for this. First, larger, heavier cars require more power to turn the steering wheel, and more expensive rackmounted-motor design are more suitable for the smaller application. Second, according to an SAE paper written by Dominique Peter and Ruck Gerhard of ZF Len system (Steering system) in Germany, the present generation of electric steering boost can’t deliver the feel and handling that sriver’s expect in larger, heavier cars, which in their country mean expensive cars.

A good answer to both these problem lies in another “new” technology that Delphi and others say is just around the corner: the electrical system. Regardless of how an electric steering is configured, current draw would be very high, more than most of today’s electrical systems can provide for any length of time.

V. Ciarla, C. Canudas de Wit, F. Quaine, V. Cahouet, Exogenous input estimation in Electronic Power Steering (EPS) systems ANR 09 VTT VOLHAND Doc B(2011), their re-search team in Gipsa-Lab was involved into the task for the design which presented simulation results of a satisfactory estimator of the exogenous torques acting on the EPS system. The typical architecture of an Electric Power Assistance Steering (EPAS) system includes a static map to provide the correct amplification to the driver’s exerted torque. In literature, it is generally known as booster curve. This document concerns a preliminary study of the current methods diffused in literature to provide this amplification and is based on the results published. The basic concepts of the Electric Power Steering (EPS) systems with a realistic model for the friction contact, that acts on the wheels are discussed. A relation between the assistance and the driver’s torque is provided, under the hypothesis of a position-oriented control of the movement and the Stevens’ power law. Finally, the simulation results proposed at the end of this paper validate the shape of the booster curves and are in accord with the initial hypothesis. To attempt to this job, the following steps have been done: The study of a mechanical model of the Electronic Power Steering (EPS) system and design of an LQR regulator to reject the typical oscillations, due to the torsion of the steering wheel, the design of an estimation of the full setof state variables as well as of the exogenous torques is carried out, modelling of the tyre/road contact friction, in order to test the mathematical model uder the most realistic conditions, study of the amplification curves, in order to provide the correct steering assistance to the driver.

Bhushan Akhare, Sanjeev S Chouhan (2012), Analysis of Power Steering System Assembly. The advancement in the technology will required more advance analysis for optimized results and accuracy. There are lot of researches have been done in the field of automobile industries related to the power steering. The power steering system with electric motor powered by battery in the advance cars provides lots of safety as well as accurate control to the user of the car and reduce the human effort up to 80 percent and also reduce the use of power so that the power reduction can be achieve and the system will not uses lot amount of fuel as well as battery power. Here in this research paper we are trying to understand the value generated by power steering sensor using a comparative study which may be use in field of automobile to reduce the error and increase the accuracy of power steering system and to get and optimized output from the system. As we studied and analyze that the power steering system in the advance cars provides lots of safety as well as accurate control to the user of the car and reduce the human effort up to 80 percent and also reduce the use of power so that the power reduction can be achieve and the system will not uses lot amount of fuel as well as battery power. Here in this paper we also see that by using these advance car system we can provide effortless and precise as well as comfort driving to the user so that the user can drive his vehicle for long time without any frazzled. There are lots of research is possible in the field of power steering system so that it can also be drive using the AI (artificial intelligent) technique so the power steering can also be drive directly using brain signals. The power steering system mostly work within the advance car some construction vehicles have a two part frame with a rugged hinge in the middle, this will allow front and rear axles to become non parallel to steer the vehicle. The input from the steering shaft forms the inner part of a spool-valve assembly. It also connects to the top end of the torsion bar. The bottom of the torsion bar connects to the outer part of the spool valve. The torsion bar also turns the output of the steering gear, connecting to either the pinion gear or the worm gear depending on which type of steering the car has.

Lokesh Kumar Chaudhary, Abhijeet Kumbhar REVIEW ON VEHICLE STEER-BY-WIRE TECHNOLOGY (2015)There is much advancement in steering control technology with time. Steering –by-wire (SBW) system is the most modern and efficient technique, the steer-by-wire is replacing the traditional steering device of the vehicle in which the conventional steering system is replaced by electronic system. This paper focus to introduce steer-by-wire technology and methodology and angle sensor is preferred to have the good accuracy.

In the steer-by-wire technology system the mechanical link between steering and wheel is replaced by electronic link.The steering angle sensor is connected to a steering wheel and steering angle sensor also connected to feedback motor, angle sensor measure the angle of rotation of steering system, the angle sensor is a gadget that detects the orientation of the object is pointing in a certain direction and angle range. The steering angle sensor measuring the steering wheel position angle rate of turn, there two types of angle sensor- Analog steering angle sensor and digital angle sensor. It can be categorized as Contact type and non-contact type, the best category is non-contact because there are no mechanical connection between steering shaft and sensor therefore no mechanical loss.

Finally steer-by-wire technology is better than conventional system with respect to their advantage over conventional system. By using the steer-by-wire technology the performance of steering system can be increase and fixed the steering ratio according to the requirement. In this technology replace the mechanical link of steering system by electric connections, therefore it have many advantage over conventional steering system like fuel free, environment friendly, less space required, the position of steering system varying according to requirement, improve the handling at low speed . . Conventional steering systems in automobiles use various forms of mechanical and hydraulic connections between the steering wheel and the steering valve, with the steering wheel rotation amplified by the steering valve to obtain a proportional articulation angle at the front wheels, therefore loss is more but in steer-by-wire technology no physical contact between steering and wheel.

The steer by wire system is getting popular because of its efficient and accurate operations the efficient and accurate operation because it is control by automatically compare mechanical system.

Manish Kumar Mishra1 ,Arjun Maurya2 , Rajiv Ranjan Dev3 (2016) It provided arrangement for converting a conventional manual steering system of an on-road vehicle to automatic steering system utilizable electric microcontroller and ultrasonic sensor. A DC motor is direct connected to rack and pinion drive to a drive mounted on the steering shaft. In this paper we work on the pre notification which helps in the reduction of the extreme impacts of the vehicle collision. This pre notification is calculated in concern with both the distinct on the steering as well as the vehicle. This paper can play an important role in the advancement of the intelligent system of the chore automotive. In this paper, we propose a safety only in terms on the road. The DC motor is connected to a electrical control unit (ECU) and moves with the steering shaft in both a manual steering mode and an automatic steering mode. An encoder provides a signal to a electrical control unit (ECU) that changes operation to the manual mode if the number of steps reported by the encoder is different than What is expected. An assembly including alternate steering Wheel, shaft pulley, adapter fit and DC motor is easily connected to the steering column. This type of design structure work both on manually and automatic.

The arrangement for converting a conventional manual steering system of an on-road vehicle to automatic steering system utilizable electric microcontroller and ultrasonic sensor. A DC motor is direct connected to rack and pinion drive to a drive mounted on the steering shaft. In this paper we work on the pre notification which helps in the reduction of the extreme impacts of the vehicle collision. This pre notification is calculated in concern with both the distinct on the steering as well as the vehicle. This paper can play an important role in the advancement of the intelligent system of the chore automotive. In this paper, we propose a safety only in terms on the road. The DC motor is connected to a electrical control unit (ECU) and moves with the steering shaft in both a manual steering mode and an automatic steering mode. An encoder provides a signal to a electrical control unit (ECU) that changes operation to the manual mode if the number of steps reported by the encoder is different than What is expected. An assembly including alternate steering Wheel, shaft pulley, adapter fit and DC motor is easily connected to the steering column. This type of design structure work both on manually and automatic. In view of such problems of the previous mastership, a primary object of the present invention is to provide an automatic power Steering system which allows an automatic steering system and a power steering system to share various components so as to simplify the structure. A second object of the present inventions to provide an automatic power steering system which allows a smooth transition from one of the operation modes to the other without involving any absence of control. According to the present invention, these and other objects can be accomplished by providing a steering control system for a vehicle comprising a steering mechanism.

CHAPTER 3

1.3 Problem Statement:-

Hydraulic Power Steering System is complicated, weighs more as compared with Electric Power Steering. Hydraulic power steering system uses hydraulic fluids for operation whereas there is no such fluid needed for Electric Power Steering, thus Electric Power Steering needs less maintenance compared to hydraulic power steering and also extracts power from engine, so it reduces the fuel mileage of the engine on other side electric power steering consumes power from battery which is also charged by engine, but it consumes less power compared to Hydraulic Power Steering.

1.4 Objective:-

- To achieve reliable and accurate operation.
- To achieve more mileage.
- To reduce human effort and cost.
- To reduce hydraulic losses and obtain simpler system in design.
- To avoid automobile accidents due to under or over steering.
- To make steering system compatible with future automobiles.

CHAPTER 4

VEHICLE STEERING SYSTEM PROPERTIES

4.1 Steering Ratios

Every vehicle has a steering ratio inherent in the design. If it didn't you'd never be able to turn the wheels. Steering ratio gives mechanical advantage to the driver, allowing you to turn the tyres with the weight of the whole car sitting on them, but more importantly, it means you don't have to turn the steering wheel a ridiculous number of times to get the wheels to move. Steering ratio is the ratio of the number of degrees turned at the steering wheel vs. the number of degrees the front wheels are deflected. So for example, if you turn the steering wheel 20° and the front wheels only turn 1°, that gives a steering ratio of 20:1. For most modern cars, the steering ratio is between 12:1 and 20:1. This coupled with the maximum angle of deflection of the wheels gives the lock-to-lock turns for the steering wheel. For example, if a car has a steering ratio of 18:1 and the front wheels have a maximum deflection of 25°, then at 25°, the steering wheel has turned 25°x18, which is 450°. That's only to one side, so the entire steering goes from -25° to plus 25° giving a lock-to-lock angle at the steering wheel of 900°, or 2.5 turns (900° / 360). This works the other way around too of course. For example if a car is advertised as having a 16:1 steering ratio and 3 turns lock-to-lock, then the steering wheel can turn 1.5x360° (540°) each way. At a ratio of 16:1 that means the front wheels deflect by 33.75° each way. For racing cars, the steering ratio is normally much smaller than for passenger cars i.e. Closer to 1:1 - as the racing drivers need to get fuller deflection into the steering as quickly as possible.

4.2 Turning circles

The turning circle of a car is the diameter of the circle described by the outside wheels when turning on full lock. There is no hard and fast forumla to calculate the turning circle but you can get close by using this:

Turning circle radius = (track/2) + (wheelbase/sin(average steer angle)

The wheelbase and track aren't radically different to any other car, but the average steering angle is huge.For comparison,a typical passenger car turning circle is normally between 11m and 13m with SUV turning circles going out as much as 15m to 17m.

4.3 Vehicle dynamics and steering

Generally speaking, when you turn the steering wheel in your car, you typically expect it to go where you're pointing it. At slow speed, this will almost always be the case but once you get some momentum behind you, you are at the mercy of the chassis and suspension designers. In racing, the aerodynamic wings, air splitters and under trays help to maintain an even balance of the vehicle in corners along with the position of the weight in the vehicle and the suspension setup.

4.4 Under steering

Understeer is so called because the car steers less than you want it to. Understeer can be brought on by all manner of chassis, suspension and speed issues but essentially it means that the car is losing grip on the front wheels. Typically it happens as you brake and the weight is transferred to the front of the car. At this point the mechanical grip of the front tyres can simply be overpowered and they start to lose grip for example on a wet o greasy road surface (Refer fig 13). The end result is that the car will start to take the corner very wide. In racing, that normally involves going off the outside of the corne into a catch area or on to the grass. In normal you-and-me driving, it means crashing at the outside of the corner. Getting out of understeer can involve letting off the throttle in

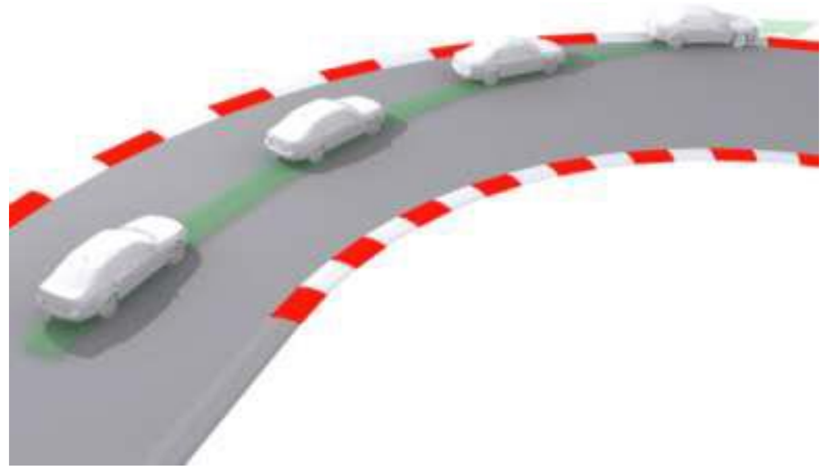

Fig.13 Under steering Of Vehicle

front-wheel-drive vehicles to try to give the tyres chance to grip or getting on the throttle in rear- wheel- drive vehicles to try to bring the back end around . It's a complex topic more suited to racing driving forums but suffice to say that if you're trying to get out of understeer.

4.5 Over steering

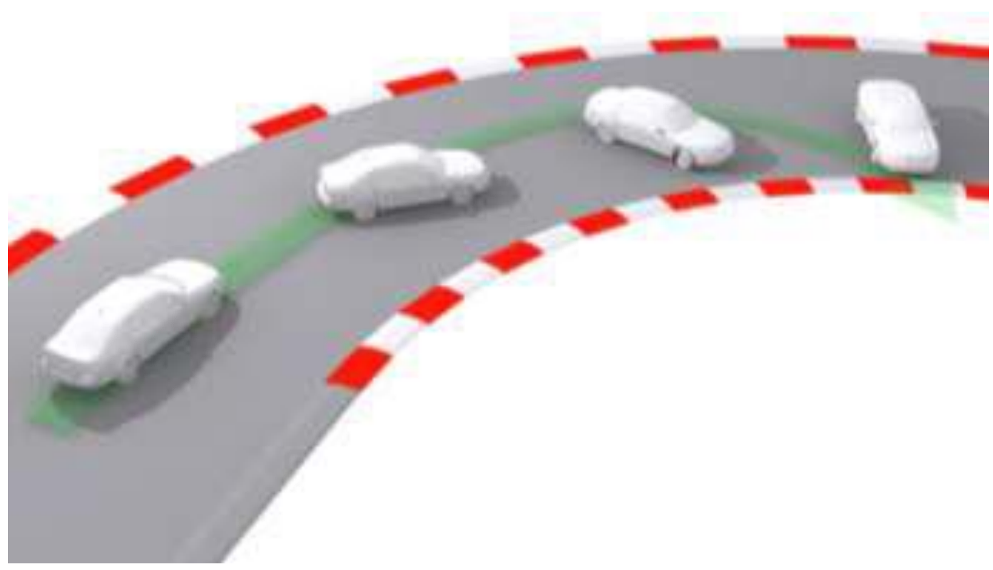

Fig 14 Oversteering Of Vehicle

The bright ones amongst you will probably already have guessed that over steer is the opposite of understeer. With oversteer, the car goes where it's pointed far too efficiently and you end up diving into the corner much more quickly than you had expected. Oversteer is brought on by the car losing grip on the rear wheels as the weight is transferred off them under braking, resulting in the rear kicking out in the corner. Without counter-steering (see below) (Refer fig 14) the end result in racing is that the car will spin and end up going off the inside of the corner backwards. In normal driving, it means spinning the car and ending up pointing back the way you came.

4.6 Counter-steering

Counter-steering is what you need to do when you start to experience oversteer. If you get into a situation where the back end of the car loses grip and starts to swing out, steering opposite to the direction of the corner can often 'catch' the oversteer by directing the nose of the car out of the corner. In drift racing and demonstration driving, it's how the drivers are able to smoke the rear tyres and power-slide around a corner. They will use a combination of throttle, weight transfer and handbrake to induce oversteer into a corner, then flick the steering the opposite dirction, honk on the accelerator and try to hold a slide all the way around the corner. (Refer fig 15) It's also a widely-used technique in rally racing.

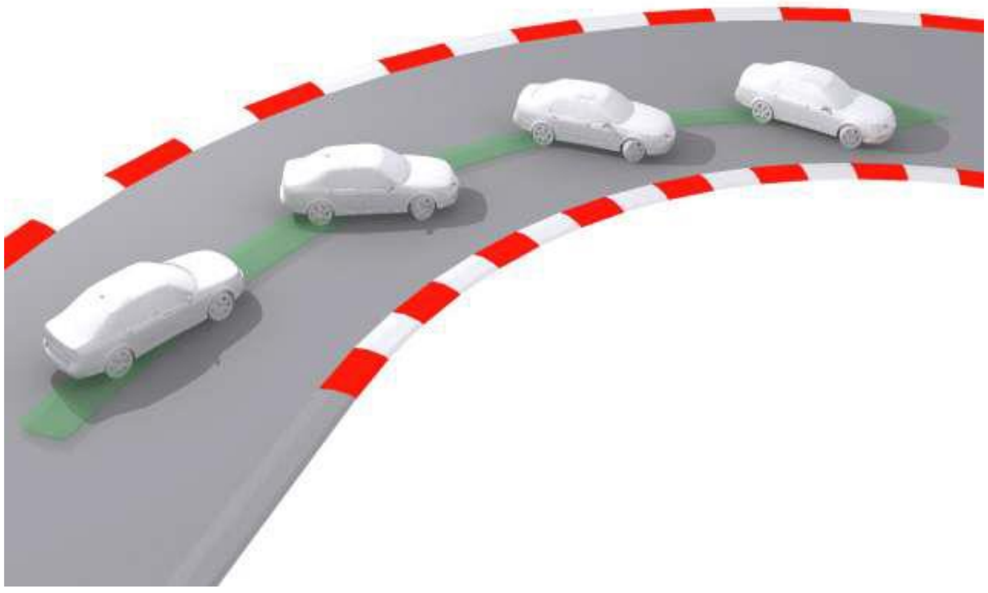

Fig.15 Counter Steering Of Vehicle

CHAPTER 5

5.1 COMPONENTS SPECIFICATION

1 D.C Motor 12 V,7.5 amp,60-100 rpm

2 Battary 12 V,7.5 amp,Lead Acid Battary

3 Limit Switch Physical Contact Type

5.1 Rack and Pinion Steering Mechanism

This is by far the most common type of steering you'll find in any car today due to it's relative simplicity and low cost. Rack and pinion systems give a much better feel for the driver, and there isn't the slop or slack associated with steering box pitman arm type systems. The downside is that unlike those systems, rack and pinion designs have no adjustability in them, so once they wear beyond a certain mechanical tolerance, they need replacing completely. This is rare though. In a rack and pinion system, the track rod is replaced with the steering rack which is a long, toothed bar with the tie rods attached to each end. On the end of the steering shaft there is a simple pinion gear that meshes with the rack. When you turn the steering wheel, the pinion gear turns, and moves the rack from left to right (Refer fig 16). Changing the size of the pinion gear alters the steering ratio. It really is that simple. The diagrams here show an example rack and pinion system (left) as well as a close-up cutaway of the steering rack itself (right).

Fig.16 Rack And Pinion Steering Mechanism

This is a simple variation on the above design. All the components are the same, and it all works the same except that the spacing of the teeth on the rack varies depending on how close to the centre of the rack they are. In the middle, the teeth are spaced close together to give slight steering for the first part of the turn - good for not oversteering at speed. As the teeth get further away from the centre, they increase in spacing slightly so that the wheels turn more for the same turn of the steering wheel towards full lock.

5.2. D.C motor

D. C. motors are seldom used in ordinary applications because all electric supply companies furnish alternating current However, for special applications such as in steel mills, mines and electric trains, it is advantageous to convert alternating current int direct current in order to use d.c. motors. The reason is that speed/torque characteristics of D.C. motors are much more superior to that of A.C motors. Therefore, it is not surprising to note that for industrial drives, D.C. motors are as popular as 3-phase induction motors. Like D.C. generators, D.C. motors are also of three type’s viz., serieswound, shunt-wound and compound wound. The use of a particular motor depends upon the mechanical load it has to drive.

D.C. Motor Principle

A machine that converts D.C. power into mechanical power is known as a D.C. motor. Its operation is based on the principle that when a current carrying conductor is placed in a magnetic field, the conductor experiences a mechanical force. The direction of this force is given by Fleming’s left hand rule and magnitude is given by;

$F = B I l$ Newton

Basically, there is no constructional difference between a D.C. motor and a D.C. generator. The same D.C. machine can be run as a generator or motor.

Working of D.C. Motor

Electrically powered steering uses an electric motor to drive either the power steering hydraulic pump or the steering linkage directly. The power steering function is therefore independent of engine speed, resulting in significant energy savings. A "steering sensor" is located on the input shaft where it enters the gearbox housing. The steering sensor is actually two sensors in one: a "torque sensor" that converts steering torque input and its direction into voltage signals, and a "rotation sensor" that converts the rotation speed and direction into voltage signals. An "interface" circuit that shares the same housing converts the signals from the torque sensor and rotation analysis sensor into signals the control electronics can process. Inputs from the steering sensor are digested by a microprocessor control unit that also monitors input from the vehicle's speed sensor. The sensor inputs are then compared to determine how much power assist is required according to a preprogrammed "force map" in the control unit's memory. The control unit then sends out the appropriate command to the "power unit" which then supplies the electric motor with current. The motor pushes the rack to the right or left depending on which way the voltage flows. Increasing the current to the motor increases the amount of power assist.

Consider a part of a multi polar D.C. motor as shown in Fig. (5.2). When the terminals of the motor are connected to an external source of D.C. supply:

- The field magnets are excited developing alternate N and S poles;
- The armature conductors carry ^currents. All conductors under N-pole carry currents in one direction while all the conductors under S-pole carry currents in the opposite direction.

Suppose the conductors under N-pole carry currents into the plane of the paper and those under S-pole carry currents out of the plane of the paper as shown in Fig. (5.2). Since each armature conductor is carrying current and is placed in the magnetic field, mechanical force acts on it. (Refer fig 5.2) and applying Fleming’s left hand rule, it is clear that force on each conductor is tending to rotate the armature in anticlockwise direction. All these forces add together to produce a driving torque which sets the armature rotating. When the conductor moves from one side of a brush to the other, the current in that conductor is reversed and at the same time it comes under the influence of next pole which is of opposite polarity. Consequently, the direction of force on the conductor remains the same.

4.3 Limit Switches

Function of limit switch:

- Limit switches provide the function of making and breaking electrical contacts and consequently electrical circuits.
- A limit switch is configured to detect when a system's element has moved to a certain position. A system operation is triggered when a limit switch is tripped.

Limit switches are widely used in various industrial applications, and they can detect a limit of movement of an article and passage of an article by displacement of an actuating part such as a pivotally supported arm or a linear plunger. The limit switches are designed to control the movement of a mechanical part. Limit switches are typically utilized in industrial control applications to automatically monitor and indicate whether the travel limits of a particular device have been exceeded. Limit switches are used in a variety of applications and environments because of their ruggedness, simple visible operation, ease of installation and reliability of operation.

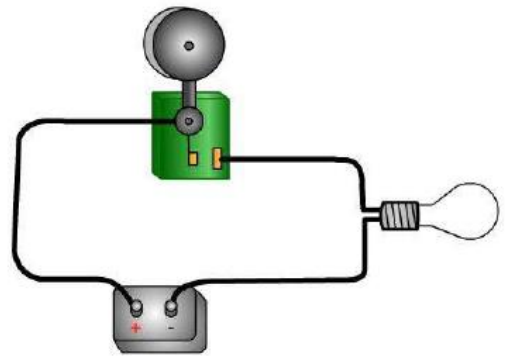

Fig 17.Limit switch

Switches

4 & 6 pole Switches are commonly used as a disconnecting means for two-speed, two winding motors. Fused switches provide both over current and short circuit protection.

Non-fusible switches normally provide a local disconnection means for two speed motors which are remote from their motor controller. 4 pole switches are also used in 3-phase, 4- wire circuits when a switching neutral is required. All 4 & 6 pole switches are service entrance rated.

4.4 Battery

These batteries have a pressure relief valve which will activate when the battery is recharged at high voltage, typically greater than 2.30 volts per cell. Valve activation allows some of the gas or electrolyte to escape, thus decreasing the overall capacity of the battery. Rectangular cells may have valves set to operate as low as 1 or 2 psi; round spiral cells, with metal external containers, can have valves set as high as 40 psi. The cell covers typically have gas diffusers built into them that allow safe dispersal of any excess hydrogen that may be formed during overcharge. They are not permanently sealed, but are maintenance free. They can be oriented in any manner, unlike normal lead–acid batteries, which must be kept upright to avoid acid spills and to keep the plates' orientation vertical. Cells may be operated with the plates horizontal (pancake style), which may improve cycle life. VRLA (valve-regulated lead–acid battery) cells may be made of flat plates similar to a conventional flooded lead–acid battery, or may be made in a spiral roll form to make cylindrical cells. At high overcharge currents, electrolysis of water occurs, expelling hydrogen and oxygen gas through the battery's valves. Care must be taken to prevent short circuits and rapid charging. Constant-voltage charging is the usual, most efficient and fastest charging method for VRLA (valve-regulated lead–acid battery) batteries, although other methods can be used. VRLA (valve-regulated lead–acid battery) batteries may be continually "float" charged at around 2.35 volts per cell at 25 °C. Some designs can be fast charged (1 hour) at high rates. Sustained charging at 2.7 V per cell will damage the cells Constant-current overcharging at high rates (rates faster than restoring the rated capacity in three hours) will exceed the capacity of the cell to recombine hydrogen and oxygen.

CHAPTER 6

6. CONSTRUCTION & WORKING ELECTRICAL STEERING MECHANISM

Working Electrical Steering Mechanism

As for Indian road transport scenario is concerned, accidents are becoming a day to day cause an attempt has been made in this project to reduce such mishaps. In our project of **"ELECTRICAL STEERING CONTROL MECHANISM"** having the following Operation occurs automatically in the vehicle. They are,

- D.C motor turns the wheel left side, when the steering rotates in the left side direction.
- D.C motor turns the wheel right side, when the steering rotates in the right side direction

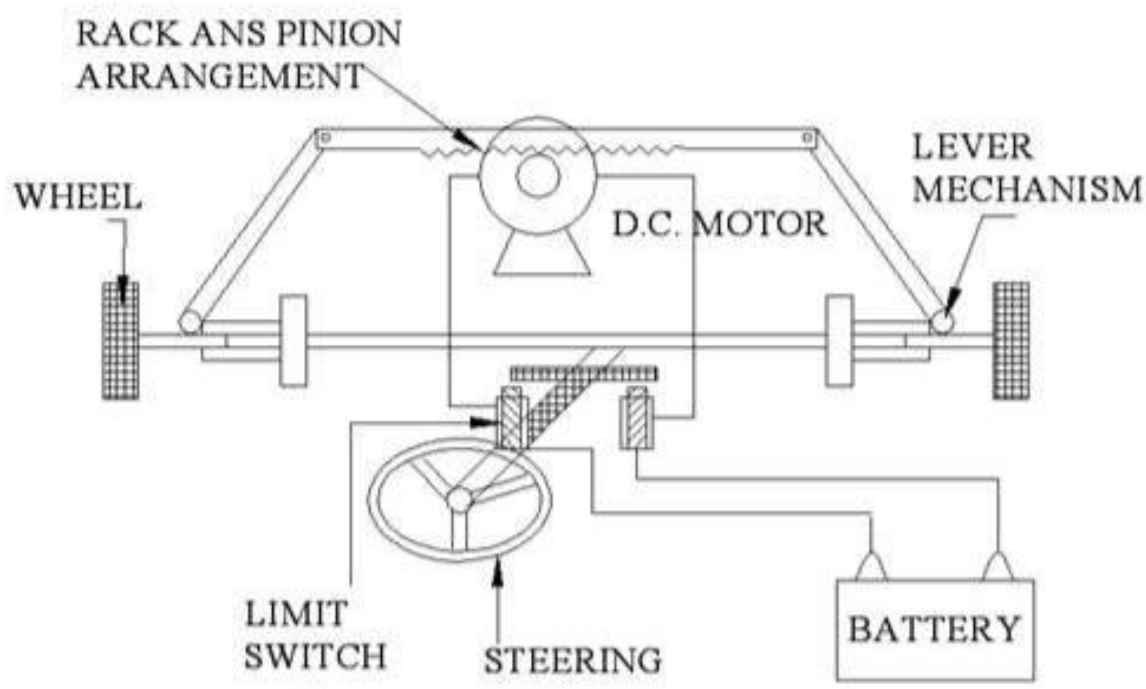

Fig 18 Electrical Steering System In Automobile

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6.1 Working Principle

In our project lead-acid 12 Volt batteries is used. The lead-acid batteries output is given to the limit switch. There are two Limit switches are used in this project. These switch outputs are connected to the steering D.C motor in Forward and reverse rotation of operation. The rack and pinion arrangement is used to turn the wheel in left and right direction. The rack is connected to the wheel with the help of liver mechanism and the pinion is coupled to the permanent magnet D.C motor shaft.The Motor is drawn supply from the battery through limit switch arrangement. When the steering is turn in the left direction, it pushes the left side limit switches, so that the D.C motor rotate in forward direction to move the wheel in left side. Similarly When the steering is turn in the right direction, it pushes the right side limit switches, so that the D.C motor rotate in reverse direction to move the wheel in right side.

6.2 DESIGN CALCULATIONS:

Numerical calculation

For an iron-less core, dc motor of relatively small size, the relationships that govern the behavior of the motor in various circumstances can be derived from physical laws and characteristics of the motors themselves. Kirchoff's voltage rule states, "the sum of the potential increases in a circuit loop must equal the sum of the potential decreases." When applied to a dc motor connected in series with a dc power source, kirchoff's voltage rule can be expressed as "the nominal supply voltage from the power source must be equal in magnitude to the sum of the voltage drop across the resistance of the armature windings and the back emf generated by the motor.-

$$Vo=(I * R)+Ve$$

Where:

Vo = power supply (volts)

I = current (a)

R = terminal resistance (ohms)

Ve = back emf (volts)

The back emf generated by the motor is directly proportional to the angular velocity of the motor. The proportionality constant is the back emf constant of the motor.

$$Ve= w* k_e$$

Where: w= angular velocity of the motor

k_e= back emf constant of the motor

Therefore, by substitution:

$$Vo=(I * R)+(w* k_e)$$

The back emf constant of the motor is usually specified by the motor manufacturer in volts/rpm or mv/rpm. In order to arrive at a meaningful value for the back emf, it is necessary to specify the motor velocity in units compatible with the specified back emf constant. The motor constant is a function of the coil design and the strength and direction of the flux lines in the air gap. Although it can be shown that the three motor constants normally specified (back emf constant, torque constant, and velocity constant) are equal if the proper units are used, calculation is facilitated by the specification of three constants in the commonly accepted units. The torque produced by the rotor is directly proportional to the current in the armature windings. The proportionality constant is the torque constant of the motor.

$$Mo=I \text{ X } k_m$$

Where:

Mo = torque developed at rotor

k_m = motor torque constant

Substituting this relationship:

$$(M\times R)/ k_m +(w \text{ X } ke)$$

The torque developed at the rotor is equal to the friction torque of the motor plus the resisting torque due to external mechanical loading:

$$M o = M l + M f$$

Where:

Mf = motor friction torque

ml = load torque

Assuming that a constant voltage is applied to the motor terminals, the motor velocity will be directly proportional to sum of the friction torque and the load torque. The constant of proportionality is the slope of the torque-speed curve and can be calculated by:

$$\Delta n / \Delta M = n_0 / M_H$$

Where:

Mh =stall torque

n0= no-load speed

An alternative approach to deriving this value is to solve for velocity, n:

$$n=(Vo/ ke)-(M/ km \times ke)$$

Differentiate both sides with respect to M

$$\Delta n / \Delta M =(-R/ km \times ke)$$

Using dimensional analysis to check units,

The result is:

-ohms/(oz-in/a) x (v/rpm)

= -ohm-a -rpm/v-oz-in

= -rpm/oz-in

It is a negative value describing loss of velocity as a function of increased torsional load.

Motor is to be operated with 12 volts applied to the motor terminals. The torque load is 20nm. Find the resulting motor speed, motor current, efficiency, and mechanical power output. From the motor data sheet, it can be seen that the no-load speed of the motor at 12 volts is 100 rpm. If the torque load is not coupled to the motor shaft, the motor would run at this speed. The motor speed under load is simply the no-load speed less the reduction in speed due to the load. The proportionality constant for the relationship between motor speed and motor torque is the slope of the torque vs. Speed curve, given by the motor no-load speed divided by the stall torque. In this example, the speed reduction caused by the 20nm torque load is:

20 x (200 /100) = 40 rpm

the motor speed under load must then be:

100 rpm - 40 rpm =60 rpm

The total motor current must be the sum of operated value and the motor no-load current. The data sheet lists the motor no-load current as 3.5 a. Therefore, the total current is:

3.5 a + 4 a = 7.5a

The mechanical power output of the motor is simply the product of the motor speed and the torque load with a correction factor for units (if required). Therefore, the mechanical power output of the motor in this application is:

Output power = 20 nm x 60 rpm x 0.048= 57.6 watts

The mechanical power input to the motor is the product of the applied voltage and the total motor current in amps. In this application:

Input power = 12 volts x 7.5 a= 90 watts

Since efficiency is simply power out divided by power in, the efficiency in this application is:

Efficiency = 57.6watts / 90 watts = 0.64 = 64%

6.3 Motor selection calculations

- Calculating mechanical power requirements
- Torque - speed curves
- Numerical calculation
- Sample calculation
- Thermal calculations

Calculating mechanical power requirements

Physically, power is defined as the rate of doing work. For linear motion, power is the product of force multiplied by the distance per unit time. In the case of rotational motion, the analogous calculation for power is the product of torque multiplied by the rotational distance per unit time.

$$P_{rot}=M * w$$

Where, P_{rot} = rotational mechanical power

M = torque

w = angular velocity

The most commonly used unit for angular velocity is rev/min (rpm). In calculating rotational power, it is necessary to convert the velocity to units of rad/sec. This is accomplished by simply multiplying the velocity in rpm by the constant

$(2 \times \pi) / 60$

$W_{(rad/sec)} = w_{rpm} \times (2 \pi / 60)$

It is important to consider the units involved when making the power calculation. A reference that provides conversion tables is very helpful for this purpose. Such a reference is used to convert the torque-speed product to units of power (watts). Conversion factors for commonly used torque and speed units are given in the following table. These factors include the conversion from rpm to rad/sec where applicable Torque units Speed units Conversion factor

Torque units	Speed Units	Conversion Factor
Oz-in	Rpm	0.00074
Oz-in	Rad/Sec	0.00071
In-lb	Rpm	0.0118
In-lb	Rad/Sec	0.1130
Ft-lb	Rpm	0.1420
Ft-lb	Rad/Sec	1.3558
N-m	Rpm	0.1047
N-m	Rad/Sec	1.0002

Table.1.Torque Speed & Conversion Factor

For example, assume that it is necessary to determine the power required to drive a torque load of 3 oz-in at a speed of 500 rpm. The product of the torque, speed, and the appropriate conversion factor from the table is:

$$3(\text{oz-in}) - 500\text{rpm} \times 0.00074 = 1.11\text{Watts}$$

Calculation of power requirements is often used as a preliminary step in motor or gearmotor selection. If the mechanical power required for a given application is known, then the maximum or continuous power ratings for various motors can be examined to determine which motors are possible candidates for use in the application.

Torque - speed curves

One commonly used method of displaying motor characteristics graphically is the use of torque - speed curves. While the use of torque - speed curves is much more common in technical literature for larger dc machines than it is for small, ironless core devices, the technique is applicable in either case. Torque - speed curves are generated by plotting motor speed, armature current, mechanical output power, and efficiency as functions of the motor torque. The following discussion will describe the construction of a set of torque - speed curves for a typical coreless dc motor from a series of raw data measurements. Motor 1624e009s is used as an example. Assume that we have a small motor that we know has a nominal voltage of 9 volts. With a few fundamental pieces of laboratory equipment, the torque - speed curves for the motor can be generated:

6.3 MEASURE BASIC PARAMETERS:

Procedure:

STEP 1:

Using a voltage supply set to 9 volts, run the motor unloaded and measure the rotational speed using a non-contacting tachometer (strobe, for instance). Measure the motor current under this no-load condition. A current probe is ideal for this measurement since it does not add resistance in series with the operating motor. Using an adjustable torque load such as a small particle brake coupled to the motor shaft, increase the torque load to the motor just to the point where stall occurs. At stall, measure the torque from the brake and the motor current. For the sake of this discussion, assume that the coupling adds no load to the motor and that the load from the brake does not include unknown frictional components. It is also useful at this point to measure the terminal resistance of the motor. Measure the resistance by contacting the mot or terminals. Then spin the motor shaft and take another measurement. The measurements should be very close in value. Continue to spin the shaft and take at least three measurements. This will ensure that the measurements were not taken at a point of minimum contact on the commutator.

Now we have measured the:

N0= no-load speed

I0= no-load current

Mh= stall torque

R= terminal resistance

STEP 2: (Plot Current Vs. Torque And Speed Vs Torque)

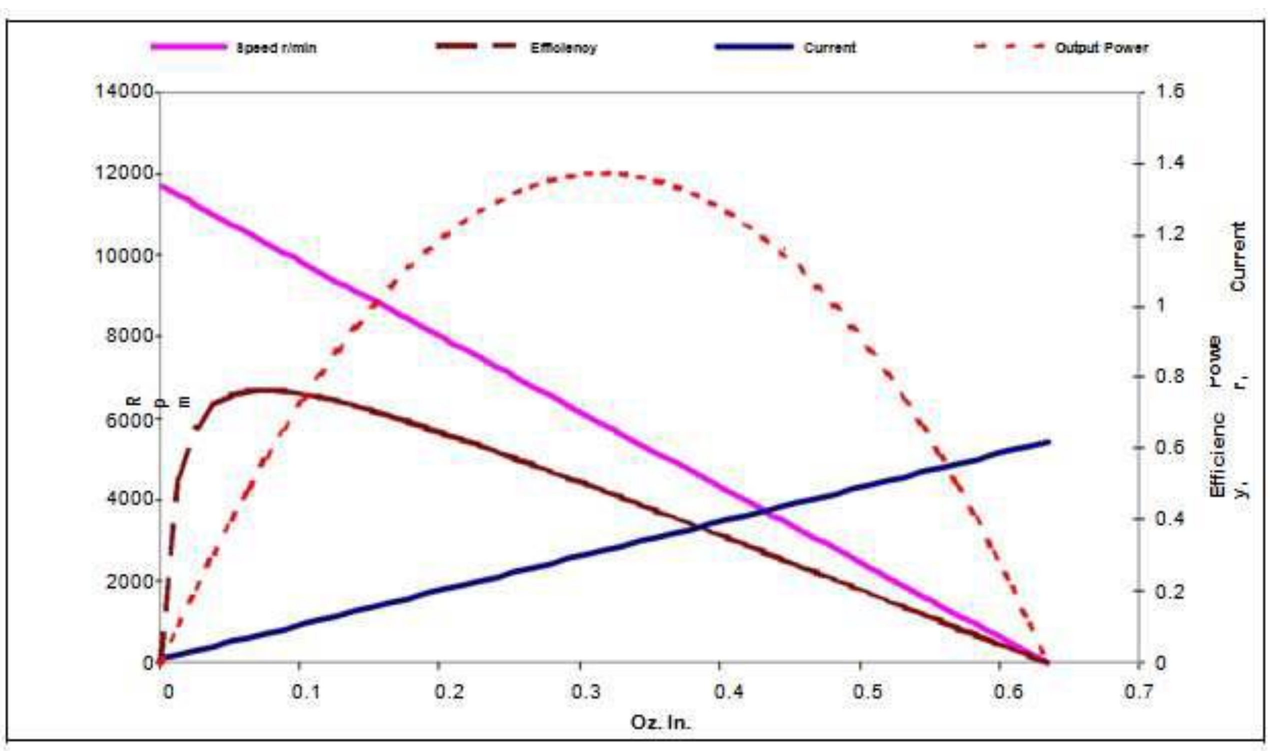
Prepare a graph with motor torque on the horizontal axis, motor speed on the left vertical axis, and motor current on the right vertical axis. Scale the axes based on the measurements in step 1. Draw a straight line from the left origin of the graph (zero torque and zero current) to the stall current on the right vertical axis (stall torque and stall current). This line represents a plot of the motor current as a function of the motor torque. The slope of this line is the proportionality constant for the relationship between motor current and motor torque (in units of current per unit torque). The reciprocal of this slope is the torque constant of the motor (in units of torque per unit current). For the resulting curves see graph 4.1 Using the relationships between motor constants discussed earlier calculate the velocity constant of the motor from the torque constant obtained above. By multiplying the velocity constant by the nominal motor voltage, obtain the theoretical no-load speed of the motor (zero torque and no-load speed) and plot it on the left vertical axis. Draw a straight line between this point and the stall torque and zero speed point on the graph. The slope of this line is the proportionality constant for the relationship between motor speed and motor torque (in units of speed per unit torque). The slope of the line is negative, indicating that motor speed decreases with increasing torque. This value is sometimes called the regulation constant of the motor. For the resulting curves see graph For the purpose of this discussion, it will be assumed that the motor has no internal friction. In practice, the motor friction torque is determined using the torque constant of the motor and the measured no-load current. The torque vs speed line and the torque vs current line are then started not at the left vertical axis but at an offset on the horizontal axis equal to the calculated friction torque.

STEP 3 (Plot Power Vs Torque And Efficiency Vs Torque)

In most cases, two additional vertical axes are added for plotting power and efficiency as functions of torque. A second left vertical axis is usually used for efficiency and a second right vertical axis is used for power. For the sake of simplifying this discussion, efficiency vs. Torque and power vs. Torque will be plotted on a second graph separate from the speed vs. Torque and current vs. Torque plots. Construct a table of the motor mechanical power at various points from no-load to stall torque. Since mechanical power output is simply the product of torque and speed with a correction factor for units (see section on calculating mechanical power requirements), power can be calculated using the previously plotted line for speed vs. Torque. A sample table of calculations for motor is shown in table 1. Each calculated point is then plotted. The resulting curve is a parabolic curve as shown in graph 1. The maximum mechanical power occurs at approximately one-half of the stall torque. The speed at this point is approximately one-half of the no-load speed. Construct a table of the motor efficiency at various points from no-load to stall torque. The voltage applied to the motor is given, and the current at various levels of torque has been plotted. The product of the motor current and the applied voltage is the power input to the motor. At each point selected for calculation, the efficiency of the motor is the mechanical power output divided by the electrical power input. Once again, a sample table for moto is shown in table 1. And a sample curve in graph 1. Maximum efficiency occurs at about 10% of the motor stall torque.

Torque (oz-in)	Speed Rpm	Current mA	Power Watts	Efficiency
0.025	11247.65	0.024	0.208	72.22
0.05	10786.3	0.048	0.399	69.27
0.075	10324.95	0.072	0.573	60.31
0.1	9863.6	0.096	0.730	63.36
0.125	9402.25	0.120	0.87	60.41
0.150	8940.9	0.144	0.992	57.40
0.175	8479.55	0.168	1.098	54.46
0.2	8018.2	0.192	1.187	51.51
0.225	7556.85	0.217	1.258	48.31
0.25	7095.5	0.241	1.313	45.40
0.275	6634.15	0.265	1.350	39.50
0.3	6172.8	0.289	1.370	36.58
0.325	5711.45	0.313	1.374	33.63
0.35	5250.1	0.337	1.360	30.67
0.375	4788.75	0.361	1.329	27.72
0.4	4327.4	0.385	1.281	24.77
0.425	3866.05	0.409	1.216	21.80
0.45	3404.7	0.433	1.134	18.87
0.475	2943.35	0.457	1.035	15
0.5	2482	0.481	0.918	12.95
0.525	2020.65	0.505	0.785	10
0.55	1559.3	0.529	0.635	7.03
0.575	1097.95	0.553	0.467	4.08
0.6	636.6	0.577	0.283	1.47

Table .2 Efficiency Calculations



Graph.1 Speed Vs Efficency Vs Current Vs Output Power

6.4 MANUFACTURING PROCESS:

Operations used for fabrication

1. **Raw materials:**

A raw material is the basic material used in the productions of the goods, finished products. The term "raw material" is used to denote material which is unprocessed.

2. **Marking:**

Marking is the process of making visible impressions on the metal surface so that required operations can be carried out as per the dimensions.

3. **Cutting:**

The raw material cut into the required dimensions using a grinding wheel cutter. Metal cutting is done by a relative motion between the work and piece and the hard edge cutting tool, which is multi point cutting tool.

4. **Welding:**

The assembly of base table is done by the process of welding. In this case the process is done by "Arc Welding". Arc welding is type of welding that uses a welding power supply to create an electric arc between an electrode and the base material to melt the metal at the welding point. They can use either direct or alternating current, and consumable or non-consumable electrode.

5. **Drilling:**

Drilling is easily the most common machining process. Drilling involves the creation of holes that are right circular cylinders. This is accomplished most typically by using the twist drill. The chips must exit through the flutes to the outside of the tool. The cutting front is embedded within the work piece, making cooling difficult. The cutting area can be flooded, coolant spray mist can be applied, or coolant can be delivered through the drill bit shaft.

6. **Hand Grinding:**

Hand Grinding is the finishing process used to improve surface finish, abrade hard materials, and tighten the tolerance on the flat and cylindrical surface by removing the small amount of material. In grinding the abrasive material rubs against the metal part and removes the tiny pieces of material. The abrasive material is typically on the surface of the wheel or belt.

6.5 FACTORS DETERMINING THE SELECTION OF MATERIALS

The various factors which determine the choice of material are discussed below.

PROPERTIES

The material selected must possess the necessary properties for the proposed application. The various requirements to be satisfied can be weight, surface finish, rigidity, ability to withstand environmental attack from chemicals, service life, reliability etc.

MANUFACTURING COST

Sometimes the demand for lowest possible manufacturing cost or surface qualities obtainable by the application of suitable coating substances may demand the use of special materials.

QUALITY REQUIRED

This generally affects the manufacturing process and ultimately the material. For example, it would never be desirable to go casting of a less number of components which can be fabricated much more economically.

SAFETY PRECAUTIONS

The following points should be considered for the safe operation of machineand to avoid accidents:-

1. All the parts of the machine should be checked to be in perfect alignment.
2. All the nuts and bolts should be perfectly tightened.
3. The operating switch should be located at convenient distance from the operator so as to control the machine easily.
4. The inspection and maintenance of the machine should be done from time to time

CHAPTER 7

PROJECT EVALUATION & COSTING

COST ESTIMATION:-

Cost estimation may be defined as the process of forecasting the expenses that must be incurred to manufacture a product. These expenses take into a consideration all expenditure involved in a design and manufacturing with all related services facilities such as pattern making, tool, making as well as a portion of the general administrative and selling costs.

PURPOSE OF COST ESTIMATION

1. To determine the selling price of a product for a quotation or contract so as to ensure a reasonable profit to the company.
2. Check the quotation supplied by vendors.
3. Determine the most economical process or material to manufacture the product.
4. To determine standards of production performance that may be used to control the cost.

TYPES OF COST ESTIMATION

1. Material cost
2. Machining cost

Material Cost Estimation

Material cost estimation gives the total amount required to collect the raw material which has to be processed or fabricated to desired size and functioning of the components. These materials are divided into two categories.

1. Material for fabrication:

In this the material in obtained in raw condition and is manufactured or processed to finished size for proper functioning of the component.

2. Standard purchased parts:

This includes the parts which was readily available in the market like allen screws etc. A list is forecast by the estimation stating the quality, size and Standard parts, the weight of raw material and cost per kg for the fabricated parts.

Project Evaluation:

Month	Work
July	Project selection
August/September	Project Concept Analysis & Design
January	Specification & Modification
Feb/march	Selection And Procurement of Material, Data Collection
April/May	Project Report

Project Costing:

Sr.No	Name of Component	Cost/Component	Quantity	Total Cost
1	Battery	1000	1	1000
2	Motor	2500	1	2500
3	Limit Switches	300	3	900
4	Rack & Pinion		1	1800
5	Steering	300	1	300
6	Universal Coupling	500	2	1000

7	Wiring			100
8	Material& Fabrication			2500
9	Printing	200	1	200
10	Total			10300

CHAPTER 8

ADVANTAGES, DISADVANTAGES
& APPLICATION OF ELECTRICAL STEERING MECHANISM

ADVANTAGES

- To provide smooth and safety ride.
- To provide mind free ride for the motorist.
- To provide the nation with an accident free roads.
- Low Cost Automation Project

DISADVANTAGES

- It cannot be used in heavy vehicles such as container and truck due to limitation of servo motor.

APPLICATION

- It is very much useful for Car Owners & Auto-garages. This Electrical steering system is used for smooth braking of the vehicles.
- Thus it can be useful for the following types of vehicles; Used in four wheel drive
- Used in Station wagons, all terrain vehicles vehicles.
- Used in Golf cart and passenger vehicles
- Used for Sedan, SUV type vehicles

CHAPTER 9

CONCLUSION AND FUTUREWORK

9.1 Conclusion

- Car safety is the avoidance of automobile accidents or the minimization of harmful effects of accidents, in particular as pertaining to human life and health.
- Electrical steering system is more cost effective as compared to hydraulic steering system. As hydraulic steering system costing is more than Rs.20000 were as electrical steering system is less than Rs.11000. Electrical power steering system has more sensitivity due to use of limit switches and sensors.
- It is more reliable than other steering systems. Electrical steering system have less components, requires less maintenance as lubrication is not required.
- Electrical steering has less prone problem and faults and more durable. Hydraulic power system extracts power from engine whereas electrical power steering system consumes power from battery which can be charged by engine so it is beneficial for increasing mileage.
- These drawbacks are however only temporary barriers for the large scale introduced of these systems in today’s car’s and it can be uniquely stated that EPS is the future in power steering.
- EPS will become most efficient, safe and reliable power steering system.

9.2 Future scope:-

To-date, technical and product liability concerns have precluded the introduction of such systems in the U.S. market through it is expected that niche application may be expected in the near-to-midterm mix of future vehicles. Such system designs have yet to prove themselves sufficiently reliable and safe to prevent dangerous auto steer event. Auto steer has crept into the lexicon as an adjunct to the development of EPS system. As the name implies Auto steer denote an uncontrolled steering event neither commanded nor stoppable by the vehicles driver due to catastrophic failure in the electron hardware or software. In truth, these systems are control servo systems, similar in function to aircraft control servo systems, and must have multiple redundancies. Although these new EPS systems are said to have multiple redundancy, their design and broad application within the automotive industry have been, and will continue to be, subject to economic pressure more extreme then found in the aircraft industry. For instance one obvious safety related item has been universally deleted from such system specifications: a clutch for physically disengaging the reduction gear box and drive motor assist assembly from the host steering system in the event of system failure. This means that a driver encountering an EPAS system failure will have to exert additional force to “Back drive” The systems reduction gear box and drive motor assist assembly while attempting to maintain control of the vehicle in the absence of normal power steering assist.

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