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Analysis of Power Steering System Assembly

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Abstract*— the advancement in the technology will required more advance analysis for optimized results and accuracy. There are lot of research is been done in the field of automobile industries the power steering is one of the most advance development which will reduce lots of human efforts. Here in this research paper we are trying to analyze 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.

***Index Terms*—Power steering, EPS CPU, EPS ECU, DC.**

I. INTRODUCTION

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 of 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. The angle the wheels make with the vertical plane also influences steering dynamics as do the tires. Advance steering system main helps to drive steer vehicles by human steering effort to the steering wheel. There are basically some actuator assemblies that may hydraulic or electrical which will add controlled energy to the mechanism. So there is very less human efforts is required for driving or turning the car steering. Power steering provides feedback of forces acting on the front wheels to give an ongoing sense of according to the wheels is interacting with the road. Power steering system can be controlled using an hydraulic actuator which is a part of servo system .These system have some direct mechanism have mechanical connection between the steering wheel and contact between steers wheel known as linkage that steers the wheels. The power steering system failure will switch to manual mode. Power steering system have a wire connection that means there is no direct mechanical connection to steering linkage this is called drive by wire this all assembly is drive by electricity which contains power data and feedback signals.

II. TECHNOLOGY FOUNDATION

The first power steering system on an automobile was apparently installed in 1876 by a man with the surname of Fits. [1] Little else is known about him. The next power steering system was put on a Columbia 5-ton truck in 1903.Robert E. Twyford, a resident of Pittsburgh, Pennsylvania, USA, included a mechanical power steering mechanism as part of his patent (U.S. Patent 646,477) issued on April 3, 1900 for the first four wheel drive system. Francis W. Davis, an engineer of the truck division of Pierce Arrow began exploring how steering could be made easier, and in 1926 invented and demonstrated the first practical power steering system. Davis moved to General Motors and refined the hydraulic-assisted power steering system, but the automaker calculated it would be too expensive to produce. Davis then signed up with Bendix, a parts manufacturer for automakers. Military needs during World War II for easier steering on heavy vehicles boosted the need for power assistance on armored cars and tank-recovery vehicles for the British and American armies. Chrysler Corporation introduced the first commercially available passenger car power steering system on the 1951 Chrysler Imperial under the name "Hydra guide".[2] The Chrysler system was based on some of Davis' expired patents. General Motors introduced the 1952 Cadillac with a power steering system using the work Davis had done for the company almost twenty years earlier. Charles F. Hammond, an American, born in Detroit, filed several patents for improvements of power steering with the Canadian Intellectual Property Office in1958.Most new vehicles now have power steering, owing to the trends toward front wheel drive, greater vehicle mass, and wider tires, which all increase the required steering effort. Heavier vehicles as common in some countries would be extremely difficult to maneuver at low speeds, while vehicles of lighter weight may not need power assisted steering at all.

The power steering system is design in various modes but basically there are two types of systems mainly used in automobile industries.

1. Electrical Power steering.
2. Hydralic Power steering.

Electrical Power Steering System: - 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

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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.

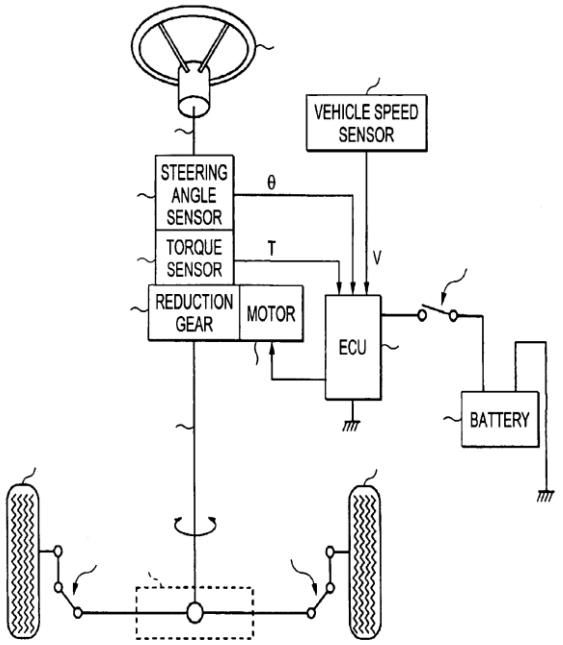

Fig 1: Electrical Power Steering System

This figure shows the electrical power steering assembly Electrical power steering system has following main parts

Steering Gear: - Steering wheel is main part as shown in figure when the steering wheel is turned; torque is transmitted to the pinion causing the input shaft to rotate. The torsion bar that links the input shaft and the pinion twists until the torque and the torsion bar and converts the torque applied to the torsion bar into an electrical signal.

DC Motor:-The Dc motor uses a worm gear to transmit the motor's torque to the column shaft.

Reduction Mechanism: - The reduction mechanism transmits power assist to the pinion shaft. The reduction mechanism consists of the ring gear that is secured to the pinion shaft and the pinion gear that is integrated with the motor shaft. The power assist of the motor is transmitted by the reduction mechanism to the pinion shaft which provides power assist to the steering effort.

Torque Sensor:-The torque sensor detects the twist of the torsion bar and converts applied torque into an electrical signal .The EPS ECU uses that signal to calculate the mount of power assist the DC motor should provide.

EPS CPU:-The EPS receive signals from various sensors make judgments according the current vehicle condition and determines the required amount of current that is been given to the DC motor.

Fail Safe:-Fail safe is mechanism like a backup circuitry in the power steering system because it will switch the power steering mode to manual mode when the failure is occur. If the EPS detects a malfunction in the EPS system a warring light illuminates to alert the driver. The EPS will store the DTC and the system will power down, however the system still provides the ability to steer manually. Another one is the hydraulic power steering system which has the following main parts those are Most power steering systems work by using a hydraulic system to steer the vehicle's wheels. *Rotary vane Pump:*-The hydraulic pressure typically comes from a generator or rotary vane pump driven by the vehicle's engine. A double-acting hydraulic cylinder applies a force to the steering gear, which in turn steers the road wheels. The steering wheel operates valves to control flow to the cylinder. The more torque the driver applies to the steering wheel and column, the more fluid the valves allow through to the cylinder, and so the more force is applied to steer the wheels. *Torque Sensor:*-One design for measuring the torque applied to the steering wheel has a torque sensor a torsion bar at the lower end of the steering column. All the other parts are same as the electrical power steering system.

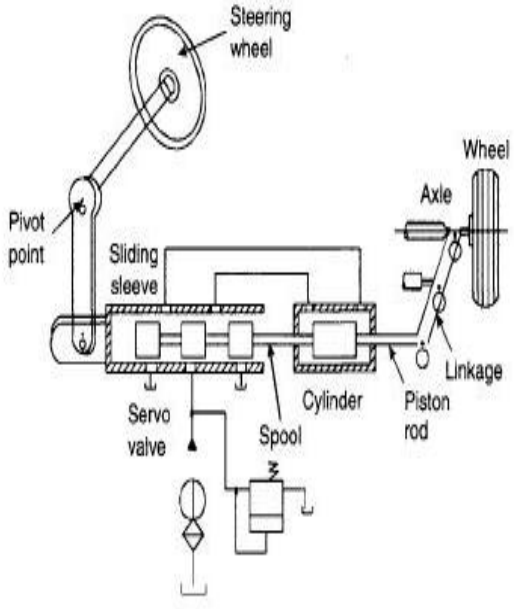

Fig 2: Hydraulic Power Steering assembly

This Figure shows the hydraulic power steering assembly The torque sensor in the steering system in following way As the steering wheel rotates, so does the steering column, as well as the upper end of the torsion bar. Since the torsion bar is relatively thin and flexible,[3] and the bottom end usually resists being rotated, the bar will twist by an amount proportional to the applied torque. The difference in position between the opposite ends of the torsion bar controls a valve. The valve allows fluid to flow to the cylinder which provides steering assistance; the greater the "twist" of the torsion bar, the greater the force. Since the hydraulic pumps are positive-displacement type, the flow rate they deliver is

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directly proportional to the speed of the engine. This means that at high engine speeds the steering would naturally operate faster than at low engine speeds. Because this would be undesirable, a restricting orifice and flow-control valve direct some of the pump's output back to the hydraulic reservoir at high engine speeds. A pressure relief valve prevents a dangerous build-up of pressure when the hydraulic cylinder's piston reaches the end of its stroke. Some modern systems also include an electronic control valve to reduce the hydraulic supply pressure as the vehicle's speed increases; this is variable-assist power steering.

III. System Model and Implemented Design

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.

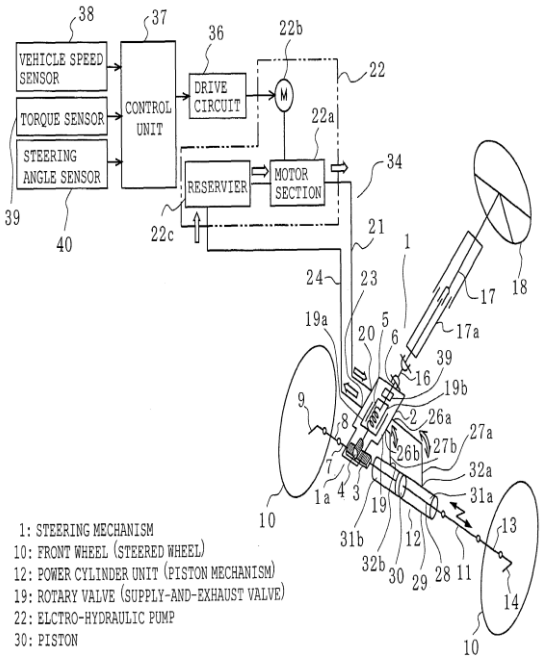

Fig 3: Shows the Electro-Hydraulic Power Steering Model

This figure shows the combination of the power steering electrical and hydraulic assembly A power-steering system should assist the driver only when he is exerting force on the steering wheel. When the driver is not exerting force the system shouldn't provide any assist. The device that senses the force on the steering wheel is called the rotary valve. The key to the rotary valve is a torsion bar. The torsion bar is a thin rod of metal that twists when torque is applied to it. The top of the bar is connected to the steering wheel, and the bottom of the bar is connected to the pinion or worm gear, so the amount of torque in the torsion bar is equal to the amount of torque the driver is using to turn the wheels. The more torque the driver uses to turn the wheels, the more the bar twists.[5] Power steering assembly have rotary valve when you first start to turn the steering wheel as the bar twists, it rotates the inside of the spool valve relative to the outside. Since the inner part of the spool valve is also connected to the steering shaft, the amount of rotation between the inner and outer parts of the spool valve depends on how much torque the driver applies to the steering wheel. When the steering wheel is not being turned, both hydraulic lines provide the same amount of pressure to the steering gear. But if the spool valve is turned one way or the other, ports open up to provide high-pressure fluid to the appropriate line. The Power Steering Model that we have studied for advance car is a combination of both types hydraulic and electrical power steering .This combination will provide highly precise output with less effort so that the driver should make lots of effort to drive the vehicle or turn it. This model uses lots of sensors and Microprocessors (CPU) to control this whole unit from a centralize point.

IV. Realization

In this part we have studied the parts that are use in Hydraulic power steering system.[6]

Engine pump assemblies

– The hydraulic unit with gear pump, pressure limiting valve and electric motor,
– The hydraulic fluid reservoir,
– The power steering control unit.

The engine pump assembly does not require any maintenance. It is lubricated internally by the hydraulic fluid. It cannot be disassembled, and no provision is made for repairs. A pressure line links the pump to the power steering gear. The return-flow line of the hydraulic fluid merges into the reservoir. *Torque sensor*:-Torque sensor that is used in this system is a G85 sensor this sensor is located on the steering column between steering column switch and steering wheel. This sensor is used on vehicle models which are available only with the electronic stability program (ESP).

***Power Steering Sensor*: -** This sensor is integrated in the housing of the rotary disc valve of the power steering gear. It detects the steering angle and calculates the steering angle rate. If the sensor fails, the steering function is nevertheless assured. The power steering switches over in this case to a programmed emergency running mode.

This sensor is also having a built in assembly named J500 control unit is integrated in the engine pump assembly. It converts the signals for driving the gear pump in line with the steering angle rate and the vehicle speed. The delivery required at a particular moment is obtained from a map stored in the control unit. The control unit detects and stores

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faults which occur during operation. A restart protection and temperature protection are integrated in the control unit.

***Restart protection*:-**The EPHS Electrically Powered Hydraulic Steering features a restart protection after a fault, failure or crash. The restart protection, if activated because of a crash, can only be deactivated with a diagnostic tool. If other faults exist, the restart protection can be cancelled by switching the ignition off and starting the engine again. It may be necessary to wait about 15 minutes in order to allow the engine pump assembly to cool down after having overheated. If, after this waiting period, it is still not possible to override the restart protection by starting the engine, this indicates there is a fault in the vehicle electrical system or the engine pump assembly is faulty. In such cases, it is necessary to conduct a self-diagnosis and, if the engine pump assembly is faulty, to change it.

***Expansion Chamber Attenuator*:-**The function of the Expansion Chamber Attenuator, ECA, is to reduce the noise level in the system. It is mounted between the pump and the valve. The component that generates the most noise in the system is the pump, which causes the ECA's dependency. The function of the ECA is to work as a hydraulic filter and dampen the pulsation emitted by the pump. The difficulty in the automotive industry is that the pump is often driven directly by the engine, which implies that the undesired frequency spectrum varies with the pump speed. Attenuator technology in industrial applications is often easier to design when the spectrum of frequency is fixed. In this research, the function of the ECA is not studied in detail; the focus has rather been on the drawbacks with the attenuator, which will reflect on the overall system layout

***Speed Dependent Assistance*:-**The power steering system can be equipped with a valve that changes the characteristic depending on the velocity of the car. In low speed maneuvering, the system has a higher assistance ratio compared with high speed maneuvering, this system works with speed dependent assistance, progressive steering, have been on the market for some time and are standard in sports cars and high-end models today. Progressive steering increases the road feel transferred to the driver via the steering wheel at higher vehicle speeds.

CAN data bus (Controller Area Network):- It provides a very rapid transfer between several equal-priority control units. The participating control units are interlinked by means of a linear line structure. If one user fails, the bus structure remains fully available for all the other users.

***Power Steering Cylinder*:-**The power steering cylinder has 8.75″ stroke, however, we can shorten the stroke to meet your needs. The cylinder ram has 5/8″ fine threads and are about an inch long. The cylinder is rebuild able as it uses common inexpensive o-rings that can be purchased at any auto parts store.

Vane Loader Pump:-A vane pump is very efficient, pumping more gallons per engine revolution then any other pump. Also the vane pump is much better in cold weather as the vanes do not come out to pump oil until the spinning of the turning shaft forces them out. By that time the engine has started. What that means is that the battery and starter didn't have to start a cold engine and pump oil at the same time. You can recognize a vane pump by its distinctive "whine". If taken care of, it will outlast a gear pump. Vane pumps come in different gallons per minute. I will size the vane pump to match your tractor's engine so the loader is very responsive without lugging the engine.

***Worm gear*:-**This part is located in an aluminum gear case where the electric motor is also mounted. A worm on the motor shaft meshes with the gear on the steering shaft. The gear ratio is 22:1. The gear body and the worm are made of metal. The gear ring is manufactured from plastic to reduce mechanical noise.

***Sensor housing*:-**Steering position sender G268 and steering moment sender G269 are located in housing. The sensor housing is mounted on the worm gear shaft above the gear. The sensor housing is connected to the control unit via a 6-pin connector.

Steering position sender G268:-This part is connected to the worm gear shaft. It registers the steering wheel lock and/or the current position the steering.

Steering moment sender G269:-This part is connected to the torsion bar. It registers a rotation angle of the torsion bar in relation to the intermediate spindle. The control unit calculates a torque from this signal. If the calculated torque exceeds a value of 0.01 Nm, the control unit assumes that a steering assistance is required.

***Electro-mechanical power steering warning lamp*:-**This warning lamp is located in the dash panel insert. If the control unit detects a fault in the power steering system, it activates the warning lamp in the display unit in the dash panel insert.

V. Conclusion

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.

REFERENCES

[1] Introduced industry first power steering Magazine

[2] http://www.time.com/time/magazine/article

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International Journal of Engineering and Innovative Technology (IJEIT)
Volume 1, Issue 6, June 2012

[3] www.autoshop101.com/forms/Hybrid17.pdf

[4] Johnson, Erik (2007-06). "2008 Infiniti G37 Sport Coupe - Suspension, Handling, and Four-Wheel Steering".

[5] http://www.howeperformance.com/rockcrawling.html

[6] http://www.volkspage.net/technik/ssp/ssp/SSP_225.pdf self study program 259

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