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FOUR WHEEL STEERING SYSTEM

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Abstract— Abstract : Four-wheel steering (4WS) systems are designed to improve the handling and maneuverability of vehicles. They do this by allowing the rear wheels to turn in the same direction as the front wheels at low speeds, and in the opposite direction at high speeds. This allows the vehicle to turn more sharply at low speeds, and to maintain stability at high speeds. There are two main types of 4WS systems: mechanical and hydraulic. Mechanical 4WS systems use a series of linkages and gears to turn the rear wheels. Hydraulic 4WS systems use hydraulic fluid to power the rear wheels .Mechanical 4WS systems are simpler and less expensive than hydraulic 4WS systems. However, they are also less responsive and can be more difficult to control. Hydraulic 4WS systems are more responsive and easier to control, but they are also more complex and expensive. The choice of which type of 4WS system to use depends on the application. Mechanical 4WS systems are typically used in smaller vehicles, such as cars and light trucks. Hydraulic 4WS systems are typically used in larger vehicles, such as SUVs and heavy trucks.4WS systems can improve the handling and maneuverability of vehicles in a variety of situations. They can make it easier to park, to turn in tight spaces, and to maintain stability at high speeds. 4WS systems can also improve the safety of vehicles by reducing the risk of accidents.

Keywords: four-wheel steering, 4WS, mechanical 4WS, hydraulic 4WS, handling, maneuverability, safety.

1. INTRODUCTION

Four-wheel steering, 4WS, also called rear-wheel steering or all-wheel steering, provides a means to actively steer the rear wheels during turning manoeuvres. It should not be confused with four-wheel drive in which all four wheels of a vehicle are powered. It improves handling and helps the vehicle make tighter turns. Production-built cars tend to under steer or, in few instances, over steer. If a car could automatically compensate for an under steer /over steer problem, the driver would enjoy nearly neutral steering under varying conditions. 4WS is a serious effort on
the part of automotive design engineers to provide near-neutral steering. The front wheels do most of the steering. Rear wheel turning is generally limited to half during an opposite direction in
turn. When both the front and rear wheels steer toward the same direction, they are said to be in phase and this produces a kind of sideways movement of the car at low speeds. When the front and rear wheels are steered in opposite direction, this is called anti- phase, counter-phase or opposite-phase and it produces a sharper, tighter turn[1].

In a four-wheel-steer car, this high-speed sway can be damped or even eliminated through the use of same-side steering. When the rear wheels are turned at the same time and in the same direction as the front wheels, the back end turns with the front, and the cornering forces occur at both axles simultaneously. The car slides smoothly to the side without sway or fishtail[2].The Comparing of turning radius for a 4WS and a 2WS has been shown in fig(1)

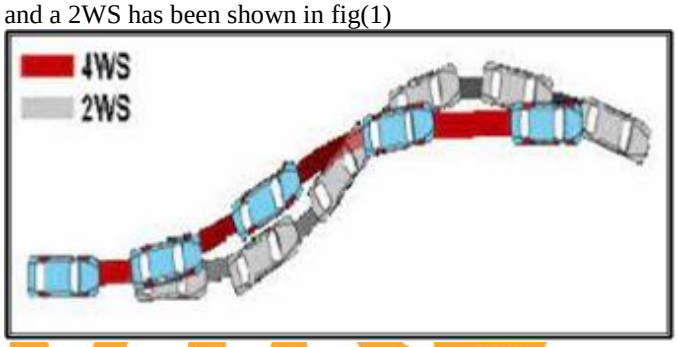

FIG: 1 Comparing turning radius for a 4WS and a 2 WS[2]

In addition to improved maneuverability, four-wheel steering can also improve stability and handling. By adjusting the angle of the rear wheels, four-wheel steering can help a vehicle maintain stability during high-speed maneuvers and sudden changes in direction. This is especially useful in high-performance sports cars, where precise handling is critical for safe and effective driving.
Four-wheel steering systems can be active or passive, and they have been used in a variety of vehicles, from high-performance sports cars to heavy-duty trucks. With its many benefits, four-wheel steering is likely to continue to play an important role in the future of automotive technology. Design of Four Wheel Steering has been shown in Fig(2).

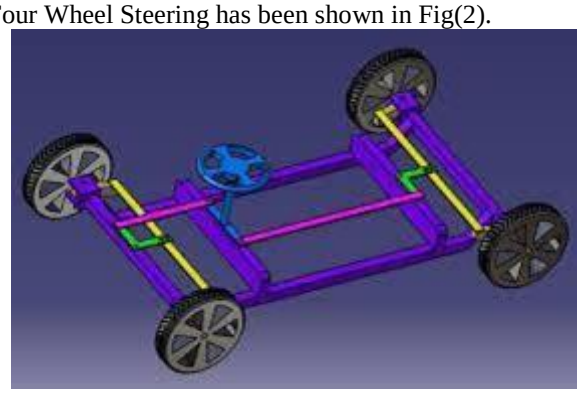

FIG: 2 FOUR WHEEL STEERING SYSTEM [3]

2. LITERATURE REVIEW

Shibahata et al. (1986) The four-wheel steering mechanism is obtained with the help of a rack and pinion for the front wheels and a connector turning the rear wheels. The front wheels are turned using a basic rack and pinion mechanism, while the rear wheels are controlled using tie rods. There is a connector between front and rear wheels which helps the rear wheels turn. At front end it is connected to the rack while at the other end a metallic ball is attached to it at the bottom which sits in the plus-shaped slot . This slot is fixed in such a way that it is free to rotate on its central axis and it is connected to the tie rods on its end which are further connected to the rear wheels. This mechanism will help to achieve two phases i.e., both out-phase and in-phase. In out-phase the rear wheels will turn opposite to the direction of front wheels and thus help reduce the turning radius, whereas in in-phase all the wheels will turn in same direction thereby, enabling an efficient way for lane changing. The turn angle of the rear wheels is just enough to assist the motion of front wheels and not provide own direction .

Since the front wheels are controlled using rack and pinion, the rear wheels are assisted with the help of a connector. This consists of two arms and a plus-shaped slot . The two arms are 1.5" wide but have different lengths. The short arm, of length 15.5", is connected to the rack on end. It sits on the frame of the vehicle fixed on its center which allows it a rotating motion as the rack moves. Longer arm, situated along the central axis, is connected to the short arm with the help of metal strips. This allows it to attain a linear motion. It measures 46" in length. It has a metal ball attached to its other end on lower side, this ball sits in the slots[3].

Bhishikar et al. (2014)-4 -Wheel Steering System is employed in vehicles to achieve better maneuverability at high speeds, reducing the turning circle radius of the car and to reduce the drivers steering effort. In most active 4-wheel steering system, the guiding computer or electronic equipment play a major role, in our project we have tried to keep the mechanism as much mechanical as possible which can be easy to manufacturing and maintenance.

This project consists of front rack and pinion mechanism assisted by three bevel gears of which one is connected to front pinion, one is connected to steering rod in which input is given by the driver and third one will be connected to rear pinion. Rear wheel system consists of two racks with two pinions. One of the racks will be in front of the rear wheel axis (primary rack) and the other will be behind the axis (secondary rack). Also at any point in the system, one of the rack & pinion assembly will be engaged with the other being disengaged. Motion of pinion will be guided by an actuating pump connected to intermediate shaft which will receive input from speed sensors. The engaging & disengaging of the rack & pinion assembly will depend on the input received from the speed sensor. At lower speeds i.e. below 35kmph the pinion will be in contact with secondary rear rack so as to keep the wheels motion out of phase while for speeds above 35kmph pinion will be in contact with front rack of rear steering system, giving in phase motion to wheels. This position of the rear pinion on the rack is controlled by a hydraulic circuit and an actuator mechanism. The angle turned by rear wheels will not be as high as that of front wheels because the function of rear steering system is to assist the motion of front wheels and not provide its own direction. This change of angle is obtained by changing gear ratio of rack and pinion. This system assists in high-speed lane changing and better cornering. It combats the problems faced in sharp turning. It reduces the turning circle radius of the car and gives better maneuverability and control while driving at high speeds, thus attaining neutral steering. Moreover, components used in this system are easy to manufacture, material used is feasible, reliable and easily available in market. The system assembly is easy to install and light in weight and can be implemented in all sections of cars efficiently.[4]

Choudhari (2014) - It is revealed that Four- Wheel steering (4WS) System is also known as "Quadra Steering System". In this paper, both front as well as rear wheels can be steered according to speed of the vehicle and space available for turning. Quadra steer is system that gives full size vehicles greater ease while driving at low speed, and improves stability, handling and control at higher speed. Quadra steering system works in following three phases Negative phase, Neutral phase, Positive phase. It enables the car to be steered into tighter parking spaces. It makes the car more stable at speed (less body roll). It makes the car more efficient and stable on cornering, easier and safer lanes change when on motorways. The steering system allows the driver to guide the moving vehicle on the road and turn it right or left as desired. The main aim is that turning of the vehicle should not require greater efforts on the part of the driver. The Quadra steer steering system offers a 21% reduction in turning radius. So , if a vehicle is capable of making a U-turn in a 25-foot space, Quadra steer allows the driver to do it in about 20 feet.
At high speed, when steering adjustments are subtle, the front wheels and rear wheels turn in the same direction . As a result, the car moves in a crab-like manner rather than in a curved path. This action is advantageous to the car while changing lanes on a high- speed road. The elimination of the centrifugal effect and, in consequence the reduction of body roll and cornering force on the tyre, improves the stability of the car so that control becomes easier and safer. In a 4WS system, the control of drive angle at front and rear wheels is most essential. The four-wheel steering system has got cornering capability, steering response, straight-line stability, lane changing and low speed maneuverability. Even though it is advantageous over the convectional two-wheel steering system, four-wheel steering is a complex and expensive. Currently the cost of a vehicle with four-wheel steering is more than that of the convectional two wheel steering of vehicle. Four-wheel steering is growing in popularity and it is likely to come in more and more new vehicles. As the system become more common place, the cost of four-wheel steering system will drop down [5].

3. FABRICATION METHODOLOGY

The fabrication methodology for a four-wheel steering system can be broken down into the following steps:

1. Design. The first step is to design the system. This includes determining the type of system, the

components required, and the dimensions of the components.

2. Fabrication. Once the design is complete, the components can be fabricated. This can be done using a variety of methods, such as machining, welding, and casting.
3. Assembly. Once the components are fabricated, they can be assembled. This involves mounting the components to the vehicle and connecting them to each other.
4. Testing. Once the system is assembled, it must be tested to ensure that it works properly. This includes testing the range of motion, the steering response, and the stability of the vehicle.

The following are some of the factors that need to be considered when designing a four-wheel steering system:

- The type of vehicle. The system must be designed to work with the specific type of vehicle. For example, a system for a car will be different from a system for a truck.
- The weight of the vehicle. The system must be able to support the weight of the vehicle.
- The speed of the vehicle. The system must be able to operate at the speeds at which the vehicle will be driven.
- The terrain that the vehicle will be driven on. The system must be able to handle the terrain that the vehicle will be driven on.

The following are some of the components that are typically required for a four-wheel steering system:

- Rack and pinion steering gear. This is the main component that converts the rotation of the steering wheel into the movement of the wheels.
- Hydraulic or electric actuators. These are used to move the wheels.
- Control system. This is used to control the movement of the wheels.

The following are some of the challenges that can be encountered when fabricating a four-wheel steering system:

- The precision of the components. The components must be made to a high degree of precision in order for the system to work properly.
- The alignment of the components. The components must be aligned properly in order for the system to work properly.
- The strength of the components. The components must be strong enough to support the weight of the vehicle and to withstand the forces that will be exerted on them during operation.

The following are some of the benefits of having a four-wheel steering system:

- Improved maneuverability. The system can make the vehicle easier to maneuver in tight spaces.
- Improved stability. The system can help to improve the stability of the vehicle during cornering and at high speeds.
- Reduced wear and tear on the tires. The system can help to reduce wear and tear on the tires by distributing the weight of the vehicle more evenly.

Overall, the fabrication methodology for a four-wheel steering system is a complex and challenging process. However, the benefits of having such a system can be significant.

4. CONCLUSION

Four wheel steering is a relatively new technology, that imposes maneuverability in cars, trucks and trailers .in standard two wheels steering vehicles, the rear set of wheels are always directed forward therefore and do not play an active role in controlling the steering in four wheel steering system the rear wheel can turn left and right . To keep the driving controls as simple as possible. The aim of 4WS system is a better stability during overtaking manoeuvres, reduction of vehicle oscillation around its vertical axis, reduced sensibility to lateral wind, neutral behaviour during cornering, etc., i.e. improvement of active safety.

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