Four wheel steering system for Automobile

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ABSTRACT

A Four wheel steering system also known as Quadra steering system. In this paper, both front wheel and rear wheels can be steered according to speed other vehicle and space available for turning. Quadra steer gives full size vehicle greater ease while driving at low speed, improves stability, handling and control at higher speed.

Production-built cars tend to under steer or, in few instances, overseer. If a car could automatically compensate for an under steer overseer problem, the driver would enjoy nearly neutral steering under varying conditions. Four wheel systems is a serious effort on the part of automotive design engineers to provide near-neutral steering.

This system finds application in off-highway vehicles such as forklifts, agricultural and construction equipment mining machinery also in Heavy Motor Vehicles. It is also useful in passenger cars.

It improves handling and helps the vehicle make tighter turns. This system is used to minimize the turning radius.

KEYWORDS: Quadra, turning radius, cornering, pure

INTRODUCTON:

What is Steering?

Steering is the term applied to the collection of components, linkages, etc. which will allow a vessel (ship or Boat) or vehicle to follow the desired course. An exception is the case of rail transport by which rail tracks combined together with railroad switches provide steering column, which may contain universal joints, to allow it to deviate somewhat from a straight line.

The steering function. The most conventional steering arrangement is to turn the front wheels using a hand–operated steering wheel which is positioned in front of the driver.

Types of Steering System:

CONVENTIONAL STEERING SYSTEM:

In that steering system, only the front wheels are steered towards right or left According to the requirement because of at rear their dead axle is present.

FOUR WHEEL STEERING SYSTEM:

In that steering system, the all four wheels are to be steered according to the steer perform to drive towards left or right. Four-wheel steering, 4WS, also called rear-wheel steering or all-wheel steering, provides a means to actively steer the rear wheels during turning maneuvers. 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.

In most active four wheel steering system, the rear wheels are steered by a computer and actuators, the rear wheels generally cannot turn as far as the front wheels. Some systems including Delphi's Quadra steer and the system in Honda's Prelude line allow the rear wheels to be steered in the opposite direction as the front wheels during low speeds. This allows the vehicle to turn in a significantly smaller radius sometimes critical for large tucks or tractors and vehicles with trailers.

Purpose of Automotive Steering System:

The purpose of the steering system allows the driver to control the direction of the vehicle by turning the front wheels. The steering system consists of the following component parts.

Components:

1. Steering wheel handles the steering operation.
2. Steering column joins the steering wheel and the steering gears.
3. Steering gears Convert the steering torque and rotational deflection from the steering wheel, transmit them to the wheel through the steering linkage, and make the vehicle turn.
4. Steering linkage a steering linkage is a combination of the rods and arms that transmit the movement of the steering gear to the left and right front wheels. Also, there are two types of steering.

Requirements of steering system:

The steering system has the following requirements.

1. Excellent manoeuvrability when the vehicle is cornering on a narrow, twisting road, the steering system must be able to turn the front wheels sharply yet easily and smoothly.
2. Proper steering effort if nothing is done to prevent it, steering effort will be greater when the vehicle is stopped and will decrease as the speed of the vehicle increase. Therefore, in order to obtain easier steering and better feel of the road, the steering should be made lighter at low speeds and heavier at high speeds.
3. Smooth recovery while the vehicle is turning, the driver must hold the steering wheel firmly. After the turn is completed, however, recovery – that is, the return of the wheels to the straight-ahead position – should occur smoothly as the driver relaxes the force with which he is turning the steering wheel.
4. Minimum transmission of shock from road surface Loss of steering wheel control and transmission of kickback due to road surface roughness must not occur.

Why Four-Wheel Steering System?

To understand the advantages of four-wheel steering, it is wise to review the dynamics of typical steering maneuvers with a conventional front -steered vehicle. The tires are subject to the forces of grip, momentum, and steering input when making a movement other than straight-ahead driving. These forces compete with each other during steering maneuvers. With a front-steered vehicle, the rear end is always trying to catch up to the directional changes of the front wheels. This causes the vehicle to sway. As a normal part of operating a vehicle, the driver learns to adjust to these forces without thinking about them.

When turning, the driver is putting into motion a complex series of forces. Each of these must be balanced against the others. The tires are subjected to road grip and slip angle. Grip holds the car's wheels to the road, and momentum moves the car straight ahead. Steering input causes the front wheels to turn. The car momentarily resists the turning motion, causing a tire slip angle to form. Once the vehicle begins to respond to the steering input, cornering forces are generated. The vehicle sways as the rear wheels attempt to keep up with the cornering forces already generated by the front tires. This is referred to as rear-end lag, because there is a time delay between steering input and vehicle reaction. When the front wheels are turned back to a straight -ahead position, the vehicle must again try to adjust by reversing the same forces developed by the turn. As the steering is turned, the vehicle body sways as the rear wheels again try to keep up with the cornering forces generated by the front wheels.

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Types of Steering Mechanism:

1 Ackerman's Steering Mechanism
2 Davis Steering Mechanism

1 Ackerman's Steering Mechanism:

Ackermann steering geometry is a geometric arrangement of linkages in the steering of a car or other vehicle designed to solve the problem of wheels on the inside and outside of a turn needing to trace out circles of different radii. It was invented by the German Carriage Builder "Lankensperger" in 1817, then patented by his agent in England Rudolph Ackermann (1764–1834) in 1818 for horse drawn carriages. Erasmus Darwin may have a prior claim as the inventor dating from 1758.

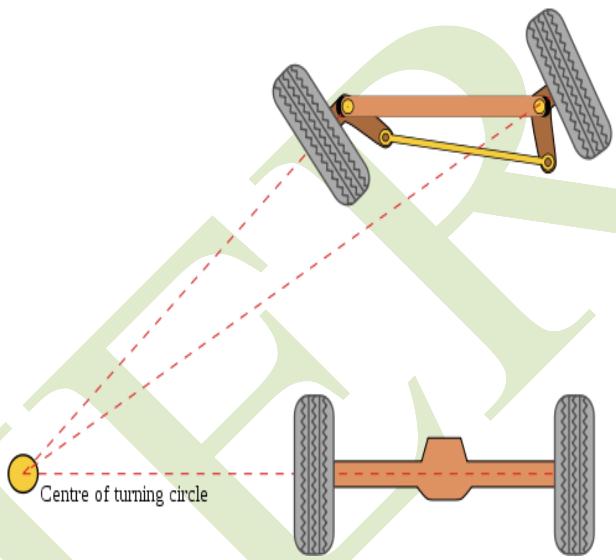

Fig 1.7 Ackerman's Steering Mechanism

The intention of Ackermann geometry is to avoid the need for tyres to slip sideways when following the path around a curve. The geometrical solution to this is for all wheels to have their axles arranged as radii of a circle with a common centre point. As the rear wheels are fixed, this centre point must be on a line extended from the rear axle. Intersecting the axes of the front wheels on this line as well requires that the inside front wheel is turned, when steering, through a greater angle than the outside wheel.

Rather than the preceding "turntable" steering, where both front wheels turned around a common pivot, each wheel gained its own pivot, close to its own hub. A linkage between these hubs moved the two wheels together, and by careful arrangement of the linkage dimensions the Ackermann geometry could be approximated. This was achieved by making the linkage *not* a simple parallelogram, but by making the length of the track rod (the moving link between the hubs) shorter than that of the axle, so that the steering arms of the hubs appeared to "toe out". As the steering moved, the wheels turned according to Ackermann, with the inner wheel turning

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further. If the track rod is placed ahead of the axle, it should instead be longer in comparison, thus preserving this same "toe out".

A simple approximation to perfect Ackermann steering geometry may be generated by moving the steering pivot points inward so as to lie on a line drawn between the steering kingpins and the centre of the rear axle. The steering pivot points are joined by a rigid bar called the tie rod which can also be part of the steering mechanism, in the form of a rack and pinion for instance. With perfect Ackermann, at any angle of steering, the centre point of all of the circles traced by all wheels will lie at a common point. Note that this may be difficult to arrange in practice with simple linkages, and designers are advised to draw or analyze their steering systems over the full range of steering angles.

Modern cars do not use *pure* Ackermann steering, partly because it ignores important dynamic and compliant effects, but the principle is sound for low speed manoeuvres. Some race cars use *reverse* Ackermann geometry to compensate for the large difference in slip angle between the inner and outer front tyres while cornering at high speed. The use of such geometry helps reduce tyre temperatures during high-speed cornering but compromises performance in low speed maneuvers.

2 Davis Steering Mechanism

The Davis gear mechanism consists of a cross link KL sliding parallel to another link AB and is connected to the stub axles of the two front wheels by means of two similar bell crank levers ACK and DBK pivoted at A and B respectively. The cross link KL slides insides in the bearing and carries pins at its end K and L. The slide blocks are pivoted on these pins and move with the turning of bell crank levers as the steering wheel is When the vehicle is running straight, the gear said to in its mid-position. The short arms AK and BL are inclined an angle 90+α to their stub axles AC and BD. The correct steering depends upon a suitab1e selection of cross-arm angle α, and is given by

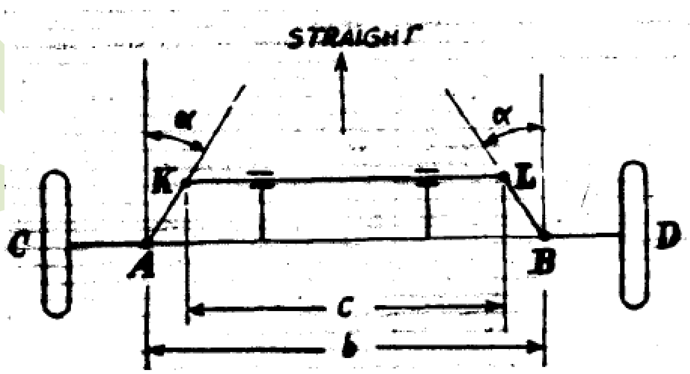

Fig 1.8 Davis Steering Mechanism

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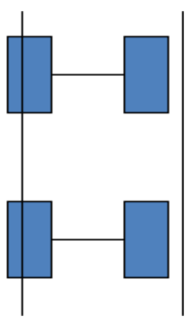
$\tan \alpha = b / 2l$

Where b=AB=distance between the pivots of front axles.
l=wheel base.

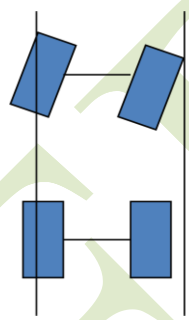
The range of b / l is 0.4 to 0.5 hence angle α lies between 11.3 and 14.10.

STEERING CONDITIONS:

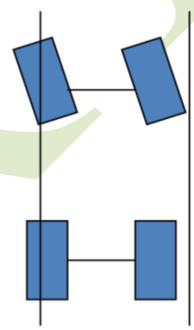
1 Normal steering



Idle position

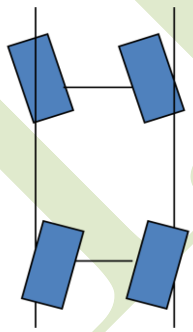


Right turn

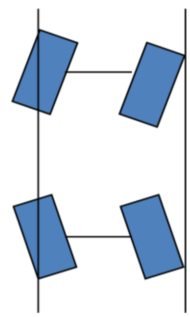


Left turn

2 Four wheel steering:



Extreme left



Extreme right

3 Comparison Of Four Wheel Steering System With Two Wheel Steering Conventional System

1. Car more efficient and stable on cornering.
2. Improved steering responsiveness and precision.
3. High speed straight line stability.
4. Notable improvement in rapid, easier, safer lane changing maneuvers.
5. Smaller turning radius and tight space manoeuvrability at low speed.
6. Relative Wheel Angles and their Control.
7. Risk of hitting an obstacle is greatly reduced

COMPARISION OF FOUR WHEEL AND TWO WHEEL STEERING SYSTEM

TURNING RADIUS	FOUR WHEEL STEER	TWO WHEEL STEER
By experiment	5.14 ft	14.70 ft

Fabrication model of four wheel steering system of Maruti 800.

Advantages

1. Superior cornering stability.
2. Improved steering responsiveness and precision.
3. High speed straight line stability.
4. Notable improvement in rapid lane changing manoeuvres.
5. Smaller turning radius and tight space manoeuvrability at low speed.
6. Relative wheel angles and their control.

APPLICATIONS:

1. Parallel parking: Due to smaller turning radius the parking and un parking of vehicle is easily performed towards the right or left side.
2. High speed lane changing: In this is less steering sensitive this does require a lot of concentration from driver since he has to judge the space and vehicles behind them.
3. Slippery road surfaces: Due to the rear wheel steering operation on low friction surfaces occurs hence vehicle direction easier to control.
4. Narrow Roads: Due to rear wheel steering on narrow roads with tight bends, counter phase steering reduces the turning radius.
5. U-Turns: By minimizing the vehicle's turning radius and counter phase steering of rear wheels enables U-Turns to be performed on narrow roads.

CONCLUSION:

It is observed that when Maruti 800 during turning actual turning radius is 14.70ft. But after making modification in the four wheel steering system it is measured as 5.14ft. hence we conclude that after making modification the turning radius is reduced more than half.

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