ABOUT THE INTEGRAL ACTIVE STEERING SYSTEM

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Abstract: The paper presents a short history of the Integral Active Steering, which varies the steering angle of rear wheels, increase security, stability and comfort for rear passengers benefit in particular.

At higher speeds, the rear wheels turn in the same direction to the front wheels, Integral Active Steering provides a higher response extremely comfortable on the road, changing lanes and curves. At low speeds, the rear wheels turn in the opposite direction, the car's turning circle is reduced to significantly improve agility and increase performance. Besides increasing the stability of the rapid changes of direction, fully active division also provides better handling during braking maneuvers.

1. INTRODUCTION

Also known as four-wheel steering (4WS) or all-wheel steering (AWS), integral steering is a technology featured only on some vehicles that improves maneuverability and stability while driving at both low and high speeds. In a system of this kind, all four wheels turn at the same time when the driver steers. However, the rear wheels cannot turn as far as the front wheels.

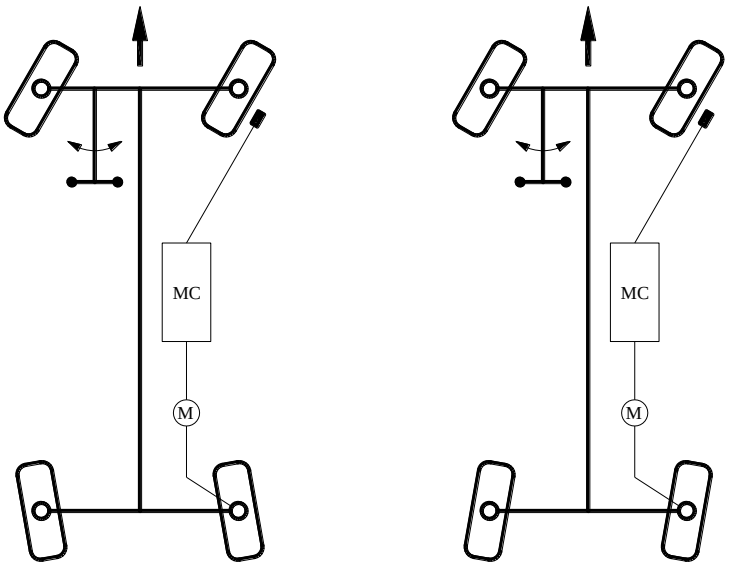
In some cases, the vehicles are fitted with controls that switch off the rear steer and option to steer only the rear wheels independent of the front wheels [1].

2. FUNCTIONALITY

At low speeds, well the tight corners, when the minimum turning radius is important, the rear wheels turn in the opposite direction to the front wheels – counter phase steering (fig. 1.a).; and at higher speeds, when the vehicle stability is important the rear wheels turn in the same direction to the front wheels - in phase steering (fig. 1.b). The steering system on the rear wheels can be considered as „full direction depending on speed”.

A few decades ago the big auto companies, mostly Japanese [2], they worried about the Integral Active Steering; the rear wheels steering which is controlled from the steering of front wheels through a mechanical system. It is so called by the full steering „wheel rotation angle”, but that seemed too expensive for the results obtained. Also have proposed variants to control the steering angle of rear wheels to take into account the speed of movement, well a function of speed and direction of the front wheel steering [3] (fig. 2).

The new technologies now allow mechanically decoupling control of the rear axle in a „computed direction”, well a transmission of the steering hydraulic motor / electric that will act directly, for example through a transmission screw - nut rear wheels (fig. 3).



a. *counter - phase steering* ***b.*** *in - phase steering*

Fig. 1. The integral steering principle.

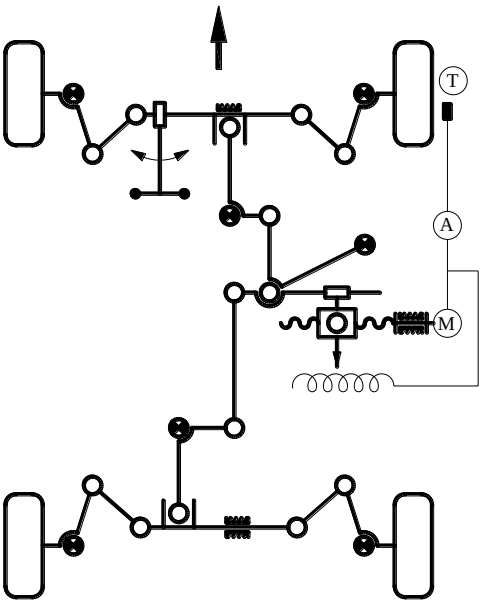


Fig. 2. The integral steering with steering angle of rear wheels adjustable speed depending.

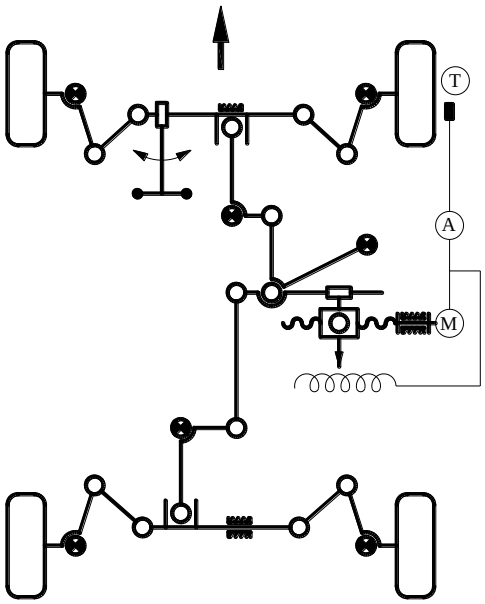


Fig. 3. The steering angle of rear wheels commanded by screw-nut device.

A computer is used to control the rear wheels and determines how much and in which direction the rear wheels should move, and whether the rear wheels should turn in the same direction as the front wheels or in the opposite direction. The movement varies up to a couple of inches. At slow speeds, the rear wheels move the opposite direction of the front wheels. This makes for easier parking and maneuvering.

Another mechanism for steering the front and rear wheels of a four-wheel-steerable vehicle includes a front wheel steering device operatively coupled to a steering wheel and having at least a rack-and-pinion gear mechanism having a nonlinear gear ratio, a rear wheel steering device, a linkage shaft operatively connecting the front wheel steering device and the rear wheel steering device disposed in a steering force transmitting path comprising the front wheel steering device, the rear wheel steering device, and the linkage shaft (fig. 4).

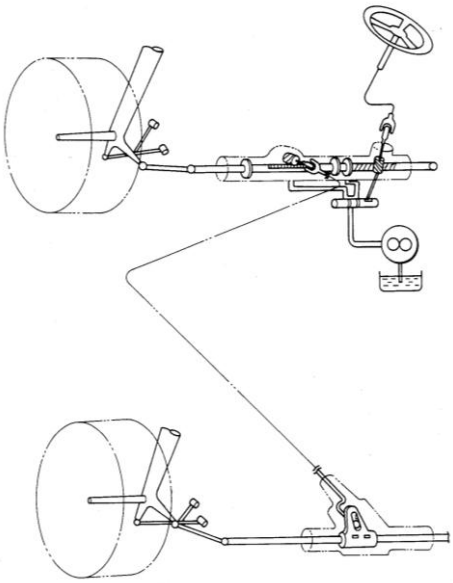


Fig. 4. The integral steering with variable report of the box steering

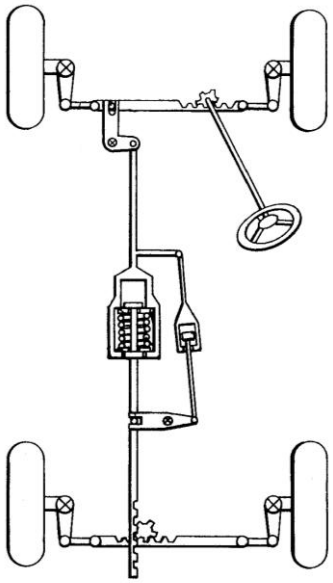


Fig. 5. The integral steering adjustable depending on position with differential mechanical device

Can also be a steering apparatus of a vehicle for steering when the rear wheels in conformity with the steering of the front wheels by a steering wheel, a control force for a rear wheel steering device is mechanically taken out from a front wheel steering device and is suitably controlled in the intermediate portion and is transmitted as a steering control force to the rear wheel steering device, whereby the front wheels and the rear wheels are steered in the same direction when the absolute value of the steering angle of the front wheels is less than a predetermined value, and the rear wheels are steered in the direction reverse to the front wheels when the absolute value is greater than the predetermined value (fig. 5).

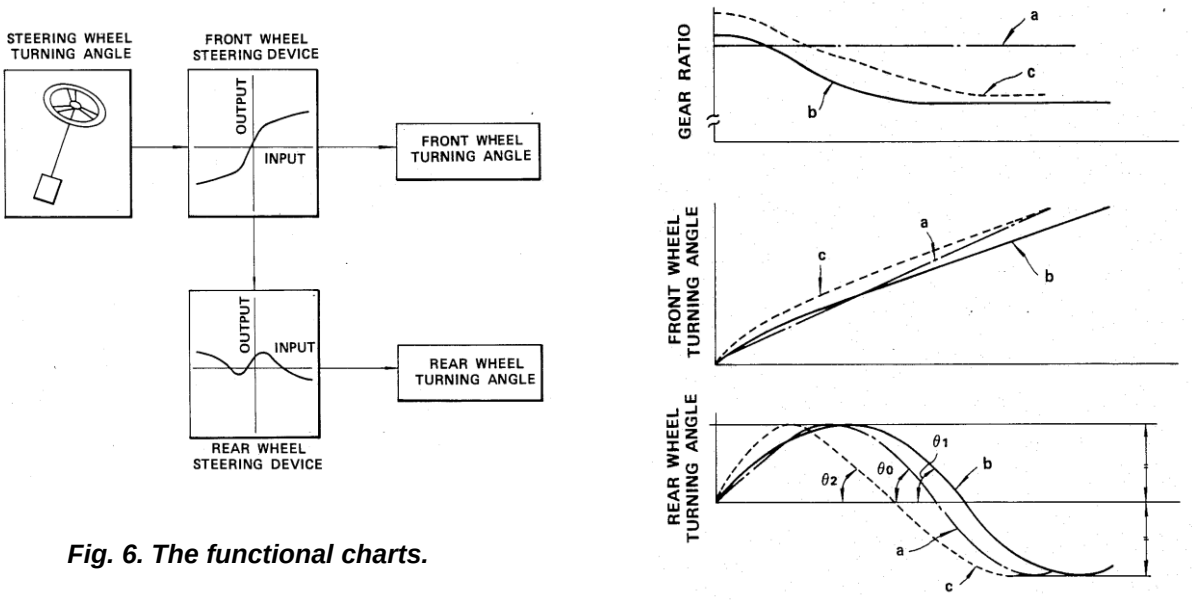


Fig. 6. The functional charts.

In the intermediate portion, the taken-out control force is divided into a same direction steering control force for steering the rear wheels in the same direction as the front wheels and a reverse direction steering control force for steering the rear wheels in the direction reverse to the front wheels, and the reverse direction steering control force is absorbed and only the same direction steering control force is transmitted to the rear wheel steering

device when the absolute value is less than the predetermined value, and the same direction steering control force is absorbed and only the reverse direction steering control force is transmitted to the rear wheel steering device when the absolute value is greater than the predetermined value (fig. 6).

3. CONSTRUCTIVE SOLUTION

Daimler-Benz had already developed four-wheel drive, four-wheel steering vehicles for the Forest Service in the 1930's (fig. 7). Their rear wheels were designed to turn in the opposite direction to the front wheels so that the vehicle could make sharp turns along narrow mountain roads. However, two of this system's pioneers were Honda's Prelude line and GM's Delphi Quadrasteer. Only a few manufacturers then used active four wheels steering in some of their vehicles, such as Infiniti, BMW, Mazda, Nissan and Toyota.

The 1987 Prelude, featuring the world's first steering angle sensing 4WS.

Fig. 7. Mercedes-Benz 170 VL / W139

Fig. 8. Sierra Denali with Quadrasteer

Today, BMW, Infiniti (in their G and M cars) and Renault (on the Laguna) are the ones that make use of this technology. Let's take, for example, BMW's Integral Active Steering featured on the 7 Series and 5 Series. Under 60 km/h, the front and rear wheels steer in opposing directions to reduce the turning circle and ensure every bend is taken with precision. Above 80 km/h the front and rear wheels turn in the same direction to ensure an extremely comfortable and superior response on the road when changing lanes.

Similarly, the Active Drive chassis with four-wheel steering on the Renault Laguna GT works like this: At speeds of less than 60 km/h, the rear wheels turn in the opposite direction to the front wheels, up to an angle of 3,5°. This brings two advantages: a smaller turning circle, for easy maneuvering; and smaller steering wheel angles thanks to the more direct, specially calibrated steering. With four-wheel steering on the Active Drive chassis, Renault Laguna GT has a 10 per cent smaller turning circle than with two-wheel steering: 10,80 meters (with 18-inch tires) instead of 12,05 m.

With front wheels and rear wheels turning in opposite directions, the car effectively pivots, which means smaller steering angles are needed for the same turning effect. Whereas it takes a 16° steering wheel angle to produce a 1° turn in the front wheels on New Laguna, it takes just 13,5° with the Active Drive chassis. And this drops to 12° when the rear wheels are turned at the maximum 3,5° angle in the opposite direction to the front wheels.

Finally, the electronic control unit on the 4-Wheel Active Steer system (4WAS) from infinity calculates the desired vehicle dynamics from a series of sensors, including vehicle speed and steering angle, and directs the system actuator to change rear geometry by moving both rear suspension lower links.

4. CONCLUSIONS

The Integral Active Steering means four-wheel steering (4WS) or all-wheel steering (AWS), where the steering angle of rear wheels turn in the opposite direction to the front wheels (to reduce turning radius in tight curves) and in the same direction with them (to maintain stability at high speeds). In this way can obtaining a good maneuverability and stability to cars.

The integral system which varies the steering angle of the rear wheels increases safety, stability and comfort to particularly benefit rear-seat passengers. At higher speeds the system ensures extremely comfortable and superior response on the road when changing lanes and in bends. At low speeds the car's turning circle is decreased to enhance performance. In addition to the enhancement of stability in quick direction changes, it also ensures better handling in brake maneuvers.

The rear wheels are turned at an angle of 3,5° with a rack or screw - ball mechanism, controlled by a electronic controller.

5. ACKNOWLEDGMENTS

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6. References

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[2] USA Patent nr. 4552239 – „Four-wheel steering device for vehicle";
[3] USA Patent nr. 4943074 – „Steering mechanism for vehicle rear wheels".