

# Research on the structure of a new type of multi party bicycle system

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**Abstract:** at present, many people’s gathering bicycles suitable for scenic spots, parks and pedestrian streets are popular abroad, but they have not been introduced in China. Based on the analysis of foreign multi person bicycles, this paper improves the suspension device, steering device, transmission device, braking device and parking device of bicycle vehicles, so as to improve the ability of multi person gathering bicycles to adapt to different road conditions and the safety, reliability and comfort in the process of riding. The research results are expected to provide reference for the development of multi-party bicycles in China.

**Key words:** Party bike; Suspension system; Steering system; Transmission system; Security

## Introduction

Since the “double carbon” goal was put forward, many industries have faced opportunities and challenges, and green transportation has aroused heated discussion again. As a travel mode with strong emission reduction benefits, green cycling can achieve the goal of reducing carbon emissions to the maximum extent without refueling and charging. In recent years, multi person party bicycles suitable for closed sightseeing and entertainment environments such as parks, scenic spots and pedestrian streets have become popular in developed countries such as Europe and the United States. Relying on its flexibility, convenience and low-carbon, it has received many inspiration. Based on the structure of the same type of multi-party bicycles in foreign countries, this paper analyzes the load-carrying strength, driving strength, driving force, braking performance, turning stability, passenger comfort, comprehensive reliability and maintenance of multi-party bicycles in China. The mechanical structure of multi person bicycle is studied from five systems: suspension system, steering system, transmission system, braking and parking system.

## 1 research ideas

### 1.1 research objectives

The new multi person gathering bicycle is suitable for parks, scenic spots, pedestrian streets and other closed tourist environments. Passengers can have face-to-face dinners, entertainment and communication activities while riding.

The bicycle is equipped with new suspension system, steering system, transmission system, braking system, differential device and other relatively complete functional mechanisms to improve the vehicle’s ability to adapt to different road conditions and the safety, reliability and comfort during riding.

### 1.2 research content

The main structure of the multi person bicycle is a frame made of high carbon steel and welded into shape (as shown in Figure 1), which has the advantages of lightweight and material saving while ensuring its sufficient safe and reliable strength.

It is characterized by a suspension device, a steering device, a transmission device, a braking device and a parking device. The suspension device connects the frame and the axle. The steering knuckle and the steering synchronous rod in the steering device are installed on the front steering axle. The transmission device is connected to the rear drive axle. The braking device and the parking device are connected to the brake wheel cylinder in the drum brake of the rear wheel.

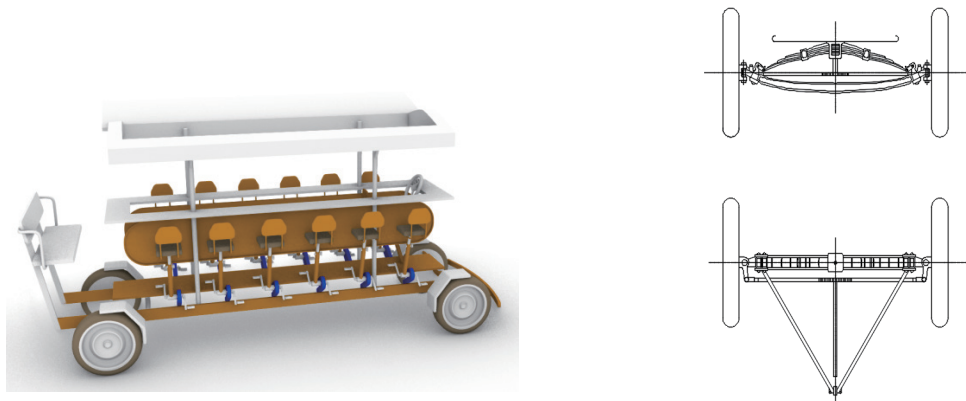


Figure 1 simplified three-dimensional schematic diagram of vehicle Figure 2 Diagram of front steering axle and front suspension

## 2 structural design of suspension system and steering system

### 2.1 structural design of suspension system

The front steering axle of the vehicle is an integral bow steering axle. The left and right front wheels are respectively installed on their

respective steering knuckles, and the latter is hinged with the left and right ends of the front steering axle. The structure is shown in Figure 2.

The steering kingpin is set with an inclination angle and a caster angle to improve the running stability of the front wheels and at the same time, so that it can spontaneously produce a “righting” trend. In this way, after the end of steering, during the operation of front wheel righting, the rotation torque that the driver needs to apply can be reduced, which can also improve the safety of the vehicle during straight-line driving and reduce the operation difficulty of the driver.

The rear drive axle is an integral drive axle, with a reducer and differential in the center. Among them, the reducer can play the role of reducing speed and increasing torque, and ensure that the rear wheels have sufficient driving torque while limiting the running speed of the vehicle, so as to easily cope with uphill and other road conditions; The differential makes the vehicle turn more smoothly, avoids the phenomenon of unilateral driving wheel slipping, and can effectively avoid a series of potential safety hazards.

The front steering axle and the rear drive axle of the vehicle are equipped with non independent suspension systems of the same mode. The above two axles use a transversely arranged leaf spring (i.e. front transverse leaf spring and rear transverse leaf spring) as the elastic element, and are connected with the triangle suspension hinged at the bottom of the frame (i.e. triangle front suspension and triangle rear suspension). The left and right ears of the front transverse leaf spring are hinged on the left and right front leaf spring lugs of the front steering axle respectively, and the middle of the front transverse leaf spring is clamped by the central limit device of the front leaf spring bolted to the frame; The left and right ears of the rear transverse leaf spring are hinged on the left and right rear leaf spring lugs bolted to the rear drive axle, and the middle of the rear transverse leaf spring is clamped by the central limit device of the rear leaf spring bolted to the frame.

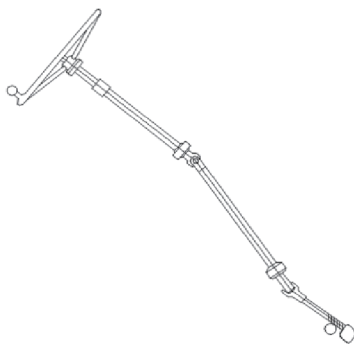
When the wheel encounters a bumpy road, the axle will jump upward with the hinge point of the triangle suspension and the frame as the center of the circle and the vertical distance from the point to the axle as the radius. The transverse leaf spring will deform under upward pressure, and then the steel plates will move wrongly. In this process, the leaf spring offsets the bumping force from the road surface through the friction generated by the elasticity of the steel plate itself and the staggering between the steel plates. While absorbing the shock and releasing the force, it protects the weak structures of the vehicle chassis and improves the vehicle life and passenger comfort. This type of single leaf spring transverse arrangement is common in the front axle of older cars in the last century. While ensuring the bearing capacity of the axle and absorbing the vibration of the road surface, the use of only one leaf spring can not only reduce the weight of the car, but also reduce the production cost.

### 2.2 structural design of steering system

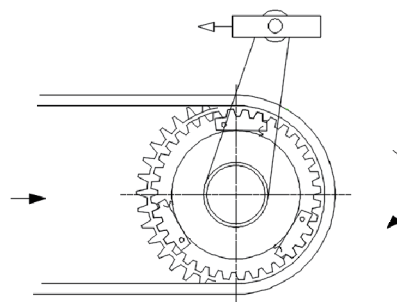
The grip ring of the steering wheel is equipped with a free-form ball head grip that can rotate freely, enabling the operator to control the steering wheel with one hand.

The steering system is composed of steering wheel, 2 sections of steering transmission shaft, 2 groups of cross axle universal joints, 2 groups of bearing fixed supports and steering gear. The structure is shown in Figure 3. The No. 1 steering transmission shaft connects the steering wheel with the No. 1 cross shaft universal joint, the No. 2 steering transmission shaft connects the No. 1 cross shaft universal joint with the No. 2 cross shaft universal joint, and the No. 2 cross shaft universal joint is connected to the steering gear. The steering gear is a rack and pinion steering mechanism, and the upper end of the steering gear shaft is connected with the lower fork arm of the No. 2 cross shaft universal joint through a telescopic spline shaft, The lower end is connected to the fixed bearing support installed on the front axle to ensure that the steering gear shaft can still closely cooperate with the steering rack of the steering synchronizing rod when the front wheel passes through the bumpy road and the front steering axle jumps up and down, without affecting the normal operation of the steering device.

The No. 1 steering transmission shaft and the No. 2 steering transmission shaft are respectively connected through the No. 1 bearing fixed support and the No. 2 bearing fixed support welded to the frame. The No. 1 cross shaft universal joint and the No. 2 cross shaft universal joint can change the inclination angle between the No. 1 steering transmission shaft and the No. 2 steering transmission shaft, so as to shorten the lateral distance between the steering wheel and the steering synchronous rod, Thus, the length of the car head is shortened, and the compactness of the car head structure is increased while reducing the cost; Among them, the No. 1 steering transmission shaft and the steering shaft maintain a coplanar and parallel relationship in space through two sets of cross axle universal joints, so as to ensure the constant speed of transmission in the steering process as much as possible.



**Fig. 3 steering mechanism**



**Fig. 4 driving mechanism at the feet of each passenger**

### 3. structural design of transmission, braking and parking system

#### 3.1 structural design of transmission system

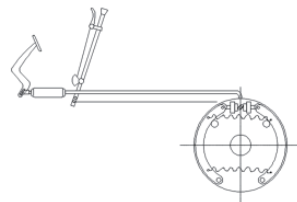
A set of toothed discs with unidirectional transmission function is set under the feet of each passenger. The structure is shown in Figure 4. There is a unidirectional clutch inside the toothed disc. Its core structure is the cooperation between the pawl and the ratchet ring with unidirectional transmission function, so as to prevent the crank from being driven reversely by the inertia from the transmission system, so as to protect the safety of passengers' legs. That is, each passenger can only output torque in one direction through the tooth disc. The toothed disc drives the transmission shaft installed in the center of the chassis through a chain, which is equipped with a transmission shaft universal joint to drive the reducer and differential located in the center of the rear drive axle. The driving structure is simple and reliable, without frequent maintenance.

#### 3.2 structural design of braking and parking system

The bicycle vehicle is equipped with a human hydraulic braking system. The brake pedal is located under the driver's right foot. The brake wheel cylinders in the two rear wheel drum brakes work through the brake master cylinder and brake oil pipe. The system is a fully sealed structure. Among them, the diameter of the cylinder cavity of the brake master cylinder is smaller than that of the brake wheel cylinder. Theoretically, the pressure can be approximately equal everywhere in the closed oil circuit. According to Pascal principle, the system can amplify the driving force of the driver to step on the brake pedal, so that the brake wheel cylinder can obtain sufficient braking pressure.

#### 3.3 structural design of braking and parking system

The bicycle vehicle is equipped with a mechanical pull-line parking brake. The parking brake pull rod with the parking brake pull rod self-locking device is located on the right side of the driver. Pull the parking brake pull rod backward, and the parking brake cable will then pull the brake wheel cylinder to work, so that the rear wheel drum brake generates parking braking force to realize parking. Because the parking brake pull rod self-locking device has self-locking effect, The brake wheel cylinder can always maintain the parking brake force. When releasing the parking brake, you need to grip the self-locking release handle of the parking brake pull rod installed in front of the parking brake pull rod, and push the parking brake pull rod forward in place.



**Figure 5 diagram of braking mechanism and parking mechanism**

Headlights can be set in front of cyclists, and road safety devices such as tail lights and reflective warning signs can be set behind cyclists. The frame is equipped with a game table for riders' entertainment, and each passenger seat can be equipped with a backrest and a simple two-point safety belt.

## 4 Conclusion

This new type of multi person bicycle suitable for scenic spots is not only a tool for travel and entertainment, but also has the characteristics of low-carbon and environmental protection. With the goal of building a green travel city put on the agenda, bicycle will become a large system of sustainable and healthy development, and the development prospect is very broad. According to the design improvement in this paper, it not only reflects the basic functions of the bicycle, but also increases the unlimited entertainment value, so that users can get a more comfortable experience. In the follow-up research center, more in-depth research will be carried out on mechanical processing, materials, shape design and other aspects to design a new type of multi person bicycle with higher cost performance.

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