

## Research Article

### Research and Design on Amphibious Limousine

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**Abstract:** The aim of this study is to design an amphibious limousine, of which the shape is beautiful, the structure is simple and reasonable and the safety performance is good and which is in line with the ergonomics and achieves the double function of traveling in water and on ground, in order to achieve people's long-cherished wish. This study specifically researches its shape design, color design and the design of retractable wheel, overwater power and overwater steering device, including the technical parameters of amphibious limousine. And then its feasibility is analyzed. On this basis, the corresponding conclusions are reached.

**Keywords:** Amphibious limousine, color design, shape design, steering device

#### INTRODUCTION

The development of amphibious car has hundreds of years. The first amphibious car of recorded by data was invented by an American Oliver Evans in 1805. In order to travel in water, Oliver Evans installed the axle and the paddle wheel in the car and the paddle wheel were driven with the belt and belt pulley of engine fly wheel axle. When this amphibious car went into the water, the paddle wheel of the rear began to work. A more accurate description was that the invention of Oliver Evans should be referred to as a ship equipped with wheels using steam as power. If judging from the structure and the use, this invention was a car of only walking in water. The amphibious car of recorded by photograph in the true sense should be the one made by the Austrian army during the First World War, but for various reasons, this car was not produced in quantity.

It is in the military field that amphibious car really get used and produced in quantity. The more famous amphibious car is the Volkswagen 166 of Germany's equipment during the Second World War, of which the top speed driving on land is close to 90 km/h, in water about 10 km/h (Wei and Jiang, 2012). After Equipped troops later, the car was widely welcomed by German soldiers and by the end of 1944, the plants of Wolfsburg and Porsche located in Stuttgart produced a total of 14238 (Wu *et al.*, 2004).

In recent years, the research and development on amphibious car for civil use is also attached great importance and the inventors from different countries have designed the different styles of amphibious cars (Zhang, 2000). For example, a company in England has

successfully developed an amphibious car, of which the top speed driving on land is close to 100 miles/h, in water about 30 miles/h.

Recently, Gibbs technology company and Lockheed Martin company began to unite for the military to develop three kinds of amphibious vehicle platforms: the first kind of platform is the amphibious Expeditionary Combat Aircraft (ACC-E), of which the length is 6096 mm, the speed driving on land is 128.7 km/h, in water 72.4 km/h; the second kind of platform is the amphibious River battle Aircraft (ACC-R), of which the length is 10668 mm, the speed driving on land is 104.6 km/h, in water 64.4 km/h; the third kind of platform is Terraquad, of which the speed driving on land is 80.5 km/h and in water exceeds 88.5 km/h. The joint development plan of the two countries of Britain and the United States actuates a new round of development on high speed amphibious vehicle for military.

The experts in the world automobile manufacturing industry think that the amphibious car will be popular in the 21<sup>st</sup> century and the human could realize the long-cherished wish of travelling across the seas and around the world by driving directly (Xiao, 2008), so the amphibious vehicle will be having broad design space (Wang *et al.*, 2004).

The aim of this study is to design an amphibious limousine, of which the shape is beautiful, the structure is simple and reasonable and the safety performance is good and which is in line with the ergonomics and achieves the double function of traveling in water and on ground, in order to achieve people's long-cherished wish.

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## RESEARCH SIGNIFICANCE OF AMPHIBIOUS LIMOUSINE

The development of amphibious limousine is not only on behalf of the scientific and technological level and industrial development level of a country, but also on behalf of the input of investing the science and technology in civil use and the high-low of people's cultural life level. Amphicar is the perfect combination of car and ship, having very high technology content. The research and development and the use of this vehicle not only could improve people's living standards, promote the development of tourism industry, improve the ability of innovation in science and technology and industrial manufacturing capacity and strengthen the national defense, but also could improve the rescue and response capacity to disasters such as the flood and marine perils. If the modified amphicar is used for the civil vehicle in the topography of inland on water and rescue vehicle, it not only could facilitate people's travel, but also could improve the environment and reduce casualties and property losses caused by the floods. Therefore, it has great theoretical significance and practical significance to design the safe, convenient and reliable amphibious limousine that is suitable for water and land use.

### DESIGN METHODS OF AMPHIBIOUS LIMOUSINE

**Shape design:** Appearance shape adopts bionic design, taking the tortoise image as the main shape. This shape is not only lively and creative, but also could relax mood. And the tortoise is typical amphibious reptile, having the moral of good health and a long life and safeness, which is very accord with the design intent, so it is better to simulate its appearance.

**Color design:** The color design is an important component of the amphibious limousine, as color has more ocular, more strong and more attractive magic power than the body. The color could firstly influence the person's sense organs than the body. So it should pay attention to the color design (Jiang, 2013a). The color design of amphibious limousine should follow the following few important points.

**Value the choice of tone:** The choice of main tone of amphibious limousine is a problem of very importance; the different tone will form different art effect. In matching color of amphibious limousine, having main tone can seem to be to unify. The color is more little, the main body characteristic is more strong, the decorate characteristic is more good and the external form relation of amphibious limousine is more unify (Jiang, 2011). Contrary, the color matches more much, causing the color more disorderly, so that it is difficult to adjust generally, the main body characteristic is unclear and the harmonious effect is broken.

The choice of tone still needs to notice whether unique beauty. It needs to hold tight people's mental request for the color of amphibious limousine, transform the tone of amphibious limousine to make it produce an unusual attraction, in the meantime, increase the category of tone to satisfy people's fondness for different colors (Fu, 2002).

Moreover, the car body of amphibious limousine is suitable to adopt the color that the lightness is relatively high as the main body color, using clear, elegant and clean color to unify overall situation to make the main tone definite. Using little area of high purity color to embellish to make the whole seem to be abundant, change and organic. The whole color generally uses monochrome or two sets of colors, not more than three sets of colors (Fu, 2002).

**Notice novelty:** The color design of amphibious limousine should notice novelty and creativity to make it have vitality and more competitiveness. The color of amphibious limousine not only can satisfy the request for appreciating beauty, under the particular condition, but also has strong influence, which can cause the transfer of people's emotion and interest to attract people's attention (Jiang, 2013b).

**Match the new age request of appreciating beauty:** With the progress of the age, the improvement of people's living standard and the increase of cultural art accomplishment, the appreciating beauty standards also change. In a certain period or a certain region or world scope, some colors are popular of people and are extensively popular, becoming the "popular color". The "popular color" has a strong age characteristic, as a result, in a period, it become the color which is used extensively. The color design of amphibious limousine also should sufficiently consider using the "popular color" to accord with the age request.

**Retractable wheel design:** When sailing in the water, the vehicle puts the wheels above the seal plate to reduce the resistance; when the vehicle will be entering the land, it lays the wheels down, performing the function of driving on land (Xu *et al.*, 2004).

**Overwater dynamic design:** Amphibious limousine not only travels on land, but also sails in water. In order to ensure that it has a certain speed and enough buoyancy, the body structure should be simplified as far as possible to reduce the weight. Therefore, in the case of having a set of power mechanism, it should not design another set of power mechanism. In this way, not only is the structure complex, increasing the weight of the vehicle, making the engine load increase (Yang, 2003), but also too many mechanisms will lead to the vehicle performance instability, making the maintenance and repair become complex and increase the design cost.

Therefore, the overwater transmission mechanism of this amphibious limousine is added on the basis of onshore transmission mechanism. In this way, it not

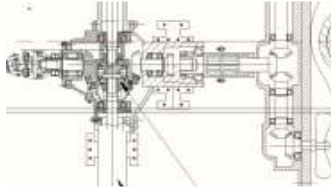


Fig. 1: Joining up device design of overwater dynamic

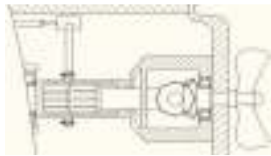


Fig. 2: Gear coupling controlled by the hydraulic system

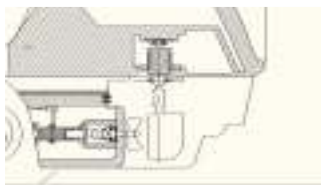


Fig. 3: Overwater guide mechanism

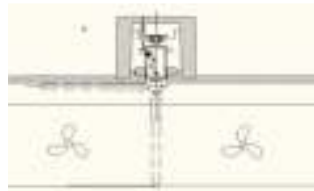


Fig. 4: Retractable overwater guide mechanism

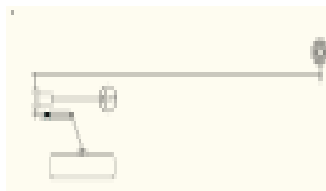


Fig. 5: Overwater steering mechanism

only could reduce the weight of vehicle, increase buoyancy, reduce the load, but also could save the design cost. The overwater drive adopts water drive and the propeller power is joined up from the main reducing gear of the rear axle, as shown in Fig. 1. The method of joining up and the one of connecting to main reducing gear of the rear axle from the power divider is similar, adopting the bevel gear to join up, of which the size is the same as the type of axle drive bevel pinion of reducer. It is shown from Fig. 2 that the other side of joining up bevel gear is the spline gear, of which the rotating speed and the one introduced from the power divider to the rear axle is same. It is a gear coupling controlled by the hydraulic system after it, which could control the connecting and disconnecting of propeller

power. The several sets after it is constant speed drive, that is, the rotating speed of the propeller and the one introduced from the power divider to the rear axle is same. This structure design not only saves space, but also flexible, reducing the weight of the vehicle, saving the production cost and more reducing the loss of energy, which is in line with the green design concept.

**Design of overwater steering gear:** This amphibious limousine adopts symmetrical arrangement of double-screw and the guiding manner of single rudder. In order to travel conveniently and reduce wear and tear, when driving on land, the guiding rudder could be put away (Jin, 1986), as shown in Fig. 3 and 4.

Retractable guiding rudder is controlled by hydraulic system and four-bar mechanism jointly. When the sliding sleeve connected hydraulic system is at the top, the guiding rudder is in the state put away, of which the axis of rotation is in a stuck state. When hydraulic lever pushes the sliding sleeve to move down, the spring of four-bar mechanism is depressed, so as to make it and the connecting rod connected by guiding rudder move up and away from the axis of rotation of guiding rudder. Under the action of hydraulic link mechanism, the guiding rudder turns downward around the axis of rotation. When turning to  $90^\circ$  with the ground, another card slot of axis of rotation of guiding rudder is jammed again with inside four-bar mechanism. At the same time, the sliding sleeve connected to hydraulic lever, the axis of rotation connected to guiding rudder and the steering wheel connected to the connecting shaft connected to the steering gear of gear circulation join together, making the guiding rudder be directly controlled by the steering wheel to rotate in the horizontal plane, thus making the amphibious limousine turn in the water, as shown in Fig. 5. When it will be getting to land from water, the hydraulic lever pushes the sliding sleeve to move up. As moving to the spring button of inside four-bar mechanism, the spring of four-bar mechanism is depressed, so as to make it and the connecting rod connected to guiding rudder move up and away from the axis of rotation of guiding rudder. Under the action of hydraulic link mechanism, the guiding rudder turns upward around the axis of rotation. When turning to horizontal with the ground, the card slot of axis of rotation of guiding rudder is jammed again with inside four-bar mechanism. This moment the hydraulic lever stops moving and the guiding rudder is fixed. Moreover axis of rotation connected to the guiding rudder is disconnected with the steering wheel connected to the connecting shaft connected to the steering gear of gear circulation. As this moment it is the movement of land, the turn also will be passed on to the steering wheel but not to the guiding rudder.

**Technical parameters of the amphibious limousine:** It has a rated seating capacity of 6 people and the speed of 15-45 km/h. The vehicle bottom installs the hull

bottom structure which could enhance the travel speed in water.

### CONCLUSION

All components and parts of this amphibious limousine all select and use lightweight, durable and waterproof special materials, which reduces the weight of car bodies by a big margin, thus reducing the engine load and the pressure of the suspension and wheels. The whole car body adopts enclosed structure. These parts of car body that are in contact with the water are completely sealed and the calculation of propeller and displacement was carried out. The key technology of this design is retractable wheel design, retractable guiding rudder design and the joining up and cutting off of the overwater dynamic. The power of the propeller is from the driven bevel gear of the main reducing gear of rear axle. The bevel gear that cooperates with the driven bevel gear joins together with the spline gear, which with the gear coupling controlled by the hydraulic system could control the joining up and cutting off of the power of the propeller. The several sets after it is constant speed drive, that is, the rotating speed of the propeller and the one introduced from the power divider to the rear axle is same. This structure not only simplifies the structural arrangement of transmission, but also reduces the weight of car bodies and the cost of production, which is in line with the green design concept. The amphibious limousine has very high feasibility, of which the power is similar with SUV, suitable for all kinds of road surface. The appearance adopts the bionic modelling of the tortoise, which is very accord with the fundamental concept of this design. It is suitable for using on water and land and is safe, convenient and reliable.

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