The design of cross-country mechanism of multi wheel ring apply in electrical controlled vehicles and robots

Rong Zhang*, Yongkang Yang, Hui Li
School of Mechanical and Electrical Engineering, Wuhan Donghu College, Wuhan, China

*Corresponding author: zhangrong@wdu.edu.cn

Abstract. This paper designs a new type of walking mechanism--the walking mechanism of multi wheel ring, which is mainly to solve the problem that the suspension system of wheeled running gear and crawler walking mechanism are too complicated to reduce the reliability of the whole structure; The multi wheel ring of the walking mechanism has multiple degrees of freedom, whose shape can change with terrain. With regard to different ground, the multi wheel ring can form corresponding shape to adapt to complex ground, thus it has a strong cross-country capability. The walking mechanism of multi wheel ring can apply to off-road vehicles, robots and tanks.

Keywords: multi wheel ring, cross-country mechanism

1. The preface
Currently, it is well known that crawler walking mechanism, wheeled running gear and foot walking mechanism are widely used in vehicles and robots. Foot walking mechanism of walking environment is very low, which can walk the unstructured complex ground and has good adaptability to the environment, while crawler walking mechanism and wheeled running gear achieve cross-country walking by suspension system, though the cross-country performance is significant, the suspension system is too complicated, which reduces the reliability of the whole structure.

2. The design of walking mechanism of multi wheel ring
In view of the above problems that the walking mechanism exists, this paper provides the walking mechanism of multi wheel ring. The walking mechanism is made up of the car-body 1 and both sides of two multi wheel ring 2. The multi wheel ring consists of the support plate, connecting rod and annulus, as shown in figure 1 and figure 2.

Figure 1. The chassis of the walking mechanism of multi wheel ring structure
Figure 2. The walking mechanism of multi wheel ring connection diagram

There are six evenly distribution of the lugs in the inner circumference of the annulus, every lug has a ring hole, the annulus is two or one and a half times as thick as the lug, which can ensure the lugs have certain structural strength. The six lugs evenly and alternately distribute on both sides of cylindrical face of the annulus so as to prevent the structure interference in process of the multi wheel ring operating, as shown in figure 3.

Figure 3. Structure of the annulus

There are three evenly distribution of the lugs on the outer circumference, every lug has a location hole, as shown in figure 4.

Figure 4. Structure of the support plate

As shown in figure 5, There is a internal spline in the center of the support plate, which connects the external splines of output shaft of the car-body, in this way, the multi wheeled ring gains power. Three lugs of the support plate, which are located in the inside of the ring, connects a group of wheel holes in a side of the ring by fastener connection, another group of ring holes in the other side of the ring connects the another group of ring hole of the next ring by hinge joints which is made up of three connecting rods and pins, the three connecting rods parallel to each other. We use hinge joints to link between ring and ring, having been assembled, each ring of the multi wheel ring staggers the arrangement mutually. As shown in figure 6.
Having been assembled by using the method described above, the multi wheel ring has multiple degrees of freedom (degrees of freedom and the quantity of rings are directly related) the shape of the multi wheel ring can change with terrain, so it has strong adaptability to complex ground. We should ensure the multi wheel ring has a certain laxity, when we install it to the car-body, thus for different height of ground, the multi wheel ring can form corresponding shape to adapt to complex ground, as shown in figure 7.

When it operates, power out-put shaft rotates ring through the permanent connection between the support plate and the ring, then ring drives ring by connecting rod transmission. So all rings of the multi wheel ring are rotating, and then the car-body moves.

We design walking mechanism of the multi wheel ring, meanwhile, we also consider its reliability. Between ring and ring, we use a group of connecting rods (three connecting rod) to splice. When one rod is damaged, all rings still function well by the remaining two links transmission. Based on above characteristic, the reliability of walking mechanism is improved significantly.
3. Conclusions
This paper designs a new type of walking mechanism—the walking mechanism of multi wheel ring, the walking mechanism have significant cross-country performance and strong adaptability to complex ground, meanwhile we also have consider the demand of reliability of the multi wheel ring. Walking mechanism of multi wheel ring can apply to off-road vehicles, robots and tanks, to substitute for crawler walking mechanism and wheeled running gear, it can play a significant role in military, geological exploration and earthquake relief work.

The multi wheel ring can be folded and unfolded because of its special structure. As shown in figure 8 the folded state of the multi wheel ring. Based on above characteristic, the multi wheel ring could apply to mars rover and lunar rover to deal with unstructured complex surface of outer planets.

Figure 8. The folded state of the multi wheel ring

References
[1] China Mechanical Design Canon editorial board. China Mechanical Design Canon (All six volumes). JiangXi Science and Technology Press, 2002.
[2] Neil sclater (America), Nicholas P.C hironis (America). The mechanical design and practical institutions and device atlas. Mechanical Industry Press. 2007.
[3] Pu LiangGui, Ji MingGang. Mechanical design. Higher Education Press, 2013
[4] Sun Huan, Chen ZuoMo, Ge WenJie. Mechanical principles, the eighth edition. Higher Education Press. 2013.
[5] Wen BangChun. Mechanical design handbook. The fifth edition [M]. Mechanical Industry Press. 2010.
[6] Wu Hao, Zong ZhenJi, Zhang Lei, Mechanical design course design manual. Higher Education Press. 2011