

## Design of Electromagnetic Intelligent Anti-theft Lock for Bicycle Axle

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### Abstract

The social problem of bicycle theft is very serious. A new type of bicycle anti-theft lock with axle electromagnetic is designed in this paper. The bicycle lock is arranged in the bicycle axle part, not removable, no lockhole, with intelligent unlock and lock function. Its working principle and structure are discussed in detail. The prototype model is used to make the preliminary study, which proves the feasibility of the scheme. It is a good solution to the serious social problem of bike theft and greatly improves the safety performance of the bike.

### Keywords

bike theft, wheel axle, electromagnetism, Tamper nuts, anti-theft lock.

### 1. Introduction

Bike theft problem plagued the people for a long time. This is a very serious social problem. The traditional bicycle lock is commonly chain lock or ring lock, and this kind of lock can be cut, the wheels of the bike can be remove, and theft can unlock it through the lockhole. If design a lock that can solve the problem above, the problem of bike theft will be solved.

In recent years, the researchs of the bike lock from the domestic and foreign scholars are the following several aspects . (1) Combining the value of bike with lock ; The literature [1] proposed a bicycle lock which combined the lock with the pedal. (2) The study of intelligent bicycle lock ; The literature [2] introduced a bike lock which can unlock it by fingerprint. The research above has made some achievement, but it is not solved the problem fundamentally. Theft can also cut the lock , remove the wheels , and unlock it through the lockhole . Therefore , a new type of bicycle anti-theft lock with axle electromagnetic is designed in this paper. The bicycle lock is arranged in the bicycle axle part, not removable, no lockhole , with intelligent unlock and lock function. The prototype model is used to make the preliminary study, which proves the feasibility of the scheme. It is a good solution to the serious social problem of bike theft and greatly improves the safety performance of the bike.

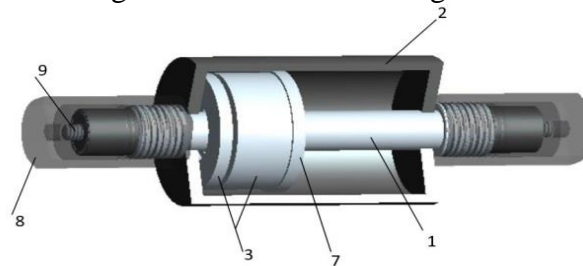
### 2. The profile of the bicycle wheel electromagnetic intelligent anti-theft lock

#### 2.1 Structural composition

The Install schematic diagram is shown in Fig. 1. The lock is in the the bicycle wheel shaft as the Fig. 1 shows. The schematic diagram of the overall structure is shown in Fig. 2. The bicycle lock is made up of mechanical transmission part and the electronic control part ; The mechanical transmission part includes inner shaft1 , shell 2 , electromagnetic brake 3 , stator 7 , nut 8 and dynamo 10. The electromagnetic brake 3 is made up of flexure strip 4 , armature 5 and electromagnet 6. The electronic control part mainly includes the remote control 17, launchers 18, receiver 19, central processing system 20, control system 21, power supply 27 and speed measuring device 28.



Fig. 1 Install schematic diagram



1.inner shaft , 2.shell , 3.electromagnetic brake, 7. stator, 8.nut , 9.shaft

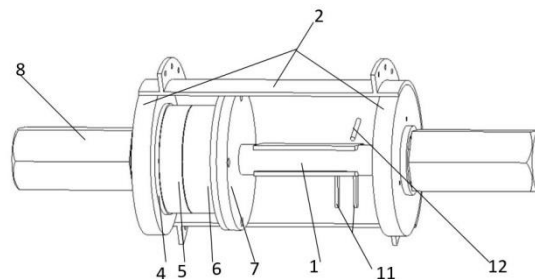
Fig. 2 Schematic diagram of the overall structure

**2.2 The working principle of bicycle wheel electromagnetic intelligent anti-theft lock**

**2.2.1 The working principle of the lock and unlock**

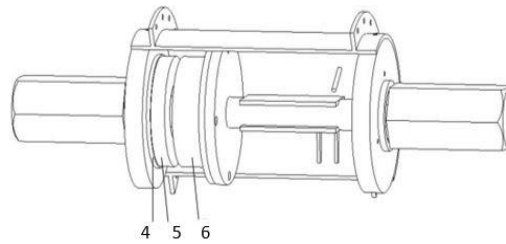
The armature 5 of electromagnetic brake 3 is connected with the shell 2 by bolt .The electromagnet 6 of electromagnetic brake 3 is connected with inner shaft 1. When the electromagnet 6 powers on , the deformation of adiprene 4 occurred , and the armature 5 is connected with the electromagnet 6 , so the inner shaft 1 is connected with the shell 2 to lock the bike, see Fig.3. when the electromagnet 6 power outages , the electromagnetic brake 3 is separated to unlock the bike, see Fig.4 .Use the separation or combination of the armature 5 and the electromagnet 6 to lock or unlock the bike.

If the electromagnetic brake 3 powers on for a long time, it not only produces a lot of calories but also consumes large amounts of energy. Therefore , add the speed measuring device to the lock . The photoelectric sensor 11 of the speed measuring device is connected with the inner shaft 1,and the shade 12 of the speed measuring device is connected with the shell 2. When the thief tries to push the bike , the shade 12 which located on the shell sweep the photoelectric sensors 11 which located on the inner shaft 1. the electromagnet 6 powers on at this time , and the deformation of adiprene 4 occurred , and the armature 5 is connected with the electromagnet 6, so the inner shaft 1 is connected with the shell 2 to lock the bike.



1.inner shaft , 2.shell ,4. adiprene , 5. armature, 6. electromagnet, 7. stator, 8.nut , 11,photoelectric sensor,12,shade

Fig.3 Structure diagram of locked structure

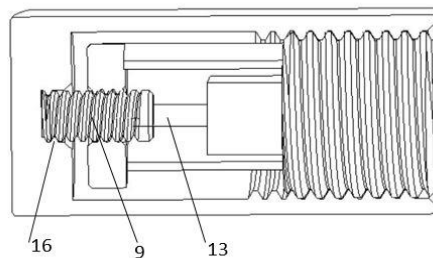


4. adiprene , 5. armature, 6. electromagnet

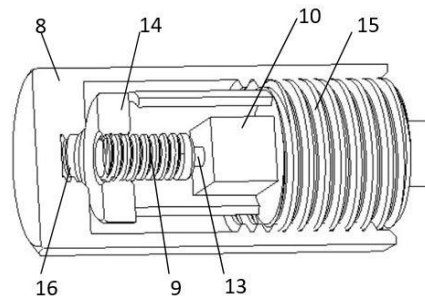
Fig.4 Schematic diagram of unlocked structure

2.2.2 The working principle of self-lock nut

The structure of the self-lock nut is shown in Fig.5. The dynamo 10 is connected with the end of inner shaft 1. When the user press the button1 of the remote control , The motor shaft 13 twirls with clockwise rotation , and the shaft 9 twirls outward until connect with the nut 8 by The screw thread . the nut 8 is connected with the inner shaft 1 by left-hand thread and the nut 8 is connected with the shaft 9 by right-hand thread . so others can not remove the wheels. When the user press the button2 of the remote control , The motor shaft 13 twirls with counterclockwise rotation, The motor shaft twirls with counterclockwise rotation , and the shaft 9 twirls inward until the nut 8 and the shaft 9 separated. The nut 8 is only connected with the inner shaft 1 by left-hand thread at this time .As is shown in the Fig. 6, the wheels can be removed.



9.shaft, 13. motor shaft, 16. screw thread  
Fig.5 Schematic diagram of detachable nut



8. nut ,9.shaft,10,dynamo, 11, photoelectric sensor,13.motor shaft ,14. connection ,15.screw thread1 , 16. screw thread2

Fig.6 Schematic diagram of non removable nut

**3. Model validation**

According to the design scheme of the bicycle wheel electromagnetic intelligent anti-theft lock, we produce the prototype model. See Fig.7 and Fig.8. The prototype model is used to make the preliminary study, which proves the feasibility of the scheme. It is a good solution to the serious social problem of bike theft and greatly improves the safety performance of the bike.



Fig. 7 Diagrammatic figure 1

Fig. 8 Diagrammatic figure 2

#### 4. Conclusion

A new type of bicycle anti-theft lock with axle electromagnetic is designed in this paper. The bicycle lock is arranged in the bicycle axle part, not removable, no lockhole, with intelligent unlock and lock function. It is a good solution to the serious social problem of bike theft and greatly improves the safety performance of the bike. The bicycle lock structure is simple and practical.

#### References

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