

Wheel slip dump valve for railway braking system

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Abstract. As we all know, pneumatic braking system plays an important role in the safety of the whole vehicle. In the anti slip braking system, the pressure of braking cylinder can be adjusted by the quick power response of wheel slip dump valve, so that the lock situation won't occur during vehicle service. During the braking of railway vehicles, the braking force provided by braking disc reduces vehicle's speed. But the locking slip will happen due to the oversize of braking force or the reduction of sticking coefficient between wheel and rail. It will cause not only the decline of braking performance but also the increase of braking distance. In the meanwhile, it will scratch the wheel and influence the stable running of vehicles. Now, the speed of passenger vehicle has been increased. In order to shorten the braking distance as far as possible, sticking stickiness must be fully applied. So the occurrence probability of wheel slip is increased.

1. Introduction

With the development of high-speed and heavy loading railway vehicle, the use of effective anti slip system can solve the problem of scratching surface and low use ratio of stickiness. Anti slip system control the exhausting, maintaining, sucking operation of braking cylinder by wheel slip dump valve according to the measurement of wheel's speed from speed sensor and the requirement for controlling. Anti slip system is mainly consist of speed sensor, controlling device, wheel slip dump valve and so on. Wheel slip dump valve is the performing component for anti slip system, which has the basic characteristics of fast response, high reliability, long life.

As is known to all, the response ability of wheel slip dump valve is the most important ability in anti slip air braking system of railway vehicles. Wheel slip dump valve has 4 actions: staged filling, staged venting, fast filling, fast venting. It can realize the braking of railway vehicles by those 4 actions. The faster the response time of this product is, the better braking results of vehicles could be achieved. If the response time of the wheel slip dump valve delays, the pressure in the braking cylinder will not be able to exhaust and fill in time, eventually, it will cause the insufficient braking of vehicles and then unnecessary accident occurs.

To optimize the response time of wheel slip dump valve, our company redesigned the structure and material of magnet valves and optimized some parameters of body which influence the performance of wheel slip dump valve.

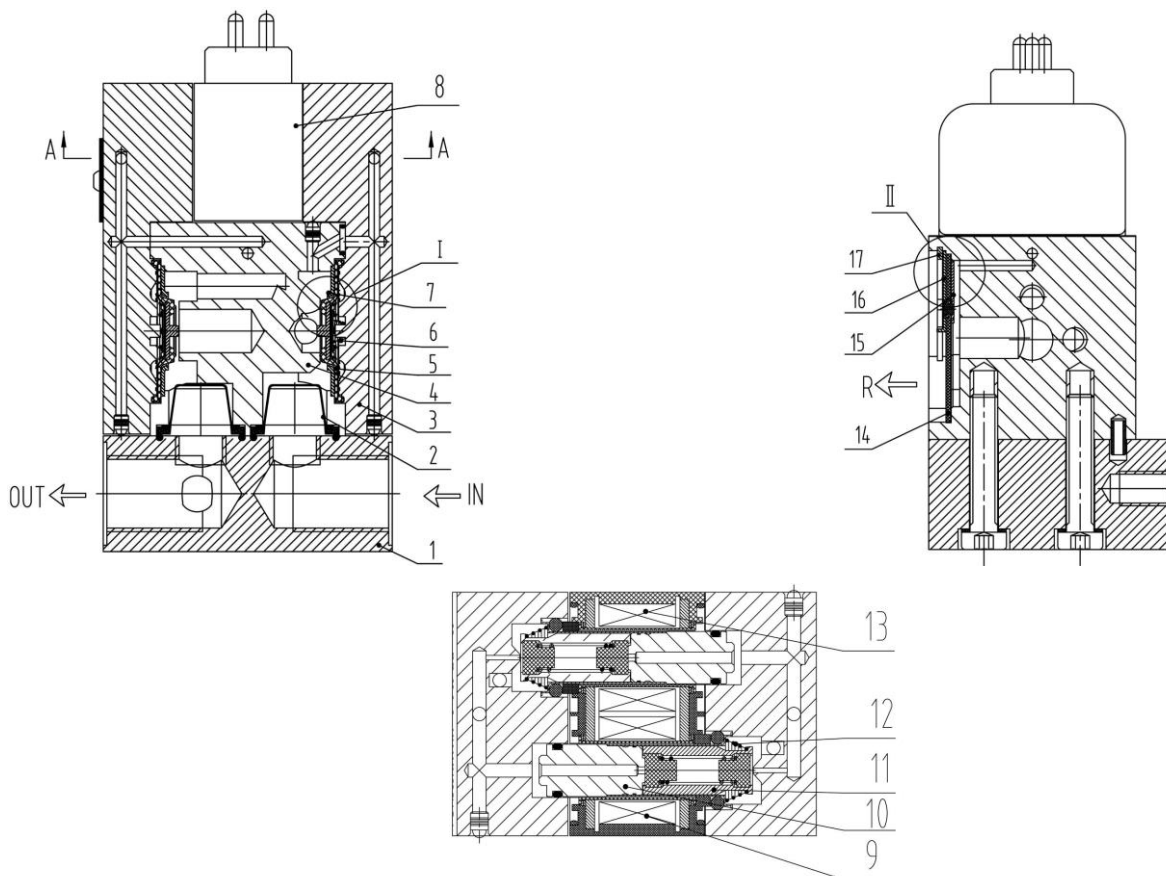
2. Description of structure and operating principle

Wheel slip dump valve which is shown on figure 1, consisting of magnet valve assembly, body, connecting plate, exit(OUT) and entrance(IN). During braking process, air comes from relay valve goes to braking cylinder by wheel slip dump valve. If the wheel tends to slip, wheel slip dump valve



works to decrease the pressure in braking cylinder to achieve the anti slip of wheels. In order to achieve fully use of the braking force, wheel slip dump valve works periodically without wheel slip occurs.

As is shown on Figure 1, solenoid valve under de-energized position, entrance IN sucks air and then the air pushes the diaphragm in right side and goes to output OUT. Later, providing power supply for solenoid valve in inlet side, right side's diaphragm contacts with body, cutting the channel between entrance IN and output OUT. If we want to decrease the pressure in the output side, providing the power supply for solenoid valve in output side, left's diaphragm leaves body, air in output side exhaust to atmosphere. If we want to increase the pressure in output side, stopping the power supply for solenoid valve in both side, air comes from entrance IN push right's diaphragm and goes to output OUT, so the pressure in output side is increased.



1.connecting plate, 2.filter screen, 3.cover, 4.body, 5.diaphragm, 51.raised valve, 52.raised point, 6.diaphragm pressure spring, 7.bush, 8.magnet valve, 9.inlet coil group, 10.static iron core, 11.dynamic iron core, 12.spring, 14.venting diaphragm, 15.diaphragm internal plate, 16.diaphragm external plate, 17.check ring

Figure 1 Structure Diagram

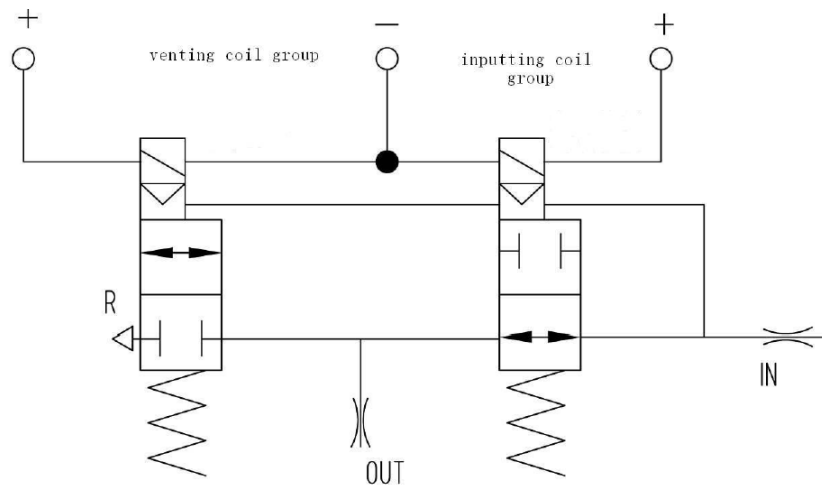


Figure 2 Coil Groups Diagram

When the coil group of magnet is in de-energized position, once the entrance(IN) sucks air, the exit(OUT) will output the air immediately. If the coil group in the inlet side is in energized position, the diaphragm 5 will connect with body 4 so that entrance(IN) and exit(OUT) are in cut position. Providing power supply to the coil group in the output side, and then venting diaphragm will leave from body so that the compressed air in exit(OUT) can exhaust to atmosphere by venting diaphragm, the pressure in exit(OUT) side is reduced. If we want to increase the pressure in exit(OUT) side, coil group in entrance and exit sides should be in de-energized position so that the compressed air sucks from entrance(IN) will go to exit(OUT).

3. Research and development process

We redesigned the structure of magnet valve and body based on the technologies of existing ABS wheel slip dump valve in our company. The performance's characteristics are shown as following:

- (1) sucking and exhausting characteristic(periodic sucking, periodic exhausting, fast sucking, fast exhausting)
- (2) Electric characteristic(working at 16.8V-31.2V)
- (3) Insulation(>100MΩ@DC500V)
- (4) Pressure resistance(won't be breakdown@DC1500V,>1 min)
- (5) Electric resistance($75 \pm 5\Omega @ 20^\circ\text{C}$)
- (6) Sealing performance(sealing performance is proven under energized and de-energized position)
- (7) Durability(function remains normal after 5 million's working times)
- (8) Protection(a certain capacity to protect products from external dust and water)
- (9) Temperature resistance(working normally under low/high temperature, and keep the sealing of product)

The front side of diaphragm has a raised point which connects to the surface of body to create a sealing surface. The back side of diaphragm distributes several raised points averagely so that the air deliveries smoothly and the diaphragm can connect to the body's surface to create a sealing surface. Increasing the efficiency of sucking/exhausting air.

In order to remain the high temperature resistance of the internal components, we choose high/low temperature resistance diaphragm with a certain wear resistance. And we invited a expert to manufacture this kind of rubber according to the requirements.

Assembling the cover and body, there will be 2 chambers in the bottom of cover. In order to prevent the mixing of compressed air and dirt, we set filter screens in those 2 chambers.

Components might rust due to the serious service environment of railway vehicles, and it can increase the maintenance's difficulty. So the fitting components of wheel slip dump valve are all made

in stainless steel.

The venting diaphragm expose to atmosphere directly. The material of this diaphragm should have the characteristics of ozone resistance, ultraviolet ray resistance, weather resistance and aging resistance. Eventually, EPDM is adopted.

In order to make the performance of magnet valve coil groups to meet with ideal effect, the material of static iron core and dynamic iron core are replaced by the magnetic material import from Japan.

About the coil of solenoid valve, we can enlarge the length of coil to increase number of turns under same electric resistance to get more suction.

Wheel slip dump valve consists of solenoid valve and body, solenoid valve is set between 2 covers, there are check rings with diaphragms setting between cover and check ring, to come true the sucking function through the action between diaphragm and body. The wheel slip dump valve has the advantages as following:

- (1) Compact structure, easy assembly and maintenance
- (2) In order to fully use of the braking force, wheel slip dump valve works periodically without wheel slip occurs.
- (3) If the wheel tends to slip, wheel slip dump valve works periodically to decrease the pressure in braking cylinder to achieve the anti slip of wheels, simple structure.
- (4) Good appearance
- (5) Good antirust performance

4. Conclusion

Wheel slip dump valve is a new product developed by Ruili Group Ruian Auto Parts Co., Ltd, which is market-oriented, user-oriented and developed in a relatively short time. It retains all of the functions of existing ABS and improves the performance of products. It can make wheel slip dump valve to meet the requirement of response time. In this way, it can reduce the braking distance of railway vehicle. Higher reliability and efficiency can create good economic benefits for our company.

References

- [1] C.W. Li, X. Zhang, Q.X.Ling : Altitude Valve, CHINA Patent 201330352233.4. (2013)
- [2] Information on <http://www.doc88.com/p-3945544839688.html>
- [3] C.Y.Qu, J.X.Li, Y.Q.Zhang: Mechanical Design Manual Vol.5 (2004), P. 80-84
- [4] J.Zhong :Assembly parts and related standards Vol.6 (2006),P.139-141
- [5] S.W.Li, P.Tang, Y.H.Ge: Modern Manufacturing Engineering Vol.6 (2011), P. 131-133
- [6] X.Y. Wang, C.W. Li, in: The new energy of commercial vehicle electric air direr, International conference on information sciences,materials and energy(ICISMME 2015) ,P. 88-90
- [7] M.Chen: Bus Technology and Research Vol.2 (2011), P. 64-65
- [8] Q.L.Meng: Electrical appliance manufacturing technical manuals (1999), P. 748-778