Machine & electrical double control air dryer for vehicle air braking system

Xuan Zhang\textsuperscript{1,a}, Liu Yang\textsuperscript{1,b}, Xian Yan Wang\textsuperscript{1,c}, Xiao Yan Tan\textsuperscript{1,d}, Wei Wang\textsuperscript{1,e}

\textsuperscript{1} SORL Auto Parts, Inc., Wenzhou 325200, China
\textsuperscript{a}13566141160@163.com, \textsuperscript{b}642295485@qq.com, \textsuperscript{c}125151738@qq.com, \textsuperscript{d}154629440@qq.com, \textsuperscript{e}13706684250@126.com

Abstract. As is known to all, a vehicle air brake system, in which usually contains moisture. To solve the problem, it is common to use air dryer to dry compressed air effectively and completely remove the moisture and oil of braking system. However, the existing air dryer is not suitable for all commercial vehicles. According to the operational status of the new energy vehicles in the initial operating period, the structure design principle of the machine & electric control air dryer is expounded from the aspects of the structure and operating principle, research & development process.

1. Introduction
As is known to all, a vehicle air brake system, in which usually contains moisture. The moisture and oil will cause many problems such like the rustiness of steel components of the braking system, the rubber sealing parts cracked, the grease decomposed, the pipeline blockaded, and the valves no actuation, eventually, leading to the components of automobile braking system cannot guarantee their normal function during the service. The existing air dryer is not suitable for all commercial vehicles. For example, the traditional air dryer has many defects due to the pure machine structure, such as the inaccurate control of pressure, the exceeded waiting time for the regeneration control of molecular sieve, eventually, leading to the untimely failure of the air dryer. At present, some air braking system replaces the traditional air dryer with electric control air dryer. Such as a patent of utility model named 《electric air dryer》, patent number 2010202172137. But the structure of pure electric control has defects too, it will cause failure of pressure control function and regeneration of molecular sieve function once the electric power supply is not available, eventually, leading to the pipeline cracked and the failure of other air control components in the braking system. Based on the existing experience in machine products and electric products, our company combines machine air dryer with electric air dryer. Electric control system will work to realize the control of pressure and the regeneration of molecular sieve when machine pressure control is inaccurate; Machine control device can protect the system when electric control system is not available and improve the reliability of the vehicle air braking system.

2. Structure
Machine&electric control air dryer which is shown on figure 1, consists of an entrance (input), an exit(output), an exhaust, a multifunctional seat 2, an integrated dryer cartridge 3, a mechanical adjuster 20 and an electric control unit 5.
3. Operating principle
Normal filter output: When the vehicle which has installed Machine&electric air dryer on board starts up, the motor will lead the compressor to pump air to reservoir, then the compressed air goes to air dryer through the entrance(input), part of oil, moisture and impurity will go to the collecting channel as the direction of arrows due to their gravity, eventually, converge at the exhaust piston. Other compressed air will go upward and the clean compressed air will output from the exit (output) after the process of filter, condensation, oil clean, dryer inside the dryer cartridge. The automatic control of the unload, back flow time, time interval of air dryer thanks to mechanical adjuster 20 and electrical control unit 5 helps the compressor to realize starting up at 0 load. This function can protect the compressor drive system, and improve the reliability of vehicle air braking system.

Exhaust open/close with electric control: The clean&dry air comes from other channel goes to mechanical adjuster 20, see enlarged view. Then the air goes to the sensors, backflow electromagnetic and the inlet of exhaust solenoid valve in the left side of adjusting piston 14 and the electrical control unit 5 as the arrow shows, electrical control unit 5 will control the exhaust solenoid valve accurately to drive the air output from exhaust solenoid valve to control chamber by channel 8 when the output pressure exceeds the nominal working pressure of braking system. So the mechanical adjuster pushes the piston 7 to left side, as a result, small hole will move together with piston 7. The air waits in the left side of adjusting piston 14 goes to the the top of exhaust piston 1 through small hole 10&13 and channel 9 while small hole 13 jumping over the O ring 21. Exhaust piston 1 moves upwards, air dryer exhausts air, molecular sieve achieves regeneration, in the meanwhile, the grease, moisture, dust
which are accumulated around the exhaust piston 1 will be exhausted to atmosphere. About exhaust process, electrical control unit 5 closes the exhaust solenoid valve when the output pressure is lower than the nominal working pressure of braking system. The piston 7 returns to original position due to the function of return spring 6, the same as small hole 13. The air in the top of exhaust piston 1 exhaust to atmosphere through small hole 10&13, air dryer stops exhaust.

Mechanical exhaust and stopping exhaust: In case power supply of electrical control system is not available, electrical control system is not available to achieve the exhausting function. The air in the left side of adjusting piston 14 overcomes the function of adjusting spring 15 gradually and drives the movement of O ring 21. The air waits in the left side of adjusting piston 14 goes to the the top of exhaust piston 1 through small hole 10&13 and channel 9 while O ring 13 jumping over the small hole 13. Exhaust piston 1 moves upwards, air dryer exhausts air, molecular sieve achieves regeneration, in the meanwhile, the grease, moisture, dust which are accumulated around the exhaust piston 1 will be exhausted to atmosphere. About exhaust process, the adjusting spring 15 pushes the adjusting piston 14 to original position when the output pressure is lower than the nominal working pressure of braking system. The O ring 21 returns to original position. The air in the top of exhaust piston 1 exhaust to atmosphere through small hole 10&13, air dryer stops exhaust.

4. Research and development process
Machine & electric control air dryer was developed basing on our existing technology of air dryer in our company, by integrating with electronic control method and mechanical spring pressure-regulating device. It consists of 4 parts including multifunctional seat, integrated dryer cartridge, mechanical adjuster, electrical control unit, and it integrates all function from traditional air dryer and electric control air dryer.

Machine & electric control air dryer set an entrance (input) for receiving compressed air from compressor, an exit (output) for outputting compressed air after filter, condensation, oil clean and dry, an exhaust for output moisture, oil, impurity collected at exhaust piston 1 to atmosphere.

There are oil, moisture and impurity collecting channel in the far left side of the multifunctional seat nearby the entrance (input), funnel annular channel and connecting screw on the top of seat, mechanical adjuster and electrical control unit in the far right side of the seat nearby the exit (output) and exhaust piston in the bottom of seat.

The integrated dryer cartridge has the function of filter, condensation, oil clean and dry.

The mechanical adjuster consists of return spring, switch piston, O ring cover, O ring, V ring, adjusting piston, adjusting piston, spring seat left, spring seat right, cover, adjusting screw and some O ring groups. It has the advantages that the exhaust pressure value can be set freely and the compressed gas is prevented from being over compressed, it can also provide control channel for electrical control unit to control the exhaust.

Basing on the original electrical control air dryer, the electrical control unit of machine & electric control air dryer leads the air dryer exhaust channel to the mechanical adjuster directly for preventing the confusions between mechanical adjust and electric adjust.

To achieve the automotive control of the unload, backflow time, time interval by mechanical adjuster 20 and electrical control unit 5. In this way, the compressor can start up without loading pressure, it is a utility protection for driving system to improve the reliability of air braking system.

5. Conclusion
Machine & electric control air dryer is a fully new product which was developed in a short time by Ruili group ruian auto parts co., LTD., based on the existing technology of air dryer. To combine the traditional air dryer with electrical control air dryer and reserving all the functions of the two air dryers to solve the confusion between electrical control and mechanical control by sharing the same control channel. Such as; Electric control system will work to realize the control of pressure and the regeneration of molecular sieve when machine pressure control is inaccurate; Machine control device can protect the system when electric control system is not available and improve the reliability of the
vehicle air braking system.

References
[1] C.W. Li, X. Zhang, L. Yan: Intelligent air dryer, CHINA Patent 200910177514.3. (2009)
[2] C.W. Li, X. Zhang: Multifunctional air dryer cartridge, CHINA Patent 200910162325.9. (2009)
[3] C.W. Li, X.Y. Tan, X. Zhang: Electric air dryer, CHINA Patent 201010193182.0. (2010)
[4] C.W. Li, X. Zhang, X. Dong, X.Y. Wang: A machine-electric double control air dryer, vehicle air braking system and vehicle, CHINA Patent 201110202179.5. (2013)
[5] C.W. Li, X.Y. Wang, in: Analysis of the electrically driven compressor for new energy vehicles, edited by Advanced Materials Research Vols.1049-1050 (2014), in press.
[6] X.Y. Wang, C.W. Li, in: The new energy of commercial vehicle electric air dryer, International conference on information sciences, materials and energy (ICISMMME 2015), P. 88-90
[7] S.W.Li, P.Tang, Y.H.Ge: Modern Manufacturing Engineering Vol.6 (2011), P. 131-133
[8] S.W.Li, Y.H.Ge, S.N. Liu: Machinery Design & Manufacture Vol.3 (2012), P. 29-32
[9] Q.f.PENG, H.Zhao, A.d.Yin, S.j.Liu: Journal of Hefei University of Technology (Natural Science) Vol.12 (2013), P. 1409-1413
[10] M.Chen: Bus Technology and Research Vol.2 (2011), P. 64-65
[11] J.B.Yu, R.He: Journal of ChengQing JiaoTong University (Natural Science) Vol.32 (2013), P. 705-711
[12] Information on http://www.weld.labs.gov.cn