и РК, фиксирует управляющую втулку 10 с фрикционным замыканием (рис.7).

Давление в камере РК становится равным давлению в МК, и пружина сжатия 26 перемещает шток 17 в полное отпускное положение

При ступенчатом повышении давления в ТМ происходит ступенчатая разрядка полости ТК в атмосферу с автоматическим перекрытием осевого канала в штоке 17 двухседельчатым клапаном 14 в конце каждой ступени отпуска. Когда при ступенчатом отпуске прекращается увеличение давления в ТМ, перепад давления на диафрагму 4 становится меньшим, и ослабевает усилие на нее снизу. При этом впуск сжатого воздуха из камеры ТК в атмосферу происходит до соответствующего уменьшения усилия со стороны камеры ТК на диафрагму 23, после чего шток 17 приходит в равновесное состояние, при котором осевой канал в штоке перекрывается впускным двухседельчатым клапаном 14. Облегчение отпуска создает пружина 24.

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PNEUMATIC AIR DISTRIBUTOR FOR ELECTRIC TRAIN

Mordovin, Evgeny A. *– service engineer of «Knorr-Bremse» (Systems for rail transport), Moscow, Russia*

ABSTRACT

Electric and (or) electro-pneumatic brakes are used as the main brakes on the multiple unit. Since they are non-automatic, the role of a stand-by brake is taken by pneumatic automatic brake with air distributor. The design of such a device has its own characteristics, which are estimated in the article both in terms of operating properties, and the novelty of the proposed technical solutions.

ENGLISH SUMMARY

Background. *Pneumatic automatic brake with air distributor refers to automatic non-direct acting mechanisms with gradual release. It acts as a reserve one, e. g. in cases of brake control system failure or traction/ brake controller failure. Pneumatic brake control allows to transport a train in lack of power supply with speed up to 100 km/h in circumstances where brake effectiveness is reduced.*

The new design provides more rapid deceleration in all modes (service, extra). Maximum speed of a transmission of brake action is not less than 285 m / s, which gives a good longitudinal dynamics and shorter braking distances.

Objective. *The author studies and tests new braking systems in order to reveal their features.*

Methods. *The author focuses on the characteristics and working modes of an air distributor KETdSo type (see: Pic.1 General view), which is a technical body of three pressure types and sets preliminary pilot pressure depending on a controlled level in the brake line. According to the rules of UIC KETdSo should be used in pneumatic brake systems.*

Type code- KETdSo, where

1. KE stands for air distributor KE,

2. T- for air distributor for motor cars (short trains),

3. d-completion with allowance of UIC 1976.

4. So-nozzle cover for special time period (deceleration/ release)

The main characteristics of an air distributor are given in a table at the end of the article.

The author describes in detail 4 working stages of a brake: charging of brake (release), discharging of brake (deceleration), overlapping, releasing of brake.

Results.

Charging of brake (release)

Compressed air from the brake line (TM on Pic.2) goes into the main chamber (MK on Pic.2).

At a pressure of 2.2 kgf/cm2 the nozzle switch 7 opens and fixes the control sleeving 10 with frictional closing operation. When pressure in the line increases slowly, charging of working chamber (PK on Pic.2) occurs through channel 5 and chokes 11.12, and with its rapid increase diaphragm 4 bends down (according to the drawing) and closes the entrance to the channel. Charging goes through choke hole 11 with diameter of 0.6 mm and an open valve 9, compressed air flows from main chamber into the working chamber (PK on Pic.2) with volume of 4 liter. Its filling is carried out through the choke 12 with diameter of 0.4 mm for 160–200 s.

Air from the reserve tank (ЗР on Pic.2) flows through the minimum pressure valve 13 to double-seat (inlet and outlet) valve 14.

Air from reserve tank passes likewise through a maximum pressure valve 15 and the choke 20 to double-seat valve 14.

Brake chamber (TK on Pic.2) with volume of 1.4-liter and the additional discharge chamber (КДР on Pic.2) are vented to the surrounding atmosphere.

Charging of the brake chamber is considered complete when Pmain chamber = Pworking chamber. Here the diaphragm 4 is in a position close to horizontal, due to the spring 24, whereby rod 17 takes its lower position, opening the air outlet from brake chamber.

Discharging of brake (deceleration)

Pressure reducing in the line with the rate of 0.5 kgf/ cm2 for 50 s does not cause the braking operation of the air distributor, since the compressed air from the working chamber (PK on Pic.3) has time to flow into the line through the choke 11, not forming a pressure differential across the diaphragm 4, necessary for its upward displacement.

Diaphragms 4 and 23 are interconnected by the rod 17 and together with double-seat valve 14 form technical body, which perceives the air pressure of three volumes: working chamber, main chamber, brake chamber. Technical body of three pressures provides gradual braking, automatic pressure maintenance in the brake chamber at the stage of overlapping according to the pressure decrease in the brake line and gradual release of air distributor.

When the pressure in the brake chamber in the mode of service braking decreases, braking action is determined by moving the diaphragm 4 up by the forces acting on the diaphragms 4 and 23 (Pic.3).

$\Delta P \cdot S_4 = P_{brake}\,chamber \cdot S_{23}$

Upon discharge of brake line in the mode of service braking compressed air discharges main chamber. Compressed air from the working chamber (PK on Pic.3) does not have time to go out in the brake line that causes the displacement of the diaphragm 4 with the rod 17 upwards.

The control sleeving 10 due to fixing of the nozzle switch 7 with frictional closing cannot follow the cap of the rod 17, whereby the valve 18 is opened and the brake line is connected to the additional discharge chamber (КДР on Pic.3). There is an additional discharge of the line to 0.04 kg/cm2.

Choke hole 20 facing the main chamber creates additional resistance to the passage of air into the main chamber, thereby deepening on its discharge, which leads to a better switching of air distributor into the mode of deceleration.

Opening of the valve 18 creates a pressure acting at the rear of the nozzle switch 7, resulting in the moving of the switch nozzle 7 in the closed position due to compression of spring and, thereby closing valve 19.

Air, flowing through the control sleeving 10 into the additional discharge chamber, creates dynamic pressure retaining control sleeving to fill the chamber in the inlet position, although friction connection is no longer valid.

At the same time the butt end of the rod rests on the double-seat valve 14, thus separating the brake chamber with the atmosphere, and then pressing the inlet valve 14 from the seat, which provides inlet of compressed air from the reserve tank through the minimum pressure valve 13 into the braking chamber.

By increasing of the pressure in braking chamber to 0.35 kgf/cm2 valve 11 is closed, providing double isolation for working chamber and main chamber (Pic. 4).

With a time delay when the pressure is 0.26 kg/cm2, valve 22 is closed through the choke 21, thereby the discharge through the additional discharge chamber into the atmosphere is also closed.

With further increase in pressure in the braking chamber to 0.7 kgf/cm2 results in closing of minimum pressure valve 13 closes and the increase in pressure in the braking chamber stops.

Further air inlet into the braking chamber continues through maximum pressure valve 15. The final pressure is determined by the spring force of the valve.

Overlapping.

After the braking stage, there is reduced pressure in the line. The diaphragms 23 and 4 occupy an equilibrium position in which double-seat valve 14 closes the inlet and outlet seats, and the pressure reached in braking chamber is fixed. The force from the pressure differential on the diaphragm 4 is balanced by the pressure of compressed air from the braking chamber on a diaphragm 23 and the force of spring 24. Pressure in the braking chamber is maintained automatically proportional to the discharge of the brake line. Thus, in the case of compressed air leakage from braking chamber equilibrium of forces on the rod is broken in favor of the efforts of the differential pressure on the diaphragm 4. The diaphragm deflects upwards, and the rod opens the double-seat valve 14 providing an inflammation of the air leakage from the braking chamber (Pic. 5).

Releasing of brake

To release the brakes the motorman increases the pressure in the brake line to a level above charge, but the tail wagons because of their remoteness release under reduced pressure in the brake line (Pic.6).

Pressure in the main chamber of air distributor of cars increases rapidly, so the diaphragm 4 goes down, and opens the outlet valve fully, because butt end of the rod 17 extends from double-seat valve 14. The diaphragm 4 closes the channel 5, and a rod seat closes an axial channel in the control sleeve 10.

As a result, the compressed air is discharged into the atmosphere from braking chamber. Pace of pressure reduction in this chamber is determined by the diameter of the choke 25.

Pace of discharge of the controlled volume is correlated with the pace of discharge of braking chamber, i. e. the pressure reduction in the braking chamber and controlled volume occurs synchronously. Elements of air distributor occupy pre-braking position.

When the pressure in the brake line is close to 4.8 kgf/cm2, which corresponds to the pressure of 0.26 kgf/cm2 in the braking chamber, the valve 22 opens and thereby activates the accelerator. Air is discharged through the additional discharge chamber (from the control sleeve position), thereby freeing the nozzle switch 7. Nozzle switch moves to the left end position, opens a connection to main chamber and working chamber, and fixes the control sleeving 10 with frictional closing (Pic.7).

Pressure in the working chamber becomes equal to the pressure of the main chamber and a compression spring 26 moves the rod 17 in a complete release position.

With gradual increase in pressure, in brake line occurs gradual discharge of braking chamber cavity to the atmosphere with automatic overlap of the axial channel 17 with double-seat valve 14 at the end of each release stage. When the release is gradual and increase in pressure in the brake line is terminated, the differential pressure on the diaphragm 4 becomes smaller, and weakens the force below the diaphragm. Thus the compressed air inlet from the brake chamber to the atmosphere lasts to the corresponding force reduction of brake chamber to the diaphragm 23, whereupon the rod 17 reaches equilibrium, at which the rod axial channel is overlapped by the inlet double-seat valve 14. Spring 24 facilitates the release.

Conclusion.

In this article devoted to pneumatic brakes with air distributors, the author focused on the technical aspects of this device. Undoubtedly, this detailed study, specifically in relation to working stages of the brakes, is of high practical importance for railway industry in general.

Key words: railway, electric train, air distributor, brake control.

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Координаты автора (contact information): Мордовин Е. А. (Mordovin E. A.) – Mordovin.evgenii@gmail.com.
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