ADVANTAGES OF ELECTRO-PNEUMATIC BRAKE OF FREIGHT TRAINS

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ABSTRACT

A scheme of electro-pneumatic brakes for freight trains is offered, its operating principles, advantages and disadvantages of the design are described. The comment that is given by the authors reveals the mechanisms of inhibitory processes (braking, overlapping, release action) and management features, existing functional dependencies in the current complex of devices. Regulatory «duties› are highlighted, which are implemented with a digital decoder installed on each car, electro-pneumatic add-on and main line for information transmission by means of digital signals.

ENGLISH SUMMARY

Background. *Although today the capacity of the Trans-Siberian railway allows somehow satisfying the immediate needs of our country in the transportation, it is unable to deal with the entire flow of goods from Asia to Europe. Now Trans-Eurasian main line from China through Kazakhstan to Europe becomes a competitor to Trans-Siberian main line and Baikal-Amur main line. The rapid development of Chinese and Kazakh Railways creates prerequisites to ensure that the main continental cargo flow goes through the new shortest way and with a fairly high speed, and, consequently, the delivery time of goods as compared to the Trans-Siberian Railway will shorten.*

Our neighbors and allies China and Kazakhstan produce accelerated modernization of existing main lines. And it attracts investors. American corporation General Electric, knowing certain perspectives, actively cooperates with JSC «NC «Kazakhstan temir zholy», investing a lot of money in many projects, in particular in the supply of new, powerful locomotives and construction of plants for their manufacturing in Kazakhstan. Russia, in order not to lag behind its neighbors, should achieve higher speeds in the movement of goods and to enhance the capacity of traffic arteries, existing in the competitive area.

Objective. *The objective of the authors is to study operation of electro-pneumatic brakes in different operation modes and to investigate their advantages and disadvantages.*

Methods. *The authors use analytical method, description and comparison.*

Results. *Increase in the speed of trains is facing many challenges that need to be urgently addressed. They include:*

1. Construction of new tracks and improvement of existing tracks to handle high-speed freight trains.

2. Development and production of modern high-speed freight trains.

3. With account of increase in speed, weight and length of freight trains we witness introduction of progressive designs of electro-pneumatic brakes (hereinafter- EPB) in freight trains.

Advantages of EPB of freight trains:

– Improving travel and operating speeds;

– Inexhaustibility of such a device as compared to the direct-acting automatic brake, since at braking there is no discharge of brake line, which is especially important for frequent braking (in order to control speed) and on downward journey to prohibitory traffic lights;

– Minimization of longitudinal dynamic reactions that occur in the train during braking, as there is a simultaneous actuation of brakes in each car throughout the train;

– Ability to control the braking force by gradual braking and release;

– A reduction in braking distance by minimizing the time of preparation of the brakes and increasing the speed of their operation;

– The ability to confidently implement a system of automatic driving of a freight train;

– Reducing the number of faults of wheel pairs of cars;

– Energy savings for traction.

Disadvantages of EPB include two points:

– Need to install on the locomotive a supplementary power supply;

– Decrease in the reliability of digital decoders in the most severe conditions for freight cars (large temperature fluctuation, vibration).

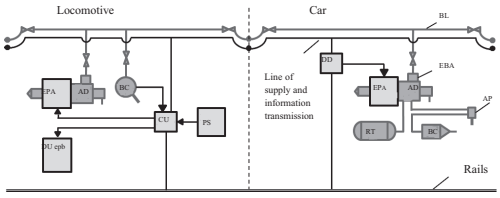
Electro- pneumatic brake is a set of devices that provide control of inhibitory processes in train by setting corresponding electrical signals through electric line [2]. Block diagram of EPB is shown in Pic. 1. Its special feature is that control over three processes (braking, overlapping, release) is achieved through transmission of digital signals by wire line of a train.

Control unit (CU) mounted on the locomotive is powered by its source (PS). Depending on the position of the handle of the brake controller (BC) digital signals corresponding to one of three modes of operation of the brakes are set in the line of information transmission. Each car has a so-called digital decoder (DD), which receives and decodes digital signal from CU, and executes commands using an electro-pneumatic add-on (EPA). Add-on with braking and overlapping valves (BV and OV) is mounted between the two-chamber tank and the main part of the air distributor (con.№ 483). With the participation of the valves, it changes the pressure in the main chamber (MC) of the air distributor (AD), thus providing one of the processes.

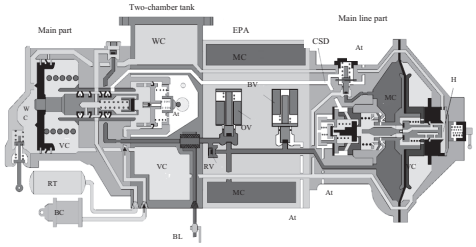
Then the authors consider the operation of EPB during charging (release) of brakes when brake controller is at the service position. From the microcontroller of the brake valve a signal arrives at CU. It does not send control signals to digital decoders, which are in a «standby» state, i. e. awaiting commands, to the line of information transmission. Valves of EPB are de-energized in the «charge-release» position (see Pic. 2). Such a solution is chosen in order to save electricity to supply EPB because most of the time train brakes are released.

When placing the handle of the brake controller in the braking position signal from the microcontroller enters CU, which sends control signals to the decoders. Decoding the resulting «package», they excite vales of overlapping and braking valves of all EPAs. Overlapping valve, after power supply, cuts off with its clapper main chamber of AD from brake line and braking valve connects the chamber with the atmosphere. Air distributors actuate for braking (see Pic. 3).

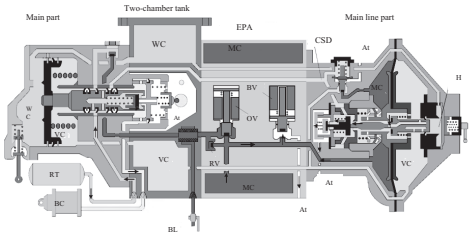
At overlapping CU sends a «package» to digital decoders, which in turn de-energize braking valves of



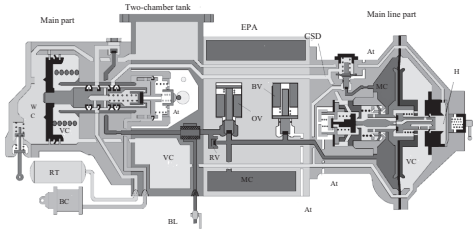
Pic. 1. Block diagram of EPB of a freight train.



Pic.2. Air distributor, con. № 483 (release, charging)



Pic.3. Air distributor, con. № 483 (service braking).



Pic.4. Air distributor, con. № 483 (overlapping).

all EPA. The release of air from the main chamber to the atmosphere stops. Overlapping occurs (see Pic. 4).

Return valve (RV) in EPA, which is connected in parallel with the overlapping valve, is designed to discharge air from the main chamber in the brake line in case of break of the latter. To improve controllability of EPB the volume of the main chamber of the air distributor is increased due to an additional hole (H) in EPA. Since the brake line during braking does not discharge, the reserve tank (RT) has the ability to be constantly replenished from it through a return valve in the main part of the air distributor. Thus, direct-action of a brake and its inexhaustibility increase with appropriate degree of automaticity.

Regulation of pressure in the brake cylinders (BC) of cars depending on their load is carried out by automatic performance (AP). To increase the automaticity of brakes with increasing length and weight of trains at their possible breakage on AD (cond. № 483) it is necessary to install emergency braking accelerator (EBA) [2]. All processes during EPB operation are displayed on the display unit (DU). The use of a digital signal can significantly extend the functionality of the brakes when installing additional devices on cars, for example:

– displaying on DU integrity of the train by sensor of a tail car;

– displaying on DU pressures in the brake line (BL) of the tail car and so on.

The length of a freight train is much more than a passenger train and a problem of significant voltage drop at the contacts and wires throughout the train arises, and in the tail of the train there is not enough electric power to supply valves of EPA. The use of a digital signal solves this problem. Decoders have embedded stabilizers of valves supply voltage. CU sets to a line of information transmission a signal of such voltage level that in the tail car digital decoder receives a signal close to the value of nominal voltage.

Conclusion. *When applying EPB discharge of the brake line does not occur, their performance is much higher than the performance of pneumatic brakes which will enable a train to move to a parking point without stops to charge a braking network and with an average speed higher than that by pneumatic brakes. Furthermore, it will be possible to remove speed limits for release of brakes depending on the length of the train. Gradual braking and release help to smoothly adjust the braking force, which in turn will increase the average speed of the train to the parking point, and a rapid filling of the brake cylinders and simultaneous operation of the brakes in all cars increase traffic safety. Thus, many restrictions imposed by the operating instruction for brakes of rolling stock to their management will be removed [1].*

Keywords: railway, freight car, electro-pneumatic brake, electro-pneumatic add-on, digital decoder, control unit, digital signal, overlapping valve, braking valve.

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