Control system of pneumatic air-spring suspension on transport

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Summary. The purpose of this article consists in development of the system of management by the PNEUMATIC air-spring suspension, which is allow to improve the comfort of passengers and to reduce dynamic impact on a way. The object of research is pneumatic air-spring suspension of high-speed railway transport. The work is performed by a method of theoretical research of control systems of pneumatic air-spring suspension. The task, the structure and the algorithm of a work of a control system of the pneumatic air-spring suspension are discussed in article. The problem of management is formulated as follows : it is necessary to provide the stable provision of a body concerning the way plane in the set interval and regulation by damping depending on the speed of movement of the vehicle and a condition of a way. The developed control system is recommended for use on passenger high-speed railway transport.

Key words: pneumospring, sensor, servomotor, three-stage throttle, electric air gates, GPS navigator.

INTRODUCTION

Nowadays the speed of movement of passenger trains increase to 200 km/h what is, considering a condition of a railway line, puts in the forefront problems of improvement of comfort for passengers and reduction of dynamic influence by a way.

One of solutions of these problems is using of systems of spring suspension on the basis of pneumatic springs. However, their operation shows that one of the basic elements - the regulator of provision of a body (the valve which regulates height "HV") doesn't correspond to a modern technological level on stability of characteristics because of demanding costs of carrying out adjusting works.

In particular, the work of HV which don't have delay mechanisms, is accompanied by considerable loss of the compressed air at body fluctuations on pneumosprings. Work of HV, in which hydraulic delay mechanisms are applied, depends on environment conditions in connection with change of viscosity of liquid that demands their change-over. They are also ecologically imperfect because of possible leakages of working liquid. More perfect are HV with electric delay mechanisms as their work doesn't depend on environment conditions, they are simpler in control. However wear and a burning of contacts of the sensor of provision of a body doesn't ensure of due stability functioning of all system as a whole.

More perfect is the regulator of provision of a body at which rubbing couples are excluded, and burning electric contacts are replaced by the contactless inductive sensor [Makarenko Y.V, Balev V.N., Masliev V. G., 2010]. However, instability of the conditions depending on conditions of environment, dispersion of parameters of analog elements and complexity of control is peculiar to the analog actuation mechanism. The purpose of this article consists in development the system of regulation of set of a body of the vehicle on height concerning the way plane at the pneumatic spring suspension, excluding the listed above shortcomings. This control system of a pneumospring differs from standard AYR-200 established on an electric train by the opportunity to make management of damping of fluctuations, to regulate level of a floor in dependence not only on a static deflection, but also on the speed of movement and a condition of a way.

OBJECTS AND PROBLEMS

The task, the structure and the algorithm of work of a control system of the pneumatic air-spring suspension of vehicles are considered in thearticle (fig.).

The task of management is formulated as follows : it is necessary to provide the stable provision of a body concerning the way plane in the set interval, at possible change from average situation ± 40 mm and regulation by damping depending on the speed of movement of the vehicle and a condition of a way.

Object of management is the pneumospring. As actuation mechanisms two electric air valves are used. One of them is forcing, and other is dumping a compressed air from a pneumospring. And also there is a three-stage throttle for regulating air supply from the additional body in a pneumospring.

It is necessary to define the provision of a body of the vehicle over level of the plane of a way of a nominal rate for regulation of height of level of a floor. The measuring subsystem is used for this purpose. It represents the module in structure of which three subsystems enter: measuring, decisive (managing director) and executive.

Measuring subsystem.

1 . The sensor of height of level of a floor consists of two rectangular plates which make longitudinal movements comparative vertical axis of the vehicle. Plates are established in such a way that they don't adjoin with each other. The reed sensors, the Vb5.42.Khkh.Khkh type, 10.5 are installed on one of them, the distance between them is 3 mm. This plate is rigidly fixed by one end on a body frame. The second plate is rigidly fixed by one of the ends on a cart frame, on other its end the constant magnet is located. By movement of the vehicle there is a vertical relative movement of a magnet along a plate to reed sensors. Depending on a deviation of a magnet comparable with initial situation (up-down) the signal Δ which arrives on the COMPUTER is formed which arrives on the COMPUTER.

2 . The sensor of acceleration of MMA1213D which is reading out geometrical roughnesses of a way.

3 . The GPS system defining the position of object in two planes (in vertical and horizontal).

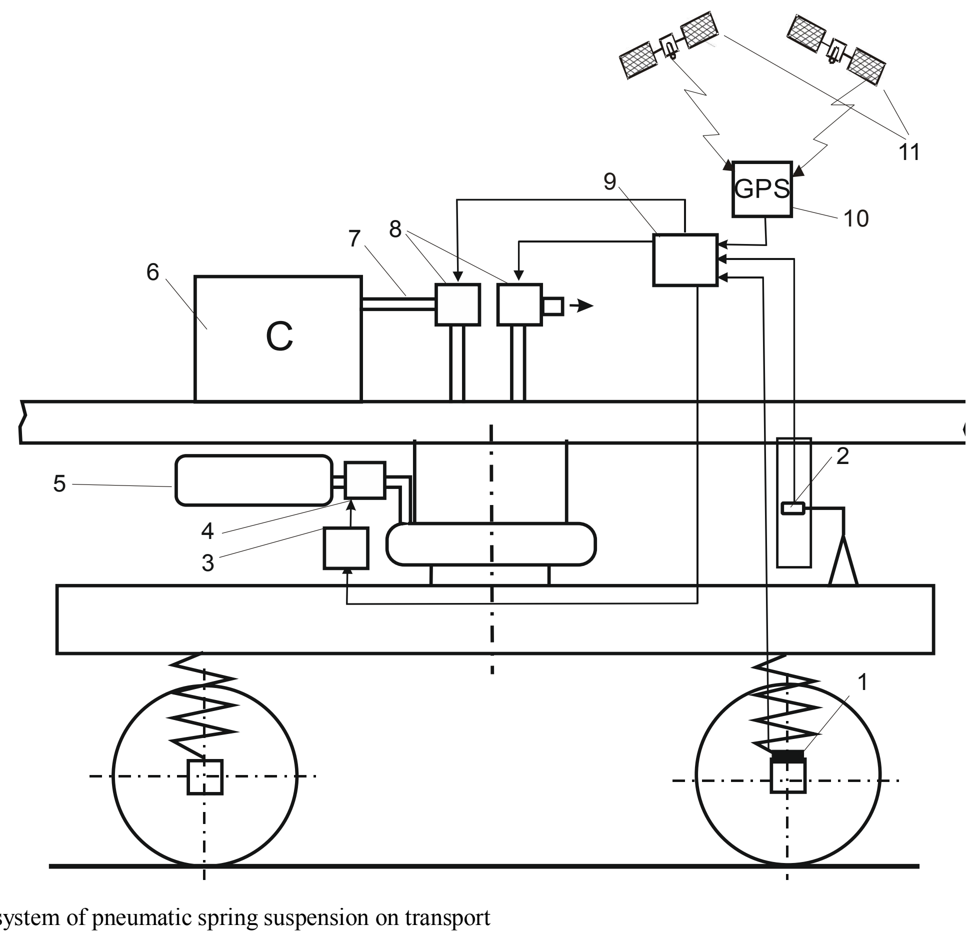

Fig. Control system of pneumatic spring suspension on transport
1 sensor of acceleration; 2 sensor of height of level of a floor; 3 servomotor; 4-three-stage throttle; 5-additional tank; 6 – compressor; 7-connecting pipeline; 8 – electric air gates; 9 – COMPUTER; 10 – GPS navigator; 11 – satellites of GPS system.

Operating subsystem.

1 . The COMPUTER which has the external (system) interface for ensuring communication between subsystems.

Executive subsystem.

1 . Two electric air VV-32 valves.

The electric air valve VV-32 of TU 16-559.341-04 is intended for management of filling depletion process in pneumosprings.

2 . Servomotor of AVV of a series 9C which through a shaft is rigidly connected to an axis of a three-stage throttle. Depending on a signal arriving with the COMPUTER, the servomotor turn of the axis regulates the provision of a butterfly.

3 . Three-stage throttle.

The algorithm of work of the managing director of system is described as follows: the sensor of height of level of a floor during movement gives out continuous sequence of electric signals. Signals represent exact display (which is corresponding to the way) of fluctuations of a body and arrive on the COMPUTER. The received signals are compared established to in advance values of possible fluctuations (according to the card of a way of routes of movement). Calculation of a phase of shift of fluctuations is made. Depending on the size of an antiphase the operated signal which arrives on one of electric air valves and on a servomotor is developed. At level excess more than 3 mm it is necessary to turn on dumping electric air gate which will let out a quantity of the compressed air, and at level reduction, more than on 3 mm, it is necessary to turn on the electric air gate of the forcing highway through which the compressed air moves in a pneumospring. Seted turn of a shaft of a servomotor establishes the section of a throttle which is necessary for damping.

The algorithm of work of system has to be steady against influencing factors, they are fluctuations and the vibrations arising at movement of the vehicle on a real railway line. Realization of operating influences has to be provided with some temporary delay (5-10 s) that these fluctuations didn't cause operation of system conducting to the increased consumption of air for a food of pneumosprings. Besides, it is necessary to provide possibility of remote change of settings of system (for example, for ensuring passing of curve sites of a way).

CONCLUSIONS

On the basis of the carried-out work, it is possible to draw the following conclusions:

- using of GPS– systems allows to recustomize hard characteristics of a pneumospring earlier that allows to improve comfort for passengers and to reduce dynamic impacts on a way;
- the developed system allows to operate more flexibly clearing of fluctuations of rolling high-speed stock;
- the offered system excludes an excessive consumption of the compressed air via electric air gates at body fluctuations on pneumatic springs, isn't sensitive to change of external climatic conditions, is protected from false operations at action of random factors;
- this system doesn't demand control in use, contains the minimum quantity of wearing-out couples of friction and electric contacts that allows to recommend it for use on modern high-speed transport.

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СИСТЕМА УПРАВЛЕНИЯ ПНЕВМАТИЧЕСКИМ РЕССОРНЫМ ПОДВЕШИВАНИЕМ НА ТРАНСПОРТЕ

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Аннотация. Цель данной статьи заключается в разработке системы управления пневматическим рессорным подвешиванием, позволяющей улучшить комфорт пассажиров и уменьшить динамическое воздействие на путь. Предметом исследования является пневматическое рессорное подвешивание скоростного железнодорожного транспорта. Работа выполнена методом теоретического исследования систем управления пневматического рессорного подвешивания. В статье рассмотрены задача, структура и алгоритм работы системы управления пневматическим рессорным подвешиванием. Задача управления формулируется следующим образом – необходимо обеспечить стабильное положение кузова относительно плоскости пути в заданном интервале и регулирование демпфированием в зависимости от скорости движения транспортного средства и состояния пути. Разработанная система управления рекомендуется для использования на пассажирском скоростном железнодорожном транспорте.

Ключевые слова: пневморессора, датчик, серводвигатель, трехступенчатый дроссель, электропневматические вентили, GPS-навигатор.