Specific Features of Development of Long-Length Tubular Vibrating and Transporting Systems

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Abstract* – *The structural diagrams of two-mass tubular conveyers with straight-line and elliptic oscillations and electromagnetic drive are analyzed. The specific features of long-length vibrating and transporting systems development by module concept of their forming with a help of separate conveying modules and elastic clutches are considered.

Key words – conveyer, vibrating system, transporting system, elliptic oscillations, straight-line oscillations.

I. Introduction

The development of long-length transporting systems is an actual technological problem. It is expedient to use vibrating and transporting systems on the factories of atomic (nuclear), mining, chemical, metallurgy, cement, pottery, porcelain and other branches of industry for conveying of radioactive, hot, pulverized (powdered), harmful, gaseous materials and products. These systems may be successfully used for lump, granular and unit products and articles transporting. The development of systems of tubular vibrating conveyers is the most rational and ensures safe working and servicing conditions. The simplicity of conveyers structures, almost absolute absence of fast wearing parts and friction pairs, slow wearing of inner surface of transporting tube, small power consumption, the possibility of loading (charging) and discharging at any zone along the system are the implicit advantages of these systems.

The analysis of literature sources [1]-[4] allows to state that the majority of efficient structural concepts were presented in the book of A.H. Tropman [4]. These results have the specific worth because they are considered to be the most complete (perfect) ones in this branch of investigation and development. And this fact allows to use these achievements and to put them into practice.

On the basis of analysis of literature sources on the subject of development of long-length vibrating and transporting systems we may state that the concept of forming of these systems in overwhelming majority of structures is based on using of one long transporting element or the element which consists of several separate sections rigidly attached one with another. The length of these systems may reach 5-100 m. The first concept of vibrating and transporting systems forming in conditions of flexible manufacture is not enough mobile and efficient. That is why the module principle of such systems forming with a help of vibrating transporting modules of various sizes is proposed in this paper.

II. Main Material Presentation

One of the most efficient transporting conveyers of closed tubular type is vibrating conveyers formed on the basis of two-mass oscillating system with electromagnetic drive. There exist two modifications of such conveyers: with straight-line and elliptic oscillations.

The model with straight-line oscillations (Fig. 1, a) has two oscillating masses of tubular type: the working (transporting) one 1 and nonworking (reactive) one 2, which are attached one with another with a help of elastic system 3 of straight-line oscillations, which set the direction of oscillations with prescribed angle of vibration β. Electromagnetic two-stroke drive of oscillations usually has circular armature 4 and two circular electromagnets 5, which are placed on the working and reactive masses, correspondingly. The conveyer may be supported by vibration absorbers, which are attached to zones of the smallest vibrations of elastic system and to the machine frame (Fig. 1, a). Also the conveyer may be suspended (hanged up) with a help of vibration absorbers attached to the reactive mass. During the operation process the antiphase oscillations of the working and reactive masses are excited with the angle β. This process ensures the efficient vibrating transportation of products and materials which are placed in the tube 1 by the working element. The necessary lateral rigidity of the working element of the conveyer, which doesn't allow undesirable harmful additional lateral oscillations, may be reached by reducing of its length, increasing of the tube cross-section moment of inertia or by more complicated method. The model with elliptic (independent) oscillations (Fig 1, b) also consists of the working 1 and reactive 2 masses, which are attached by combined elastic systems 3 and 4 of longitudinal and lateral oscillations, and supporting vibration absorbers 7. The current is applied to the electromagnetic vibration exciters of horizontal 5 and vertical 6 oscillations with phase shift, which allows to obtain elliptic oscillations of elements and ensures efficient transporting at detachable (tossing) or not detachable (not tossing) modes of vibrating transportation with the possibility of its reverse.

On the basis of the concept of vibrating transporting systems forming with a help of separate transporting modules we obtain the opportunity to develop economical long-length vibrating transporting systems of straight-line, branched or other types. In comparison with the systems with one rigid transporting element these systems have the following advantages: simple mounting of the transportation line of the necessary length; possibility of system charging at larger number of points; smaller mass of the system and power consumption; the lines may be formed by simpler modules of vibrating conveyers.

The working transporting elements are attached one with another with e help of terminal clamps of various rigidities, which are filled by rubber on the inside. The vibrating transporting systems may be formed by modules of equal or different lengths using special distance pieces

(spacers). The specific feature of setting up of such systems consists in ensuring of parameters of vertical oscillations lengths in the range of 5% deviation, which allows to obtain the uniformity of transportation. On the basis of experimental investigations, we may state that the parameters of horizontal oscillations are stable along each tube. The mentioned factors may be ensured by almost equal parameters of oscillations of separate modules.

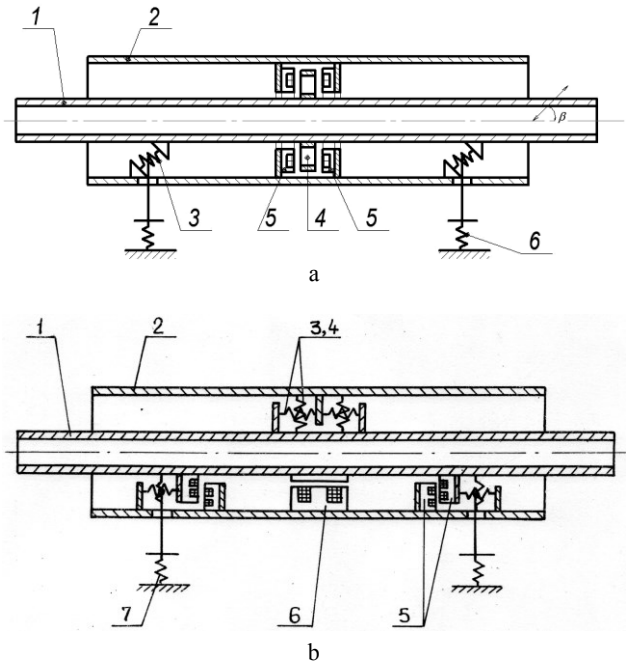

Fig. 1. Structural diagrams of vibrating conveyers:
a – with straight-line oscillations, b – with elliptic oscillations

The long-length vibrating transporting system, which consists of modules with independent longitudinal and lateral oscillations of the working elements, is presented in the Fig. 2. Each module of the system consists of tubular working element 1, which is attached to reactive mass 2 with a help of units of paired springs 3 and 4. The vibration exciters 5 and 6 excite longitudinal and lateral oscillations, correspondingly.

The working elements of vibrating transporting modules of long-length system are attached one with another with a help of distance pieces 7, which are connected with the working element 1 by terminal clamps 8 and rubber spacers 9. If there exists the phase shift between longitudinal and lateral oscillations of the working element, the trajectory of its motion has the shape of ellipse. The trajectory ensures efficient transporting of products and loose materials in the modes without tossing. Close to optimal phase shift is ensured by turning on the vibration exciters 5 and 6 into different phases of three-phase circuit. Such conception ensures the transportation of fine-dispersed powdered materials, for example, cement, which cannot be transported using straight-line oscillations.

The loose material, which is being transported, fills almost whole volume of the tube of the working element and increases the productivity of the transporting system. The elastic system, formed by lattice (grate-type) springs, ensures full vibration isolation of the structure, when the longitudinal and lateral oscillations are carried out, and optimal resonance setting up of these oscillations.

Experimental investigations, carried out in different working conditions, showed that the vibrating transporting system, formed by the module concept, is more efficient than the long-length conveyers with the same parameters of oscillation frequencies, amplitudes and internal diameters of transporting tubes. For example, the productivity of the proposed system for sand transporting is 1.5-1.7 times larger and the power consumption is 2.2-2.4 times smaller.

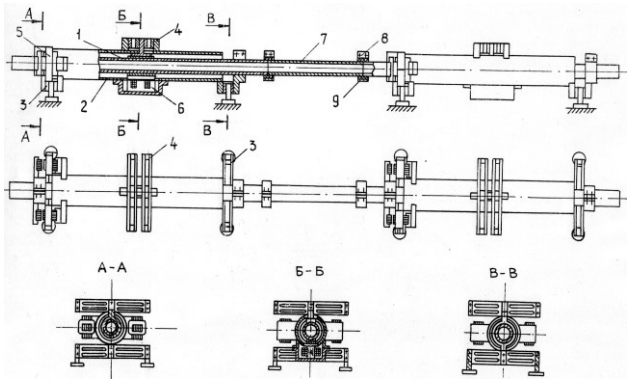

Fig. 2. Vibrating transporting system with elliptic oscillations

Conclusion

The large variety of publications, related with development of vibrating transporting systems with a help of module concept, substantiates the prospects of this concept for modern flexible manufacture. If there exists the necessity to set-up the system in the working conditions, it is expedient to use the electronic indicators and computer equipment for reducing time losses. It is necessary to concentrate the theoretical investigations on the development of technique of calculation of vertical oscillations parameters and on the methods of ensuring their uniformity along the system.

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