# HOPPER FOR BULK CARGO EXCLUDING MANUAL LABOR

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## ABSTRACT

Domestic transportation, storage and terminal structures in recent years cannot cope with volatile market load. This is clearly illustrated by, in particular, grain transportation.

An innovative solution to the problems of interaction of storage and transport facilities in terms of anti-crisis measures in the country, according to the author, refers to a construction of grain storage with easily controlled technological process, proposed by the author.

*Keywords: transport, infrastructure, grain storage, loading / unloading, controlled process, innovative design.*

**Background.** *In 2014 grain harvest amounted to about 104 million tons, export of grain cargoes – 32 million tons, which exceeds the amount of 2013 by 22 per cent. And this despite the fact that at least since 2009 in the fields crops of grain have been consistently high, and sale and transportation of wheat remain in demand to this day.*

*Demand, however, is not satisfied in full. Some grain products are reloaded on ships through sea ports of neighboring countries. The situation is, in fact, that the growth rate and level of exports of grain cargoes are limited to capacities of modern transport infrastructure and require modernization of supply chain, including storage, transportation and transshipment.*

*Specialists have to admit that the main obstacle in the way of solving this problem is worn, underdeveloped infrastructure of the transport complex, inadequate logistics capacity of the grain market. There is a shortage of high-tech elevators, port terminals, which would respond to increasing requirements of transport logistics, would have a certain potential to increase the capacities in a timely manner and to respond flexibly to changing market conditions [1–4].*

*Transport infrastructure works at full capacity. At the same time, we cannot ignore that fact that freight carrier is guided by the projected average annual grain exports, rather than the peak (record), and is unlikely to be ready to keep for a simple special equipment [1].*

*Owners of cars in competition environment, cannot also afford poor performance, and the shipper has to reconsider his attitude to a purchased service.*

*There is an inverse relationship – the cost of services is directly related to operational efficiency of work with car fleet, so how fast the consignor and the consignee load and unload cars. In fact, the cargo owner himself generates cost of services, and this is a key difference of this new stage. Although not everybody turned out to be ready for this. As a result, up to two-thirds of time is spent on initial-final operations (i.e. loading and unloading of grain cargoes), but not on movement of grain carrier.*

*One of the major problems of increasing efficiency of transportation became against this background the interaction of different types of transport, including sailors and port railways. Not by chance a significant portion of managers believes that low processing capacity of sea and river ports prevents the turnover of freight trains.*

*And we must note that Russian ports play an important role in ensuring not only foreign trade but also inland traffic. For example, in October 2014 due to disruption of cargo unloading congestion of cars on port railways exceeded 47 thousand units. Every day in anticipation of unloading at ports more than 130 freight trains set aside of motion, which was 40% higher than the previous year's level [7].*

*Improving interaction between rail and maritime transport is largely dependent on transshipment processes and systems of their organization, in particular, comprehensive mechanization of loading and unloading operations.*

*At the moment, none of production associated with grain cargoes cannot do without special equipment for accumulation, storage and unloading of the goods transported. The role of accessories in the transport and processing circuits is played by hoppers, silos and hopper devices.*

*Work of transport and technological lines as a whole has a direct impact on the safety of bulk cargo and their quality. Violation of continuity of functions of accessories increases the time of loading and unloading operations, leads to the need for manual labor. Therefore, improving the devices used for bulk materials of different connectivity remains an obligatory task.*

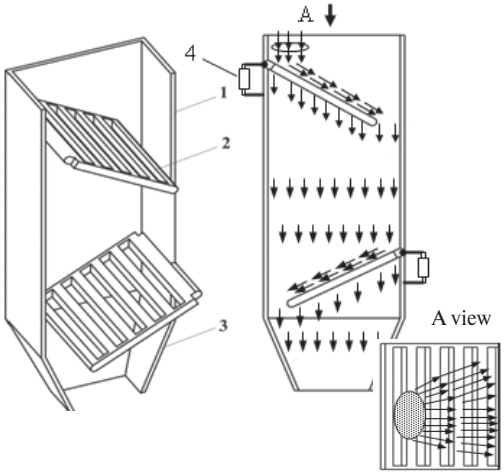
**Objective.** *The objective of the author is to present a new design of hopper used in bulk cargo transportation focused on elimination of manual labor.*

**Methods.** *The author uses general scientific and engineering methods, comparative analysis, simulation.*

**Results.** *Increase in efficiency of transport and processing lines is possible by improving their elements, including hopper-silo systems. A large number of real scientific research on hopper equipment and processes taking place in their cavity, is virtually ignored. Design, however, is most often conducted on the basis of elementary calculations and rough assumptions. Naturally, with this approach perception of storage of bulk cargo as simple objects is not conducive to development of their technical level.*

*Due to the higher criteria and requirements for complete mechanization and automation of processes of loading, storage and release of bulk cargo hopper devices should provide the maximum bandwidth with low energy consumption and absence of manual labor.*

*As an alternative to previous options it is offered to use the design of bulk cargo storage with technological process controlled in an automated mode, see. Pic. 1. It consists of a body of a hopper 1, in which elements of loading-distribution device 2 are mounted movably or grid plate arranged in a checkerboard pattern, which provides a cascade filling of the tank, as well as unloading chute 3 [8].*




***Pic. 1. The proposed storage structure with a controlled technological process.***
***Legend: 1 – tank; 2 – element of a device for control of loading/unloading; 3 – unloading chute; 4 – passive drive (ratchet).***

*The device operates as follows. The cargo is filled and stored for period of time required by technology and even longer. During loading part of cargo flows on grid plates, and the other – is spilled through the cracks. This scheme reduces segregation to a minimum, reducing compression of cargo in the tank and a uniform distribution of particles of cargo throughout the cross section of the tank. Because in the process of storage grid plates are not removed, they are bearing support for emergence of vaults, but in turn the elements of loading-distribution device serve as breakers of pressure arising during storage.*

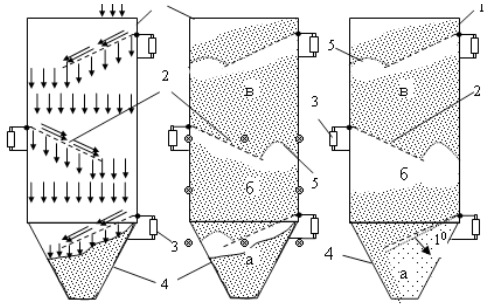
*Each element of loading – distribution device divides the tank into individual sections within which the pressure is minimal, as on the grid plate lays the mass of cargo, confined to the upper grid plate. The material in each storage area is in decompressed state.*

*If it is necessary to empty the tank the gate device opens, after which the cargo weight that is in the «A» zone, starts to flow out freely. Then, when the whole mass of the area «A» is unloaded, it is sufficient to bring down the first grid plate of the unloading chute by 1° in order to destroy the vault for flowing out of cargo weight, located in the «B» zone, etc. – to complete emptying of the tank (Pic. 2).*

**Conclusion.** *The proposed design allows to modernize and create new elevator capacities, which ultimately leads to higher transportation efficiency by reducing logistics costs:*

*– For shippers – reducing delivery time, reducing cost of transportation, lack of seasonal shortage of cars, formation of shipload lots of grain in elevators;*

*– For Russian railways – acceleration of turnover of cars, increase in cargo turnover and expansion of cargo base, lack of congestion on approach lines and opportunity to form full train shipment.*




***Pic. 2. Scheme of predictable process of loading, storage and unloading.***

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