Use of active related transportation systems in the extractive industries of the national economy and protection complex

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Abstract. The range of practical applications of active articulated transport systems is considered (AATS). AATS have a lower specific pressure of the propellers on the supporting surface, all other things being equal with single machines. This allows you to increase the payload on the transport system, increase the off-road capability of vehicles and on supporting surfaces with low bearing properties. The presence of separate power and technological sections makes it possible to create a range of technological systems with different functional properties. It is most expedient to use AATS in the raw materials and extractive industries and in the defense complex.

1. Introduction
The work of transport and technological machines in some sectors of the economy is specific. This is due to their operation on temporary roads or off-road conditions. In the timber industry, the operation of transport systems takes place on simplified temporary roads, which make up about 40% of all types of timber haul roads [1-3].

The emergence of new energy-rich multi-operational machines allows mechanizing most of the work in the forestry, agriculture, oil and gas and mining complexes, the defense industry and other areas of the national economy. [4, 5]

2. Experimental results
The use of all-wheel drive transport systems based on the activation of the trailer stock and the use of one of the promising tasks in the implementation of many tasks that perform during the operation of transport and technological complexes in the conditions of winter roads, dirt roads during the thaw period and in other specific conditions.

The concept of an articulated transport system (ATS) includes a whole range of machines with two or more sections, connected by a hinge with one or more degrees of freedom. Some ATS have a specific steering design. ATS is often considered as road trains with active trailers (TAT). [6-8]

The use of TAT and ATS in the sectors of agriculture, forestry, oil and gas complexes and other raw material sectors of the economy makes it possible to create a wide range of technological and transport systems.

The most general concept of all-wheel drive ATS should be considered active articulated transport systems - AATS. [9, 10]
ATS are technological and transport. This division is determined by the purpose of the transport system.

Technological AATS consists of two or more sections, one of which plays the role of a mobile power plant (energy module), and the second has a narrow utilitarian function (technological module). Similar AATS schemes can be widely used in the forestry, oil and gas industries, and municipal services.

A transport AATS is a car or tractor train with a different distance from the energy module to the trailer link. The transport AATS includes wheeled and tracked transport systems with a “breaking frame”. [11, 12]

![Figure 1. Articulated transport system classification](image)
As an example, consider the use of AATS in agriculture, mining, and the defense industry.

In agriculture, the share of transport work in the annual employment of wheeled tractors exceeds 50%, and most of them fall on temporary roads and field conditions. Under unfavorable weather conditions, especially in the zones of “risky farming”, such roads become a significant obstacle in the performance of technological operations and transportation of products.

Most of agricultural machinery performing specific technological operations, high power of the internal combustion engine. This technique is used no more than one month a year. At the same time, the equipment must be stored in special conditions, undergo maintenance during operation and during storage. Maintenance of equipment with internal combustion engines must be carried out by highly qualified personnel in special conditions. [13]

The use of AATS in agriculture implies the following scheme: one energy module (a serial tractor can be used), depending on the technological operation being performed, is connected to a technological module (section) having drive wheels to increase cross-country ability (Figure 2).

**Figure 2.** The scheme of using AATS in agriculture

In the mining industry, the use of AATS allows you to abandon heavy-duty dump trucks with a lifting capacity of 1.5 - 1.7, and using an energy module as part of a trailer link to reduce the total weight of the transport system by at least 25% with an increase in the lifting capacity to 3 - 3.5. [14]
In the defense complex, the use of AATS makes it possible to create fundamentally new platforms for the deployment of advanced types of weapons. The appearance of new propellant charges makes it possible to significantly increase the rate of fire and the range of fire in self-propelled artillery. Self-propelled artillery pieces (SPAP) are designed to conduct short-term (time of a safe stay at one firing position up to 1 minute) high-intensity fire with a change in firing position. SPAP move into position, conduct high-intensity fire at distant targets, then move to another position before the enemy can return fire. With the growth of automation of fire control of modern artillery and the widespread introduction of radar reconnaissance means for detecting firing positions, the reaction time of enemy artillery as part of reconnaissance and firing systems operating in real time, and, accordingly, the time for the safe stay of the SPAP in a firing position is significantly reduced. Therefore, a means for overcoming these problems is the creation of a SPAP, with fundamentally new, unconventional structural and layout schemes, providing a significant increase in mobility and firepower (and, accordingly, a decrease in the time spent on a firing position of the SPAP). [15, 16]

In this case, an artillery installation with a loader is considered the basic layout. For example, the experimental vehicle "Coalition - SV" based on the SPAP 2S19 "MSTA-S", as part of the design Uraltransmash (Yekaterinburg). This basic layout of an articulated self-propelled artillery unit (ASPAP) consists of two separate machines designed to perform specific tasks. Each of the vehicles has a power plant and a crew, and can operate both as part of the ASPAP and independently.

A fundamentally new platform does not have to have two propulsion systems and two crews. The most rational and promising is the use of a platform with one power plant and one crew. The loading process is controlled by the crew of the artillery gun. This solution involves the creation of a separate structure (Figure 3). [17, 18]

![Figure 3. The modular principle of building an ensemble of machines](image.png)

The installation, for performing any task, is located in the combat (technological, transport) module - a section that does not have a power plant and has a drive for propellers. At the same time, there is a
control (energy, power) section - a module where the power plant and the crew are located. Modules have the ability to connect using a articulation unit. The articulation unit allows the power flow to be transferred from the power module to the technological one, changes the relative position of the modules to rotate the system and provides mutual movement of the modules in three degrees of freedom. The modular principle of building the platform is not limited to the use of two sections - the combat module and the control module. [19-21]

3. Conclusion
The use of a multi-set or multi-section principle creates complexes with a large ammunition load, which has great survivability and mobility.

To increase the firepower and increase the tactical and operational-tactical mobility of the CAO, it is necessary to create a fundamentally new look of the platform. To the greatest extent, the requirements are met by multi-set articulated transport systems, which make it possible to create an ensemble of transport systems that ensure the combat capability of an artillery unit. [22]

Thus, one of the most important reserves for increasing the efficiency of transport and transport-technological operations is the increase in cross-country ability and maneuverability, achieved by the creation of structurally different chassis. The requirements are met by multi-set articulated systems that create an ensemble of transport and transport-technological machines, and ensure high efficiency in performing production tasks.

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