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Paper Authors

Sh.A. Mamasov

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PROSPECTS FOR STEEL WHEEL TRACTOR DEVELOPMENT WITH HYDRAULIC DRIVE

Sh.A. Mamasov – candidate of technical sciences (PhD), Associate professor, Samarkand state university, shmamasovsh63@mail.ru, Samarkand, Uzbekistan.
Tel.: +998-97-397-20-63.

Abstract. The article discusses a new scheme for increasing the lateral wheel tractor stability intended for agrotechnical measures, transport and other works complex on mountain and foothill slopes. The proposed scheme of a steeply sloping wheel tractor provides for hydrostatic transmission use instead of a mechanical one, which eliminates the need to install swinging final drives, simplifies the design, and reduces the tractor weight and cost. To ensure the vertical position of the tractor body on a slope, the front and rear drive wheels have an individual hydraulic drive and are mounted on parallelogram suspensions.

Keywords: steep slope tractor, slope tractor, parallelogram mechanism, hydraulic drive, hydraulic motor, hydraulic pump, leveling mechanism, wheel, body, mountain and foothill slopes.

Introduction. The soil and climatic conditions of Uzbekistan with rich soils, a long growing season, and light, heat abundance are very favorable for various crops, orchards and vineyards cultivation.

There are not so many undeveloped plain areas, and new areas developing problem at the expense of mountain slopes comes to the fore. Quite large areas of such lands are located in the mountain foothills of the Surkhandarya, Kashkadarya, Samarkand, Jizzakh and Tashkent regions [1,2].

The mountain farming conditions differ significantly from those plains in terms of agricultural technology, mechanization and electrification, irrigation and land reclamation methods. By the production processes mechanization level, mining agriculture lags far behind many other agriculture branches.

The correct modern scientific direction choice for a mountain tractor creation is of fundamental importance for the further development of mountain agriculture. Work on mountain tractors creation only by lowering the gravity center of conventional tractors must be considered incorrect. Such tractors, of course, can be resistant to overturning on slopes, but the unequal tractor weight distribution among the propellers significantly reduces the tractor efficiency. In addition, a decrease in the gravity center causes a low ground of the tractor clearance and makes it difficult to use it in rough terrain and completely excludes its use when processing tall crops. The resistance to movement of such tractors increases markedly. As a result of all this, the hook power is reduced, and as a result of wheel slip, the course straightness is noticeably deteriorated, sliding and sliding down the slope increase.

The mobile counterweight use in mountain tractors to increase the tractor stability on slopes must also be considered unacceptable. Despite the relative constructive simplicity of solving this issue

for stability, it does not prevent a decrease in the tractor efficiency when working on slopes [3].

Existing steep tractor version with all drive wheels, designed for work in mountain agriculture on slopes up to 20 ° steepness. To increase lateral stability, the tractor is equipped with an automatic frame stabilization system, due to which, depending on the steepness of the slope, the rear wheels, together with the swinging final drives of the rear axle, turn in opposite directions in the vertical plane. On the plain, the frame stabilization system is disabled, i.e. the turning of the final drives is blocked. However, the steep-slope modification differs from the base model in a more complex design, higher metal consumption and, accordingly, high cost [4].

One of the reasons that impede the quality and functional indicators improvement of mobile machines is the dominance in their centralized collective mechanical or hydromechanical drive transmission of the wheel propeller and working bodies.

Materials and methods. The tractor frame and wheels aligning principle in a vertical position, regardless the slope steepness should be considered the correct direction for creating a mountain tractor-slope. This principle ensures the same tractor distribution preservation weight on the upper and lower ones - relative to the wheel slope, which excludes the increased slipping possibility, maintains high dynamic stability, ensures the traction preservation on slopes at a flat - ordinary tractor level, good cross-country ability and high ground clearance of the slope tractor, as well as the normal operating conditions of the tractor driver, the engine, the lubrication process and power engine supply and, finally, the normal operation of the slope tractor in the mountain agriculture conditions [5,6].

A steep slope tractor must have four wheels that are both driving and steerable. The advantages of wheel travel for slope tractors compared to crawler tracks are obvious. The use of the principle of hydrostatic transmission in mountain slope tractors is expedient in all respects in comparison with mechanical.

Results and discussion. Automatic preservation of the vertical position of the wheels and the tractor body on the slope is the basis of the proposed slope tractor scheme. The use of the articulated parallelogram ensures the vertical position of the wheels. This leveling scheme is typical for steep-slope combine harvesters. Thanks to the automatic change of the parallelogram angles, the left wheel vertically descends down the slope, and the right wheel rises up, remaining strictly vertical. As a result of this method of maintaining the vertical, the distance between the planes of rotation of the wheels B_1 decreases in comparison with the track of the tractor on the plain B, when the parallelograms become horizontal, i.e. fully open in breadth, and the force vector of gravity G always passes through the center C.

If the automatic stabilization of the tractor works flawlessly, i.e. the left wheel is automatically lowered and the right wheel is raised, then the tractor will be quite stable on the slope.

A distinctive feature of the proposed slope tractor is the use of a hydraulic drive for all wheels instead of swinging final drives.

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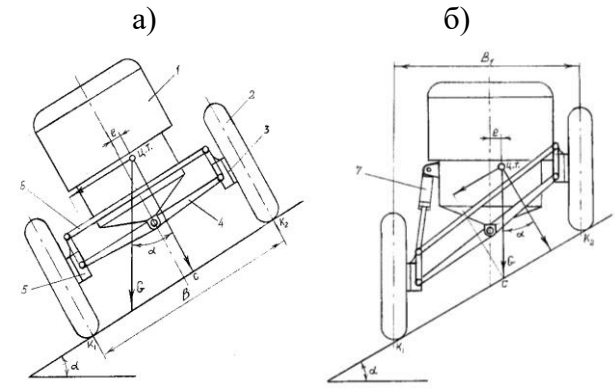

Fig. 1. Diagram of a steep wheel tractor with hydraulic drive: a - position of the tractor on a slope without leveling; b- position of the tractor on a slope during leveling. 1-frame of the tractor; 2-rear wheel; 3-brake mechanism; 4,6-lower and upper parallelogram suspension bars; 5-hydraulic motor; 7-hydraulic cylinder.

At present, all over the world it is practically impossible to name such a branch of industry or agriculture in which a hydraulic drive would not be used. And the rates of creation and development of serial production of new machines with hydraulic drive, which have increased in recent years, are a clear confirmation of scientific and technological progress.

As a result of the introduction of modern technological processes and the improvement of hydraulic equipment and machines with a volumetric hydraulic drive over the past two decades, the quality of their manufacture has significantly improved, the duration of uptime and technical resource have increased.

Hydraulic drives can be of two types: hydrodynamic and volumetric. In hydrodynamic drives, the kinetic energy of the fluid flow is mainly used. In volumetric hydraulic drives, the potential energy of the working fluid pressure is used. Hydrostatic or hydrostatic transmission is a combination of a volumetric hydraulic pump with a hydraulic motor of a similar design (one or more) [7,8].

Advantages of hydrostatic transmissions in comparison with traditional ones: steeples change of the transmission ratio as a whole within a very wide range; the possibility of replacing all mechanisms of the mechanical transmission, not only the gearbox and clutch, with one or two pairs of "hydraulic pump-hydraulic motor"; layout, associated with the possibility of placing hydraulic motors at any distance from the hydraulic pump, as a result of which the hydraulic motors can be placed directly in the wheels; the ease of reversing the transmission and obtaining the same speeds when moving machines forward and backward [9,10].

The principle of operation of the simplest hydrostatic transmission used on the slope tractor is as follows. The pump, connected directly to the tractor engine, creates a hydrostatic head of the working fluid and delivers it through the main pipelines to the hydraulic motor or motors, which convert it into mechanical work on their output shaft (shafts). To exclude cavitation phenomena and replenish the working fluid, the amount of which may decrease due to leaks, a special pump is included in the system, supplying fluid through a filter and special valves to the low pressure line, where overpressure is maintained. A pressure reducing valve is provided to limit the maximum pressure in the circulation circuit.

Hydrostatic units of various types can be used in tractor hydrostatic transmissions: gear (screw), blade (gate), and radial or axial piston. To regulate the number of revolutions of the driving wheels of the tractor and the torque supplied to them at a constant operating mode of the engine, a change in the pump performance, the installation of a

variable hydraulic motor, or both at the same time can be used. The easiest way is to change the pump performance. In this case, at a constant engine power, there is a hyperbolic relationship between the tractor speed and the moments on the driving wheels, which determines the best dynamic characteristics of the tractor.

The use of a full-flow hydraulic drive of both front and rear wheels from high-torque hydraulic motors with adjustable working volume will significantly reduce the metal consumption of transmission units; - to increase the reliability and resource of transmission units, since the latter does not contain heavily loaded wheel reducers with high contact voltages; - to reduce fuel consumption, in comparison with hydromechanical and, partially, mechanical transmissions due to the fact that e.c. CSG with new generation hydraulic machines will be 0.93 ... 0.95 (instead of 0.80 and 0.92 for hydromechanical and mechanical transmissions, respectively); - to reduce the cost of the tractor as a result of less metal and energy consumption in the production of transmission units, especially the rear axle. It should be borne in mind that foreign mobile machines and equipment without a hydraulic drive are not manufactured, because it is the volumetric hydraulic drive that provides new operational properties and a high technical level.

On a steep slope tractor with a full-flow hydrostatic transmission, the engine rotates two axial-plunger pumps through a transfer case, which drives the front and rear drive wheels of the tractor. Instead of the gear lever, you can install a joystick that changes the gear ratio of the hydraulic transmission.

By changing the inclination of special washers, you can adjust their performance from direct to reverse over a wide range. Pressurized oil is supplied to four axial piston motors, similar in design to pumps. Each hydraulic motor is connected to its wheel by a short transmission, which has a braking device and a clutch that allows the drive to be turned off.

Conclusions. Thus, the hydrostatic transmissions use on steep tractors reduces the machine weight and cost, simplifies the wheels drive and their adjustment depending on the terrain slope angle. Such a slope tractor can be used for cultivating orchards, vineyards and other crops located on mountain and foothill slopes.

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