Improving The Efficiency Of Forest Disc Tools Using The Tool For Ancillary Equipment Of Mounted Tractor

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Abstract: The main course of the known methods of regulation of working op-Ganov mounted tillers at a given depth of processing are: altitude, position, power and combined. However, these methods are effective mainly for massive hinged agricultural tillage equipment operating in a much more favorable conditions and with special design elements in the form of one or more of the supporting wheels, skis, soles of the workers, and so on. N. A more promising way to improve zaglublyaemosti disc working is of use for this purpose a forced vibration. The results made in VGLTA experimental verification on a production forest disc harrow KLB-1.7-Confirm Dili effectiveness of this method. Made by the authors in-depth analysis of the functioning of the various possible all-Rianta structural embodiment attachments tractors allowed to offer the following solutions to the problem. Using the developed device hydraulically ustanav-Lebanon between the tractor hitch and put in dis-kov instrument, ensure the unit when moving the ability to control the situation to the extent necessary SCW links on the tractor and spring. Provedeggy analysis confirmed the effectiveness of the proposed design tools.
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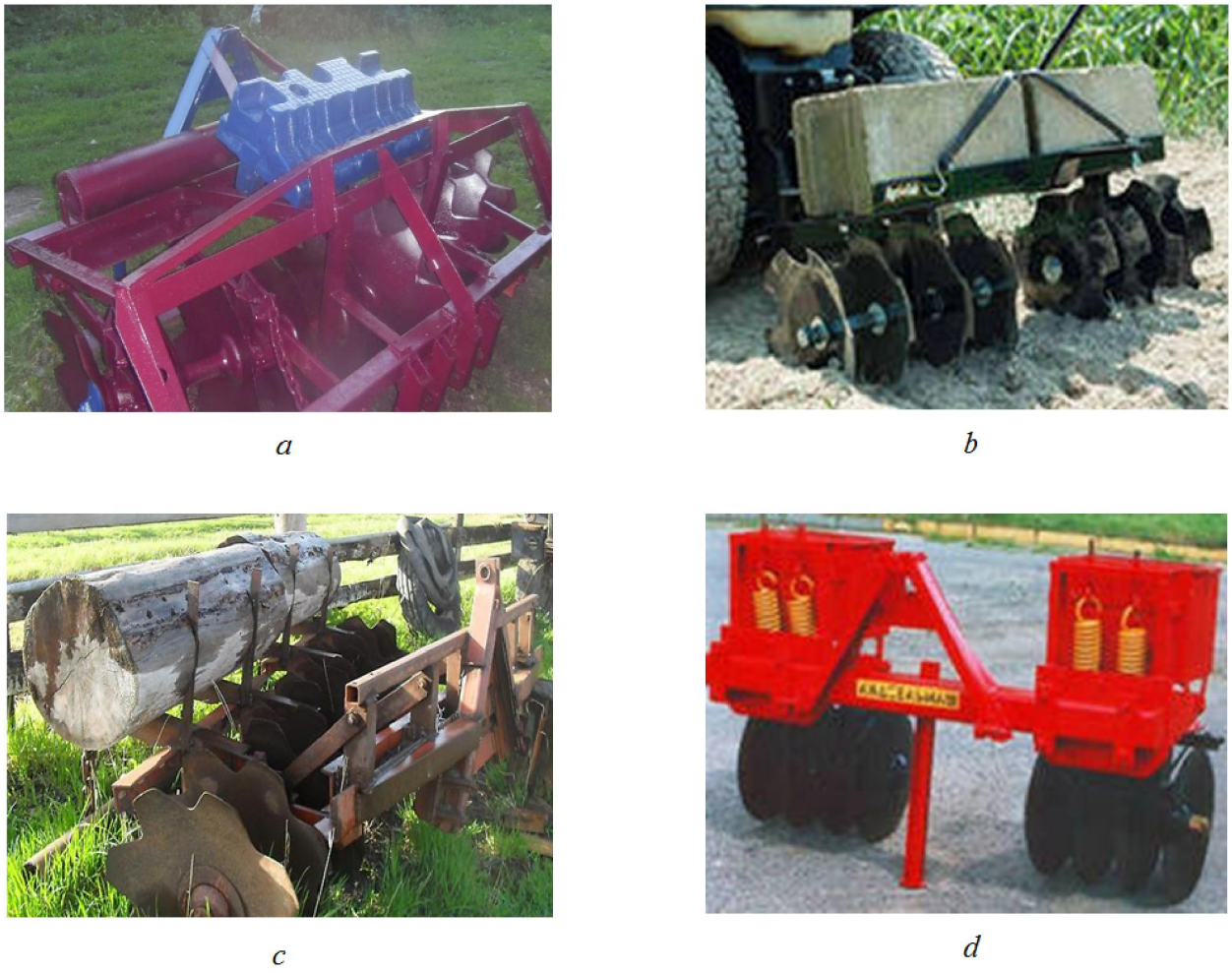
Introduction

The main course of the known methods of regulation of working bodies mounted tillers at a given depth of processing are: altitude, position, power and combined. However, these methods are effective mainly for massive hinged agricultural tillage equipment operating in a much more favorable conditions and with special design elements in the form of one or more of the supporting wheels, skis, soles of the workers, and so on. (Bartenev, 2010; Lurie, 1977; Z1elikov et. Al., 2014).

A more promising way to improve zaglublyaemosti disco-O working bodies is to use for the purpose of forced-tive vibration. The results made in VGLTA experimental verification on a production forest disc harrow KLB-1.7 confirmed the effectiveness of this method. For forced vibration working bodies have developed special construction of hydro (Posmetiev et. al., 2008) and gidropulsatornogo (Posmetiev et. al., 2010) drives. Using vibration working bodies not only in improving zaglublyaemost discs, but also to improve the crumbling and loosening the soil, as well as self-cleaning of working bodies of adhering soil and weeds (Zelikow, 2011). In this case, the energy consumption of the engine of mounted on the tractor hydraulic vibratory mechanism is fully offset by reductions of 20-25% of the working tools of resistance. The disadvantages of this method are becoming more sophisticated and more expensive design tools, as well as the need for continuous operation of the hydraulic system of mounted tractor (Posmetiev and Tretiakov, 2011).

Currently, machine operators to better zaglublyaemosti working bodies as forest and

agricultural disc harrows, forced them reloaded with additional weights in the form of massive metal and concrete blocks, logs, sand boxes, and so on. N. (See Fig. 1).



a *b*

c *d*

Figure 1. Increased ability to bury disc harrows using their frames and working bodies of the additional weights: a - metal-crystal details; b - concrete blocks; in - the log; g - sandbox

Additional weight set or a common frame guns, either individually on each frame sections disc batteries. Forest tillage designed to work on cutting, due to the large number of the last major obstacles (stumps, surface and poluzaglublennyh roots, boulders, rock outcrops), have no bearing structural elements with respect to which the adjustment of the working bodies at a given depth of tillage. Installation on forest guns such support elements inevitably led to under-to frequent breakdowns of both the elements and tools in general (Posmetiev, 1999).

Such tools are traditionally forest design with the use of additional goods, provide guidance to the working depth of working bodies. As used goods available at forest sites materials - sand, rocks, logs, and so on. N., Which are placed in fixed on frames guns special boxes, such as cultivators KLB-1.7 (see Fig. 2, g), plows PLD -1.2 and PRN-40D and others. In this regard, the rational selection of the mass and placement on disk cannon additional weight gain importance as underload and overload implements the same negative impact on its effectiveness (Nartov and Posmetiev, 1982).

When designing mounted unsupported disk tools developers often underestimate the impact of the instantaneous center of rotation (SCW) units of mounted hitch on the tractor zaglublyaemost spherical disc working of the soil. The main reason for this is the massive use of agricultural tractors on the entire line of traction class (from 0.6 to 8) mass-produced rear attachments sizes OU-2, OU-3 and OU-4, the design parameters are regulated by GOST 10677-2001. However, this standard does not apply to tractor mounted devices for special purposes, including forestry (n. 1 standard). Construction attachments made to meet the requirements of this standard, practically pos-Will change the position of the device links SCW adjustment to the extent necessary and only limited by the height of the axis of suspension guns to the bearing surface of the tractor. This does not affect the guns with plow working elements for which these devices are in the ground and recommended standard. At the same time the efficiency of the mounted guns unsupported disk depends strongly on the ability of the attachment to install SCW significantly below the axis of the suspension means and the reference plane of the tractor (the surface of the treated soil) (Zelikow et. al., 2012).

In order to determine the effect of the provisions of SCW standard attachment mechanism on the amount of additional load to perform a calculation in accordance with the scheme shown in Figure 2 for the series of forest disc cultivator KLB-1.7 in the unit with wheel tractor "Belarusian 82.1", equipped with a hinged mechanism size OU-2, intended for tractors of 0.6-2. To simplify the calculations, we introduce the following main admitted-tion does not significantly affect the accuracy of the final result: the force of friction in the joints of the attachment mechanism insignificant and ignore them; forces acting on the tool in the transverse vertical plane due to their smallness does not take into account; height position of the suspension axis mo guns invariably located at a distance of 400 mm from the reference plane of the tractor, the recommended standard; movement unit assumed to be steady, uniform and pryamoli--linear, and the surface of the processed row cultivator plantations rovoy; physical and technological properties of the soil to be treated cultivator cutting unchanged; working resistance of the cultivator and reactions to working bodies are constant in magnitude; motion drives on a given working depth accept stable (Zelikow et. al., 2008).

The equilibrium condition of the forest disc cultivator KLB-1.7 in the longitudinal vertical plane defined by (Sviridov and Vershinin, 2002) from the equation of moments about the axis of the front ends of the lower arms of the tractor hitch (the axis of suspension guns), vol. E. Point O (see Fig. 2). Then, taking into account the equality $P_x = R_x$ we have.

$$\sum M_o = G_н \cdot l_1 + G_{op} \cdot l_2 + G_c \cdot l_3 - R_z \cdot l_4 - P_z \cdot l_4 = 0. \quad (1)$$

From this formula, the value of the goods G_c we can find as follows:

$$G_c = (-G_н \cdot l_1 - G_{op} \cdot l_2 + R_z \cdot l_4 + P_z \cdot l_4) / l_3, \quad (2)$$

Where $G_н$, G_{op} – respectively weight force attachment mechanism and tools, H; R_z and P_z –vertical components of the resultant R_{xz} soil reaction and traction tractor P_{xz}, given to the axis O_1 of disk battery, H; l_1, l_2, l_3, l_4 – shoulders of the forces, respectively $G_н$, G_{op}, G_c, R_z и P_z, m.

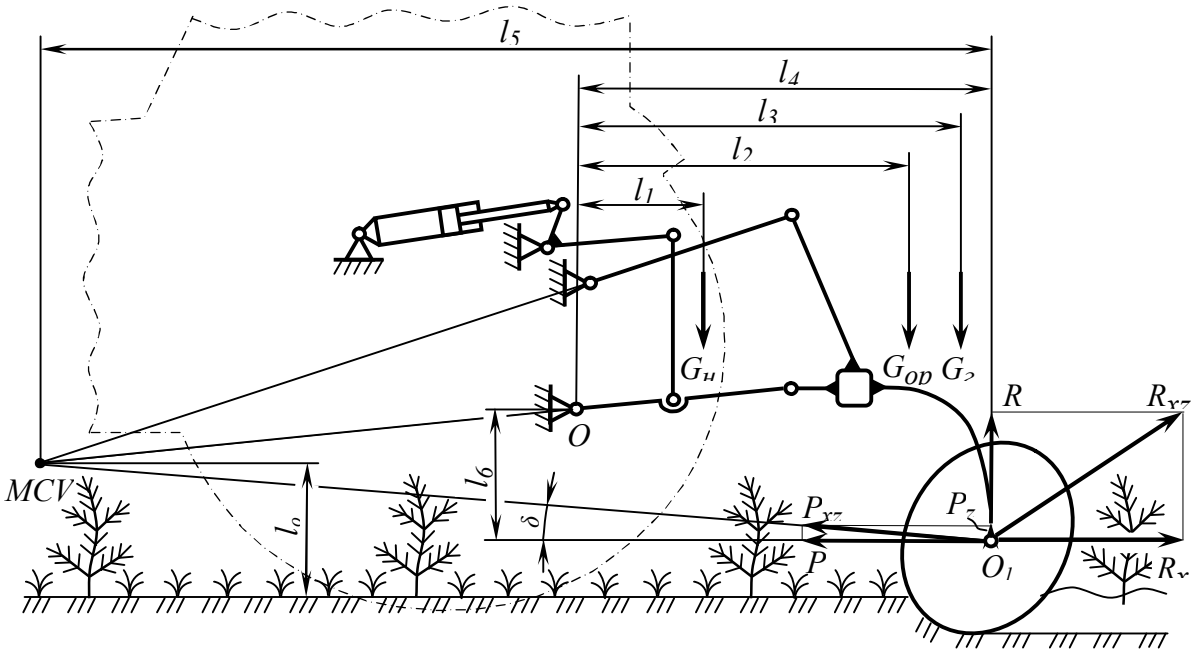


Figure 2. The calculation scheme for determining the amount of additional cargo $G_г$ for forest disc cultivator KLB-1,7

Components of the resultant Phz traction tractor, in accordance with the calculation scheme (Fig. 2) can be determined from the obvious equalities $P_x = R_x$, и $P_z = P_x \cdot tg\delta = P_x \cdot l_6 / l_5$. Here: R_x and P_x – horizontal components R_{xz}, resultant soil reaction and traction tractor P_{xz}, given to the axis O_1 of disk battery; l5 and l6 - projection segments respectively vertical and horizontal connecting points SCW and the axis O_1 disk battery; O_1 – conditional angle thrust disk guns, grad., in the position of the attachment, in which the distance from the point to the SCW supports-tractor's surface is equal to its default values, and so on. e. l_0 = 0,4 m. According to (Sineokov and Panov, 1982) for discs with a diameter of 510 mm, the angle of attack of 150 and Glu-bean processing R_z value of 6-10 cm is recommended to be taken as R_z = 1,5Rh. After substitution reactions expressed through R_x reactions of R_z and P_z in equation (2) and simple transformations we obtain the final formula for the approximate determination of the amount of additional cargo $G_г$ investigated cultivator (Zelikow, 2014; Posmetiev at. Al., 2013).

$$G_г = [-G_н \cdot l_1 - G_{op} \cdot l_2 + R_x(1{,}5 \cdot l_4 + l_4 \cdot l_6 / l_5)] / l_3. \quad (3)$$

To determine the expression (3) the required quantity Gg sle¬duyuschie accept input data: $G_н = m_н \cdot g$ = 1200 H, $G_{op} = m_{op} \cdot g$ = 5250 H, where $m_н$ = 122 and m_{op} = 536 kg - the weight of the attachment and tools, g = 9,8 - the acceleration of gravity, m /s^2; l_1 = 0,44 m, l_2= 1,23 m; l_3 = 1,45 m; l_4 = 1,53 m; l_5 = 4,88 m; l_6 = 0,4 m.

Find R_x out the value of known expression (Sviridov and Vershinin, 2002)

$$R_x = K\,(B - em),$$

where K – specific resistance to draw tool, Н/м; B – width of the tool, m; e – value of the protection zone on each side of row crops, m; m – number of rows of crops.

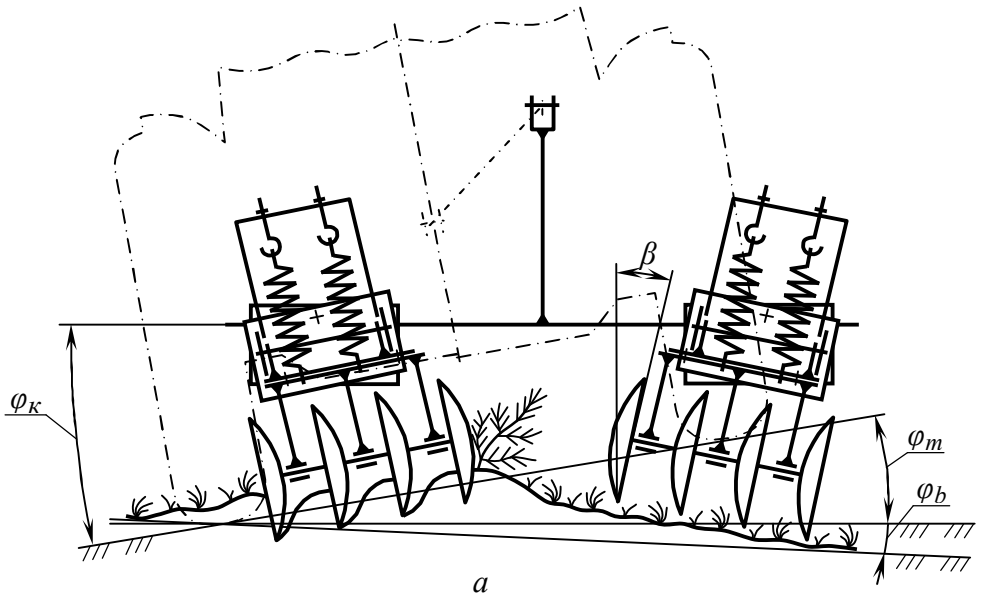
Here, the value of K depends on the physical and technological properties of honorary member-you, including its hardness. According to various published sources (Sviridov and Vershinin, 2002; Sineokov and Panov, 1982) for disc harrow, used in the care of the forest cultures, the value of K varies between 2000-4000 N/m at a depth of 6-10 cm cultivation (at the maximum possible under the passport 12 cm). Desired value Gg define for the following three cases, the care of disk cultivator of forest plantations: To equal mini¬malnomu, average, and maximum of the possible values, ie. E. K_1 = 2000, K_2 =3000 and K_3 = 4000 N / m.

After substituting the expression (3) the

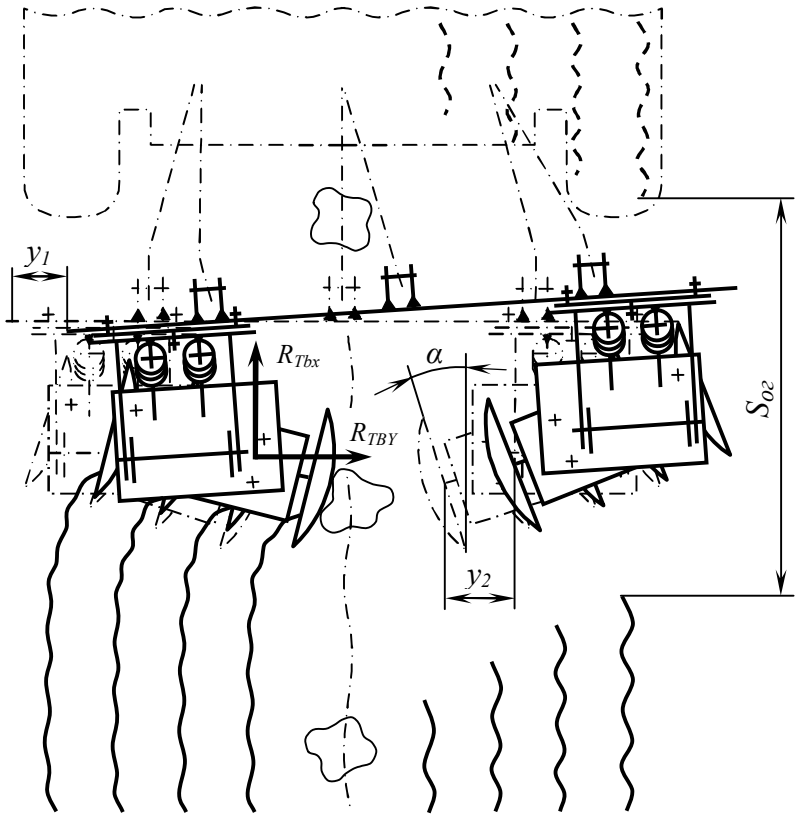
original data were obtained the following values G_g. When G_c magnitude of the force of additional cargo amounted la G_g = -812 N, which corresponds to the weight of the goods Mg = G_g/g =-83 kg. Here, the negative sign in the force Gg additional cargo at K_1, indicating excess amount of the total mass of cultiuvator and hitch of the tractor to accept the task. It is obvious that in this case the mass of the cultivator and attachments Arrangetion and additional weight is required. When the value of K_2 and G_g и m_g are respectively 1190N and 121 kg, with K_3 respectively 3193 N and 326 kg (Posmetiev et. al., 2014).

Analysis of the data allows us to conclude the following. Parameters designs serial cultivator KLB-1.7 and the standard attachment size OU-2 mounted on the tractor "Belarus 82.1" in the care of forest plantations in clearings with easy group mechanical composition of the soil (sand and sandy loam, with weak grassed and shoots) provide normal operation of the gun, even without any additional cost. In this case, the excess weight of the cultivator, which is equal to 83 kg, in this case, provides traffic drives on the maximum depth of 10-12 cm. Soils of the middle group (loam, grassed and with moderate regrowth) to provide the desired working depth 6-12 cm must be reloaded cultivator additional load on disc batteries (in ballast boxes) with a total mass of at least 121 kg. On soils with severe group (clay, much of weed shoots) normal maintenance of forest plantations is possible only when installed on kultiva-tor additional weight total weight is not less than 326 kg.

Consequently, serial cultivator KLB-1.7 uses can-vatsya clearings with mild to moderate soil groups of the mechanical-to whom the composition, with moderate saturation grassed and weeds. In this case, clearings, having even within the same rut soils with different physical and technological properties, ensure the stability of stroke disks at a given depth is not possible. Tractor driver is not able to timely and fully implement the relevant adjustment tools by changing the value of the additional cargo. Due to the great discomfort of having to frequent change of magnitude of the mass of cargo (loading, unloading, and search for the presence of a suitable material, and so on. N.) Machine operators often do not use it, so that the depth of tillage discs is not maintained within the specified limits. Owing to these reasons, the quality of care of forest plantations on cutting disc harrow is still insufficient nym. To improve the quality of tillage on cutting machine operators produce where it is necessary, repeat passages cultivator, which leads to excessive fuel consumption and longer maturities undue care of forest plantations. Besides the need to always carry ballast (20-40% or more by weight of the gun) to work on cutting the soils of moderate and severe groups, which significantly reduces the reliability and efficiency of this pochvoobraba Pipeline unit.



a



b

Figure 3. Education blemish S_{og} and damage to forest plantations as a result of a cart-action component R_{Tbu} force of traction resistance of a recessed circular battery and lateral displacement of the frame y_1 and y_2 drive serial cultivator, hung on a tractor with a standard hitch

Another significant shortcoming of standard attachments is their inability to provide a full copy of the soil both batteries disc cultivator clearings. This is due to significant irregularities treated surface, typical for logging, as well as the lack of value of the angle of inclination of the axis of suspension in the vertical transverse plane in relation to the reference surface of the tractor (see Fig. 3a). Slopes treated furrows φ_b and the bearing surface of the torus-track φ_m in vertical transverse plane can reach 15-20 degrees or more, and, relative to the total slope of the soil surface on the cutting, they may be in different directions. In the latter case, the total bias $\varphi_b + \varphi_m$ can reach 30 degrees or more, whereas skewed cultivator frame φk guaranteed standard hitch of the tractor does not exceed 10-150, which inevitably leads to partial or complete vyglubleniyu a disc batteries. As a result, under the influence of the lateral component P_{Tby} recessed battery, it shifts to the containment zone being processed row by the value y2, and its innermost disk damages seedling (see Fig. 3b). The magnitude of the obtained blemish S_{oz} also depends on the angles of the disc batteries: α - attack in the horizontal and β – to the bottom of the furrow in cross-vertical planes.

Thus, the design and permissible adjustment parameters of the standard hitch of the tractor, and the use of goods on disk batteries do not provide the cultivator to achieve the required quality of soil treatment in the ranks of forest crops in clearings. Besides the efficiency of such soil tillage implement unnecessarily reduced because of excessive fuel consumption and lack of productivity.

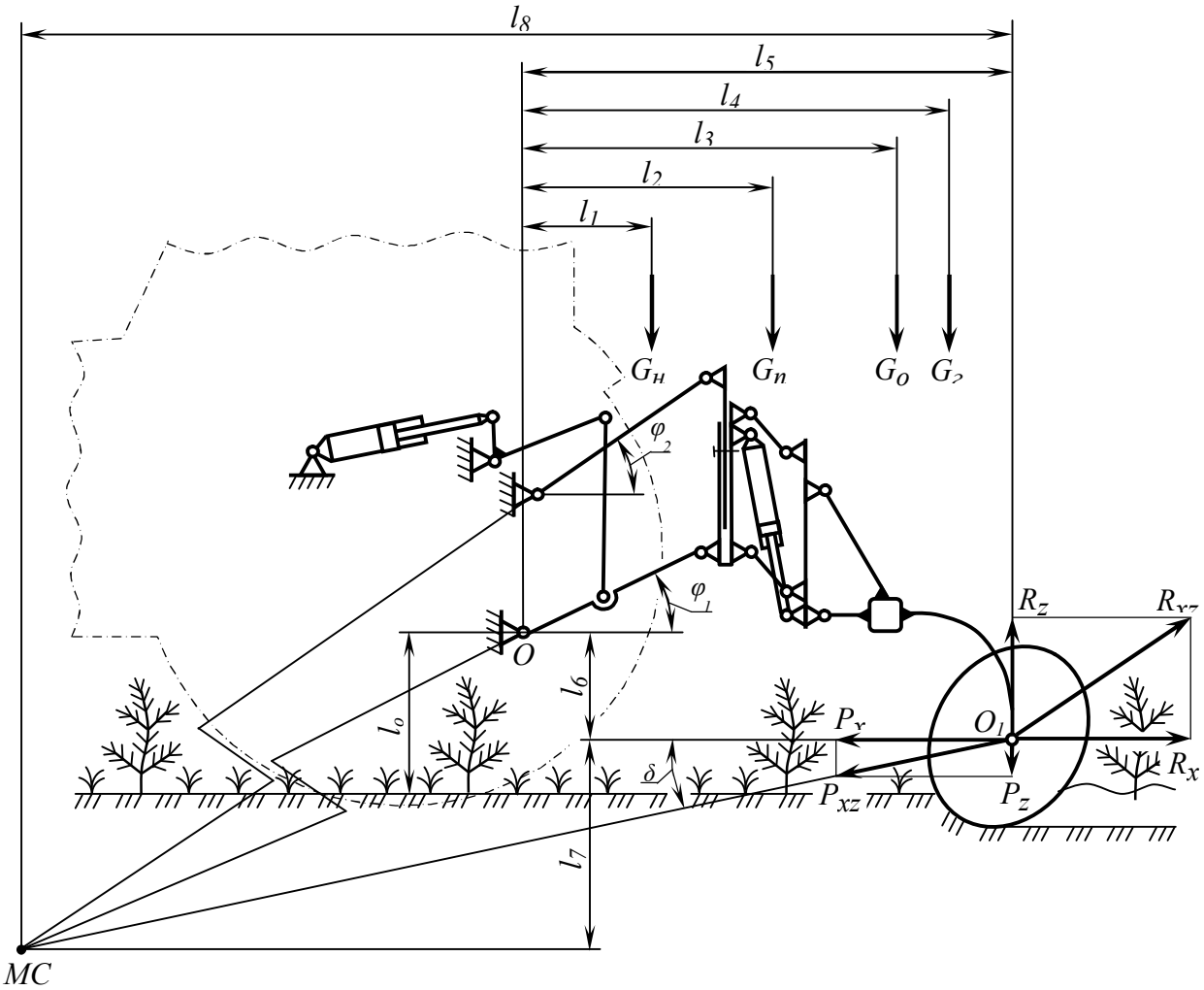


Figure 4. The design scheme to the determination of the amount of additional cargo G_g Forest disc cultivator KLB-1,7 PNGA attachment to the tractor hitch

Results

Made by the authors in-depth analysis of the functioning of different possibilities of constructive implementation attachments tractors (Kalbus, 1982; Popikov et. al., 2014) suggested the following solutions to the problem. With the help of The developed-ous devices hydraulic (PNGA) established between the tractor hitch and put in disk instrument to ensure the motion unit capacity of regulatory-tion to the extent necessary position SCW links hitch of the tractor. In this connection, perform the calculation and analyze the effectiveness of the proposed design tools.

Calculations were carried out similarly to the previous made for standard hitch, tractor "Belarus 82.1" and the serial cultivator KLB-1.7 based on the assumptions and input data, taking into account the design parameters of the proposed device. Then, in accordance with the calculation scheme (see Fig. 4) the equation of moments about the point O will take the following form:

$$\sum M_o = G_н \cdot l_1 + G_n \cdot l_2 + G_{op} \cdot l_3 + G_г \cdot l_4 - R_z \cdot l_5 + P_z \cdot l_5 = 0. \qquad (4)$$

From equation (4) after the expression reaction R_z and force P_z through reaction R_x and simple transformations, the value of the goods G_g defined as

$$G_г = [-G_н \cdot l_1 - G_n \cdot l_2 - G_{op} \cdot l_3 + R_x \cdot l_5 (1{,}5 - l_7/l_8)] / l_4, \qquad (5)$$

where G_H, G_p and G_{or} – respectively weight force attachment mechanism, devices and instruments, H; R_x - the horizontal component of the resultant R_{hz} on the working bodies of the soil reaction, reduced to the axis O_1 disk battery, *H;* l_1, l_2, l_3, l_4 and l_5 - shoulders of the forces and reactions, respectively, G_H, G_p, G_{or}, G_g, R_z and P_z, m; *l7* and *l8* – projection segments respectively vertical and horizontal plane connecting points S_{CW} and the axis O_1 disk battery.

The initial data for determining the value Gg using semi-chennogo expression (5) are as follows: GH = MN · g = 1200 N, Gor = mor · g = 5250 N, Gp = MP · g = 1000 N, where MN = 122 kg mor = 536 kg and MP = 102 kg - weight of the attachment, tools and accessories; g = 9,8 - the acceleration of gravity, m / s 2; l_1 = 0,44 m, l_2 = 1,0 m; l_3 = 1,23 m; l_4 = 1,45 m; l_5 = 1,53 m; l_7 = 0,5 m; l_8 = 4,88 m. input data values Rx and to similar those found above for the formula (3).

Were calculated using the expression (5) in the case of use in autonomous prispo-PGNA when attaching a serial cultivator tractor with a standard hitch and installed with the help of a hydraulic cylinder device the maximum value of the conditional thrust angle δ guns showed the following. When the hardness of the treated soil K_1 = 2000 N/m additional load magnitude of the force was G_g = -2071 N, which corresponds to the weight of the cargo M_g = -211 kg. Negative value and high value of the mass of the load in this case reveal a large excess bury moment on the working bodies of the cultivator at work on forest soils with low hardness. In this case, by controlling the hydraulic cylinder devices via a workstation tractor operator to easily set the desired value of the working depth of the disc batteries cultivator.

When soil hardness K_2 and K_3 = 3000 = 4000 N/m value of mass Mg additional cargo amounted to -36 and 139 kg. In the first case, the device provides reliable penetration drives without load at maximum operating depth is 12 cm. In the second case without load working depth of no more than 6 cm and 10-12 cm - weight at 139 kg of cargo. However, given that the clearings of the soil with high hardness 4000 N/m are relatively rare, the need for additional loads to be determined on the gun, almost disappears.

Thus the proposed fixture design PNGA to provide a reliable penetration disc batteries serial tiller to the desired depth without the use of additional processing load on cutting various hardness of forest soils.

Basis adopted scheme and basic design and operating parameters of the proposed device allowed to design and manufacture its prototype (Posmetiev et. al., 2013). Fixture design (see Fig. 5) includes a frame consisting of interconnected vertical and horizontal bars, *2* In the vertical tool bar located retractable stand with eye *3* for joining the rear end of the upper link 19-foot canopy of the tractor. Front regulated to the desired height with your finger 4, inserted into the hole in the sill 1 and the corresponding hole in the rack. The rear ends of the two lower links of the tractor hitch *20* are hinged on the axes, formed at both ends of the horizontal beam of the frame *2* devices. Frame *8* by an upper and lower two levers *9*, by means of arms *5* and *14*, as well as eyelets *6* and *7* are pivotally connected to a connecting triangle of coupler 10 on the triangle connecting the mating part hinged coupler with the tiller 18 at lower ends of the connecting-triangle using spacers rigidly connected to the timbers *11*, the center bracket *15* is mounted between the bracket *5* and *15* pivotally mounted cylinder *16* which is connected by flexible piping tractor hydraulic directional control valve (in Fig. not shown). In the transport position device with attached to it cultivator is securely held chain *17* by a pin in the bracket *5* To disconnect rigged *18* guns from the device from the tractor cab is the handle *12* with rope, held in the operating position by a spring *13* is connected kinematically to handle placed in the connection *10* triangle lock with which weapon securely connected to the device when attaching without the tractor driver or support staff.

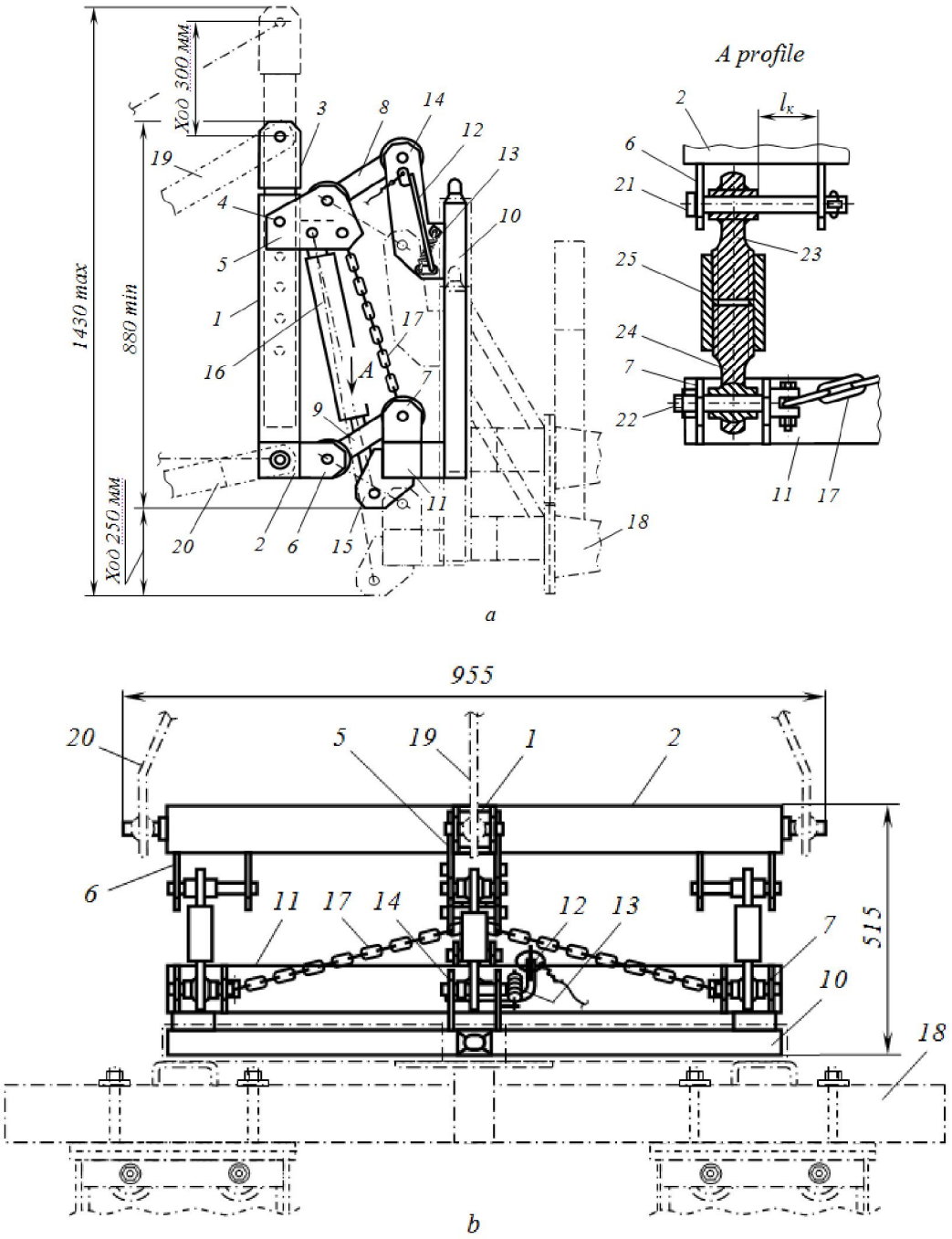


Figure 5. Tool hydraulic PGNA to hitch tractor with disc Unitized his guns equipped with a coupler: a, b - side and top views; 1 and 2 - the vertical and horizontal bars of the frame; 3 - retractable stand with pro-Ushin; 4 - clamp; 5 - an arm; 6 and 7 - eyelets; 8 and 9 - the upper and lower control arms; 10,15 - respectively connecting triangle, beam, handle lock, springs, upper and lower brackets frame coupler; 16 - cylinder; 17 - chain; 18 - cultivator; 19 and 20 - the upper and lower link hitch of the tractor; 21 and 22 - the fingers; 23 and 24 - and a cylindrical head with a spherical bushing; 25 - threaded bushing

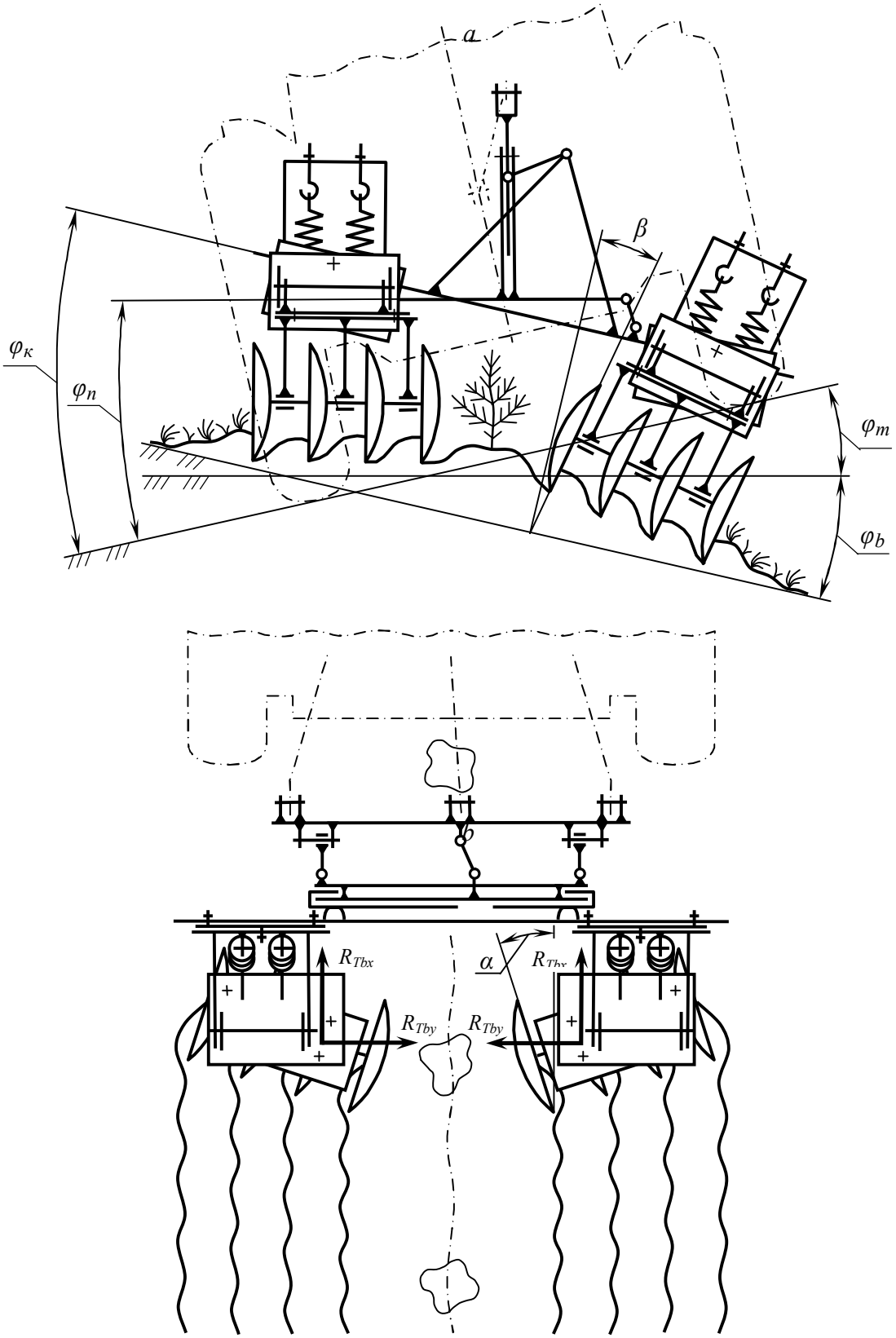


Figure 6. Scheme of the forest on the cutting serial disc cultivator, hinged on the tractor hitch using the tool PNGA

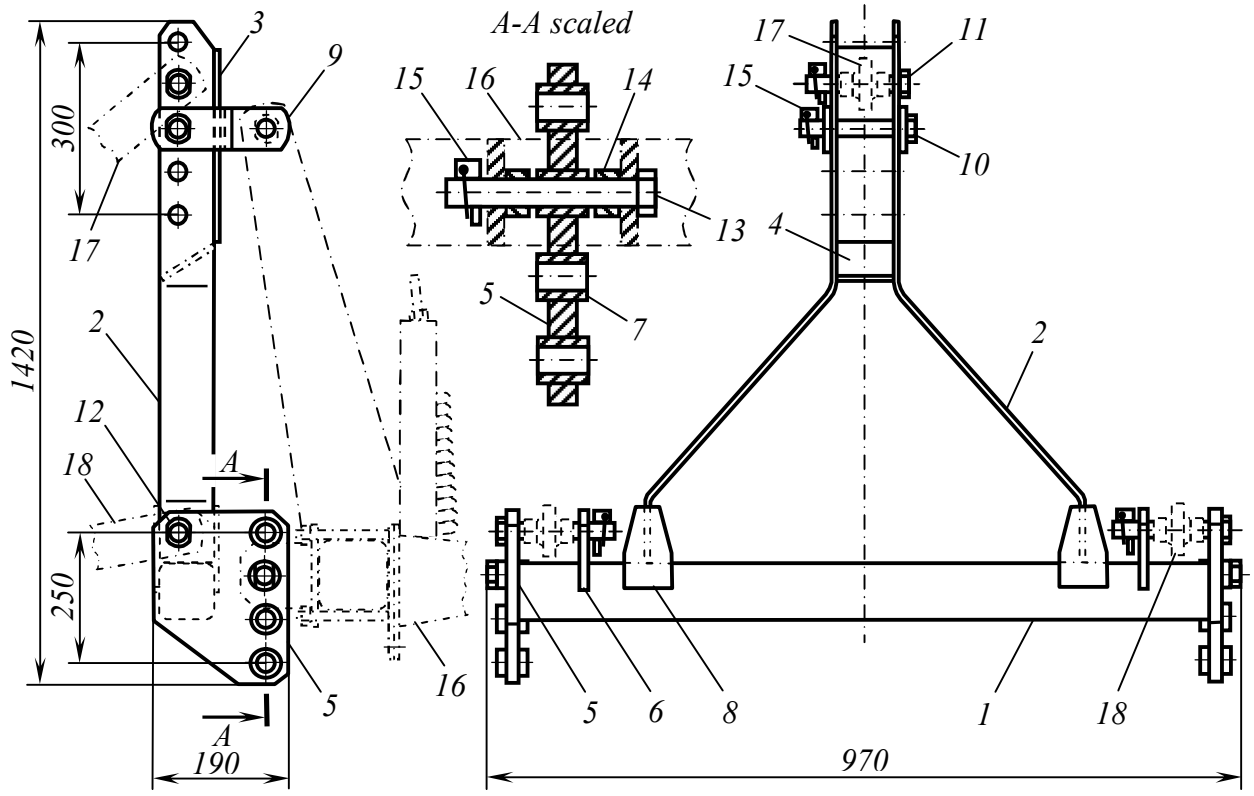


Figure 7. Device Mon to hitch tractor Unitized it with disc implements, not equipped with a coupler: 1 - timber; 2 - Front-brace; 3 - wall; 4 - strut; 5 and 6 - eyelets and the inner end face; 7 - Bush; 8 - kerchief; 9 - Earring; 10, 11, 12, 13 - the fingers; 14 - ring; 15 - check; 16 - cultivator; 17 and 18 - the upper and lower links of the tractor hitch

PGNA device operates as follows. Before hinged-vaniem first cultivator tractor mounted device. For this purpose, the upper arm 19 of the attachment of a tractor with a finger in the eye fix 3 extendable rack vertical bar 1, and the two lower arm 20 and put on record the checks on the horizontal axis of the frame beam 2 In this case, the moving part devices – bar 11 with a connecting coupler Delta 10, is at the top-it vehicle and locked the chain 17 After this tractor, maneuvering the tractor in reverse, produces in the normal way of connecting triangles coupler connection devices 10 and 18 cultivator Then, lifting hydraulic cylinder tractor attachment tool in the transport position, Soil the unit should be on the forest object.

Before you start an instrument is lowered to the ground and the upper end of the chain is detached from the bracket 17.5 Then use your finger latch 4, placed in the hole of the vertical beam 1 device in one of the holes in the front with eyelet 3, push and fix it to the desired height adjustable within the stroke of 300 mm. At the same time take into account that smaller on the value of the parameter to be changed corresponding to the largest displacement SCW rod attachment as forward facing tractor and down in the vertical longitudinal plane of him. In this case, gives the greatest Depth member effect of exposure to the disc Battery efforts PZ (see. Fig. 4). Conversely, when nominating rack up the value deepened efforts PZ decreases. Additionally, when this adjustment into account also control the front and adhesion to the soil of the driven rear wheels of the tractor. Having thus established the top link hitch of the tractor to the desired position with the hardness and soil conditions, soil cultivator lowered when "floating" position control valve hydraulic drive tractor hitch and the unit starts to work.

During the movement of the unit on the cutting, with local changes of the hardness of the treated soil, hold the disc batteries at a given depth of processing carried out with the tractor workplace. To do this, use the appropriate section of the tractor control valve and the hydraulic cylinder 16 moves the movable part is forced to adapt-ment (11 bar, connecting triangle 10) up or down relative to the frame of fixed appliances (bars 1 and 2). The magnitude of the displacement stroke is 250 mm,

which is sufficient to ensure that the location of the SCW, in which guaranteed provided zaglublyaemost disc batteries without the use of ballast when working cultivator on soils with different hardness. Translation tools from working to transport position is carried out in reverse order-of (Chen et. al., 2014).

The design feature of the proposed device PNGA is also its ability to provide a hinged frame guns when moving the machine on the cutting corners in the transverse vertical plane relative to the triangle connecting the attachment Arrange-tion of the tractor at an angle β to 200 in both directions (see Fig. 6). This is achieved by using ball joints at the upper 8 and lower arm 9, and also in the eyes of the hydraulic cylinder 14 Thus, given the standard regulated angle triangle connecting hitch of the tractor relative to the core equal to 10-150, the total rotation angle of the frame is hung on device implements guaranteed When cornering is 300 frames guns form a natural reduction in the distance between the lower horizontal bar levers 9 2 devices offset by an increase in the eyes of the distance LK 6 (see Fig. 6a). The significant increase of the angle of rotation of the frame of the cultivator, a better copy it to disc batteries soil surface with a large curvature of the surface and, consequently, increases the quality of care of forest plantations in clearings. In contrast to the traditional building-block forest cultivators use device eliminates the repeated passes on the clearings.

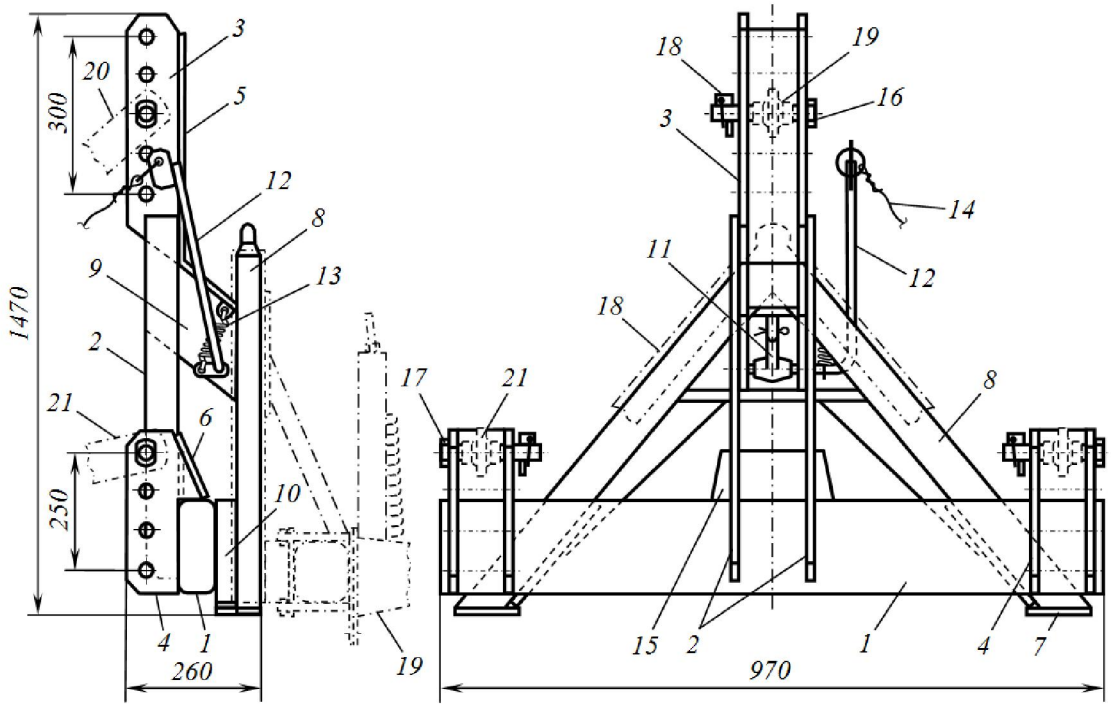


Figure 8. The adaptation of the PNA to the hitch of the tractor when it Unitized with disc implements equipped with a coupler: 1 - timber; 2 - Front; 3 and 4 - the upper and lower eye; 5 - a wall; 6 and 7 - covers; 8 - frame; 9 - cheek; 10 - strut; 11 - catch; 12 - the handle; 13 - spring; 14 - a rope; 15 - kerchief; 16 and 17 - the fingers; 18 - check; 19 - cultivator; 20 and 21 - the upper and lower links of the tractor hitch

Discussion

The proposed design tools PNGA to extend the capabilities of standard attachments, especially when Unitized tractors with mounted disc harrows. This is achieved by the ability to design tools to change the angle δ traction implements a much greater extent than permitted by the standard coupling devices. Thus, the motion control unit is provided with a workplace-tractor driver were cause of the vertical component of Pz traction tractor compensating vertical component Rz soil reaction, ejects the disc to the surface. Thus there is no need for additional loads when working cultivator clearings with different types of soil in clearings.

The authors have also developed two simpler design prispo-Packs designed similar purpose: for disk tools are not equipped with a coupler (PN) (see Fig. 7) and equipped it (PNA) (see Fig. 8).

In both designs, the rear ends of the upper devices linkage hitch tractor rearranged the

traditional way with your fingers and made holes in the rack. Installation and operation of devices is similar to that described above to fit PNGA.

The principal difference between the two designs from the device PNGA is the need to manually swap the rear ends of the lower links of the tractor hitch, depending on the hardness of the treated soil on the cutting. Besides the design of devices Mo and the PNA does not provide a frame distortions BRUCHAPaneel guns relative attachment tractor over 10-150, which impairs copying discs machined surface of the soil. Despite the simplicity of the design of these devices, in contrast to the standard attachments, allow serial Disc Tools provide better treatment of the soil with no additional cost (Zhaglovskaya et. al., 2014).

In order to verify that the proposed designs of devices were fabricated and subjected to the tests of the experimental samples on a universal laboratory complex for field studies attachments tractors, tillage equipment and machines, running parts of wheeled and tracked vehicles (Posmetiev et. al., 2013). Stand scheme with the one set-lennym it serial cultivator KLB-1.7 is shown in figure 9, and an example of the working torque on the stand in the experiments with the cultivator and the device PNGA – in Figure 10.

In accordance with the established methodology of laboratory experiments, as well as through a variety of optional plug-in devices and modern instrumentation on the stand carried experiments to study the impact on the qualitative performance of the tiller using the proposed adaptations PN, PNA and PNGA. Each series of experiments was performed in triplicate and compared with serial cultivator attachment is mounted on the stand without tools.

As a removable devices in experiments on the stand using different simulators obstacles (stumps, cut and not cut the discs roots, shoots), and soils with different hardness. Necessary soil hardness in the range 2000-4000 N / m was achieved by a fiber gasket compactors after each pass of the cultivator. Working stroke trolley rails 8 9 installed on it replaceable equipment 10 is provided by means of telescopic hydraulic cylinder 7 to the maximum stroke of 3 meters with a pulling force of up to 1 m and velocities of 0.5-1.5 m/s.

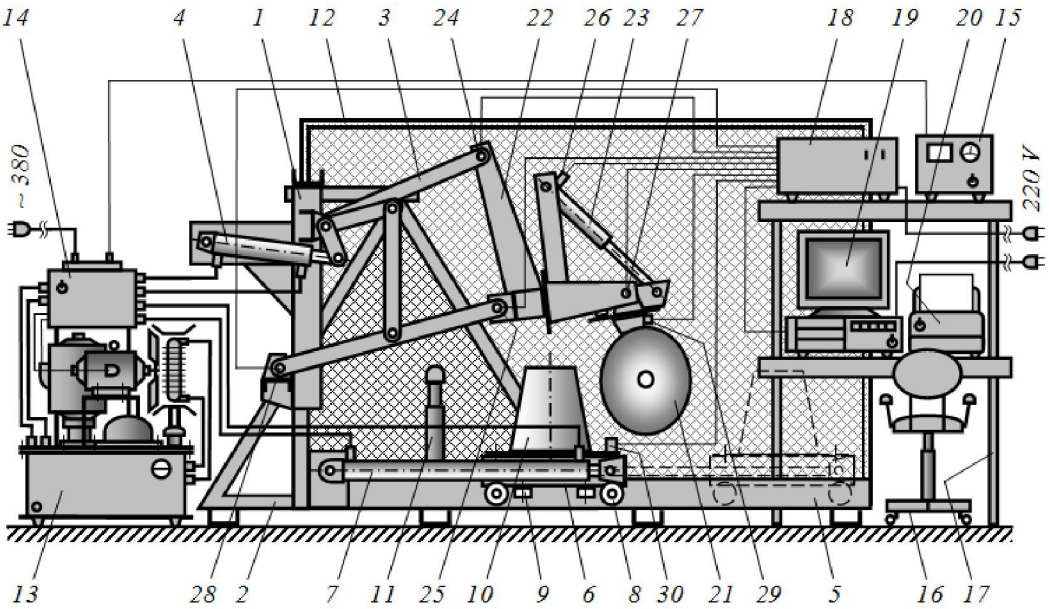


Figure 9. Diagram of a universal laboratory complex for the Exploration of the experimental attachments tractors, tillers and outboard machines, running parts of wheeled and tracked machines: 1 - a wall; 2 - sidewall; 3 - removable canopy-ing apparatus; 4 - cylinder actuator attachment; 5 - guides; 6 - those-maturation; 7 - cylinder drive cars; 8 and 9 - suspension and steering wheel carts; 10 - simulator obstacles; 11 - Turn limiter units attachment; 12 - fencing; 13 - Hydraulic power station; 14 - spool device; 15 - Remote Control-of pumping stations; 16 - Operator Workplace; 17 - equipment rack; 18 - unit strain gauge equipment; 19 - the computer; 20 - printer; 21 - Circular battery cultivator; 22 and 23 - the frame and cylinder guard cultivator; 24-30 - tensor-metric sensors, respectively upper and lower tenzopaltsy, pressure gidrotsi Lindre-Fuse cultivator, rotating disk batteries and lower link attachment, efforts at the front disc batteries, linear accelerations trolley

During the experiments at the same time been measured following 12 parameters studied: efforts at the top and bottom of both rods hitch tractor; fluid pressure in the hydraulic cylinder device PNGA; horizontal and vertical displacement, rotation angles separately cultivator frame and fittings in the transverse vertical plane; operating depth of each of the two disc batteries. The first four parameters were recorded by a wireless remote tenzometrirovaniya, and the rest - by digital video, image recognition, processing, transmission, storage and analysis of data about the object.

Wireless tenzometrirovanie recorded parameters was carried out as follows. Deformation of mechanical stress in the attachment rods tractor and sensor pressure sensor registers corresponding strain gauge, converted into electrical signals, which are amplified by the differential amplifier and normalized to the desired value. Then, after they were transferred to the filtration analog-converter of the microcontroller, coded and shaped in the form of relevant protocols. Next, the digital signal must be received in the radio, and after amplification using a wireless Wi-Fi connection was transferred to the computer.

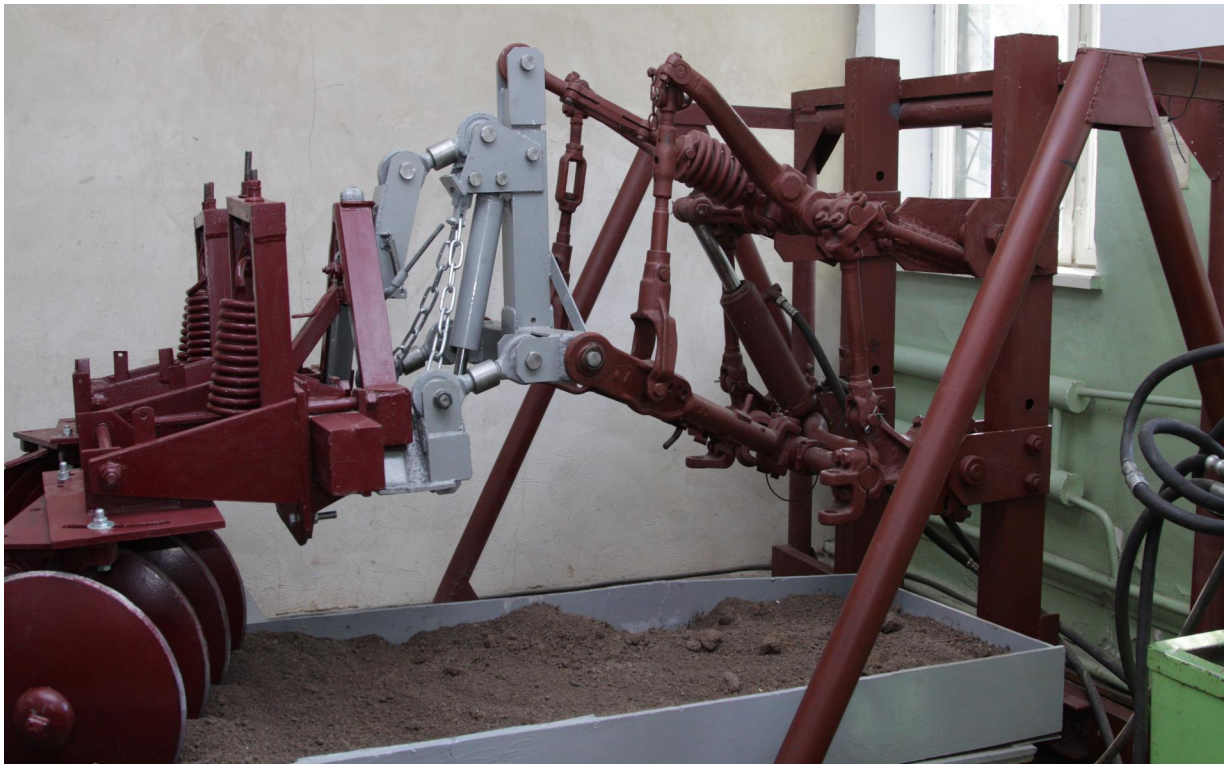


Figure 10. The working time of the experiment on the test stand as an example PNGA devices with attached thereon forest serial disk cultivator KLB-1.7

The developed methodology and the results of experiments made it possible to check the performance and with sufficient precision and accuracy to evaluate the effectiveness of the proposed designs adaptations to the standard hitch of the tractor (see Table. 1). As a result of the experiments performed at speeds trolley stand 1.0 m / s the following was found.

When using devices force values on the rods attachment tractor increased on average by 20%. This is due to higher operating resistance tools by increasing the depth of processing of its working bodies, as well as an increase in the time from the action of reactive forces on the disc batteries due to the greater height of the axis of suspension guns.

Table 1. Specifications of adaptations to the standard hitch tractor with implements its Unitized disc cultivator KLB-1.7

Parametres	Type of device		
	PN	PNA	PNGA
1 Size used standard tractor hitch (class of tractor)	NU-2 (0,6-2)		
2 Mounting dimensions of the tractor and put in the tool	correspond to GOST 10677-2001 device hinged back agricultural tractors 0,6-8,0 classes. Types, basic parameters and dimensions		
3 Permissible BRUCHAPaneel guns at a distance of 610 mm from the axis of suspension, kg: automatic tow hitch without CA-1 with automatic coupler SA-1	 1600 1400		
4 Maximum working depth, cm, soil hardness, H/m: 2000 3000 4000	 12 10 –	 12 12 –	 12 12 6
5 Maximum angle frame hinged instruments in cross-vertical plane relative to the reference surface of the tractor, hail.	10-15	10-15	25-30
6 Offset internal disks in a protective area us-inal processed row, see if the value of the total skew cultivator frame, hail: 10 20 30	 5 17 30	 5 17 30	 2 4 6
7 Working fluid pressure in the hydraulic circuit, MPa	–	–	>= 5
8 Overall dimensions: width height, max/min length	 190 1420/– 970	 260 1470/– 970	 515 1430/880 955
9 Weight, kg	51	65	85
10 Ability to set the depth of tillage implements the working bodies of the disk from the tractor cab	no	no	yes

The data table shows that all three constructs devices reliably provide a disc cultivator operation on soils with a hardness in the range 2000-4000 N / m Processing depth of 10-12 cm, the average velocity of 1.0 m / s and the uneven surface of the soil with deviations within 10-300. Under the same experimental conditions cultivator KLB-1.7 devices without providing a predetermined cutting depth of 10-12 cm in the soil at a hardness of up to 2000 N / m without any additional cost, with a hardness of up to 3000 N / m with load of 90 kg and at a hardness of up to 4000 N / m with a load of 250 kg. Here disagreement with the theoretical values of the same mass of additional cargo (respectively 121 and 326 kg) at a hardness of honorary member-you 3000 and 4000 N / m explains the assumptions made, as well as the neglect of the experiments the presence of plant inclusions in the soil and weed growths on the surface of the processed row.

Measurements of displacement y2 (see. Fig. 3, b) internal drive battery cultivator in the protection zone of the processed row show the effectiveness of adaptation PNGA, which restricts the use of the offset value of the safe 2-6 cm. This is achieved provided the ability to design PNGA good copy at the surface of the processed row distortions cultivator frame to 300 Devices PN and PNA in the same conditions of the experiments at the same offset values showed disks in the protection zone, safe - 5 cm, with distortions cultivator frame to 10-150 and unacceptably large displacements - 17-30 cm with distortions 20-300. In the latter case, the probability

of damage to seedlings is very high, ie. To. Magnitude of the protection zone is 20-25 cm from each side row. Similar high offsets discs recorded in the cultivator hung on the tractor without tools. Unacceptably large displacement drives cultivators with or without fittings PN and PNA is due to their inability to provide a full copy of the processed surface of the working bodies of the order. The main reason is the failure of such devices to provide add-on frames guns angles distortions in cross-vertical plane over 10-150. For this reason, when larger values of the angles of the total of 150 distortions frame means and the support surface one from the tractor disc batteries partially or completely loses contact with the ground, as well as the wheels are set at an angle of attack (10-300) facing unit, the displacement of the implements relative to the axis order is imminent.

The results of the study allow us to conclude the following. The proposed design fixtures Mon, PNA and PNGA are in addition to the standard hitch tractors of 0.6-2.0, they are easily fitted and removed by one person, does not require modifications of structures, as the attachment of the tractor, and the connecting device (coupler) BRUCHAPaneel disk tools. The mechanism is simple in construction and maintenance, and their production does not require scarce materials and quite a force itself in a machine-repair shops.

Designed for example, hinged wood disc cultivator way to improve the ability to bury bodies disc working with removable devices, providing a wide range position correction SCW units of standard attachments, is also applicable to other mounted disk forest and agricultural shout-diy. For heavier guns mounted disk - plows, harrows, and so on. N. Sizes with attachments tractors OU-3 and OU-4, respectively, for mounting onto tractors of 3-4 and 5-8, the application of a reinforced devices similar to design Mon, PNA and PNGA. Use of the proposed devices can improve the efficiency of disk tools by eliminating the use of additional cargo-tary, increased productivity and better their Rabo in the care of forest plantations in clearings, as well as reduce fuel top-Liva of mounted tractor.

Next, the final stage of the study is to conduct a pilot production test developed devices in actual use disc cultivator clearings. The results of this test and refine the basic design parameters of devices is expected to develop recommendations for the effective implementation and introduc-NIJ in production.

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