

## AGENCY OF THE SUSPENSION OF THE BACK IDLER ON TRANSPORT VIBRATION OF THE TRACTOR WITH TRIANGULAR CATERPILLAR CONTOUR

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### **Abstract**

Recently leading producers of farm tractors even more often apply in running systems triangular caterpillar contour (TCC). In such running system one of the most problem knots is the back idler (BI) which is loaded by reaction from a caterpillar track and from weight of the casco having on this support. Thus the vertical component of reaction from a tension of a caterpillar track in addition loads with a tie-rod tangential force suspension bracket BI, thereby disturbing with a casco and reducing smoothness of a course of a tractor. Modelling and the analysis of dependence of affecting of vibration on a seat of the motor-man depending on applied type of a suspension bracket of a back idler are in-process executed. The analysis of parameters of smoothness of a course for the circuit design with triangular caterpillar contour and the offered suspension bracket of a back idler showed that in comparison with base configuration of a tractor of family VT On transport operations, at traffic on the soil road with the lifted tool, affectings on a seat of the operator decrease in 1,1-1,7 times in vertical and in 1.1-1.2 times in horizontal directions, at work with nominal loading, and also with  $R_{kr}=50$  kN, on an eddish, provides minor alteration of smoothness of a course, the divergence of values of affecting on a seat of the operator, on the average, makes 12–19 %. In comparison with triangular caterpillar contour and "a classical" suspension bracket of a back idler, various displacement-yoke systems of a back idler, at work on transport operations, slightly influence a divergence of parameters of affecting on a seat of the operator which make 2.6 % and 4 % for vertical and horizontal affectings accordingly. At work with nominal loading on an eddish, affectings on a seat of the operator decrease in 1.7–2.7 times in vertical and in 1.4–1.8 times in horizontal directions and at work with draw-bar loading of  $R_{kr}=50$  kN on an eddish, affectings on a seat of the operator decrease in 1.4–2.1 times in vertical and periodically increase on some speeds no more than by 30 % in a horizontal direction.

**Keywords:** *triangular caterpillar contour, suspension, back idler, modelling*

One of the basic trends in agricultural tractor industry throughout all period of its existence is productivity agriculture vehicles. Such result is attained, in the core, at the expense of increase in working speeds of a tractor and tool width. The increase in weight of a tractor and power of an engine for possibility of implementation of a higher tractive force and working speeds becomes a consequence. To realise such way of perfection of traction means was possibly with simultaneous development of running systems and suspensions.

The running system of the crawler tractor should provide effective implementation of a tractive force which is attained, in the core, at the expense of increase in the square of contact of a caterpillar track with a ground and uniformity of distribution of pressure on all bearing area [0].

Recently heading tryings in agriculture of running system with the overhead arrangement of a drive gear become, thus the form of caterpillar contour gets triangular (TCC) the form (Fig. 1). To its basic advantages it is necessary to refer to [0]:

- possibility of maintenance of the big traction force at smaller weight of a tractor;
- the raised stability in pitch at the expense of the increased length of a bearing area;
- decrease in gabarits of a tractor at the expense of features of configuration of running system;
- possibility of maintenance of necessary displacement of the centre of gravity forward and raises draw-bar loading, etc.

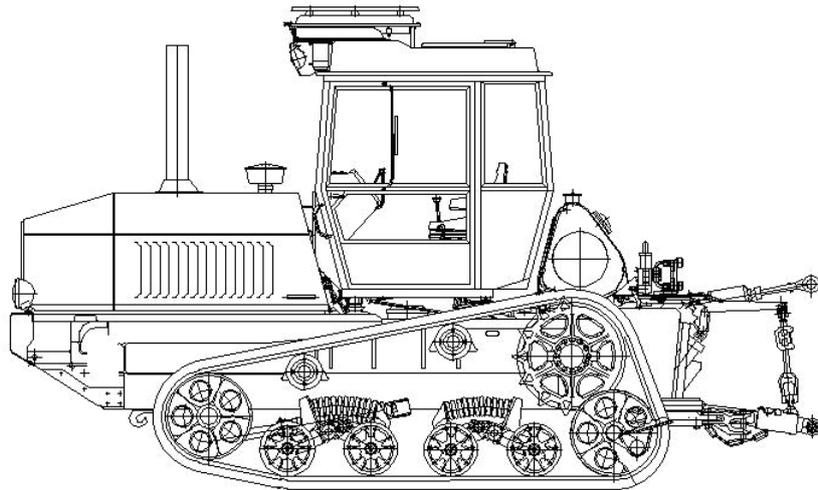


Fig. 1. Developed configuration of a tractor with TCC

The most widespread "classical" design of a suspension bracket of a back idler (BI) [0], Fig. 2.a, at its application in running system with TCC, tests the raised loading: from vertical reaction of a bearing area and  $P_V$  from vertical making reaction from a tie-rod tangential force  $P_{SK}$  from which the caterpillar track acts on a back basic wheel. The resultant of a tangential force of the tie-rod  $P_{SK}$ , enclosed by a caterpillar track to a back basic wheel, creates the moment  $M_{SK}$ , aimed to turn the balancer on which the back basic wheel fastens. As a result suspension rate and a dynamic course of a basic wheel that reduces overall performance of a suspension bracket [0] essentially changes.

For decrease in negative agency of vertical making reaction from a tangential force of a tie-rod  $P_{SK}$  on the basis of the analysis of alternatives of suspension brackets the circuit design of a suspension bracket of the back idler, shown on fig. 2.б [0] has been offered. Overall performance of a suspension bracket because the suspension bracket characteristic changes as a function of a tractor operating mode.

Total reaction of a tangential force of the tie-rod  $P_{SK}$ , acting on axis BI, it is possible to present proceeding from values of a tangential force of a tie-rod  $P_K$ , and also an angle between a bearing area and a leading branch of the track chain.

$$P_{SK} = \sqrt{(P_K \cos(\beta) + P_K)^2 + (P_K * \sin(\beta))^2} . \tag{1}$$

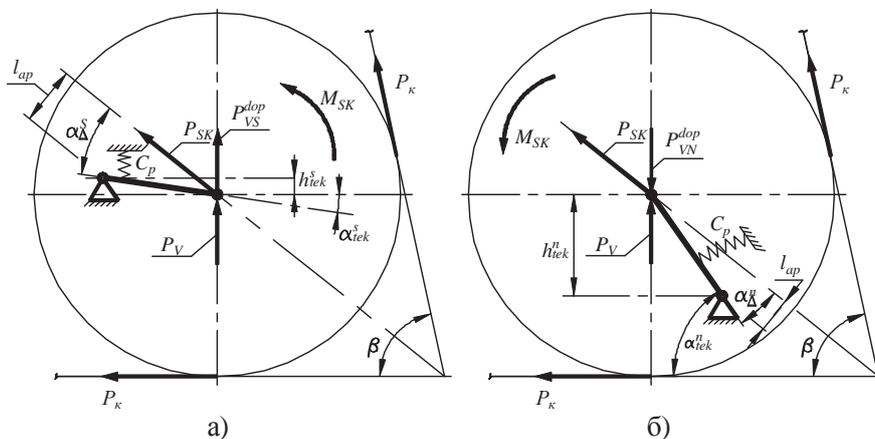


Fig. 1. Circuit designs of suspension brackets BI "classical", offered

For classical suspension bracket BI the reaction formula, becomes:

$$P_{VS}^{dop} = \frac{P_{SK} * l_{bal} * \sin(\alpha_{\Delta}^s)}{l_{bal} * \cos(\alpha_{tek}^s)}, \quad (2)$$

where:

$$\alpha_{\Delta}^s = \alpha_{tek}^s - \frac{\beta}{2}, \quad (3)$$

- angle on which balancer BI concerning a bisector  $\beta$  turns;

$$\alpha_{tek}^s = \arcsin \frac{h_{tek}^s}{l_{bal}}, \quad (4)$$

- current angle between an axis of BI's balancer and a horizontal axis passing through an axis of fastening of the balancer;

$$h_{tek}^s = l_{bal} * \sin(\alpha_{nygol}) - h_{zok}, \quad (5)$$

- current distance between a horizontal axis in a point of fastening and BI's balancer axis;

$l_{bal}$  - length of BI's balancer;

$h_{zok}$  - current course of a running idler concerning an initial rule at completely unloaded suspension bracket.

For the offered circuit design of suspension bracket BI calculation of additional vertical reaction from a tension of a caterpillar track a tie-rod tangential force can be written down in the aspect presented more low. The difference in formulas is caused by various geometry of an arrangement of the balancer, in the rest formulas are identical:

$$P_{VN}^{dop} = \frac{P_{SK} * l_{bal} * \sin(\alpha_{\Delta}^n)}{l_{bal} * \cos(\alpha_{tek}^n)}, \quad (6)$$

$$\alpha_{\Delta}^n = \frac{\beta}{2} - \alpha_{tek}^n, \quad (7)$$

$$\alpha_{tek}^n = \arcsin \frac{h_{tek}^n}{l_{bal}}, \quad (8)$$

$$h_{tek}^n = l_{bal} * \sin(\alpha_{nygol}) + h_{zok}, \quad (9)$$

The specified effect for offered suspension bracket BI at tractor work on different regimes is attained at the expense of such installation of the balancer of a running idler that at its deviation from a bisector between a leading branch and a bearing area the moment originating from total reaction of a tension of a caterpillar track by a tangential force of a tie-rod, is aimed to return the balancer on a bisectrix.

Conducting of research of smoothness of a course was spent on regulated GOST 12.2.002-91 profiles for the basic operating modes of a tractor.

The estimation of parameters of smoothness of a course of observed tractors was spent according to CH 2.2.4/2.1.8.566-96.

Integral criterion normal affectings on a seat of the operator is defined from expression:

$$K_{UI} = \frac{\sqrt{\sum_{i=1}^n (U_i K_i)^2}}{\sqrt{\sum_{i=1}^n (U_i^T)^2}}, \quad (10)$$

where:

$U_i$  - average quadratic value vibro-accelerating in  $i^{\text{th}}$  strip;

$K_i$  - weight number for  $i^{\text{th}}$  strip for an absolute a value;

$U_i^T$  - maximum permissible value vibro-accelerating in  $i^{\text{th}}$  strip for transport vibration.

Thus, a legitimate value of integrated criterion always  $\leq 1$ .

On Fig. 3, 4 parameters of smoothness of a course of compared tractors are resulted at work with the most probable draw-bar loading and increased to 50 kN.

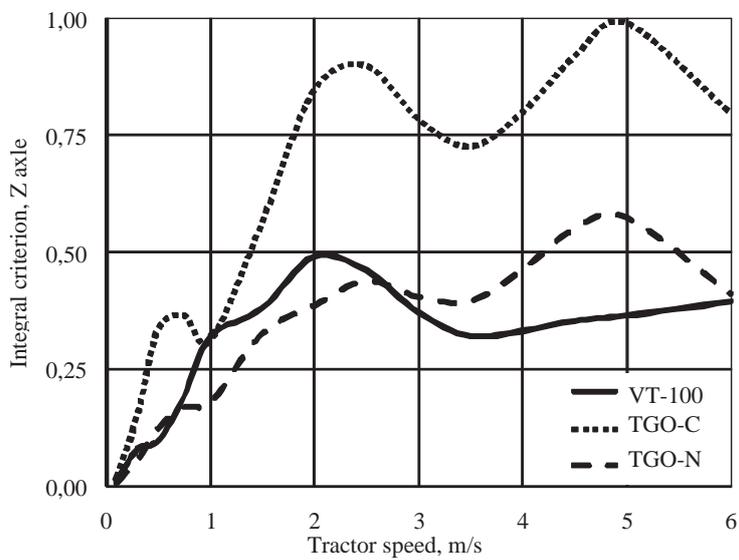


Fig. 3. Integral criterion norm vertical affecting on a seat of the operator at tractor traffic on an eddish with nominal loading

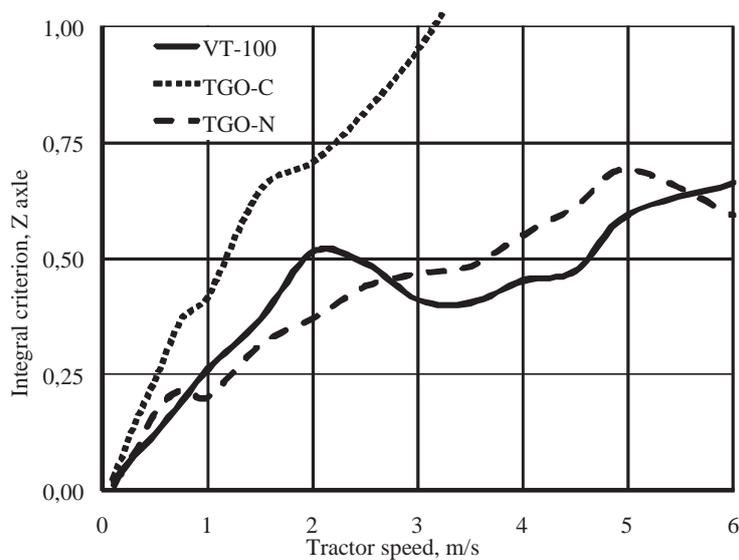


Fig. 4. Integral criterion normal vertical affecting on a seat of the operator at tractor traffic on an eddish with draw-bar loading of  $P_{kr}=50$  kN

Raised loading 50 kN is chosen taking into account possibility of rational expansion of a traction range without necessity of essential change of a design of a tractor. From the analysis of schedules it is visible that application of running system with TCC and offered displacement-yoke system BI provides demanded parameters of smoothness of a course that allows to expand a traction range and scope of application of tractors of family VT at conducting of their modernisation.

Index TCC marks out the characteristic of an initial suspension bracket without agency of forces in a caterpillar track, TGO-C – the resulted characteristic of a "classical" suspension bracket of a back idler, TGO-N – the resulted characteristic of the offered suspension bracket on different operating modes.

It is installed that application of the developed suspension bracket of a back idler provides conformity of a farm tractor with triangular caterpillar contour to demands of the acting standard documentation on vibration affecting of a seat of the operator. The analysis of parameters of smoothness of a course for the circuit design with triangular caterpillar contour and the offered suspension bracket of a back idler showed that:

- 1) In comparison with base configuration of a tractor of family VT:
  - On transport operations, at traffic on the soil road with the lifted tool, affectings on a seat of the operator decrease in 1.1-1.7 times in vertical and in 1.1-1.2 times in horizontal directions [0].
  - At work with nominal loading, and also with  $R_{kr}=50$  kN, on an eddish, provides minor alteration of smoothness of a course, the divergence of values of affecting on a seat of the operator, on the average, makes 12–19 %;
- 2) In comparison with triangular caterpillar contour and "a classical" suspension bracket of a back idler:
  - Various displacement-yoke systems of a back idler, at work on transport operations, slightly influence a divergence of parameters of affecting on a seat of the operator which make 2.6 % and 4 % for vertical and horizontal affectings accordingly [0];
  - At work with nominal loading on an eddish, affectings on a seat of the operator decrease in 1.7–2.7 times in vertical and in 1.4–1.8 times in horizontal directions;
  - At work with draw-bar loading of  $R_{kr}=50$  kN on an eddish, affectings on a seat of the operator decrease in 1.4–2.1 times in vertical and periodically increase on some speeds no more than by 30 % in a horizontal direction.

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