Roller function-generating mechanism preventing the crank-drive machines' overloads

V. Semenyuk[1], V. Lingur[2] and N. Punchenko[3]

[1]*ONPU Odessa University, Ukraine, e-mail: v.f.semenuk@opu.ua*

[2]*ONPU Odessa University, Ukraine, e-mail: vnlingur@rambler.ru*

[3]*SATRQ Odessa Academy, Ukraine, e-mail: iioonn24@rambler.ru*

Abstract.

In their exploitation process, crank machines are often overloaded that causing the breakdowns of machinery main parts: bed, shafts, and slide. In order to prevent these failures various types of safety devices are used. However, existing safety cutoffs have disadvantages and cannot provide a reliable protection of crank machines from overloading.

Suggested is a safety device implemented as a roller function-generating mechanism. It can significantly increase both accuracy and reliability of crank machines protection from overloads. This roller function-generating mechanism provides the machine's moving parts kinetic energy absorption after the machine's electric engine shutdown at the expense of this preventer device activation. Therefore it increases the accuracy of crank machines protection from overloading.

Defined are the analytical dependences for roller function-generating mechanism calculating. This mechanism provides variable reduction ratio during the rollers displacement and increases that ratio after safety device activation start. Established is the rigidity index value of spring as this preventer gage element, which ensures that the effort developed in the machine power circuit shall never exceed the nominal force of preventing safety device activation.

Key words: roller mechanism, crank machine, overloading, protection accuracy.

1 Introduction

To increase the machine work efficiency, it is necessary to increase power levels, working movements velocity, as well as to reduce durations of transitory processes, that leading to the increase in machinery dynamic load degree and consequently to an abrupt increase of impact forces.

When calculating machines strength, we used to admit the design load as this determined based on economic considerations with respect to different load values' repeatability index. At unfavorable coincidences during the machines operation process, the real load may exceed this one calculated at design and therefore lead to some parts breaking and to the machine breakdown. Such

incidences' emergence resulting from machinery overloads is unacceptable for several machines classes.

The engineering enterprises' technical equipment accidents and failures analysis shows that the largest number of accidents due to overloads happens with heavy loaded machines: crank-drive presses, mills, load-lifting machines.

Special safety devices are used in order to exclude machine's and its main parts' breakdown occurrence due to possible overloading. These devices should combine a function-generating mechanism, a gage element (monitoring the controlled parameter's effects and continuously comparing it with that parameter predetermined limit value), and an executive element, which at some given instance defined by the gage element, shall prevents the controlled parameter increase.

Currently there exist numerous many devices, designed to protect machines from overloads including those purposed for crank-drive machines. Considering the crank-drive machines operation specificity, here used are not only safety devices, which control the crank torque, but also those, that control the force acting on the slide.

The breakdowns analysis in respect of crank-drive presses, used at the engineering enterprises, showed that all crank-drive presses, where such accidents occurred, have been equipped with safety devices controlling either the torque (friction clutch or shearing pin) or for the controlled effort (shearing cups).

High efficiency of machinery protection from overloads depends on both components' and safety devices' overall accuracy and reliability and on preventer's ability to meet the requirements arisen from the given machine operating condition peculiarities. That is why the problem of increasing the machine's overload prevention accuracy and reliability is really complex one and requires a systematic approach to its solving.

2 Analysis of researches and publications

The majority of studies in the field of machines protection from overloading is devoted to the engineering, researching and definition of the main parameters of safety clutches. To these works, belong fundamental researches of Tepinkikhiev V.K. [7], Gonskoy G.V. [2], Pokhilyuk S.A. [4], Malashchenko V.A. [3], Dietz P., Lohrengel A. [1], Wittel H., Muhs D., Jonnasch D., Voßiek J. [8].

Significantly less attention is devoted to increasing the protection accuracy from machines overloads, when the working element makes a translational motion and not only the torque is controlled but also the force developed by a machine during the technological operation implementation.

Works of Zapiatoy V.P. [9], Semenyuk V.F. [6], Scheffler M., Pajer G., Kurth F. [5] are devoted to the development and researching of safety devices, controlling the machines operation effort.

The carried out studies allowed to increase the accuracy of safety devices. However, the problem of creating high-precision safety devices is not solved completely.

3 Research aims and tasks

The aim of this work is to define structural parameters of the roller function-generating mechanism, which allows increasing the accuracy of crank machines overloads prevention.

For this aim realization, the following tasks should be solved:

- develop structural scheme of the roller function-generating mechanism;
- define dependence between nominal force of the preventer activation and spring force compressing the rollers;
- define the spring rigidity of roller preventer at which absorption of crank-drive press moving masses energy running-out is provided.

4 Main research exposition

For increasing protection accuracy of machines with a large reserve of potential and kinetic energy and translational motion of executive element from overloading it is necessary to solve the problem of parts moving masses energy running-out after shutdown of the machine drive electric engine as a result of activation of self-restoring preventer.

Absorption of moving masses energy running-out is possible in that case, if safety device under overload acts on a protection object with such condition:

$$\frac{dP_{nom}}{d\lambda} \le 0, \qquad (1)$$

where P_{nom} – nominal force of preventer activation; λ – displacement of moving parts of preventer after its activation beginning.

Suggested condition (1) shows that during the preventer activation, force in power circuit does not increase $\left(\frac{dP_{nom}}{d\lambda} > 0\right)$, but remains constant. $\left(\frac{dP_{nom}}{d\lambda} = 0\right)$ or decreases $\left(\frac{dP_{nom}}{d\lambda} < 0\right)$.

Implementation of condition (1) is possible with the use of mechanism with variable reduction ratio. Reduction ratio should increase during the displacement of preventer moving parts after its activation beginning.

Variable reduction ratio may be implemented with mechanism in the fig. 1.