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To the question of creation of the working stand cold rolling mill pipe with safety device

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Abstract

This paper presents version of the new design of the safety devices for the mill of the cold rolling pipe rational design. Considered Constructive differences safety devices and the push mechanisms of working mills of cold rolling tube constructions of "EZTM" and NPF "Vostok-Plus". Presents the elastic characteristics of the elements of the working mill HPT - 55 for different values of the rolling force. The results showed that the most ductile element of working stand, which transmits the load from the pass to the frame, is the safety device. In order to reduce the total deformation of elements working stand and save time when replacement the element of shear, a new safety device, which is fundamentally different from the previous one, had been designed. It is set in a working mill drive line and represents a cassette with the finger of shear, at the destruction of which we need only hold its replacement without disassembling the stand. The paper also presents fragments of the technical documentation and three-dimensional models of the working stand.

Keywords: MODERNIZATION, COLD ROLLING MILL TUBES, SAFETY DEVICE, DEFORMATION

At a number of domestic enterprises of the pipe production in the force line of cold rolling mill tubes (HPT), effective working stand of rational design of LTD "Vostok Plus", which combines the increased rigidity, minimum weight, and high operational strength, is in operation [1].

Stand is spatial foundry stand consisting of two interconnected frames as oval bonds, each of which is formed by the inner and outer shells linked by vertical longitudinal crosspiece of variable thickness. In the windows of frame in rolling bearings placed in saddles, the pressure mechanism and work rolls are mounted with pressed on both sides of the gears.

Unlike typical working stand, the push mechanism is placed perpendicularly to the axis of rolling process (see Fig. 1) and contains wedge and a screw devices.

In contrast to the typical working stand, designed by OJSC "EZTM", push mechanism is placed perpendicular to the axis of the tube-rolling technology and comprises two wedge and screw device to move them.

Figure 1. Working stand cold rolling mill pipe of rational design

1 - oval-shaped frame; 2 - the rolls installation 3 - pressure mechanism

A wedge device is provided with wedges 9 moving along the inclined contact surfaces of pads 10 of the upper rollers 11 by segment supports 6 and compensating inserts 7 with the cylindrical surface of the screw 2 of the screw device, which is rigidly fastened to the body frame 1 (Fig. 2). The pressure device provides placing the safety device (Fig. 2), which consists of a punch (cylindrical projection plane of the compensating insert 7), shearing (safety) disc 8 and the matrix 9 (a wedge).

This device is used for virtually instantaneous rise of the pillow of the upper working roll at 20-25 mm as result cut of safety disks when a vertical rolling force, which exceeds the maximum permissible values [2].

The use of such safety devices greatly contributes to the preservation of components of working stand and the main mill drive. However, these devices have some significant drawbacks, which include: plastic deformation of the edges of punch, the matrix and of the disc itself, which distorts the dimensions of the roll gap, a large labor input and the duration of the disc changer after cutting them and, finally, high elastic devices deformation that half reduces working stand stiffness, which affects the pressure of rolling, the magnitude of forces on the return stroke and the quality of rolled tubes.

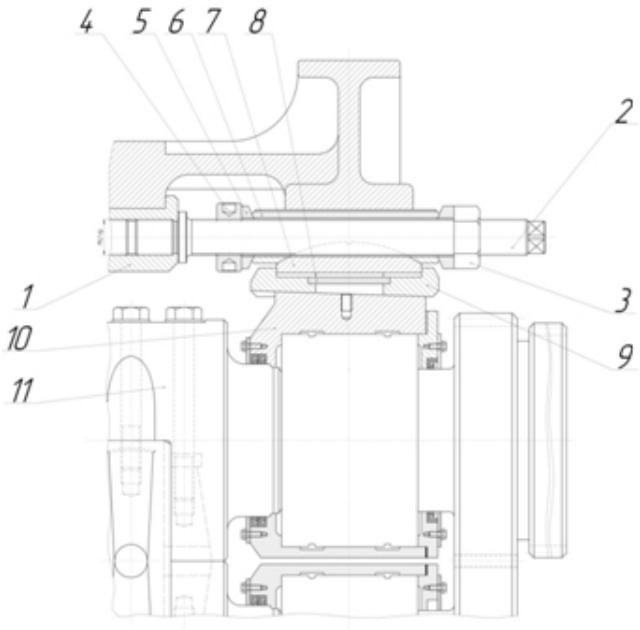

Figure 2. Pressure oval-shaped mechanism of working HPT- mill stand 55 with a wedge safety device with half-disk gauges:
1 - housing; 2 - screw; 3 - nut; 4 - special nut; 5 - washer; 6 - segment bearing; 7 - compensating semi-cylindrical insert; 8 - shear disc; 9 - wedge; 10 - pillow top roll; 11 - roll top

Effect of elastic deformation of the stand on the quality and performance of pipe mills HPT was noted in a number of papers [2 , 3, 4, 6]. Thus, in [2] it is shown that the total elastic movement of workers caliber rolling mill HPT is a result of elastic deformation of its parts and components located between the deformable mandrel working cone and the stand of working stand.

Moving elements of working stand mill in a vertical plane is equal to the amount of elastic displacement

of the working rolls, moving the support bearings built into a safety device of the pressure device node; and pillars of the frame of the working stand.

In [3], an experimental determination of the elastic movement of the working elements of the stand of the mill HPT of different sizes was conducted. So, for the mills HPT 55 in Fig. 3 [2], the dependence of the elastic movement of the frame and its components from the rolling force is shown.

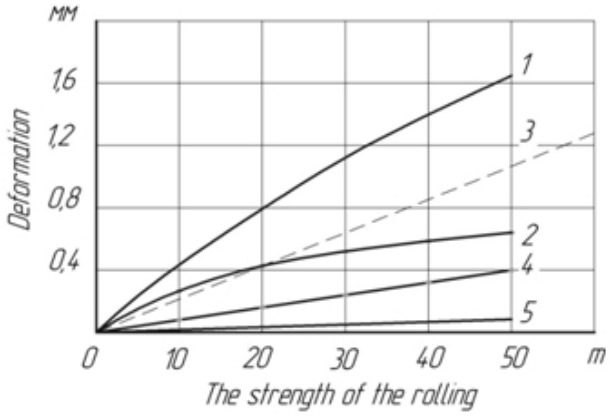

Figure 3. Dependence of the elastic deformation of the mill stand HPT-55 from the rolling force:

1 - total deformation (in the presence of the pressure device);2 - the deformation of the safety device; 3 - total deformation (without a safety device); 4 - deformation of the work roll with cushions; 5 - deformation of the frame

Characteristic is significant elastic movement of the safety device, the value of which is practically equal to the elastic displacement of all the remaining elements of the working stand (Fig. 4 [2]).

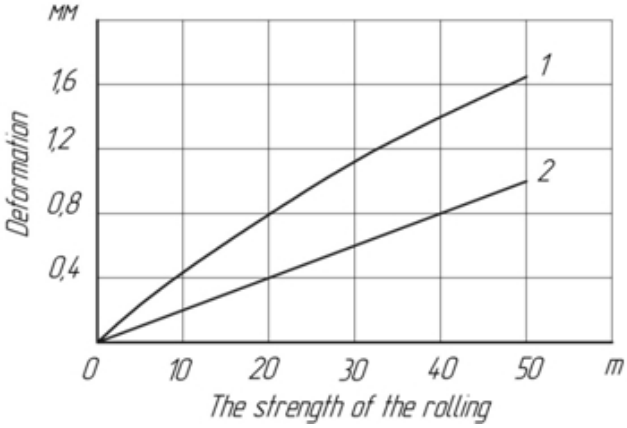

Figure 4. The elastic deformation the stand of the mill HPT 55:

1 - with the safety device; 2 - without safety device

Except mentioned disadvantages, there is also the need for additional setting of the mill, after replacing the discs of safety that was destroyed; it requires a significant investment of time. In order to eliminate these disadvantages, as well as taking into account the experience of creation of a safety device for a typical working stand unlike the existing one [5], the safety device for working stand of mill HPT 55 of the rational form has been developed by us. It was set in line of drive to protecting parts of stand and drive from overload and possible damage (Fig. 5).

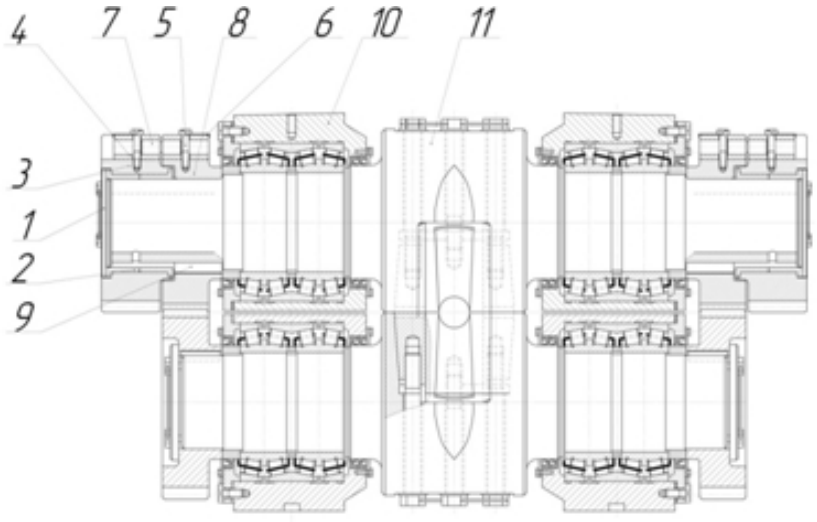

Figure 5. Roller setting oval-shaped of the working stand with the half-disk of calibers HPT 55 with a new safety device:

1 - flange; 2 - bushing ; 3 - pinion; 4 - cassette ; 5 - bolt; 6 - lock washer; 7 - finger safety; 8 - driven gear; 9 -dowel; 10 - the cushion of top roll; 11 - upper roller

At the end of the upper work roller 10, tooth gears are set; one of them, which is leading 3, is pressed onto sleeve 2, and another one is slave 8 and fixed to the spline 9. Planting sleeves 2 onto roller is sliding.

Thrust washer (flange) 1 is used to prevent axial movement of the sleeves 2 with the onto pressed gear 3 and driven gear 8. At both gears, there are nests, where cassettes 4 are placed; they are secured in the housing of the gears through the bolts 5 and lock washers 6.

The driving gear (which is in engagement with the stationary rack 11(Figure 6)) transmits the plane-parallel movement on the work roll through the driven gear 8. Cassettes 4, which are interconnected by means of a safety pin 7, are mounted in gear.

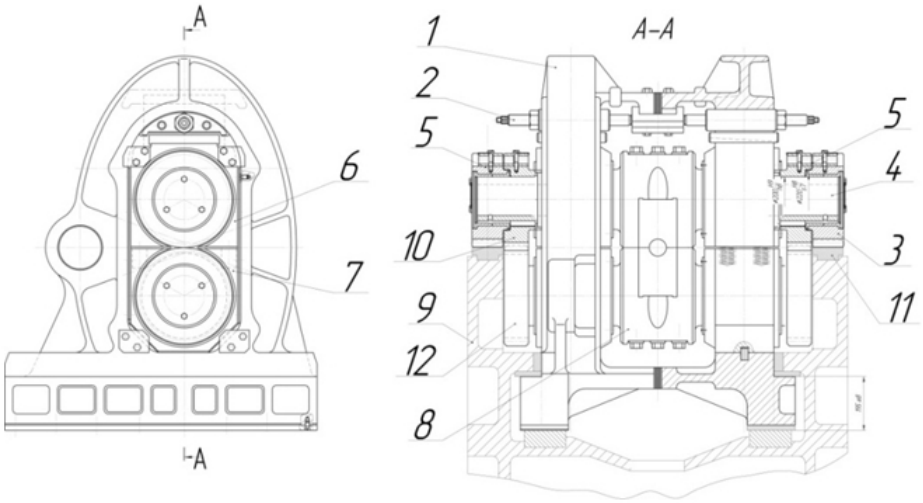

Figure 6. Oval-shaped working stand mill HPT-55 with a safety device with a half-disk in the drive line of gauges:

1 - oval-shaped frame; 2 - pressure mechanism; 3 - pinion; 4 - the upper roller; 5 - the safety device; 6 - the upper roll pillow; 7 - pillow lower roll; 8 - lower roller; 9 - stand under the working stand; 10 - upper gear; 11 - rake; 12 - gear lower roll

When the finger breaks, the connection between the gears 3 and 6 is torn, and the rolling is carried out not by compulsory effective radius (as in the case when rolling tubes), but on the natural effective radius. Herewith, a mismatch between the positions of the driving and driven gear occurs; it leads to the fact that the driven gear collides into one of the switches 1 that are set at the beginning and the end of the motion of stand (Fig. 7) and disables the mill. These switches do not function during normal mill operation (due availability of experimentally determined gaps between the limit switch and the surface of the drive gear).

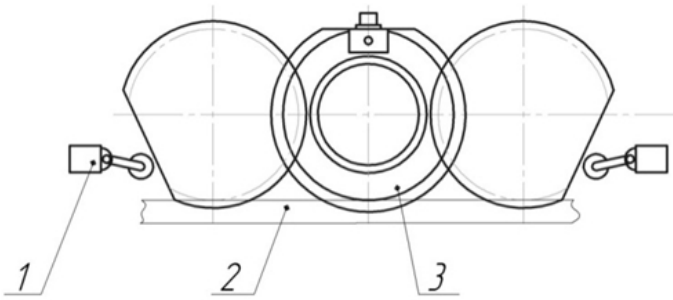

Figure 7. Driving off mill stand drive HPT - 55 after the cut-off safety device fingers:

1 - Limit switch; 2 – Rack; 3 - driven gear

In the new safety device, cutting disc 8 was expelled from the push mechanism. If the destruction of the safety (shear) element was at working motion (move forward), the gears 3 and 8 with the deforming profile of the roller are behind the position that determined by the compulsory effective radius deforming the profile radius, and consequently, the force to the work rolls decreases. To eliminate the shear of the safety device at idle (back) pass, limiting relative rotation of the gears 3 and 8 must be installed. For example, the configuration the ledge of the pinion gear 3 and the cavity synchronizing gear 8 may be

formed as a pair of ratchet elements permitting rotation only in one direction. Installing such a limiter may be performed after experimental rolling and the experimental determination of loads in a working stand of mill HPT 55 with the new safety device. The dimensions of the safety element are selected from the terms of the fracture in case of cut at the maximum breaking load that is known for each mill size [6]. Herewith, the strength of finger is obviously lower than strength of protects parts. General view of the working stand of mill HPT 55 of the rational design with a safety device in the line of drive of the rolls is shown in Fig. 8.

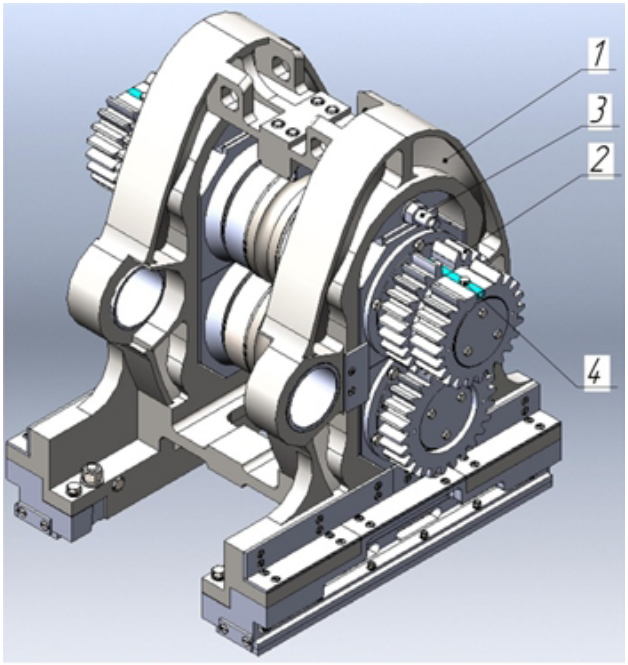

Figure. 8 A general view of the working stand of mill rational design of HPT-55 with ring caliber with a safety device in a line-drive of rollers:

1 - oval-shaped frame; 2 - the rolls installation; 3 - pressure mechanism; 4 - safety device

Conclusions

The proposed safety device design for oval-shaped working stand of mill HPT differs from known constructions by higher efficiency, improves working stand rigidity by 2.5 times as compared with the existed design, reduces the time to replace the safety elements (fingers) by aruond 4.5 times (time to replace the existing shear disc safety device and mill setup is about 40-45 minutes, and the time for the replacement of cut fingers of the proposed safety device is about 8-10 minutes) without further adjustment of the mill, it helps to reduce its downtime and increase productivity.

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