# SAFETY COUPLINGS USED IN THE MECHANICAL TRANSMISSION OF THE ROTATING SYSTEM ON 1400 EsRc BUCKET WHEEL EXCAVATORS

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**Abstract:** This paper presents constructive and functional solutions suitable for the safety couplings used in the mechanical transmission mounted on the bucket wheel excavator EsRc 1400 30/7. The current solution is analyzed and two new solutions are proposed that lead to safer operation of transmission and rotation mechanism in general.

**Keywords:** bucket wheel excavator, rotating mechanism, friction safety coupling, ball safety coupling

## 1. INTRODUCTORY REMARKS

Bucket wheel excavators are mechanical equipment used for coal and sterile rock cutting in open pit of Oltenia coalfield. The rotating mechanism is a subassembly, component part of the excavator, which ensures the rotation of its upper platform along with the rotor equipped with buckets and cutting teeth, providing the pivoting movement. The safety couplings are found in the composition of mechanical transmission (that provides the transmission of movement from the electric motor to the crown gear that carries out the rotation of the upper platform) which mainly serves to protect the transmission from overload.

The revamping of excavators reflects the modernization of excavators and of the rotation mechanism in case of mechanical transmission, including safety couplings, which are less reliable technical solutions.

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## 2. FRICTION SAFETY COUPLING

The role of the safety coupling is to protect the rotation mechanism, namely the supporting construction against overload caused by side contact between the bucket wheel and the slope. Friction safety coupling, Figures 1 and 2, is mounted on outlet shaft reducer of the drive group.

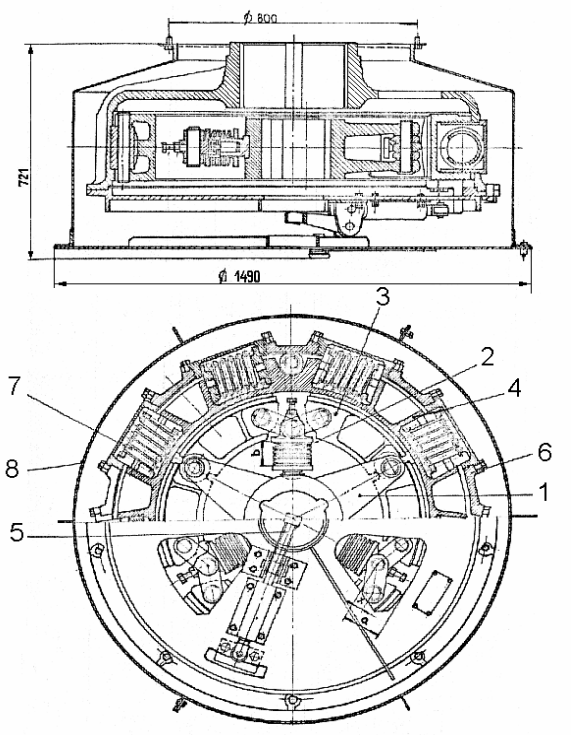


**Fig. 1.** Friction safety coupling

**Fig. 2.** General view of the friction safety coupling

The outlet shaft of the reducer comprises the star - shaped body 1, in which the disk spring packages are placed, 2 that press the brake drum, 4, with the brake shoes, 3. The rotating momentum from the drum shaft (outlet gear) is transmitted to the housing of the coupling, 6. From the housing of the coupling, the movement is transmitted through the coil springs, 7, to the brake drum, 4, which presses brake shoes, 3. The brake shoes, through three disk spring packages, 2, forward the movement on star – shaped body, 1, which is fitted together with bearing attack pinion on the outlet shaft of the reducer.

When the triggering momentum is exceeded, there occurs a relative motion between the housing of the coupling, 6, and the brake drum, 4, and the stroke limiter for side overload takes action through a lever system, 5. The stroke limiter is mounted on the coupling guard, 8, and is designed to disconnect the electrical rotating mechanism. If the stroke limiter against side overload fails to operate, the whole operation will be interrupted by sliding the brake shoes, 3.

The moment for the adjustment of the safety coupling are the following ones: the triggering momentum, $M_d$ = 11000 Nm, sliding momentum, $M_p$ = 12500 Nm. It is the least reliable element of the rotating mechanism that has registered most failures.

## 3. SAFETY COUPLING WITH BALLS AND TRAPEZOIDAL CANALS

Figure 3 presents the general solution selected for the safety coupling, also called the overload coupling, together with flexible coupling with brake washer. This unit is mounted between the electric drive motor and speed reducer.

The significance of parts shown in the figure is as follows: 1 – block; 2 – O ring 35507500; 3 - adjusting nut; 4 - M12×40 threaded pin, 3 pieces; 5 - M12 nut low; 6 - pressure ring; 7 - package of two disc springs; 8 - pressure washer; 9 - 24 balls BR12; 10 - pressure flanges; 11 - M10×25 threaded pin (2 pcs at 120°); 12 – O ring 35516500; 13 - protective housing; 14 - radial ball bearing 6017-2z; 15 – spacer washer; 16 - elastic semi – coupler with flange - type rosette; 17 - screw with cylindrical head and hexagon slot M10×30 and Grower washer; 18 - rosette of elastic material (rubber); 19 - Φ350×140 brake washer; 20 - elastic semi – coupler with block - type rosette; 21 – M10×35 screw; 22 - Grower washer

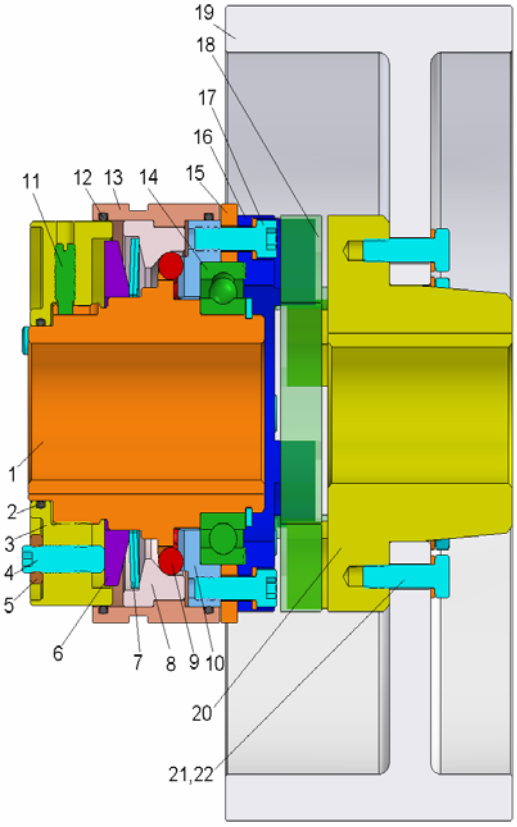


**Fig. 3**. General view of the assembly comprising the overload coupling with elastic coupler with brake washer

The components of the assembly numbered from 1 to 15 form the proper safety coupling and the components from 16 to 22 are part of the elastic coupling with brake washer. Adjusting the decoupling is achieved by nut, 3, through the pressure ring, 6, and the package consisting of two disc springs, 7.

When the set momentum is surpassed, the coupling slips out; the pressure washer, 8, performs an axial motion and the limiter detects this motion and orders the decoupling of operation.

The shown safety coupling is with balls and trapezoidal canals.

Figure 4 shows the overall design of this type of coupling.

The component elements of the safety coupling with balls and trapezoidal canals are the following ones: 1 – block; 2 – O ring 35507500; 3 - adjusting nut; 4 - M12x40 threaded pin, 3 pieces; 5 - M12 nut low; 6 - pressure ring; 7 - package of two disc springs; 8 - pressure washer; 9 - 24 balls BR12; 10 - pressure flanges; 11 -

M10x25 threaded pin (2 pcs at 120 °); 12 – O ring 35516500; 13 - protective housing; 14 - radial ball bearing 6017-2z; 15 – spacer washer; 16 - M6x10 pin for the blockage of the sealing housing against the pressure washer.

The active stroke for decoupling is 2.5 mm.

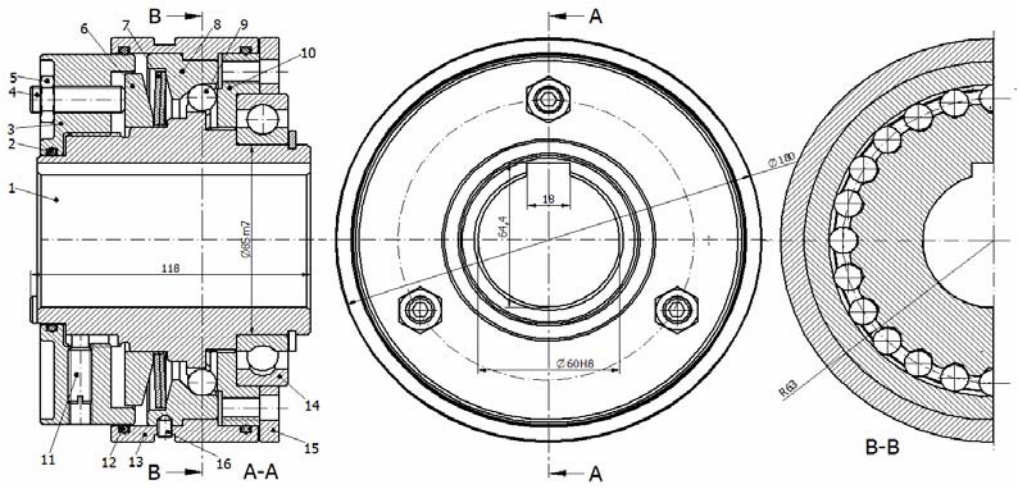


**Fig. 4.** Safety coupling with balls and trapezoidal canals

A 3D modelling (in Figures 5, 6 and 7) shows the main components that provide the operation of safety coupling with balls and trapezoidal canals.

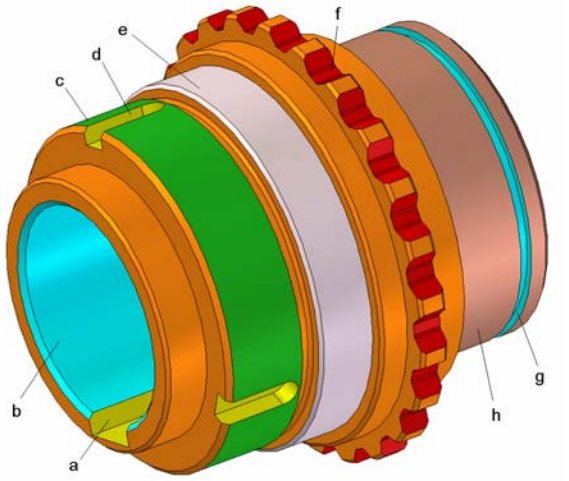


**Fig. 5.** Block

a - wedge canal (18×4,4); b – bore hole Ø60 H7; c – thread M95×2;
d – slot for the head of the threaded pin; e - Ø100 e7 surface for the sliding of the pressure ring;
f – slot for the ball Φ12 with an 90° angle; g – canal for the elastic ring;
h – mounting surface of the Ø85 m6 bearing.

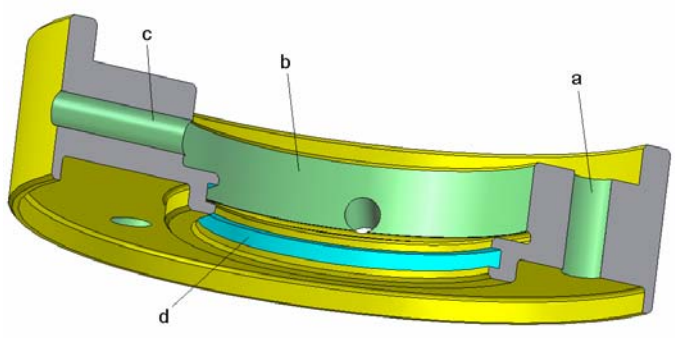


**Fig. 6.** Adjusting nut:
a – M 12 hole for the pressing pins (3 pcs); b – M95×2 threaded surface;
c – M 10 hole for M10×25 blocking threaded pins; d – canal for O ring

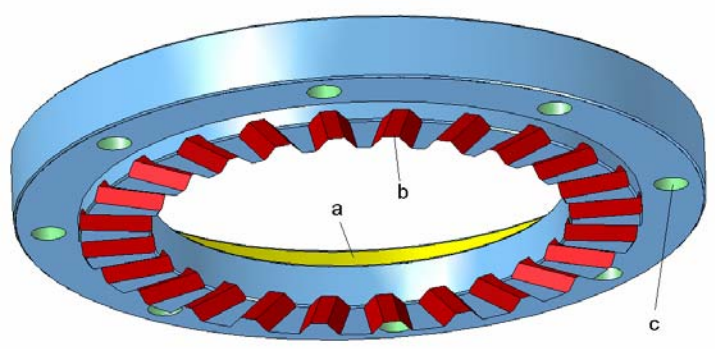


**Fig. 7.** Pressure flanges:
a – bore hole for the Φ130 M7 bearing; b – slot for the Φ12 ball with a 90° angle; c – 8 threaded holes M 10 for fastening the elastic semi – coupler with flange - type rosette.

Figures 8 and 9 show two of the coupling elements of the elastic coupling with brake washer.

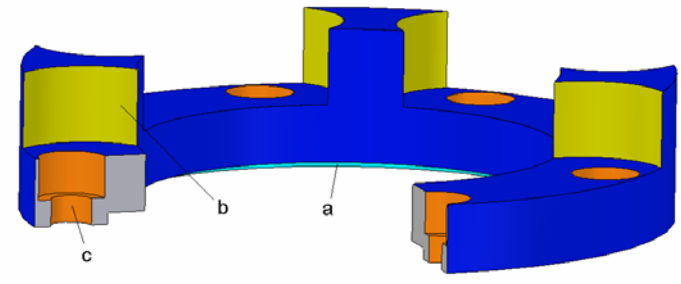


**Fig. 8.** Elastic semi-coupler with flange - type rosette:
a – bore hole Φ130 H7 for centering on the bearing;
b - contact surface with the elastic rosette; c – 8 holes Φ18/Φ11.

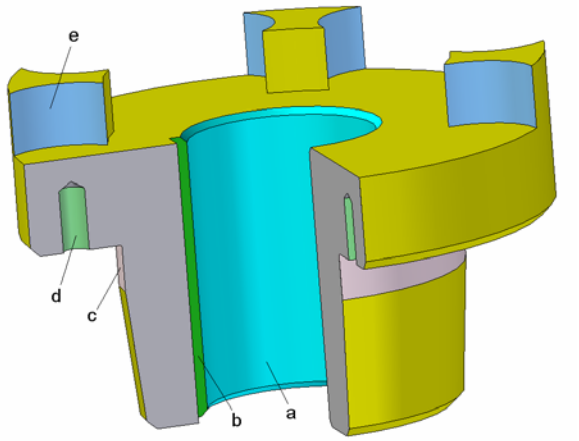


**Fig. 9.** Elastic semi-coupler with block - type rosette:
a – bore hole Φ60 H7; b – wedge canal (18×4.4);
c – centering surface of the brake washer Φ110 h7;
d - 8 holes M 10 for the fastening of the washer; e – contact surface with the elastic rosette.

## 4. SAFETY COUPLING WITH BALLS

A similar option, but functionally more efficient is the safety coupling with balls, whose overall design is presented, modelled in 3D, in Figure 10 and in plan in Figure 11.

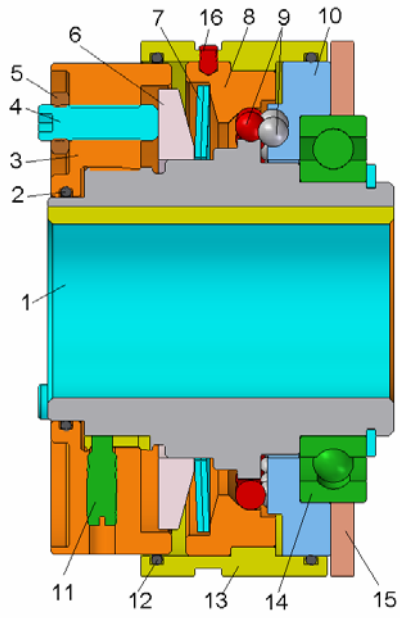


**Fig. 10.** 3D modelling of safety coupling with balls

The active stroke for decoupling is 2.3 mm for this type of coupling.

Significance of parts is the same as for the coupling with balls and trapezoidal canals. Only two components are different to the previous one, namely, the block, Figure 12, and pressure flange, Figure 13

If compared against the first possibility, there has increased number of trapezoidal slots for the balls from 24 to 28 and the diameter of the ball fell from Φ12 mm to Φ10 mm. There have also been replaced the 24 trapezoidal slots with 28 holes Φ10 mm for positioning the balls.

The diagram in Figure 14 shows the pre - tensioning feature of the disk springs package, for the coupling with balls and trapezoidal canals and Figure 15 for the coupling with balls.

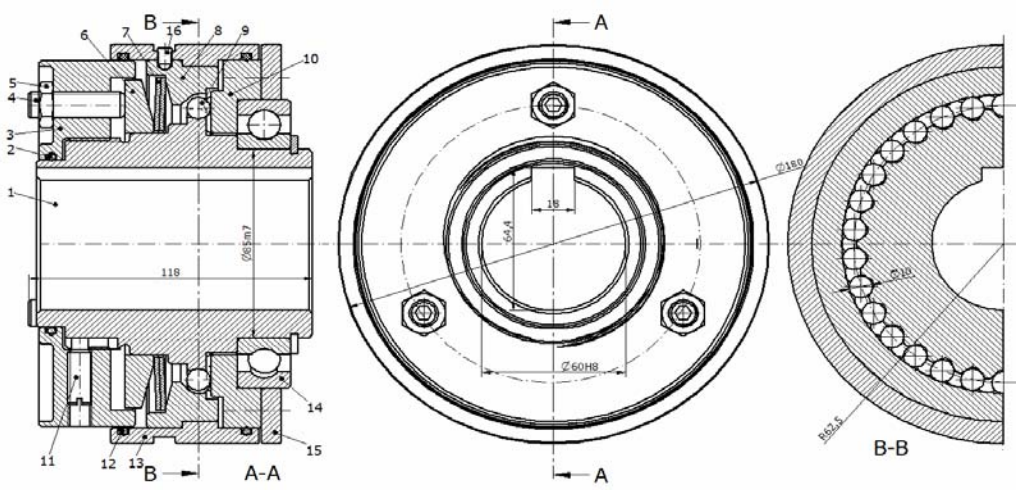


**Fig. 11.** Safety coupling with balls

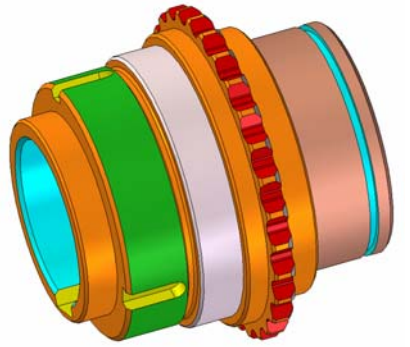

**Fig. 12.** Block for the coupling with balls

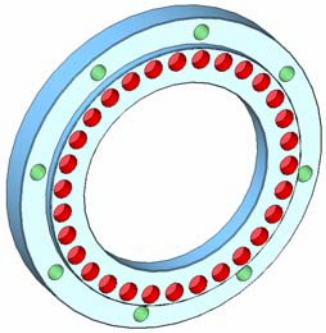

**Fig. 13.** Pressure flange for the coupling with balls

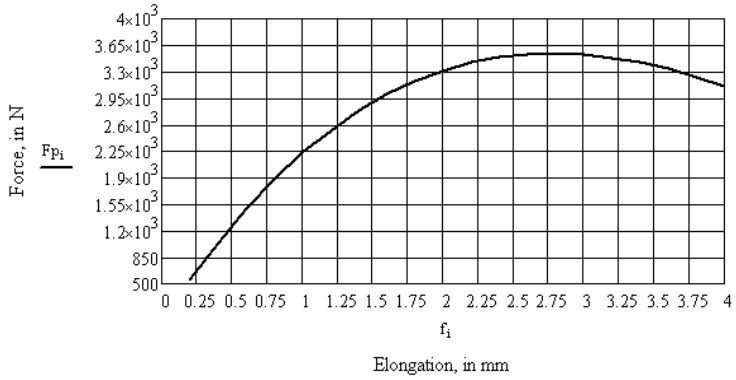


**Fig. 14.** Pre - tensioning feature of the disk springs on the coupling with balls and trapezoidal canals

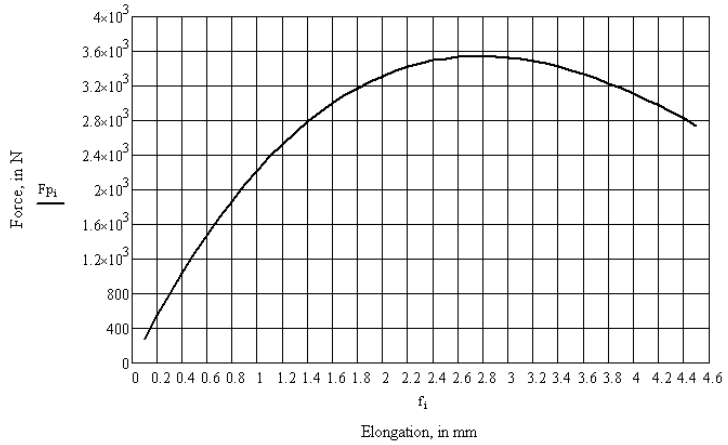


**Fig. 15.** Pre - tensioning feature of the disk springs on the coupling with balls

## 5. CONCLUSIONS

Monitoring the operation of the friction safety coupling used in mechanical transmission which is a component part of the rotating mechanism rotor excavator has demonstrated its low reliability, and this is why there have proposed two new options.

The new options include safety couplings with balls; the first possibility is with trapezoidal canals and the second with the ball – shaped slots.

These options are structures that are much more reliable, improving the safe operation of the rotating mechanism mounted on the rotor excavator.

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