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THE POSIBILITY OF APLYING THE SELSINES IN COMMANDING THE CUPE WHEEL EXCAVATORS

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ABSTRACT
It was considered the obtaining of a horizontal hearth as well as realizing judicious by chosen excavating works, with obtaining a continuous visualisation of the excavation height, which is obtained by tangent with the port-bucket wheel of the surface where is the bucket wheel excavator. It was also watched the using of installations level for determining the lateral repose angle in the transversal plain of the advancing direction, which is made by rotating with 90° against the walk direction of port buckets arm and tangent the terrain with the port buckets wheel. Another application of installation is to determine, when the excavator is on horizontal plane, of the cant angle, angle which is start from the front part of the director caterpillar (frontal repose angle), and determining the height or depth of excavation. It must be considered that the system has as a reference a gravitational pendulum mounted on the port–wheel arm with buckets.

CONCEIVING AND REALISING OF THE INSTALLATION FOR DETERMINING THE HEIGHT OF EXCAVATION AND OF THE SLOPE

The installation was conceived and realised for the BWE–1400–30/7 excavator, but can be adapted, by changing the indicator dial at all types of BWE used in the mine–shafts from C.N.L. Oltenia.

The dimensions determined at calculating the height of the inferior bucket facing the heart's plane, considered horizontal are given in figure 1, where:

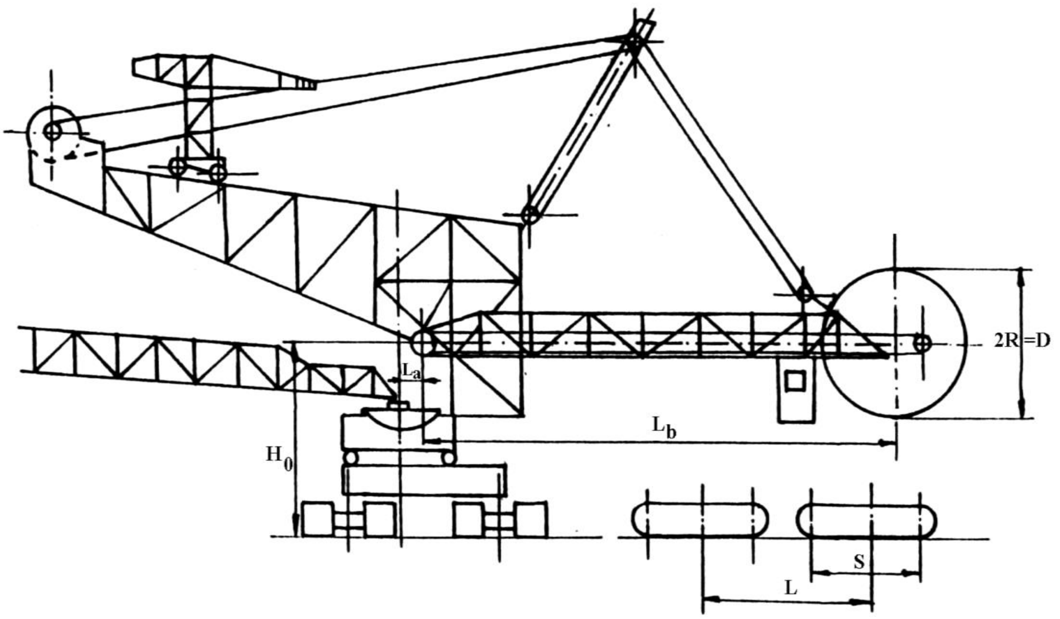

Figure 1.

H_0 = 13,7 m – the height where is the arm's articulation;
R = 5,75 m – the exterior radius of the port buckets wheel;
L_b = 36,2 m – the length of the port wheel arm from the centre of the wheel to arm articulation;
L_a = 1,5 m – the distance between the pivoting axle of the excavator's platform and the arm's articulation;
L = 12,975 m – the distance between the turning caterpillar axles;
S = 8 m – the length on which is stepping a caterpillar on ground.

It was mounted a pendulum on the port–wheel arm, and the couple which is activating is:

$$M \cdot g \cdot l \cdot \sin \alpha,$$

where: M – weights; g – gravitational acceleration; l – length from the axle to the weight centre of pendulum; α – slope angle of the part–wheel arm facing the horizontal.

By lifting the arm, the position of the pendulum remaining vertical, the angle made by the arm with the pendulum is modified. It must be found the correspondence between this angle and the height the inferior bucket of the port–buckets wheel where is found, so that once mounted and standardized the emitting device (DE) to transmit directly in meters by using a selsine receiving device (DR) mounted in the excavator man cabin and other points (for example in the BRs cabin), the height where is this found facing the caterpillar plain considered horizontal plane, respectively the value of the slope where are the BWE's caterpillar

THE MEASURE DOMAIN AT BWE–1400–30/7

The port–wheel arm is making an angle α_h between the position when it is excavating at the depth of h=7m below the caterpillar and the position when it is excavating at the depth h=30m above the caterpillars.

In the first case (fig.2), ERC is excavating below the caterpillar's level at 7m.

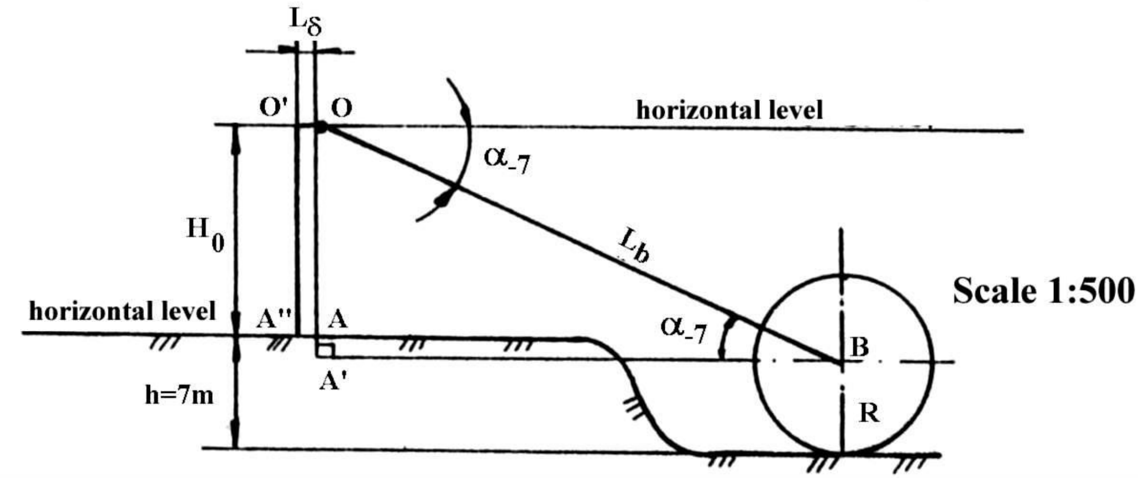

Figure 2.

Let it be α_{-7} the angle made by the arm for the position –7m facing the horizontal, so:

$$\sin\alpha_{-7} = \frac{OA'}{OB} = \frac{H_0 + h - R}{L_b} \tag{1}$$

Introducing the values according to figure 1, is obtained: $\alpha_{-7} \approx 24^o40'$.

In the second case (fig.3), BWE–1400 is excavating at height of 30m.

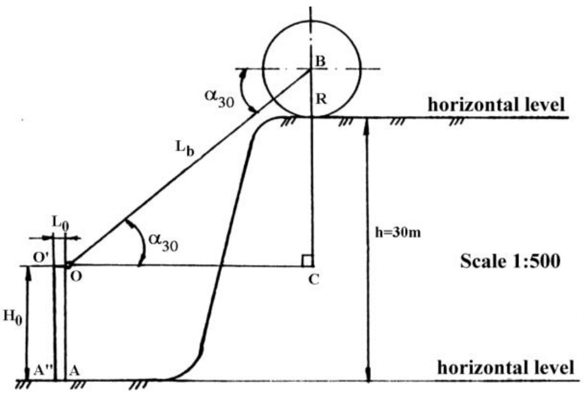

Figure 3.

Let α_{+30} be the angle made by the arm in this case facing the horizontal. From the triangle OBC is resulting:

$$\sin\alpha_{+30} = \frac{BC}{OB} = \frac{R + h - H_0}{L_b} \tag{2}$$

If the BWE–1400 considered, $\alpha_{+30} \approx 37^o52'$ it is obtained.

The 37 marks (7 m and 30 m above the horizontal level) are impossible to realise and read on the domain of the 62º angle.

Also, the re–copying precision of the traducer (selsine), which is ±60 minutes of arcs, makes the direct coupling of the emitting selsine with the receiving selsine unusable.

Using two steps of amplification, it was realised a rapport of 1:5, which extends the domain from 62º to 5x62º=310º. To determine in this situation the indication, it was proceeded in this way: to the exterior length of the indicator dial is corresponding 360º, and proportionally to the 310º corresponding a length from the indicator dial's circumference of:

$$x = \pi D_c \frac{310}{360} \cong 2{,}7 D_c \tag{3}$$

where: D_c – indicator dial's diameter.

From D_c = 110 mm is obtaining a length of 8 mm which is corresponding in (medie) to a meter of excavation from the 37 m, and on this length of 8 mm can be traced the 4 marks representing each of the 25% from a meter.

MEASURING THE HEIGHT AN DEPTH OF EXCAVATION (ΔH)

The strictly necessary condition is to put the excavator on a horizontal plane, when:

$$\Delta H = h_{excavaţion} - h_{hearth} \quad (4)$$

Due to the fact that the relation between the angle made by the pendulum with the arm and the height of excavation is non-linear led to the calculating from 25 to 25 cm of centre corresponding angle.

Figure 4 contains the values of the heights, real angles, amplified angles and their positions depth, respectively to the height of 30 m; also, fig.4 shows the correspondence of the excavating height at DR which exists in the excavator man cabin.

MEASURING THE SLOPE

For measuring the slope, the strictly necessary condition is that the plain must be continuous and of the same slope.

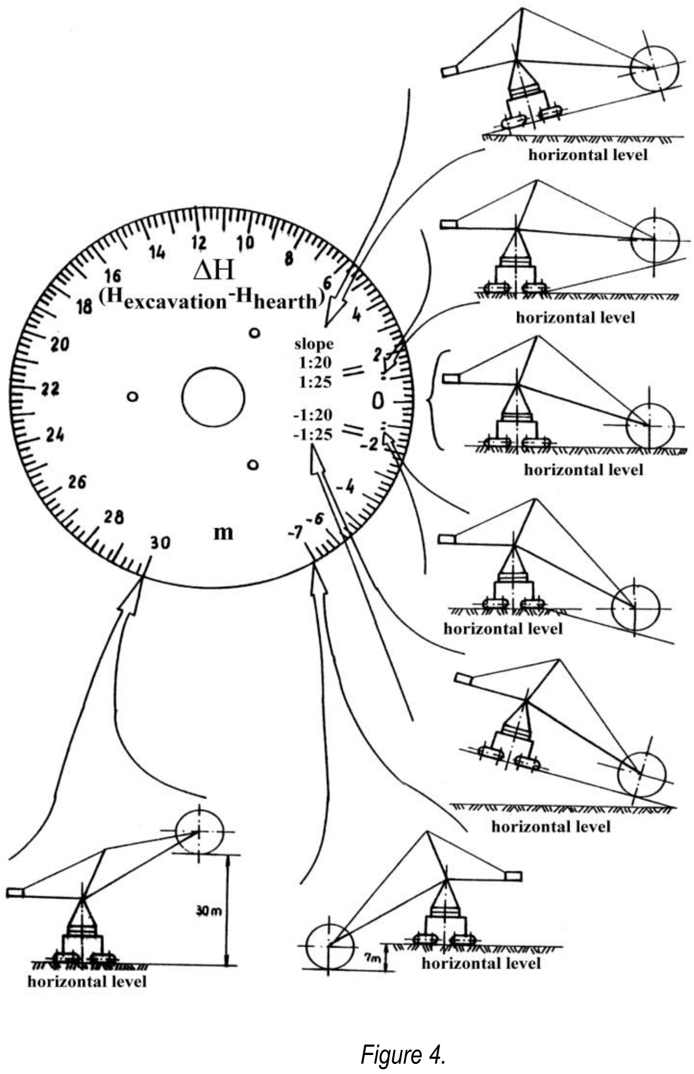

Figure 4.

The slope represents the connection rapport between the level difference between two points, and it's projection on horizontal.

The slope is given for an ERC–1400–30/7:
a) Work slope, max. ± (1:25);
б) Marsh slope, max. ± (1:20).

On the indicator dial the slope is indicated in two situations:
a) The excavator is situated on a cant (fig.5a). The arm is brought so that the wheel port buckets to tangent hearth. The needle indicates the slope on which the excavator is situated. The reading is made using continuous red gradations from the indicator dial.
b) The excavator is situated on a perfect horizontal plain, (fig. 5b). From the contact point of first director caterpillar of the ERC with the hearth the cant begin. It brings the arm so that the port buckets wheel to tangent the cant. The needle is indicating the slope of the cant on which the excavator will be engaged. The reading is made using the red doted gradation

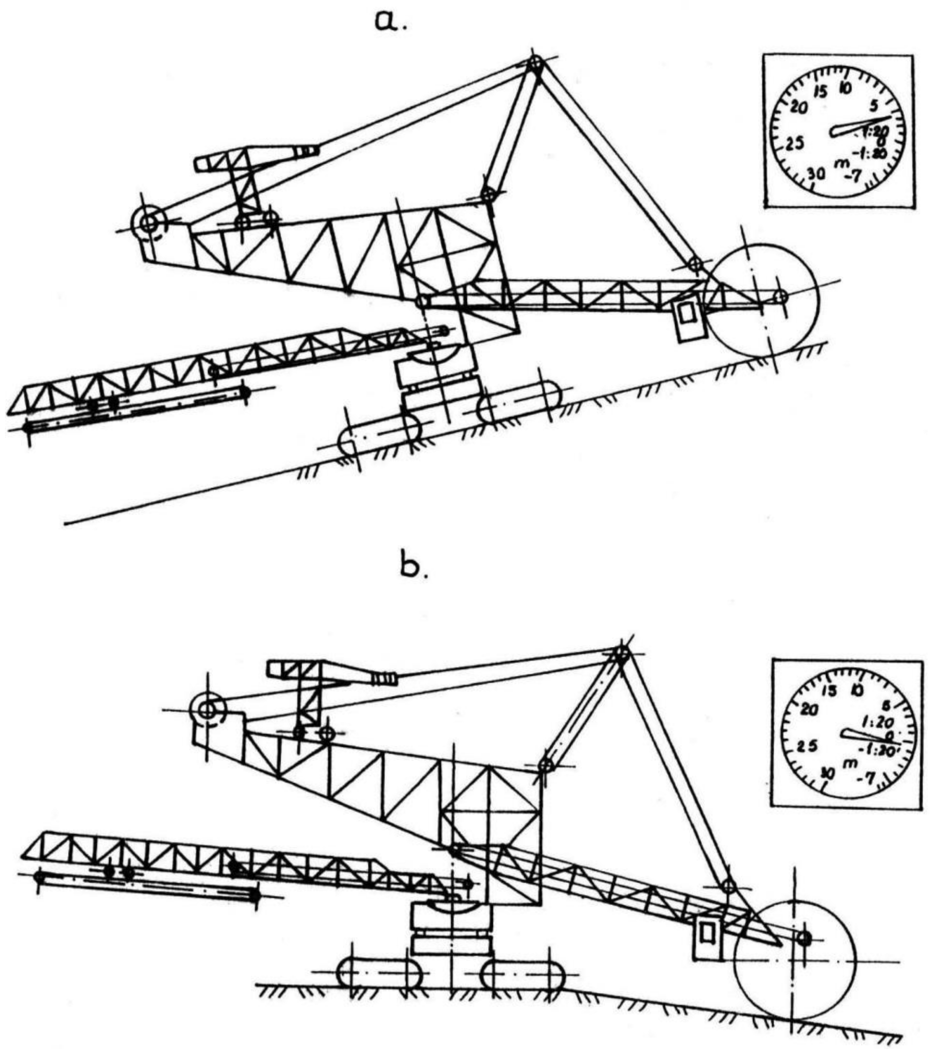

Figure 5.

a) Determining the position of the gradations from the indicator dial (continuous red lines)

The excavator is situated on a cant of δ angle (fig.6)

Because the emitting device (DE) is accorded on the vertical position of that place, he makes a δ angle with the machine's vertical. So, as angles with perpendicular sides, the angle of the cant is equal with the angle of the pendulum of the emitting device with the vertical machine:

Slope ± (1:20):

$$\mathbf{tg}\delta = \frac{1}{20};\ \delta = \mathbf{arctg}\frac{1}{20} = 2{,}86° \qquad (5)$$

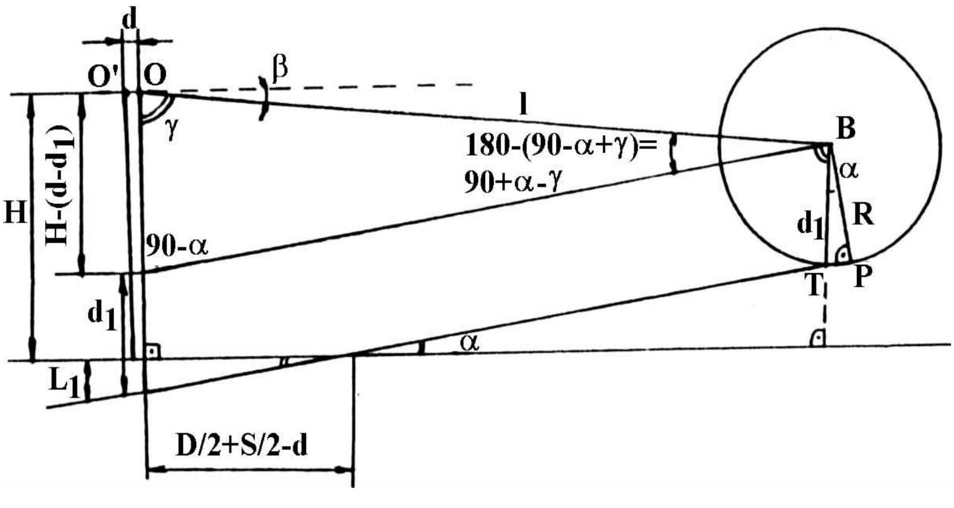

Figure 6.

The correspondence on the indicator dial, if the multiplying factor 5 is taken consideration, is: 2,85º x 5 = 14º19'.
So for the slope + (1:20):
$\beta_{1:20}$=58º32'+14º19'=72º51'.
So for the slope – (1:20):
$\beta_{-1:20}$=58º32'–14º19'=44º18'.

Slope ± (1:25):

$$\mathbf{tg\delta = \frac{1}{25}\,;\ \delta = arctg\frac{1}{25} = 2{,}2906^{\circ}} \qquad (6)$$

The correspondence on the indicator dial, if multiplying factor 5 is taken into consideration, is: 2,2906 x 5 = 11º27'.

Determining the respective angles was possible by applying the sinus theorem.

So, for the slopes (1:20) and (1:25) figure 7 was used for determining the respective angles.

The sinus theorem:

$$\frac{L_b}{\sin(90-\alpha)} = \frac{H_0 - d_1 + l_1}{\sin(90+\alpha-\gamma)} \text{ and}$$

$$tg\alpha = \frac{l_1}{\frac{L}{2}+\frac{S}{2}-L_a} \text{ From triangle BTP results } \cos\alpha = \frac{R}{d_1}\,;$$

$$d_1 = \frac{R}{\cos\alpha}\,;\ l_1 = \left(\frac{L}{2}+\frac{S}{2}-L_a\right)tg\alpha$$

$$\frac{L_b}{\sin(90-\alpha)} = \frac{H_0 - \frac{R}{\cos\alpha} + (\frac{L}{2}+\frac{S}{2}-L_a)tg\alpha}{\sin(90+\alpha-\gamma)} \qquad (7)$$

b) Determining the position of the gradation from the indicator dial (the red dots from indicator dial) (fig.7)

The plain of the caterpillar perfectly horizontal is considered and the slope (1:20) and (1:25).
In triangle OBN (BN|| MP):
The sinus theorem:
The slope (1:20) and for the slope (1:25) resulted, the correspondence on DR indicator dial is showed in fig. 7.

THE ELECTRICAL WIRING DIAGRAM FOR CONNECTING THE EMITTING DEVICE WITH THE TWO RECEIVING DEVICE

Three selsines were used, with the nominal data for the exciting winding of 220V, 50Hz, and the connecting scheme is showed in fig.8.

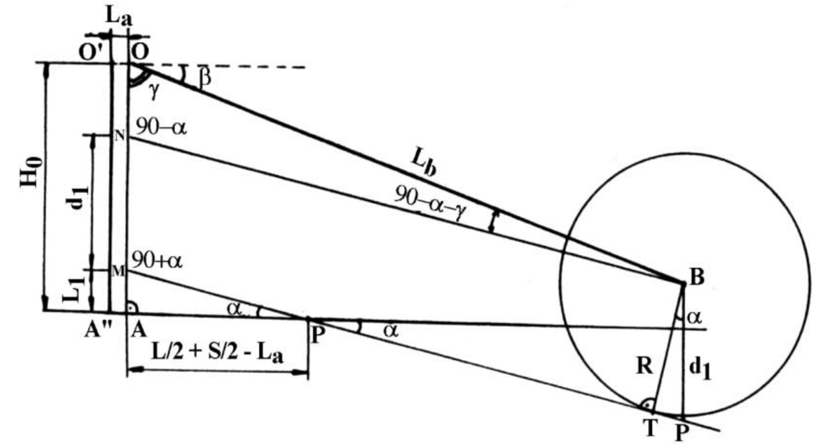

Figure 7.

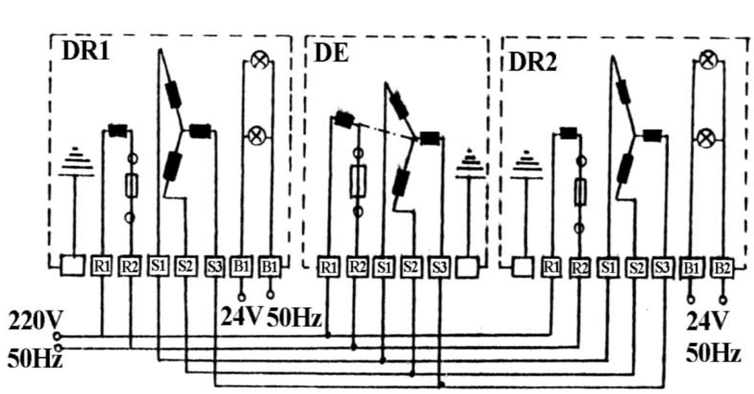

Figure 8.

Table 1. The values of resistors:

Hubs	DE	DR	DE; DR1; DR2 connected
R_1R_2	61 Ω …75 Ω	127 Ω…156 Ω	31 Ω…39 Ω
S_1S_2 or S_2S_3 or S_3S_1	32,4 Ω …40 Ω	279 Ω…341 Ω	26 Ω…33 Ω

Table 2. The value of absorbed current at 220V, 50Hz by the exciting winding R_1R_2 are:

DE	DR	DE; DR1; DR2; connected
Max.360 mA	Max. 150 mA	Max.660 mA

CONCLUSIONS

By applying the respective installation at BWE–1400–30/7, an improvement functioning, especially were observed nighttime, an improvement fiability and of work security in the mineshafts.

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