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THE RESULTS OF THE RESEARCHES REGUARDING THE USE OF CAMS MECHANISMS IN ASSEMBLING ELECTRICAL DETONATORS

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Keywords: cams mechanisms, assembling, electrical detonators, contraction machine with 12 cams.

Abstract: In this study the author presents, the result of the investigations attempted for the implementation of a contraction machine with twelve cams, undertaken by a hydraulic press through mediation of a gear wheel mechanism - cog rack.

In order to demonstrate the efficiency of this device we initialized two types of experiments:

- The efficiency of the assembling in order to remove accidental explosion of the detonator during dynamic extortion;
- The efficiency of the assembling against water flooding inside the detonator and this way damaging the explosive load. At this test we checked if the excessive clamping of the grips did not lead to punching of the tube in that area, the rheophores unstucking from the inflammatory, short-circuiting of the rheophores.

1. INTRODUCTION

The electric caps used in breaking activity, have in composition the pyrotechnic detonator and the electrical lighting device [3].

Assembling these two components is done by the clamping of the metallic tube of the detonator on the drain plug of the electrical lightening device. This way when its rheophores are stretched by the miners there are no unexpected explosions.

Also, if the mines holes are full with water this cannot enter in the detonator and allows it to function proper.

In this study, the author presents the results of the researches done in order to realise a clamping device with 12 cams and powered by a hydraulic press with a gear wheel mechanism - cog rack.

2. THEORETICAL CONCEPTS

From the assembling of electrical detonators we understand the technological operation of assembling the tube of the detonator

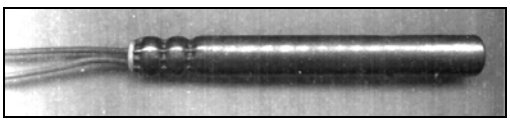

Figure 1. Electric caps.

with the drain plug of the electrical device for ignition. This way we obtain the device from figure 1.

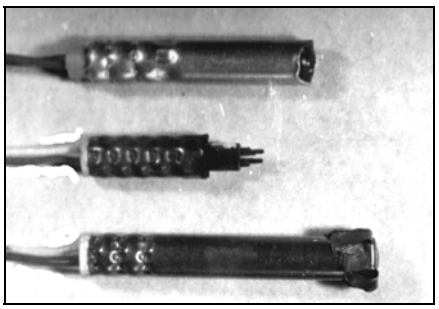

Figure 2. The assembling with many clamping circles.

The assembling is achieved through the plastic contortion of a drain pipe with a perfect sealing of internal from external, anti humidity.

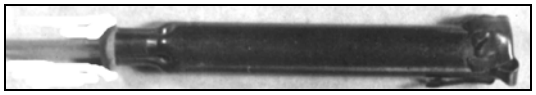

Figura 3. The assembling by folding.

There are known two ways of assembling detonators:

- the assembling with many clamping circles (figure 2);
- the assembling by folding (figure 3).

The assembling with more clamping circles is most spreaded and is done with devices with 10 -12 radial plucking grips (figure 4).

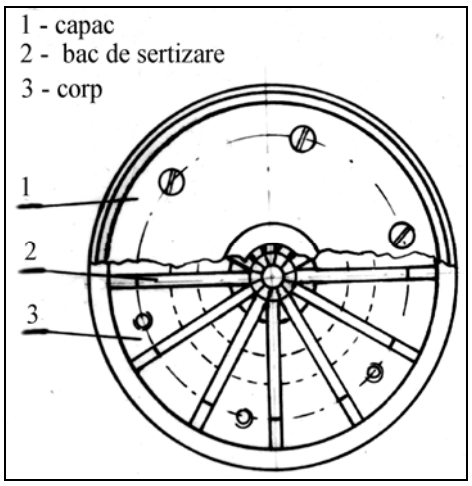

Figure 4. Devices with 12 radial plucking grips.

The assembling by folding is done in three stages: folding, bordering, and pressing.

The assembling with more clamping circles is done with 3, 4, 5, 6 clamping circles, depending on the material. The entering depth of the grips varies from 1,25 mm to 1,55 mm and depends on the number of circles used, the shape of the grips, the plasticity of the drain plug and derangements produced in the rheophores assembling zone. Also, an exaggerate clamping of the grips leads to punching in this area, unsoldering of the rheophores from the inflammatory and short circuiting of the rheophores.

3. THE PRESENT STATE OF THE ORIGINAL MANUFACTURING

3.1. The influence of the manual assembling on the detonator's safety

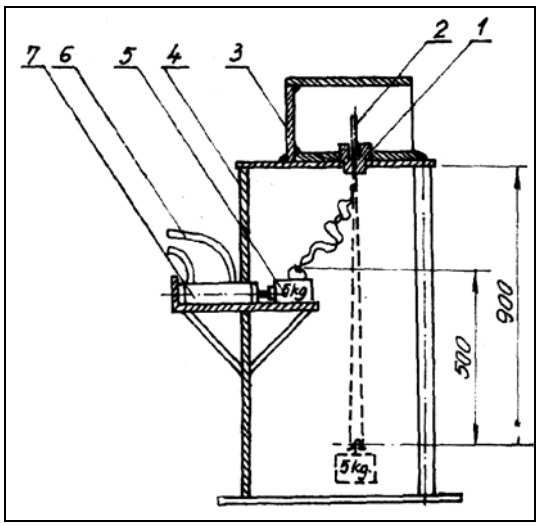

Figure 5. Plucking device based on the dynamic shock of the rheophores.

The strengthening of the electrical devices for ignition in the tubes of the homemade detonators is done nowadays with the help of a drain plug made from plasticized PVC and manually assembled. The assembling is done with a device with 12 grips and 3 grousers on each grip.

Taking into consideration that on the technological flux the assembling is done manually, it is inevitable for some quality and quantity problems not to appear during working hours.

Comparing the quantity produced in each hour by some assembling devices, we come to the conclusion that the rhythm gets slower in the second part of the program, after a 30 minutes break. It should be noted that in the last hour of work the quantity assembled is three times smaller than the quantity

assembled in the first hour. Also, the assembling diameter is very constant in the first part of the working program, when the hand's muscle is rested and variable, and between 4,2 – 5,4 mm in the second part of the working program when muscular force decreases.

After all these conclusions, the author built a plucking device based on the dynamic shock of the rheophores [4], shown in figure 5, with the following characteristics:

- The weight that does the plucking, - 5 Kg;
- The height from where the weight falls, - 50 cm;
- The length of the rheophores (between the drain plug and the node), - 90 cm.

A cage cylinder was used in order to push the weight from its place.

We took 100 detonators as samples after each hour of work. The detonators came from the same assembling device and it was tested by plucking the rheophores with a dynamic shock. In the device from figure 5 we found out that the number of explosions is higher in the detonators assembled in the last two work hours (table 1).

From here we conclude that in the case of home-made detonators, the frequency of explosions during plucking is related to the slowing of work's rhythm before finishing the work program and also it is related to the employees' resistance to fatigue.

Table 1

Time when we took sample		I	II	III	IV	V	VI	VII	VIII
Pieces assembled at ∅ mm	∅= 4,2-4,5 mm	98	99	99	97	99	96	94	92
	∅= 4,6-5,3 mm	2	1	1	2	1	4	4	5
	∅> 5,3 mm	0	0	0	1	0	0	2	3
Detonators tested		100	100	100	100	100	100	100	100
Number of explosions		1	0	1	2	1	3	5	6

3.2. The influence of the drain plug

Taking into consideration different sources that can generate the clamping force of the grips on the tube of the detonator we came to the conclusion that the clamping force can be different after the clamping, for the same diameter d_s. The clamping force variation depends of the hardness of the tube, the elasticity of the drain plug, the empty space between the plug and the tube and between the plug and the rheophores.

Figure 6. Drain plug injected on rheophores.

We should also mention that in the case of indigene electrical detonators manufacturing there is the risk of modifying those parameters in quite large limits.

Considering the exigency of the beneficiaries of electrical detonators and after analyzing some foreign products from the same category, we came to the conclusion that by injecting the drain plug on the rheophores and by making an assemblage with four rows of grousers we can eliminate all the open faults between rheophores, drain plug and tube on one part and the plucking of the rheophores on the other hand, if a constant force acts upon it for 8 hours.

Starting from this idea, we injected the drain plug (figure 6) with a special device. [3]. As an agent for injection we used grains of plasticized PVC STAS 7014-87. The experiments established that the fourth row of grousers must clamp the surface with the smallest diameter of the drain plug, and the grips of the assembling device from this area must make a reflanging of the tube's mouth.

In table 2 we show the results from the tests related to the clamping by dynamic shock where we used a drain plug on the rheophores and an assembling with 3 grousers and another detonator with a drain plug injected and an assembling with 4 grousers. The results show that the detonators with a drain plug injected on rheophores and a 4 grousers assembling is better.

Table 2

Results of the checking	Assembling at ∅= 4,2 mm with 3 grousers and a drain plug put on rheophores				Assembling at ∅= 4,2 mm with 4 grousers and a drain plug injected on rheophores			
	Inflammatory with the insulating compound of prespan		Inflammatory with the insulating compound injected		Inflammatory with the insulating compound of prespan		Inflammatory with the insulating compound injected	
	pieces	%	pieces	%	pieces	%	pieces	%
Rheophores broken or unstuck during welding	67	25,58	16	6,40	37	14,80	12	4,80
A broken or unstuck rheophore from the detonator and the other broken at 5-50 cm	72	28,57	92	36,80	77	30,80	2	0,80
Both rheophores broken at 5-50 cm	61	24,20	39	15,60	58	23,20	108	43,20
Both rheophores in good condition	36	14,28	97	38,80	70	28,00	125	50,00
Clamping from the blades of the insulating compound	4	1,58	-	-	-	-	-	-
Explosions	12	4,76	6	2,40	6	2,40	3	1,20
Number of detonators tested	252	100	250	100	250	100	250	100

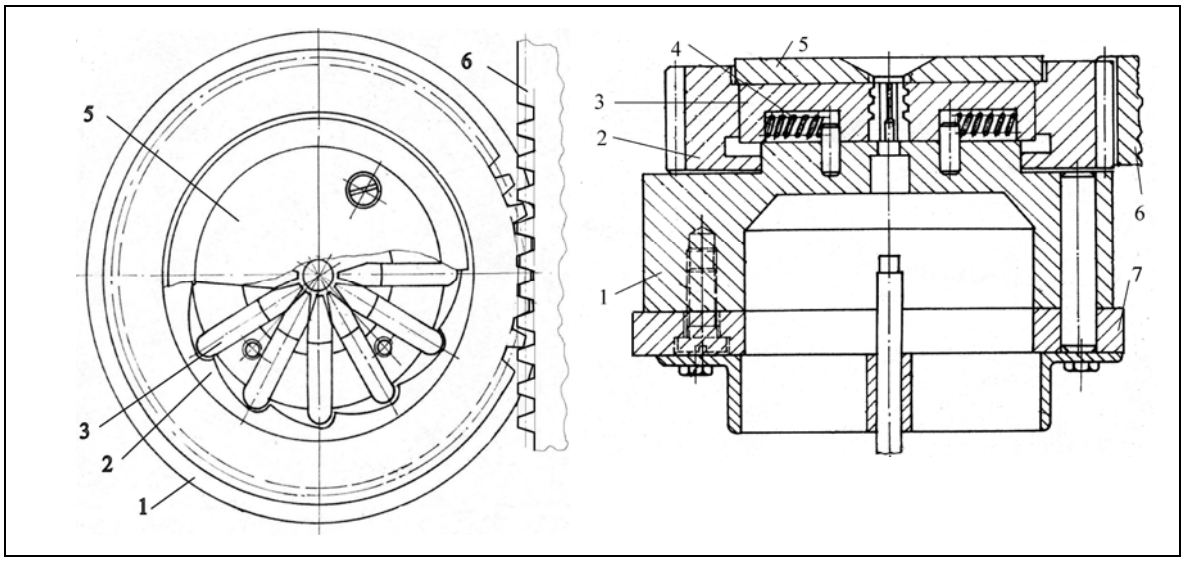

Figure 7. The experimental model designed.

4. THE EXPERIMENTAL MODEL DESIGNED

The author has designed and practical realised an experimental model of an assembling device of detonators with 12 grips for clamping which are maneuvered by clamps. The clamps are part of a mechanism with a cog rack gear wheel.

In figure 7 is shown the assembling device which is made from: 1- attachment device; 2 – cogged sector with 12 interior cams; 3 – assembling grips; 4 – return pass springs; 5 – cap; 6 – double cog rack; 7 – base.

The author has designed this device to work in the same time with another racks device and both of them are maneuvered by the same symmetrical cog rack. Both devices were banked (together) on the table of a hydraulic press of 3 tf, (figure 8). On the headwork of the press we attached the cog rack and on the bottom of it we attached a limit stop. This way the assembling is done at a diameter of 3,8 mm minimum. Behind each assembling device we attached a cloud chamber for possible detonations that might occur during the clamping process.

The assembling device in figure 7 acts as it follows:

When the press' headwork moves the cog rack acts upon the cogged sector, this way moving radial the 12 grips towards the clamping centre. The four teeth of each grip plastically deform the tube of the detonator, and decline its diameter. Also they clamp it on the drain plug, this way we obtain the device from figure 1. At a return pass of the cog rack the grips are moved the other way by the spring **4**.

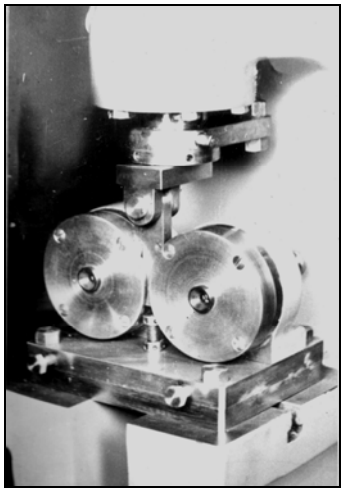

Figure 8. The table of a hydraulic press of 3 tf. and the experimental model.

5. THE RESULT OF THE EXPERIMENTS

In order to demonstrate the efficiency of this device we initialized two types of experiments:

- The efficiency of the assembling in order to remove accidental explosion of the detonator during dynamic extortion;
- The efficiency of the assembling against water flooding inside the detonator and this way damaging the explosive load. At this test we checked if the excessive clamping of the grips did not lead to punching of the tube in that area, the rheophores unstucking from the inflammatory, short-circuiting of the rheophores.

The first type of experiments was done with the help of the rack from figure 5. and the results are shown in table 3.

The second type of experiment was done after the rules of STAS 8136/1985, and that is why we had to introduce the detonators into a water container, one meter deep and the electrical measurements were done after detonations. The measurements were done after the detonators were kept in water for 24 hours.

The results of the experiments are shown in table 4.

Table 3

The diameter of the assembling circle [mm]	Assembling with 3 grousers		Assembling with 4 grousers	
	Number of detonators tested	Explosions or movements from the insulating compound	Number of detonators tested	Explosions or movements from the insulating compound
Ø 6,6	100	38	100	32
Ø 5,4	100	8	100	2
Ø 4,6	100	0	100	0
Ø 4,2	100	0	100	0

Table 4

The assembling circle [mm]	Number of detonators tested	Number of detonators that worked	Failures
Ø 6,6	100	8	92
Ø 5,4	100	43	57
Ø 4,6	100	98	2
Ø 4,2	100	100	0

6. CONCLUSIONS

After analyzing the results we came to the following conclusions:

- If we modify the depth where the assembling grips are introduced, from a maximum value Ø 4,2 mm to a minimum value of Ø 6,6 mm, we see a bigger movement of the rheophores from the drain plug; thus movement is usually followed by an explosion;
- In the device with 3 assembling circles there are no pluckings of the rheophores under a 4,2 mm diameter, while in the device with 4 assembling circles the pluckings take place starting from a 4,6 mm diameter;
- The assembling with 4 circles is safer and it does not allow water flooding in the detonator starting with a 4,2 mm diameter;
- Mechanical assembling is safer if we want to remove non-uniform assembling of detonators which might be followed by explosions during handling;
- The use of cramps in the maneuvering of the grips - belaying cleat is a very good solution in building clamping devices with more fingers.

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