

# IMPROVING THE EFFICIENCY OF THE COMBINED METHOD OVERSIZE CRUSHING

A.O. Pokoptsev

Gm1994.23@gmail.com

*Scientific adviser: Ph.D., Senior Researcher, Filatov G.P., TPU*

## Abstract

In the mining industry there is the problem of the formation of oversize blocks rocks, which require secondary crushing. Using the combined method of electric crushing oversized to accelerate compared with the technologies using today, and automate this process.

The main task in this method is a shift from the source industrial frequency power supply to the pulse of electrical energy. An important component is the switching time is necessary take into account the direction of the current flowing through the rocks. For these purposes the controller Arduino Uno, which allows to configure the switching power sources.

## Introduction

In the mining industry there is the issue of the secondary crushing oversized rocks. Secondary crushing - the destruction of oversize rock mass in open pit and underground mining. At the blasting is not possible to achieve a uniform splitting of the rock, due to rock inhomogeneities formed oversized pieces. A particularly acute problem in underground mining. transportation of oversized rocks on the surface impossible.

There are methods for crushing oversized. Conventionally are using mechanical or detonation of the explosive methods. But also to develop new methods of crushing, based on the principle of electrical breakdown in a solid. Combined splitting method is based on the impact on the rock power frequency current, upon reaching a certain value is made the supply of high-voltage pulse. Which creates electrodynamic effects inside the rock, leading to destruction. For this method, a device that allows for the achievement of the required parameters turn off the power frequency current, and apply a high voltage pulse.

## Methods

In the combined method of crushing the Communist Party. Which, initiates the formation of a conductive channel due to the release of energy by Joule-Lenz. Then, formed on the conductive channel filled with a mass of molten rock, is supplied a high voltage pulse which generates electrodynamic effects on the rock, leading to its destruction [1].

By using this technology, the fundamental is the time when the high-voltage pulse is fed. When the flow of power frequency current, the current does not vary linearly.

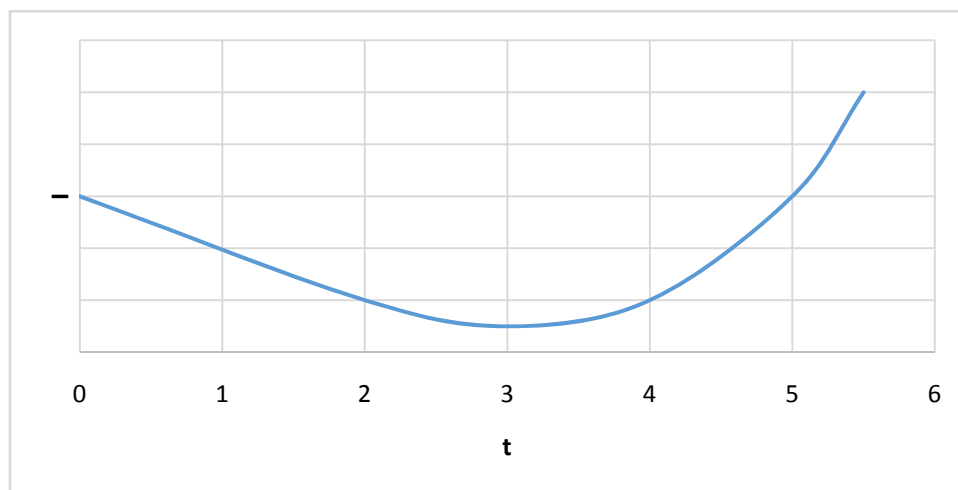


Figure 1. Graph of change of current according to time.

As seen from the graph, up to a certain point in time the current passing through the formation decreases. This is due to the fact that the rock in its internal structure has crystallohydrates of salts and water. When current arises along the heating channel breakdown, which leads to the evaporation of water and increasing resistance. Further, the current increases, due to the fact that begins to form a conductive channel is filled with molten rock [2].

Feeding high-voltage pulse is necessary during the increase of the current. The most effective point on the graph will be the point 4. Since before this time has not yet started to form a conductive channel, and then begins to increase at the current feeder power frequency current, which leads to the risk of a short circuit, and to an increase in losses of electricity [3].

The oversize secondary crushing device which uses a combined method necessary the sensor to be responsive to the change in current over time.

$$\frac{\Delta I}{\Delta t} > 0.$$

The authors, for this purpose, it was proposed to use current relays Bistable RTD-21M. The relay reacts to a change in the current of 50mA and 120mA. But due to the fact that time a relatively large current change, the relay does not have time to react to the change in current. Also due to the low current control capabilities that vary greatly depending on the breed. Relay RTD-21M is not suitable for this purpose [4].

Using a controller Arduino Uno as a current change detector flowing in the rock. What allowed perform the setting to turn off industrial frequency current. The fee Arduino Uno is based on the microcontroller ATmega328. Power is supplied by a voltage converter, which is connected through a connector to the 2.1 mm with central positive pole. Power supply voltage is 7-12 V. Programming controller carried on the C language. It was provided the opportunity to setting rate of change current [5].

## Results

Figure 2 (a, b) shows the change in AC amplitude for use as objects of concrete specimens 200 mm (Figure 2a) and granite 65 mm (Figure 2b). To enable the various moments of the generator high voltage pulse (points 1, 2, 3) an analysis of the nature of the destruction of concrete and granite samples. Results of analysis destruction for the combined effect shown in Table 1. The table shows that when a signal is input to the sensor including a high voltage pulse at a time when the rate of change of AC amplitude is less than zero (point 1), the destruction of the object isn't observed.

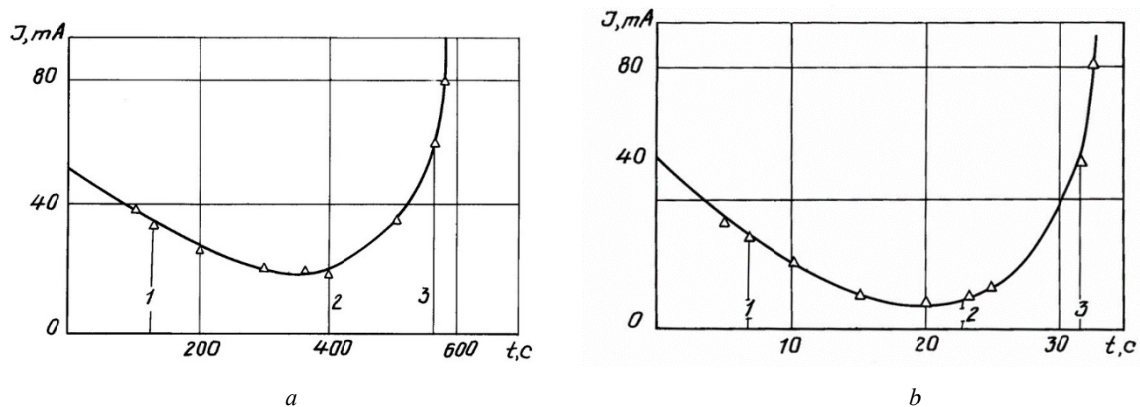


Figure 2. a) Change the AC amplitude for a 200 mm concrete  
b) Change the AC amplitude of 65 mm granite

If the material when exposed to the variable frequency current channel is formed electrothermal breakdown (point 3), then the subsequent impact of a high voltage pulse is also not effective. The maximum efficiency of process failure occurs when the impulse high voltage is supplied to the sacrificial object when the rate of change of the AC becomes larger than zero (point 2).

Table 1. Results of the combined method for various points

Material samples	Moment of switching of high voltage pulse		
	Point 1	Point 2	Point 3
	The result of the combined effects		
Concrete 200 mm	not destroyed	4 fragment	not destroyed
Granite 65 mm	not destroyed	6 fragment	2 fragment

### Conclusion

Using Arduino Uno controller to determine when to switch the power supply makes the most efficient to implement the combined method secondary crushing oversized rocks. That in turn reduces the time spent on a single crushing rock. And reduce energy consumption for crushing. The same controller Arduino Uno allows setting in a wide range, the entire system to a specific type of rock.

### Bibliography

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