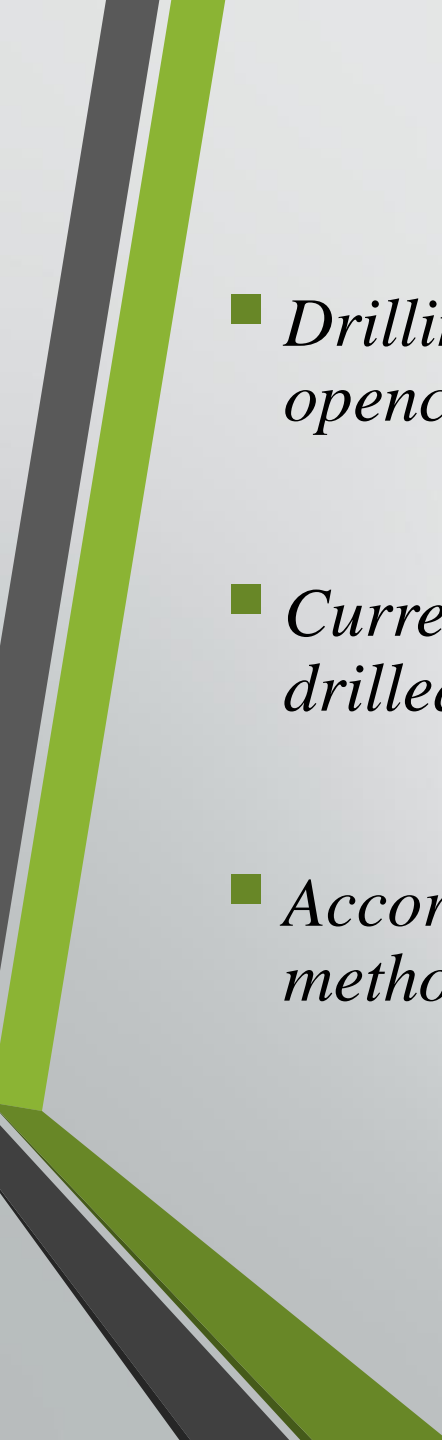




Project
«Drilling tool Bogomolov»



*The efficiency of the blast hole
with a square cross-section*

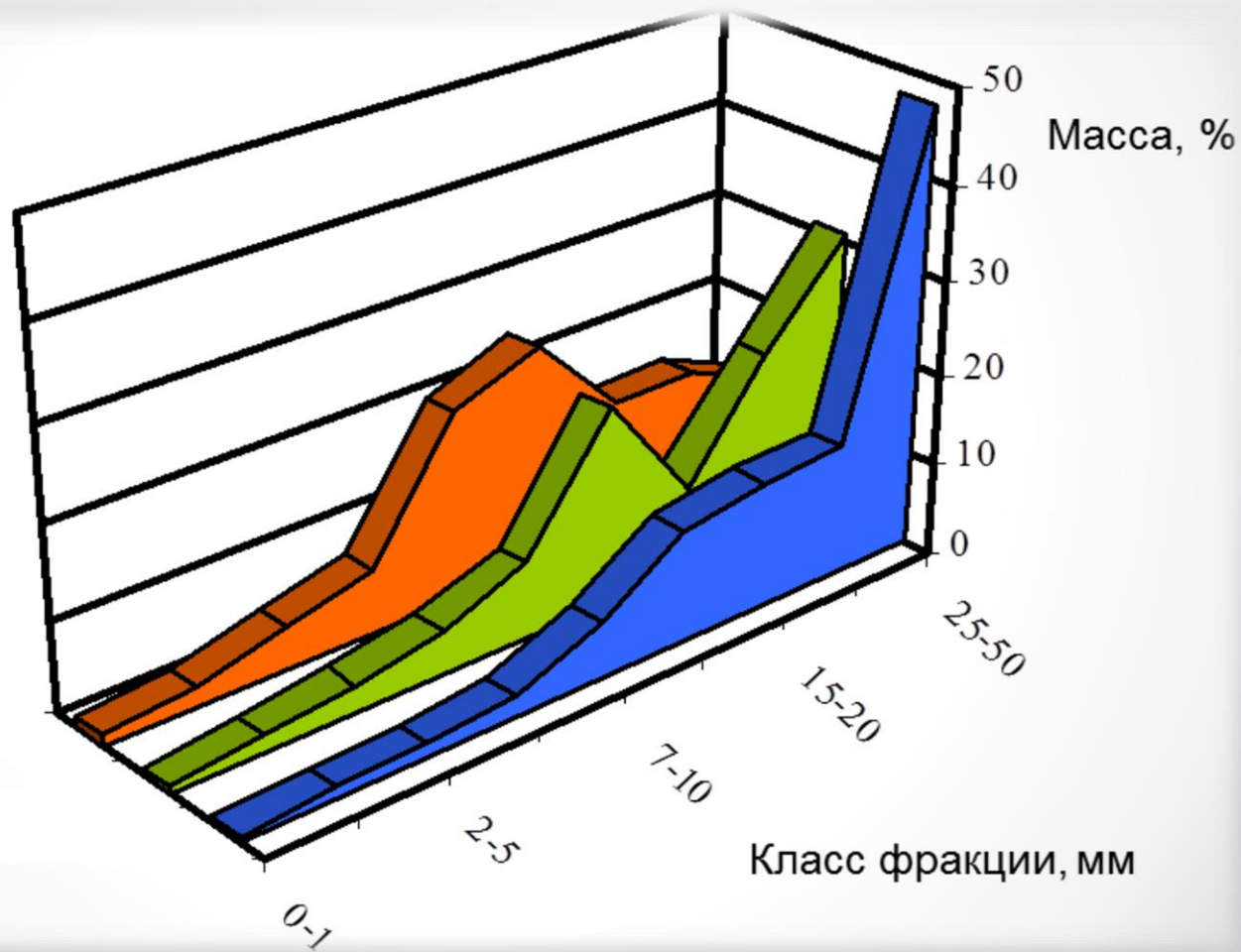
- 
- *Drilling and blasting are one of the major processes in opencast mining.*
 - *Currently almost all blast holes at the quarry are drilled in cylindrical shape.*
 - *According to the analyzed researches the alternative method of conducting drilling and blasting operations.*



*Researches in drilling and blasting,
laboratory tests on the explosion of
sand-cement blocks*


The distribution of the fractions by weight depending on the shape of the cross section of the hole during sand-cement blocks blasting

- квадрат
- окружность
- треугольник



Test result

Optimal granulometric composition of the exploded block was revealed while using wells with the square cross-section. A small yield of larger fractions indicates the best crushing.

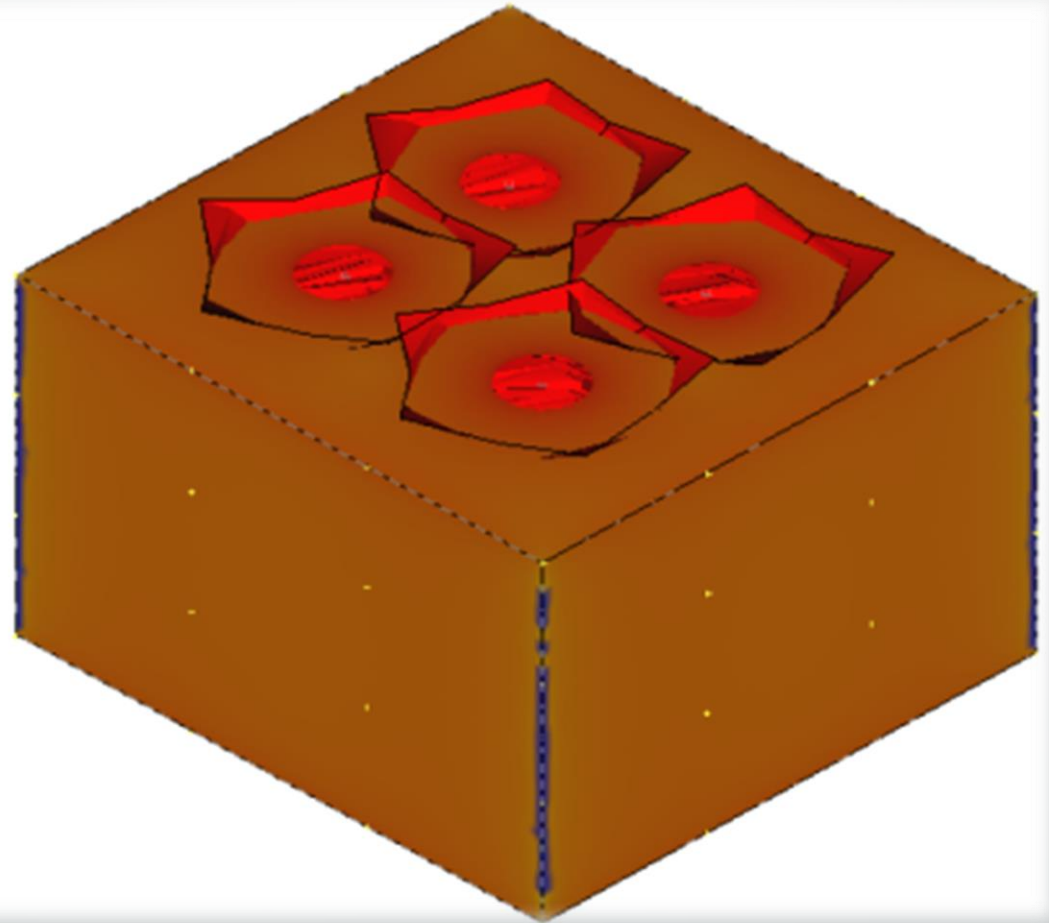
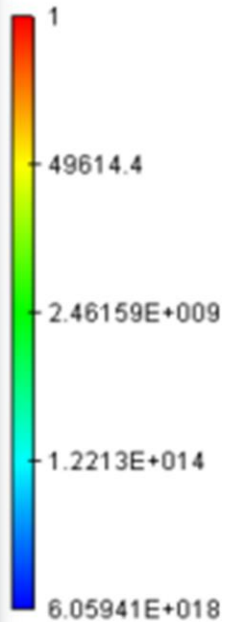


The modeling of the explosion process in the mountain range by static loading of the borehole walls with square and round cross-section

The modeling of explosion of the round wells with a diameter of 216 mm with a grid of 5x6 meters

ит запаса по эквивалентным напряжениям
масштаб перемещений: 1.00

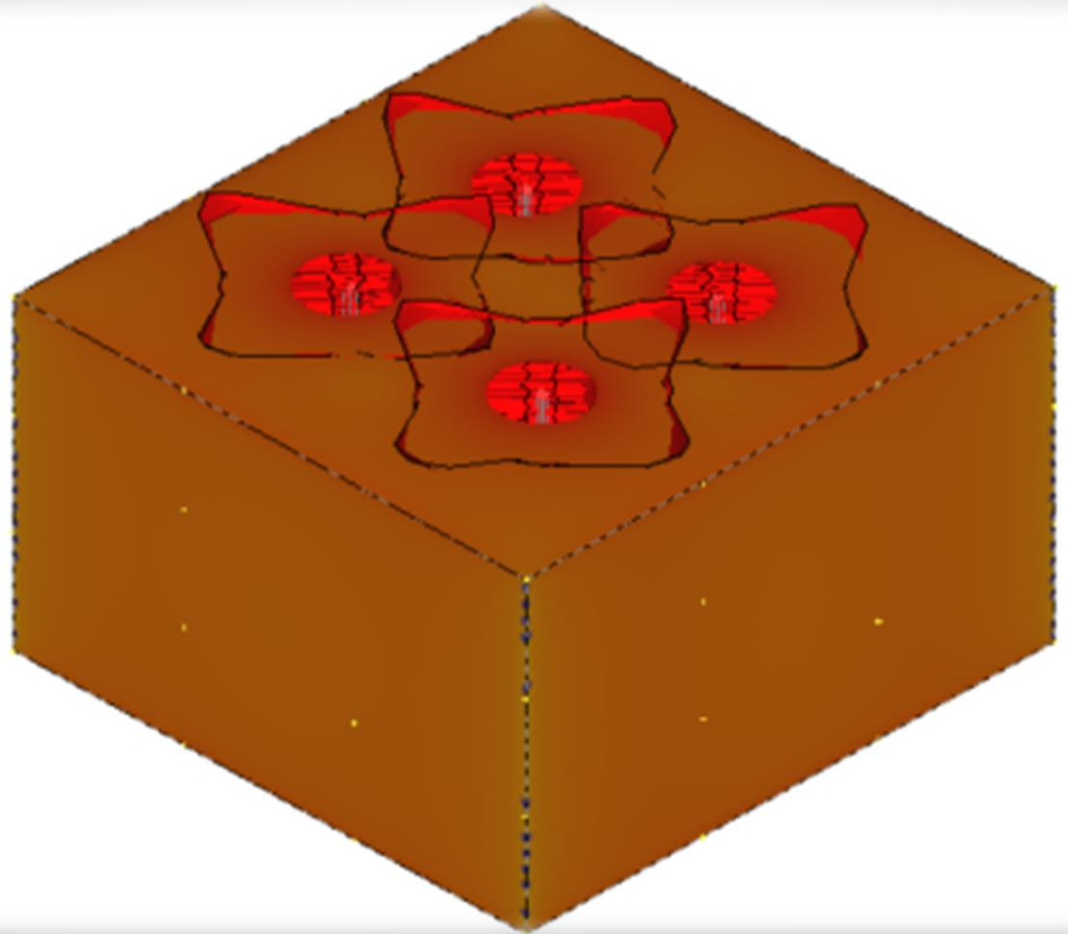
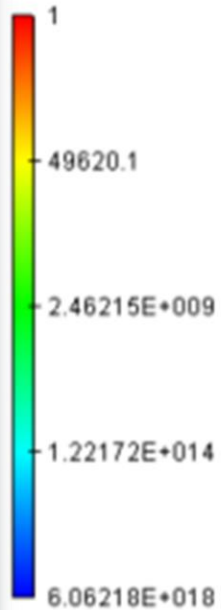
lin = 0.101325



*The modeling of the explosion of the square holes
with size 191 mm and a grid 5,5x6 meters*

от запаса по эквивалентным напряжениям
Масштаб перемещений: 1.00

Min = 0.0680835




Test result

<i>Name</i>	<i>Grid with drilling and blasting, meter</i>	<i>The safety factor for equivalent stresses</i>	<i>The volume of blasted rock mass, cubic meter</i>
<i>The bore of circular cross-section</i>	<i>5x6</i>	<i>0,117</i>	<i>2400</i>
<i>The bore of square cross section with a larger grid</i>	<i>5,5x6</i>	<i>0,068</i>	<i>2640</i>

Appliance of wells with a square cross-section allows

- *To increase the volume of blasted rock mass by 10%.*
- *To increase the yield of rock mass per one meter of the well by 10%.*
- *To increase the size of the well grid by 10%.*
- *To reduce the consumption of explosives in blasting operations by 10%.*
- *To reduce the amount of drilling by 10%.*



*The economic effect of using a
blast hole with a non-circular
cross-section*

According to the project research the usage of wells with non-circular cross-section allows you to:

- *To increase the size of the well grid by 10%.*
- *To reduce the consumption of explosives in blasting operations at 10%.*
- *To reduce the amount of drilling by 10%.*

The grid size for drilling and blasting operations

<i>Name</i>	<i>Units</i>	<i>Blast hole circular cross-section</i>	<i>Blast hole square cross-section</i>
<i>Length</i>	<i>m</i>	<i>5</i>	<i>5,5</i>
<i>Width</i>	<i>m</i>	<i>5</i>	<i>5</i>
<i>Depth</i>	<i>m</i>	<i>9</i>	<i>9</i>

The consumption rate of the explosives in the borehole

<i>Name</i>	<i>Units</i>	<i>Blast hole circular cross-section</i>	<i>Blast hole square cross-section</i>
<i>Column length</i>	<i>m</i>	<i>5,85</i>	<i>5,85</i>
<i>The consumption rate for the length of the column</i>	<i>m/t</i>	<i>32,12</i>	<i>32,12</i>
<i>Specific consumption of explosives in the borehole</i>	<i>t</i>	<i>0,18</i>	<i>0,18</i>

The production rates of the drilling rig per month

<i>Name</i>	<i>Units</i>	<i>Blast holes of circular cross-section</i>	<i>Blast hole of square cross-section</i>
<i>The volume of blasted rock mass</i>	<i>cubic meter</i>	<i>Equal volume</i>	
<i>The number of drilled wells</i>	<i>pieces</i>	<i>3000</i>	<i>2727</i>

Drilling tool resource

<i>Name</i>	<i>Units</i>	<i>Blast hole of circular cross-section</i>	<i>Blast hole of square cross-section</i>
<i>Resource</i>	<i>linear meters</i>	<i>10000</i>	<i>5000</i>
<i>The number of tool replacements per month</i>	<i>pieces</i>	<i>2,70</i>	<i>4,91</i>

Expenses per one unit of resources

<i>Name</i>	<i>Units</i>	<i>Blast hole of circular cross-section</i>	<i>Blast hole of square cross-section</i>
<i>Explosive substance</i>	<i>\$/t</i>	<i>371,75</i>	<i>371,75</i>
<i>Drilling tools</i>	<i>\$/pieces</i>	<i>594,80</i>	<i>1189,59</i>

The other items remain unchanged.

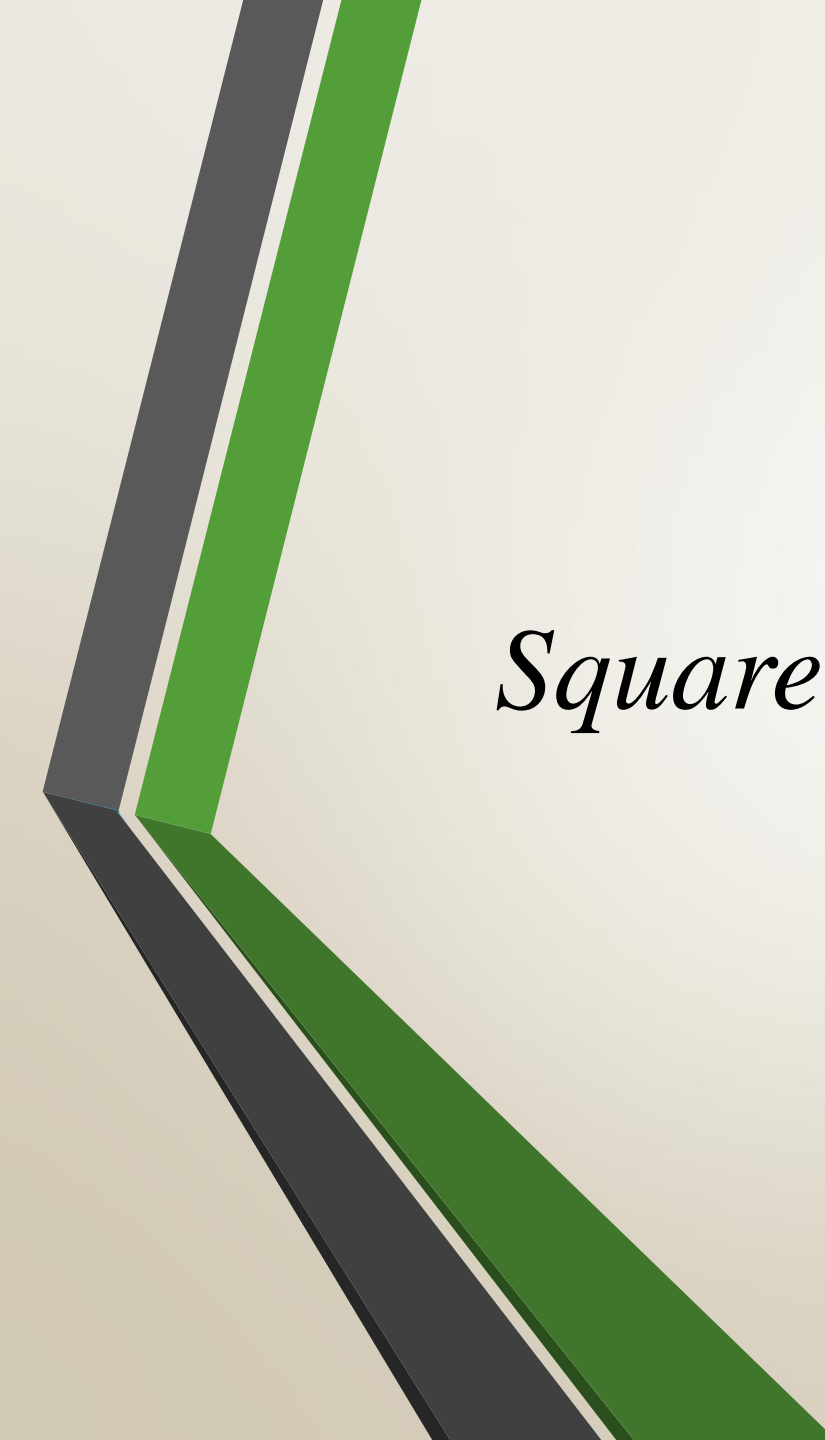
Total monthly expenses for carrying out drilling and blasting operations

<i>Name</i>	<i>Units</i>	<i>Blast hole of circular cross-section</i>	<i>Blast hole of square cross-section</i>	<i>Economic effect</i>
<i>Explosive substance</i>	\$	203118,42	184653,11	18465,31
<i>Drilling tools</i>	\$	1605,95	5839,81	-4233,86
<i>Total</i>	\$	204724,37	190492,92	14231,45

The other items remain unchanged.

The use of wells with non-circular cross-section allows

- *Reduce monthly expenses explosive by approximately 9%.*
- *Reduce the cost of drilling and blasting operations by 7%.*
- *The annual economic effect from one machine under equal conditions of development of the volume of blasted rock is \$170777,37.*

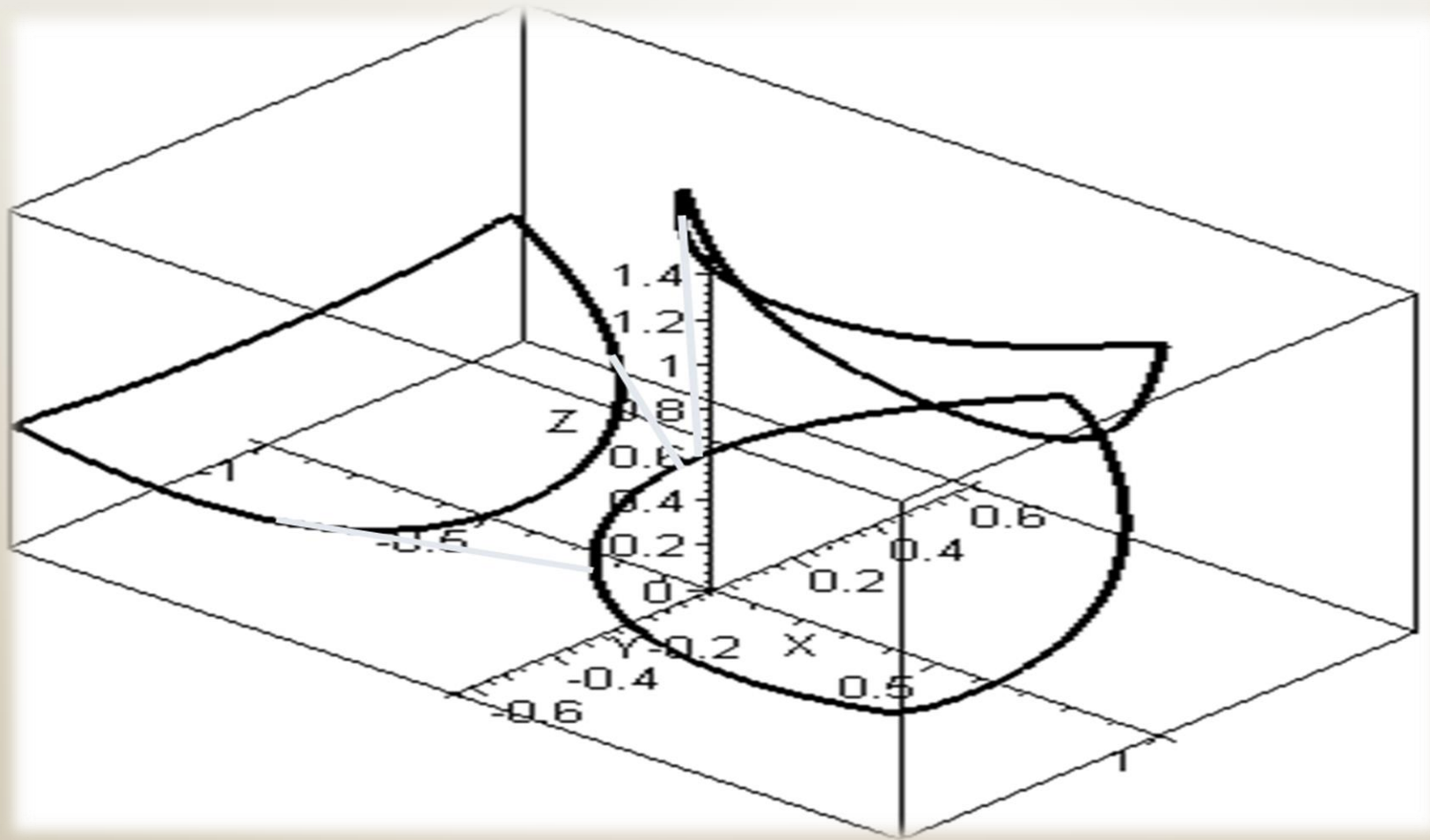


*Square cross section wells
forming*

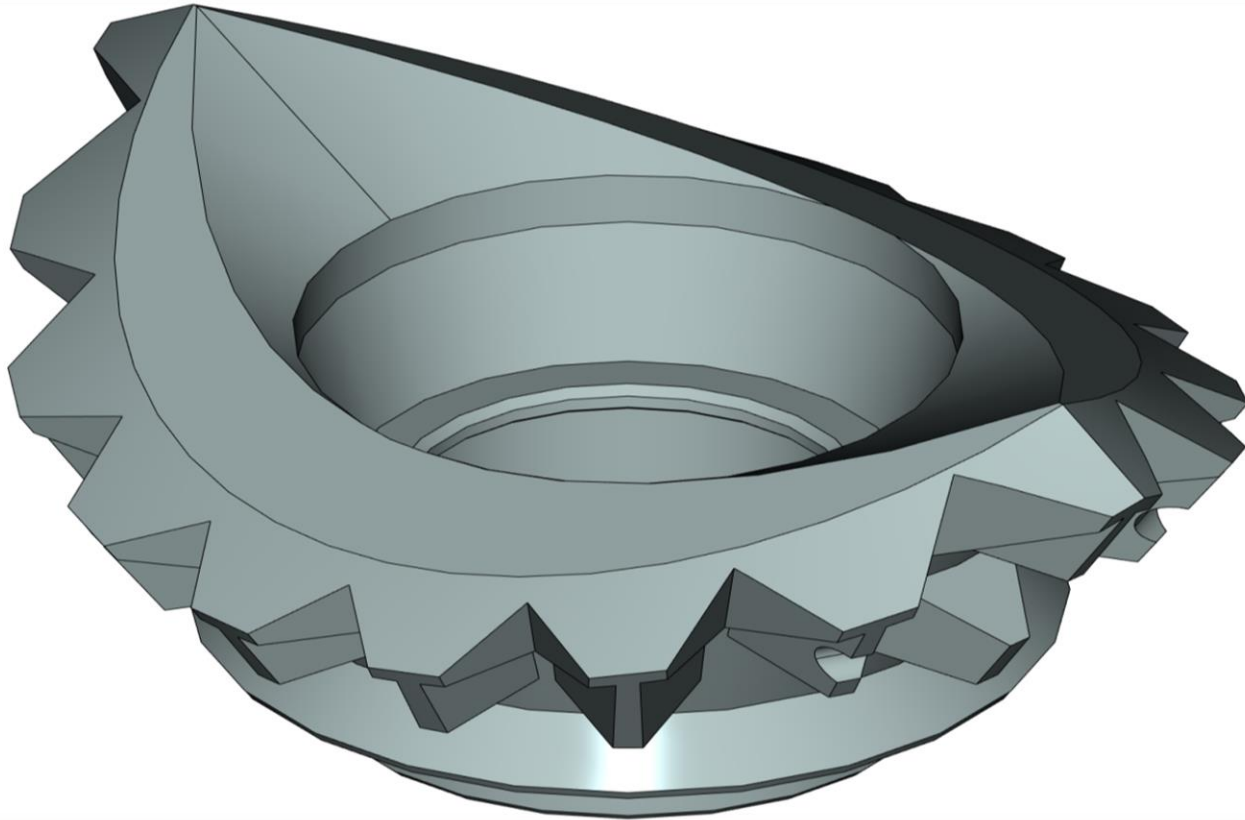
Requirements for prospective drilling tool

- *Providing the possibility of square cross-section wells forming.*
- *Unitized construction, allowing operation on production drilling machines.*

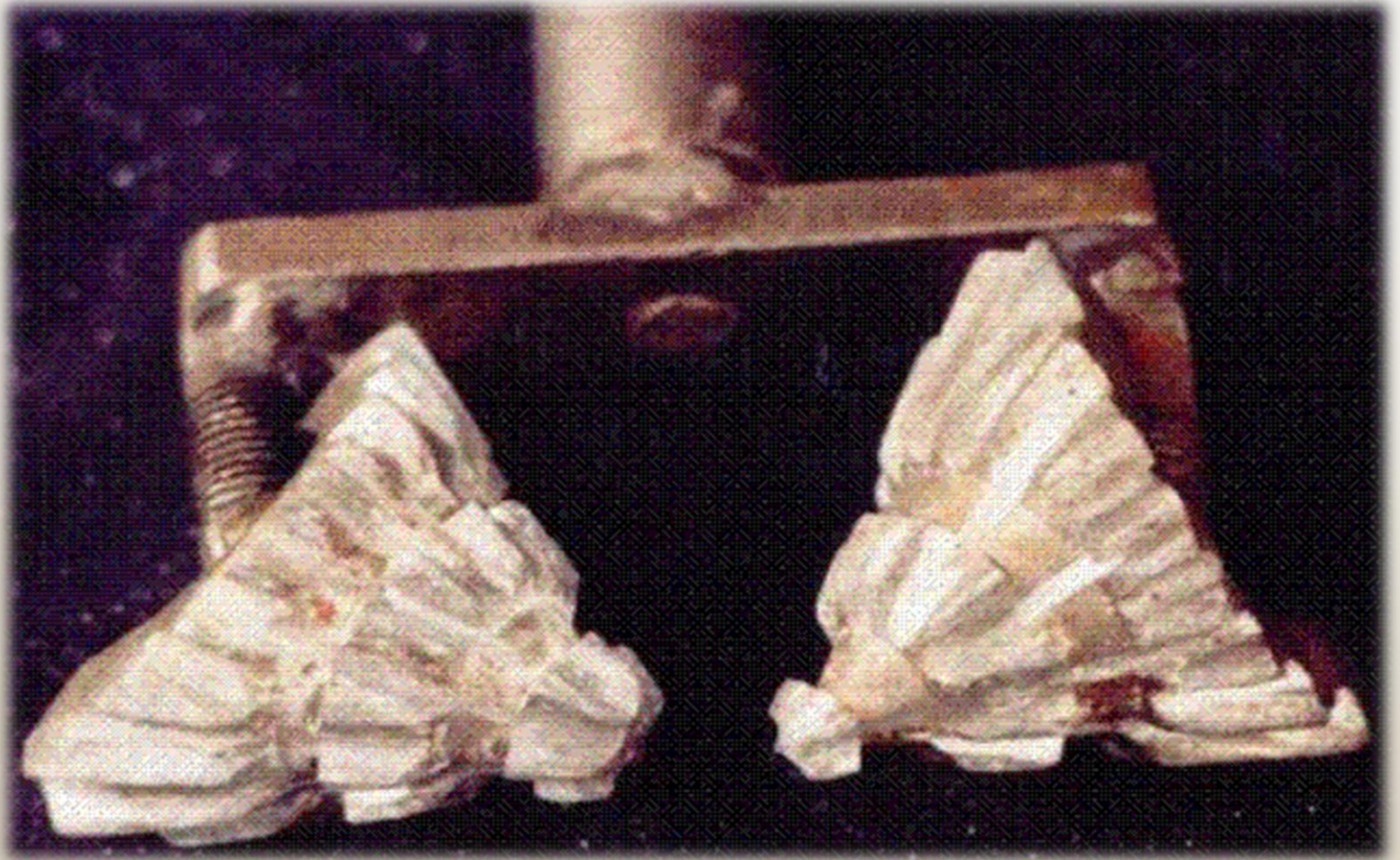
Modeling of the rectangular wells edges shaping process



Designed shape of the cutter for moulding the square cross section bore



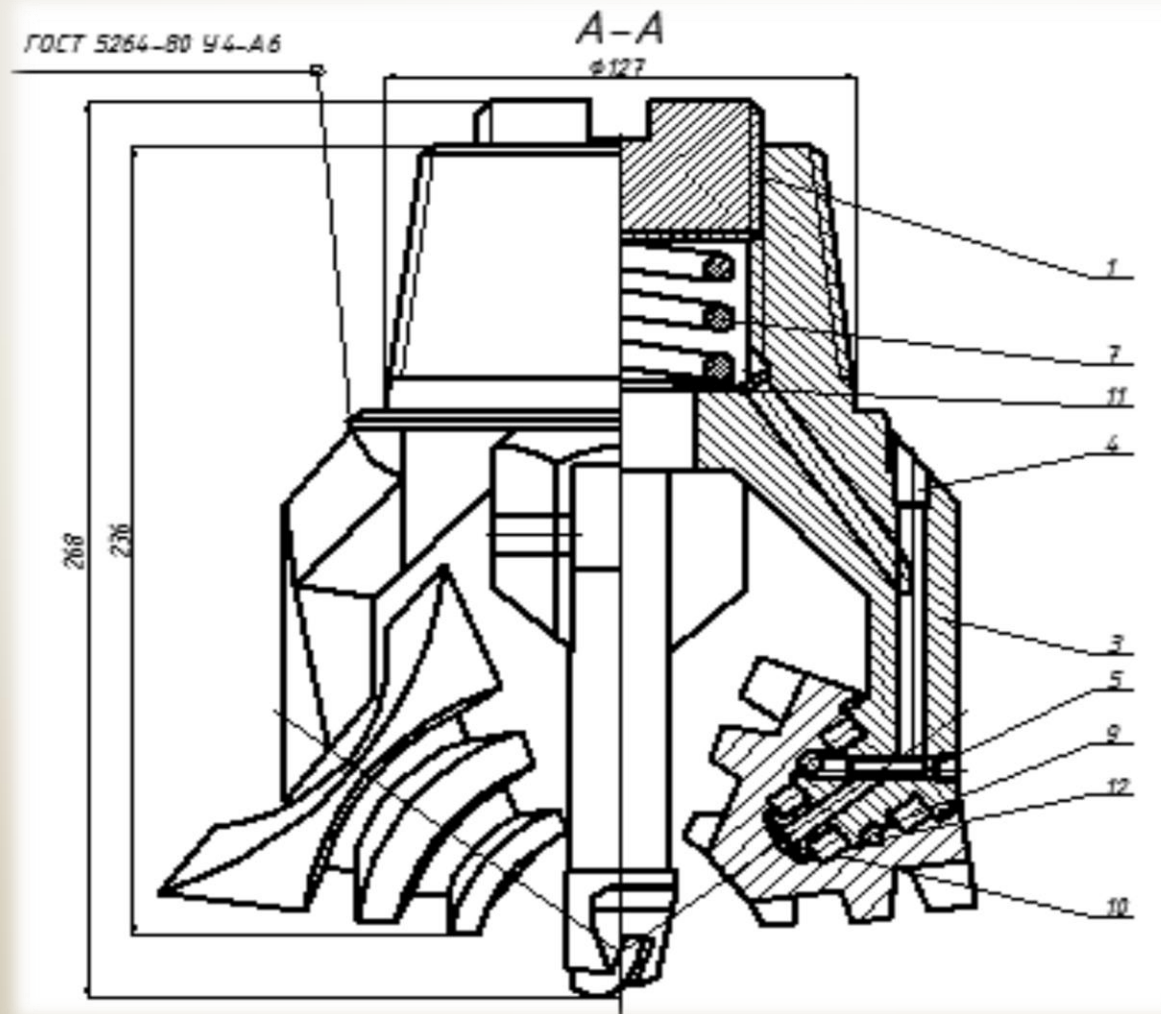
The first prototype of a drilling tool



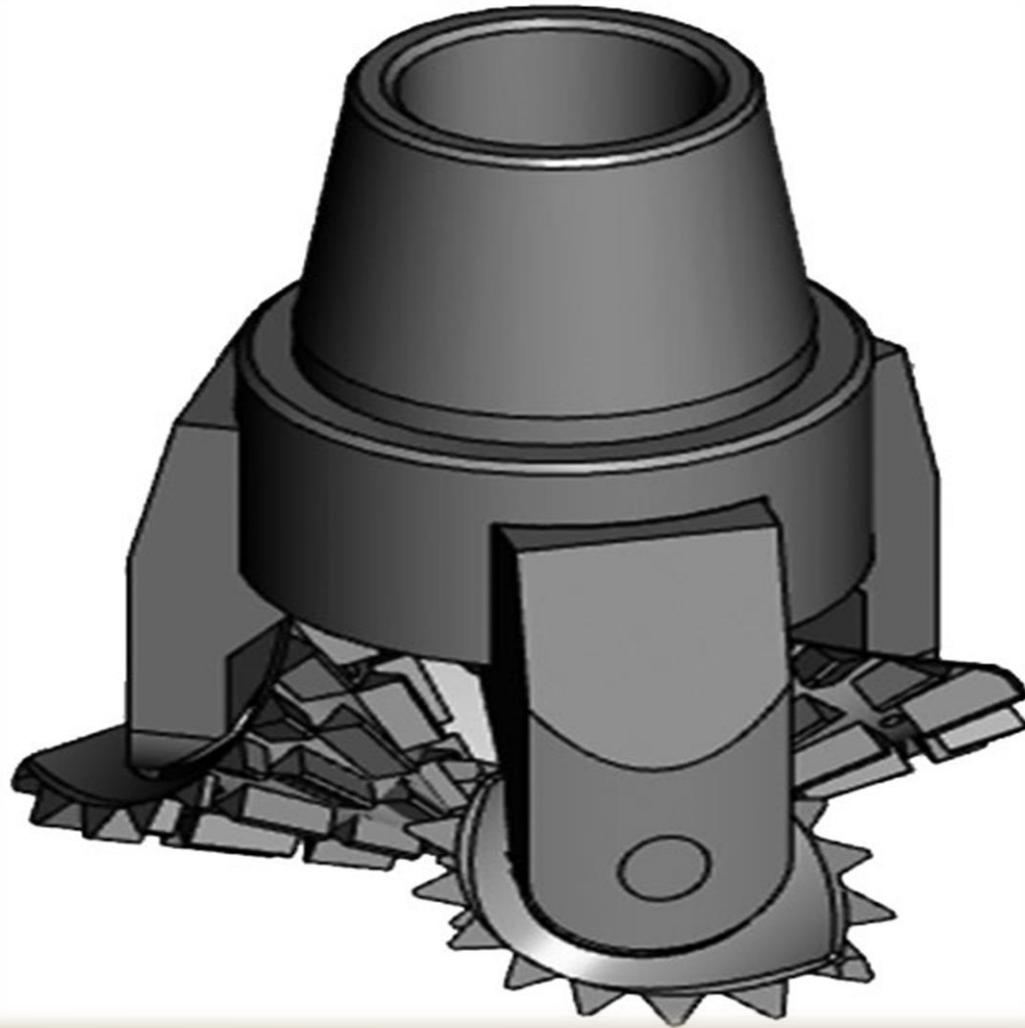
The first drilling results



A possible embodiment of the serial cutting-cone drilling tool




Possible version of serial tricone drilling tools



The results of research

- *There are developed the methods for determination of milling cutter geometric parameters, which is able to drill wells with a square cross-section.*
- *There is made a layout of a cone drilling tool for drilling holes with a square cross-section.*
- *Experimental drilling is carried out.*
- *There were identified possible options of «Drilling tools Bogomolov» serial execution.*

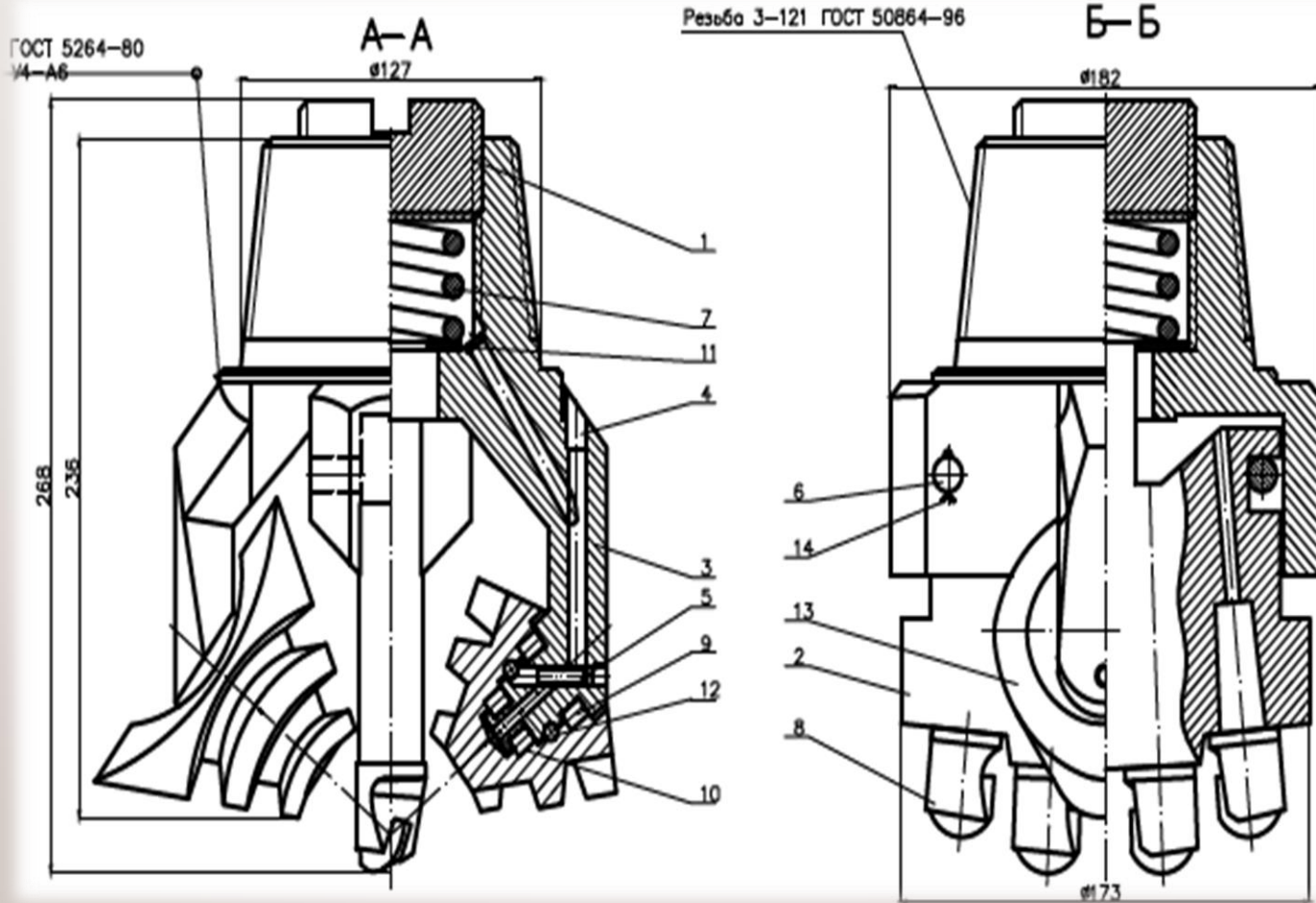


*Development of modifications
of the drilling tool for
boreholes with a square cross-
section*

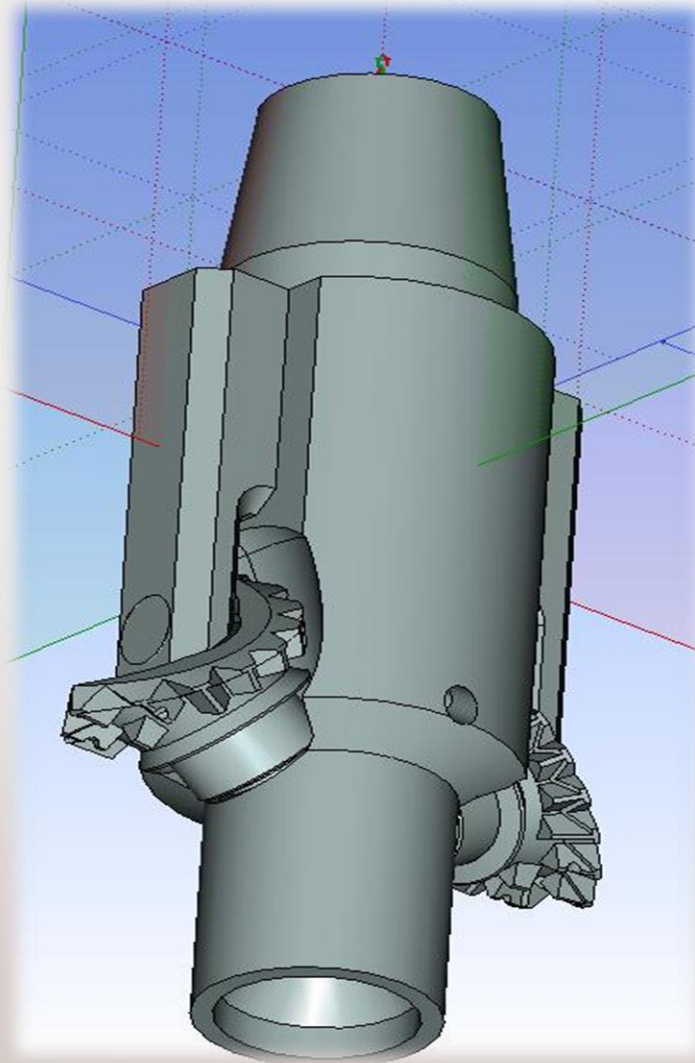
Drilling tools implementation requirements

- *Provides the possibility of forming wells with a square cross-section.*
- *Unitized body construction, allowing operation on production drilling machines.*
- *The possibility of applying on the rocks of hardness from 6 to 14 on the Protodyakonov scale.*
- *Tool resistance should not be lower than 50% of the existing drilling tool in order to obtain wells of circular cross-section.*

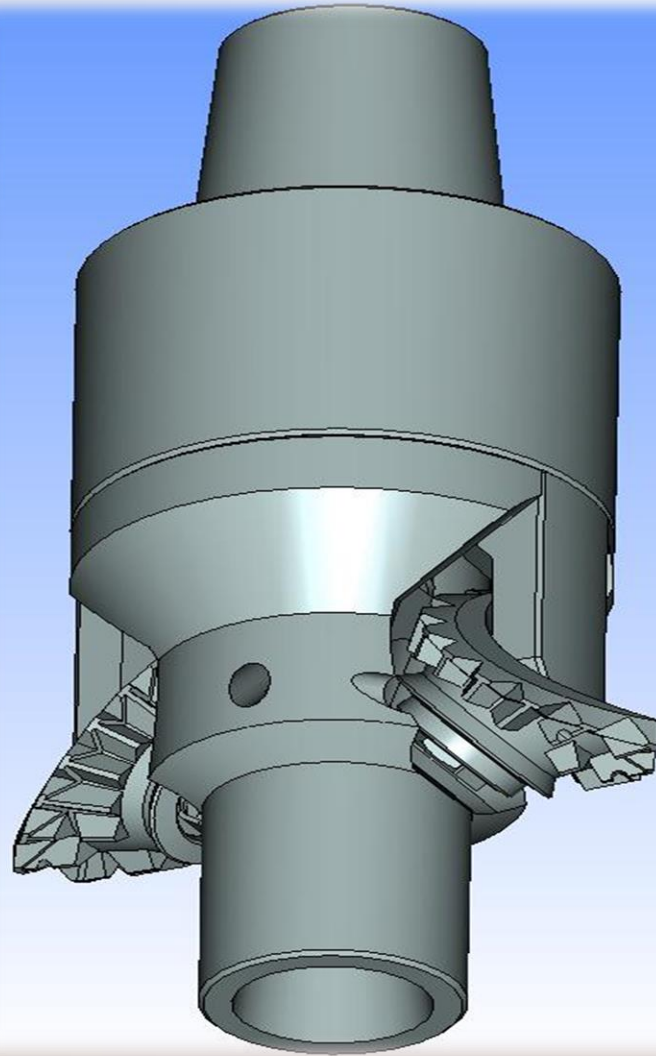
Developed design of a cutting-cone drilling tool



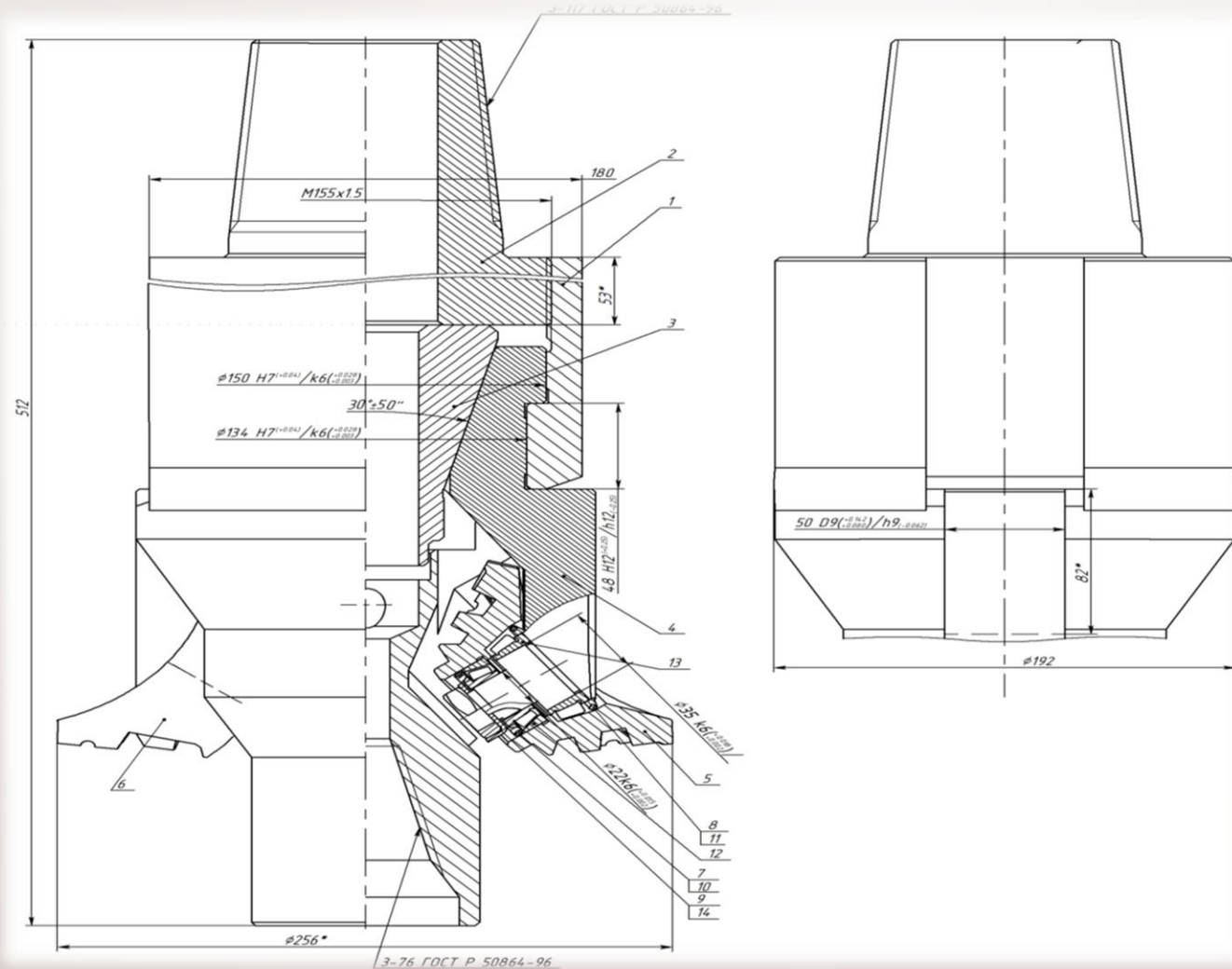
3D model of non-separable roller expander



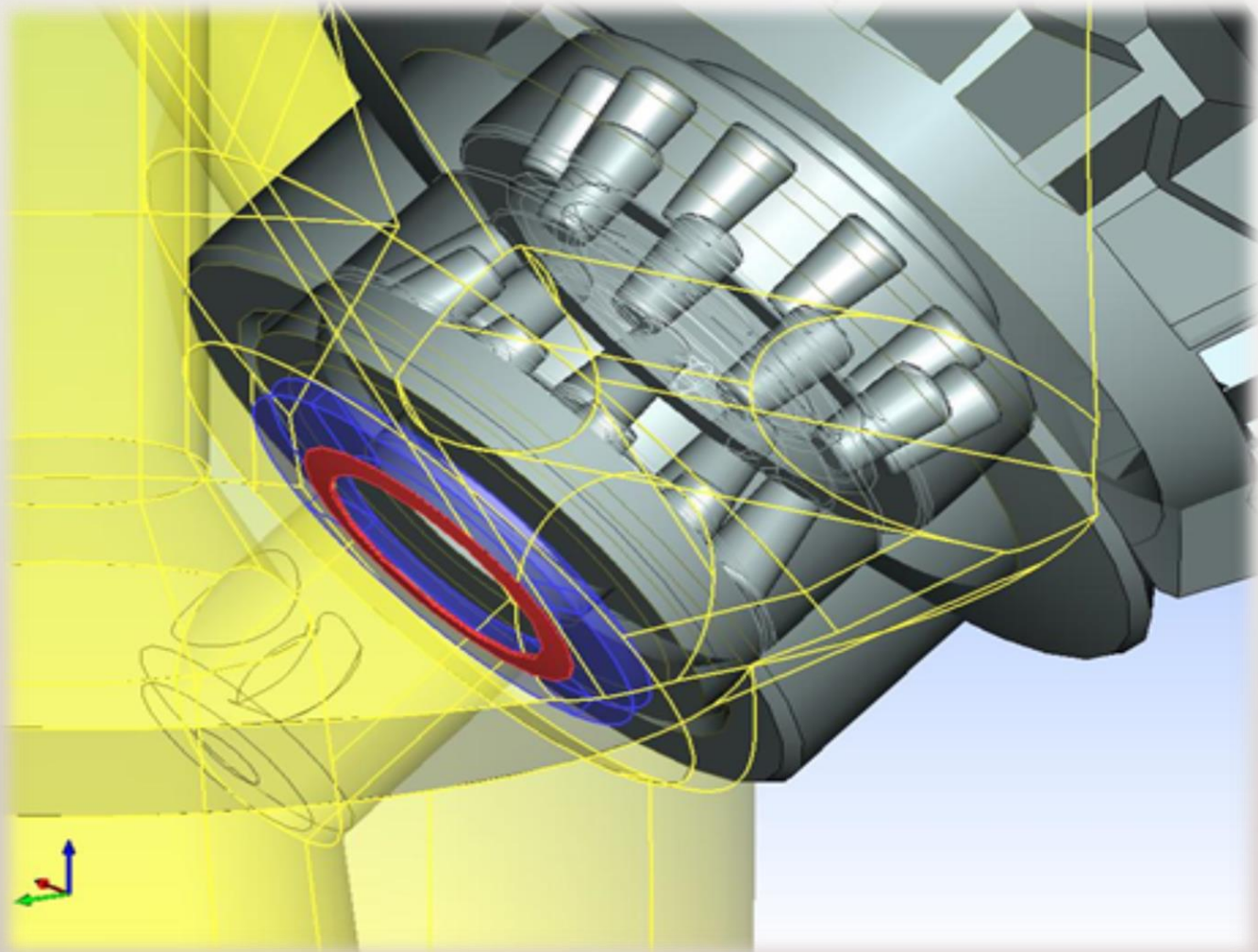
*3D model of a collapsible roller
expander*



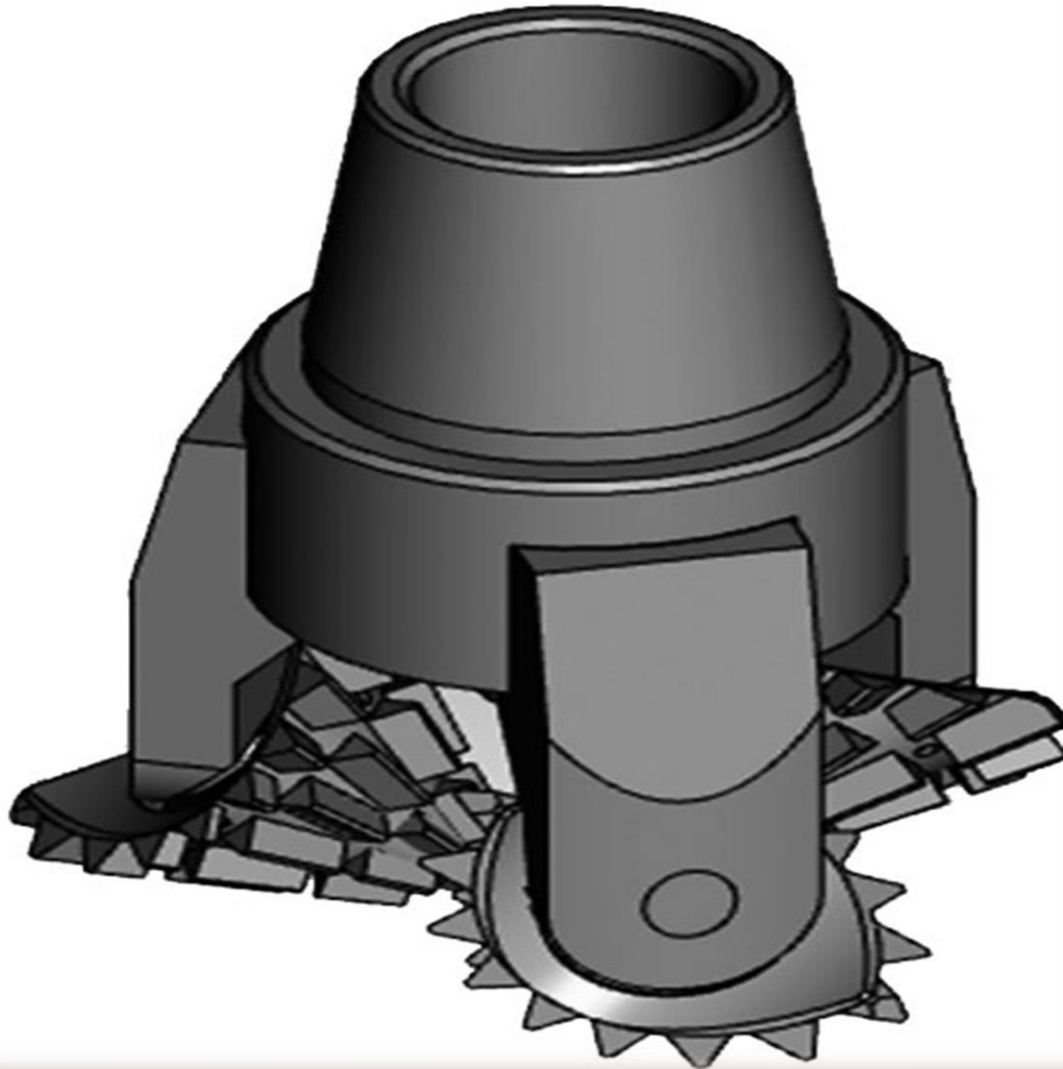
Developed design documentation for production of collapsible roller expander



*Performed power calculations of a bearing unit in the
new drilling tool*



Advanced development of serial Tricone «Drilling tool Bogomolov»



Results

- *There was performed technical justification for the design of drilling tool for square cross-section holes drilling.*
- *There was developed a design documentation for production of double-cone collapsible drilling tool industrial version.*
- *There were developed design solutions for different versions of «Drilling tool Bogomolov» production.*
- *There were registered 8 intellectual property items.*



*Intellectual property of the
project*

Cutting-rolling cutter drill bit

- *Patent: №116563 PΦ*
- *Classification MIIK: E21B 10/14 (2006.01)*
- *Application: №2012101044/03*
- *Date: 01.11.2012*
- *Publication date: 05.27.2012*
- *Bulletin №15 – page 8*
- *Authors: I.D. Bogomolov, M.K. Husnutdinov, O.V. Lyubimov, D.A. Malyshkin, I.P. Golovin*
- *The patentee: Federal state educational institution of higher professional education «Kuzbass state technical University named after T.F. Gorbacheva»*

Drilling tools

- *Patent: №141750 PΦ*
- *Classification MПК: E21B 10/26 (2006.01)*
- *Application: №2014103419/03*
- *Date: 01.31.2014*
- *Publication date: 06.10.2014*
- *Bulletin №16 – page 3*
- *Authors: I.D. Bogomolov, M.K. Husnutdinov, O.V. Lyubimov, D.A. Malyshkin, I.P. Golovin*
- *The patentee: Federal state educational institution of higher professional education «Kuzbass state technical University named after T.F. Gorbacheva»*

Collapsible rolling cutter drilling tool

- *Patent: №141747 PΦ*
- *Classification MПК: E21B 10/28 (2006.01)*
- *Application: №2014103421/03*
- *Date: 01.31.2014*
- *Publication date: 06.10.2014*
- *Bulletin №16 – page 3*
- *Authors: I.D. Bogomolov, M.K. Husnutdinov, O.V. Lyubimov, D.A. Malyshkin*
- *The patentee: Federal state educational institution of higher professional education «Kuzbass state technical University named after T.F. Gorbacheva»*

Collapsible drill bit

- *Patent: №144645 PΦ*
- *Classification MПК: E21B 10/28 (2006.01)*
- *Application: № 2014113590/03*
- *Date: 04.07.2014*
- *Publication date: 08.27.2014*
- *Bulletin №24 – page 3*
- *Authors: I.D. Bogomolov, M.K. Husnutdinov, O.V. Lyubimov, D.A. Malyshkin*
- *The patentee: Federal state educational institution of higher professional education «Kuzbass state technical University named after T.F. Gorbacheva»*

Rolling cutter drilling tool

- *Patent: №2544195 PΦ*
- *Classification MПК: E21B 10/16 (2006.01)*
- *Application: №2014103417/03*
- *Date: 01.31.2014*
- *Publication date: 03.10.2015*
- *Bulletin №7 – page 7*
- *Authors: I.D. Bogomolov, M.K. Husnutdinov, O.V. Lyubimov, D.A. Malyshkin, I.P. Golovin*
- *The patentee: Federal state educational institution of higher professional education «Kuzbass state technical University named after T.F. Gorbacheva»*

Collapsible drilling tools

- *Patent: №2548274 PΦ*
- *Classification MПК: E21B 10/28 (2006.01)*
- *Application: №2014103415/03*
- *Date: 01.31.2014*
- *Publication date: 04.20.2015*
- *Bulletin №11 – page 5*
- *Authors: I.D. Bogomolov, M.K. Husnutdinov, O.V. Lyubimov, D.A. Malyshkin*
- *The patentee: Federal state educational institution of higher professional education «Kuzbass state technical University named after T.F. Gorbacheva»*

Collapsible drill bit

- *Patent: №2549336 PΦ*
- *Classification MПК: E21B 10/28 (2006.01)*
- *Application: №2014113586/03*
- *Date: 04.07.2014*
- *Publication date: 04.27.2015*
- *Bulletin №12 – page 10*
- *Authors: I.D. Bogomolov, M.K. Husnutdinov, O.V. Lyubimov, D.A. Malyshkin*
- *The patentee: Federal state educational institution of higher professional education «Kuzbass state technical University named after T.F. Gorbacheva»*

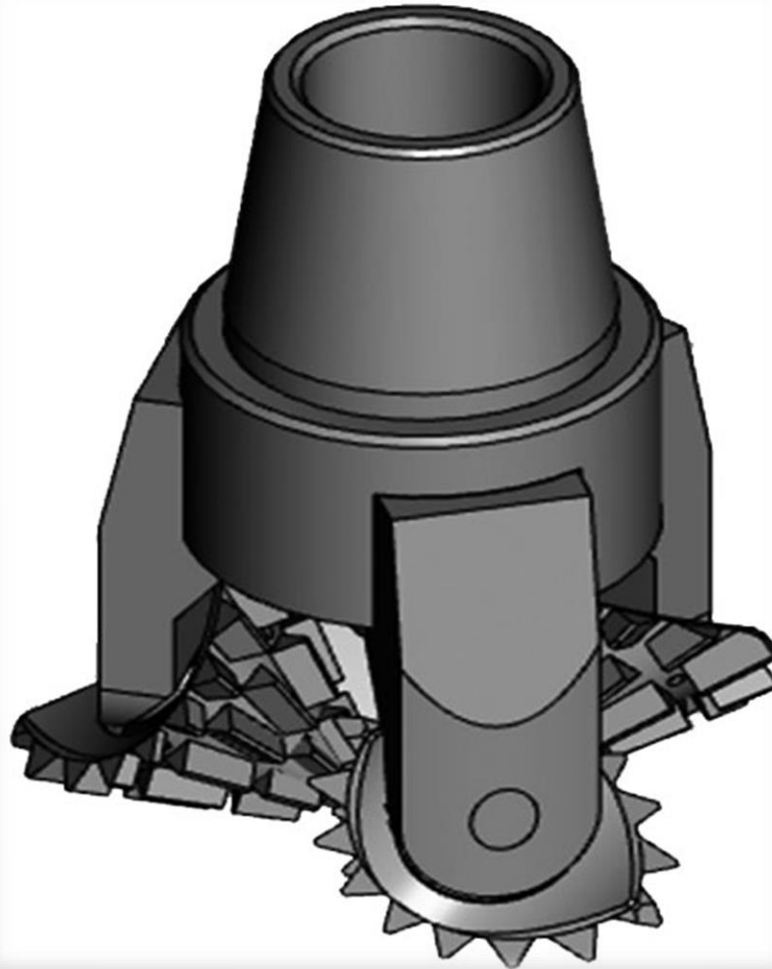
Method of drilling

- *Patent: №2550703 PΦ*
- *Classification MПК: E21B 10/16 (2006.01)*
- *Application: №2014113582/03*
- *Date: 04.07.2014*
- *Publication date: 05.10.2015*
- *Bulletin №13 – page 8*
- *Authors: I.D. Bogomolov, M.K. Husnutdinov, O.V. Lyubimov, D.A. Malyshkin*
- *The patentee: Federal state educational institution of higher professional education «Kuzbass state technical University named after T.F. Gorbacheva»*



Investment proposal

The roller bit is a kind of drilling tools designed for mining rotary drilling machine



The subject area of the project

- *Branch – mechanical engineering;*
- *It specializes in drill bits manufacturing for quarry machines rotary drilling;*
- *The ultimate consumer of the finished product – mining enterprises of the coal industry that carry out opencast mining.*

«Drilling tool Bogomolov»

It is a kind of drilling tools, which you can use to get explosive wells square cross-section

The product range

- *Cutting roller bit for the rock hardness of 6-9 on a Protodyakonov M.M. scale;*
- *Tricone rock bits for the rock hardness of 9-16 on a Protodyakonov M.M. scale;*
- *Dvohsotrichchya dilators for the rock hardness of 9-16 on a Protodyakonov M.M. scale.*

Technical efficiency of «Drilling tool Bogomolov»

- *Increases in the volume of blasted rock mass by 10%;*
- *Increases in the yield of rock mass per one meter of the well by 10%;*
- *Increases the size of the well grid by 10%;*
- *Reduces the consumption of explosives in blasting operations by 10%;*
- *Reduces drilling volumes by 10%.*

Economic efficiency of «Drilling tool Bogomolov»

- *Increases the volume of blasted rock mass by 10%;*
- *Reducing monthly costs on explosives by 10%;*
- *Reduces the cost of drilling and blasting operations by 7%;*
- *Annual economic effect in case of one drilling rig operation is \$138345,86.*

Intellectual property protection

- *There have been registered 8 items of intellectual property;*
- *In the future, during the implementation of the project, all technical developments such as utility models and inventions will be patented.*

Marketing project

- *55% of coal in the world is extracted in by the open way;*
- *4325,6 million tons of coal were mined in the world in an open way in 2012;*
- *251,8 million tons of coal was extracted in the open way on the territory of the Russian Federation in 2014;*
- *60 thousand bits were manufactured in the territory of the Russian Federation, mainly for the domestic market;*
- *\$481 the average cost of a serial bit (size 215.9 mm);*
- *\$962 is an average cost of «Drilling tools Bogomolov»;*
- *\$0,03 billion is the approximate volume of the commercial drilling tool market in the Russian Federation;*
- *\$0,5 billion is the approximate volume of the commercial drilling tool global market.*

Project implementation plan

<i>Stage</i>	<i>Result</i>	<i>Duration of the stage</i>
<i>#1</i>	<ul style="list-style-type: none">- <i>Theoretical and laboratory evaluation of the effectiveness.</i>- <i>Development of the tool design documentation</i>	<i>Completed</i>
<i>#2</i>	<ul style="list-style-type: none">- <i>Production of pilot batch «Drilling tool Bogomolov»</i>- <i>Industrial tests performance</i>- <i>Finalize the design</i>	<i>12 months</i>
<i>#3</i>	<ul style="list-style-type: none">- <i>The development of small-series production of drilling tools</i>- <i>Development of an enhanced product line</i>	<i>12 months</i>
<i>#4</i>	<ul style="list-style-type: none">- <i>Mastering of «Drilling tool Bogomolov» serial production</i>	<i>12 months</i>

Results of stage #1

- *There was performed technical justification for the design of drilling tool for square cross-section holes drilling.*
- *There was developed a design documentation for production of double-cone collapsible drilling tool industrial version.*
- *There were developed design solutions for different versions of «Drilling tool Bogomolov» production.*
- *There were registered 8 intellectual property items.*
- *There was successfully implemented a grant called «УМНИК» during the period from 2012 to 2014.*

Business model

- *The project is possible with the creation of the «Technical innovation of engineering and cents»;*
- *The average number of staff your organization will be 7 employees;*
- *Team to implement the project fully formed.*

Monetization of the project

- *Engineering services;*
- *Licensing of manufacturers developed intellectual property.*

Forecasted market share of «Drilling tool Bogomolov»

<i>#</i>	<i>Name</i>	<i>Units</i>	<i>1 year</i>	<i>2 year</i>	<i>3 year</i>	<i>4 year</i>
<i>1</i>	<i>Russian Federation</i>	<i>%</i>	<i>0,00</i>	<i>1,50</i>	<i>10,00</i>	<i>20,00</i>
<i>2</i>	<i>Global market share</i>	<i>%</i>	<i>0,00</i>	<i>0,10</i>	<i>0,60</i>	<i>1,50</i>

Sales plan (\$)

<i>#</i>	<i>Name</i>	<i>1 year</i>	<i>2 year</i>	<i>3 year</i>	<i>4 year</i>
<i>1</i>	<i>Total income from licensing of products</i>	<i>0</i>	<i>92930</i>	<i>586470</i>	<i>1321800</i>
<i>2</i>	<i>Engineering services</i>	<i>0</i>	<i>45110</i>	<i>45110</i>	<i>45110</i>
	<i>Итого</i>	<i>0</i>	<i>138050</i>	<i>631580</i>	<i>1366920</i>

Investment plan (\$)

<i>#</i>	<i>Name</i>	<i>Stage</i>	<i>Total</i>
<i>1</i>	<i>Staff</i>	<i>2 – 4</i>	<i>292330</i>
<i>2</i>	<i>One-time costs</i>	<i>2</i>	<i>3010</i>
<i>3</i>	<i>Variable costs</i>	<i>2 – 4</i>	<i>191640</i>
<i>4</i>	<i>The cost of prototypes and test</i>	<i>2 - 4</i>	<i>541350</i>
<i>5</i>	<i>Intellectual property and expertise</i>	<i>2 - 4</i>	<i>150380</i>
<i>Total:</i>			<i>1178710</i>

The main technical and economic indicators of the project

<i>#</i>	<i>Name</i>	<i>Units</i>	<i>Value</i>
<i>1</i>	<i>Investments</i>	<i>\$</i>	<i>1178710</i>
<i>2</i>	<i>Sales volume of «Drilling tool Bogomolov» in the world (P)</i>	<i>Pieces per year</i>	<i>27469</i>
<i>3</i>	<i>The fee for the licensing of manufacturers</i>	<i>%</i>	<i>5,00</i>
<i>4</i>	<i>Annual discount rate</i>	<i>%</i>	<i>13,40</i>
<i>5</i>	<i>The net present value (NPV)</i>	<i>\$</i>	<i>118226</i>
<i>6</i>	<i>Discounted payback period (PBP)</i>	<i>год</i>	<i>3,82</i>
<i>7</i>	<i>Internal rate of return (IRR)</i>	<i>%</i>	<i>21,30</i>
<i>8</i>	<i>Rate of return discounted costs (PI)</i>	<i>-</i>	<i>1,18</i>

Results of the project

- *Mining companies will get an innovative tool that will allow to reduce costs in mineral extraction.*
- *Manufacturers will receive a finished product that will have a steady demand.*



Project team

History of the project

- *The project «Drilling tool Bogomolov» was launched in September 2011. The basis for implementation of the project was the design and technical solutions of Igor D. Bogomolov in the field of «Drilling tool for obtaining wells with a non-circular cross-section»*
- *Currently the first phase of the project is successfully completed*

Igor Dmitrievich Bogomolov

Role:

Creator of the concept

Professional achievements:

- *Doctor of technical Sciences*
- *Honored inventor of the Russian Federation*
- *Created and tested a tool for obtaining square section wells for mine workings*



Michael Konstantinovich Khusnutdinov

Role:

Technical project leader

Solved problem:

- *Design*
- *Patenting*
- *Research work*
- *Mathematical modeling*

*Oleg Vladislavovich
Lyubimov*

Role:

Power calculations

Professional achievements:

- *Candidate of technical Sciences*

Solved problem:

- *Design development*
- *Power calculations and modeling of loads on the worker nodes*
- *Research work*

*Dmitry Aleksandrovich
Malyshkin*

Role:

Mathematical modeling

Professional achievements:

- *Candidate of technical Sciences*

Solved problem:

- *Develop design diagrams*
- *Mathematical modeling*
- *Research work*

Igor Petrovich Golovin

Role:

Project Manager

Solved problem:

- *Project management*
- *Business planning*
- *Marketing*
- *Design and technological preparation of production*

Archive of presentations

- *The efficiency of the blast hole with a square cross-section*
- *The economic effect of using a blast hole with a non-circular cross-section*
- *Square cross section wells forming*
- *Development of modifications of the drilling tool for boreholes with a square cross-section*
- *Intellectual property of the project*
- *Investment proposal*
- *Project team*

Publications archive

- *Effective appliance of drilled wells with noncircular cross-sectional area during mine stripping at the open cast*
- *Preconditions for creating and using a tool for blastholes forming at the open cast mining*
- *Drilling tool for stress-raiser well drilling*
- *Appliance and development of drilling tools with noncircular cross-section*
- *Resource-saving drilling tools appliance for noncircular cross-section wells forming*
- *Investment proposal «Drilling tool Bogomolov»*
- *Mining tool for boreholes with square cross-section «Boring tool of Bogomolov»*

*Thank you for your cooperation
and understanding!*

«Drilling tool Bogomolov»

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