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(54) **A method of detaching a monolith from rock massif and a device for application of the method**

(57) A method of detaching a monolith from rock massif, consisting in that, depending on length and volume of the monolith (1) to be detached from rock massif (2) or concrete block (1) to be split, shot holes (3) are drilled in such massif or block with identical diameter d = 25-75 mm, identical distance between holes c = 10-25 cm, identical distance e = 10-15 cm of the outermost holes (4) from the edges (5 and 6) of the main massif (2) and identical distance k = 10-20 cm from lower plane (7) of the monolith (1) to be detached. Next, depending on the diameter (d) and number of holes (3), prepared is the same number of identical gas-generating devices (8) having casings, made preferably of polyethylene, adapted to diameter and height of the holes and equipped with initiating device (11) provided with pyrotechnic igniter (16) equipped with electric wires (17) that is surrounded

with binary mixture (12) containing 88-105 parts by weight of sodium chlorate (NaClO_3) and 0.8-1.5 parts by weight of iron oxide, functioning as a catalyst of burning. Further, 7.8-13.5 parts by weight of fuel oil (19) for diesel engines is injected into the mixture by means of any commonly known method and the so prepared and tightly closed gas-generating devices (8') are placed, depending on height (H) of the shot holes (3), in at least one row on bottoms of the holes in such a way that their electric wires (17) protrude above the surface of the monolith to be detached, and further the commonly known operations are performed related to sealing the holes by means of clay, sand, or their mixture and igniting said ternary mixture initiated by initiating devices (11) and generating heat and gas with pressure amounting to 95-105 MPa resulting in detachment of monolith (1) from rock massif (2) or avalanche massif or splitting a concrete block (1).

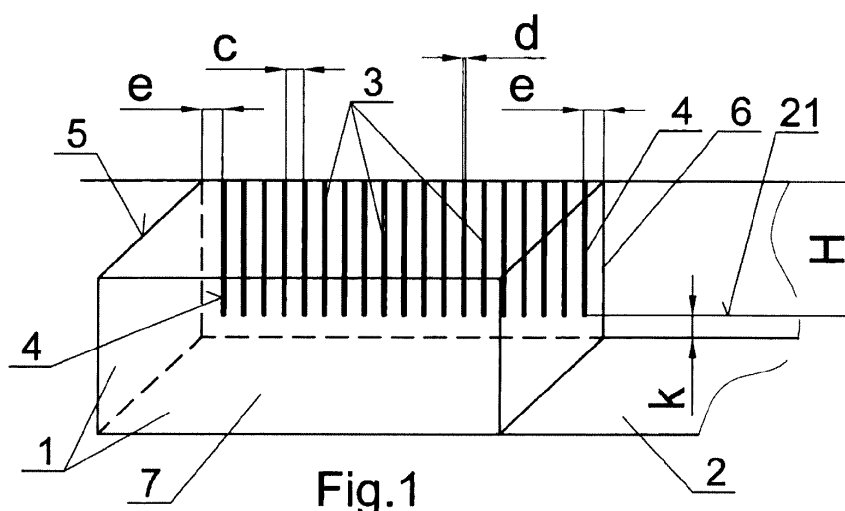


Fig. 1

Description

[0001] The subject of the present invention is a method of detaching a monolith from rock massif with diverse compactness and dividing monoliths into sections and blocks, especially in seismically sensitive regions, as well as splitting concrete blocks, and a gas-generating device for application of the method, designed mainly to be used in work related to preparation of investment in seismically sensitive regions, especially in liquidation of effects of cavings, landslides, mudslides, and effects of extraordinary events caused by e.g. an earthquake, or loosening rocks as a result of roadwork excavations made in close vicinity of building structures.

[0002] To date, the engineering works carried out in relation with preparation of land for an investment require execution of land leveling, making excavations or profiling escarpments, whereas the work must be frequently carried out in hard soils or in rocks. Using machines for winning such land is very difficult, and often impossible in view of both hardness of the winning and location of such work, especially in the case of demolition of rock embankments or profiling roadside batters on steep slopes. Therefore, in many cases such work is carried out with the use of shooting in order to loosen the soil or rock medium by means of shot-firing charges of explosives to obtain the assumed profile of escarpment, liquidation of rock blocks with large dimensions, or liquidation of rockslides occurring as a result of earth slide or rockfall. A difficult problem is also related to winning rocks aimed at obtaining stone material in the form of blocks, as in this case detonation of explosive in any environment generates, apart from positive results including fragmentation of the rock, also numerous negative phenomena and effects such as:

- generation of vibrations of the ground excited with detonation;
- creation of air shock wave;
- creation of micro-cracks, damage of the stone block in the course of machining and thus occurrence of material loss;
- hazard related to scattered fragments of the worked rock;
- creation of artificial fissures or micro-cracks.

[0003] Therefore, execution of such works in regions with limited interaction of paraseismic waves the source of which can consist in detonation of typical explosive charges and materials, is subject to substantial limitations which is caused, among other things, by the fact that action of these charges is characterized with high velocity.

[0004] Known is the method of extracting slab stone consisting in drilling shot holes in rock, locating in such holes properly prepared charges of explosive materials provided with means causing their ignition and slow combustion at increasing pressure, resulting in generation of

gas and chipping rock blocks off the rock massif. In this method, the used explosives include charges made based on fulminating mercury (mercury fulminate) and lead nitride, and in the case of a stretch-type action, charges made based on penthrite, trinitrotoluene, and ammonium nitrate are used, however these are materials showing low resistance to humidity and temperature which results in significant degradation their shooting properties.

[0005] Known are also devices for detaching rock blocks, containing explosive liquids based on ammonium nitrate, nitroesters with various additives, gun powder, and detonating fuse (Shukin Ju. G. et al. in "Industrial explosive substances based on recycled ammunition", OSA "Nedra" Publishing House, Russia, M. 1998 pp. 54-62).

[0006] Further, known from Ukrainian patent description No. UA13373 is the method of chipping off rock blocks or artificial construction objects that consists in drilling shot holes in rock or artificial construction objects, preparation of charges equipped with means initiating ignition, installing the equipped charges in shot holes, connecting the means initiating ignition with the device starting ignition of the charges, activation of the means initiating ignition with further deflagration of the charges resulting in chipping off the rock block with simultaneous movement of the block along its lower surface in the course of generation of gases as a result of combustion of the chemical compound of the charge in the closed space of shot holes. In the method, shot holes designed for installing properly equipped charges have length of at least 0.8 m, and the charges are located on the bottom of each of the holes and situated at equal distances from each other or in parallel in several rows at one level, whereas in the holes placed is a gas-generating ternary chemical mixture composed of crystalline oxidizer, a liquid mixture of hydrocarbons, and powdered modifier of the slow burning process (deflagration), and thereafter the means causing ignition are installed and connected by means of electric circuits with a device initiating detonation of the charge, resulting in ignition of the mixture. Further, the shot holes instrumented this way are sealed from the top side with a layer of sand and clay or other material allowing to close the holes tightly, after which the ternary charge is ignited and burned at increasing pressure leading to detonation of said shot holes and generation of large amounts of gases along the walls of the shot holes and chipping off the rock or artificial construction objects along the whole surface of the released shot holes. This allows for effective extraction of slab stone from rock or demolishing artificial construction objects not allowing to origination of micro-cracks or partial fracturing of stone both in the block chipped off and in the whole massif.

[0007] Also, known from Ukrainian patent description No. UA 13372 is a device for chipping off rock or demolishing artificial construction objects comprising a polymer cylindrical casing closed with plugs on both sides with

ternary chemical mixture places inside capable to produce gases with high temperature and pressure under the influence of external factors, and moreover comprising the means initiating ignition of the mixture, having direct contact with said mixture and connected with a source of direct electric current by means of electric wires, whereas the chemical mixture contains a crystalline oxidant, liquid mixture of hydrocarbons, and powder modifier of the burning process in proportions as (69.99-89.99) : (30- 10) : (001) .

[0008] The objective of the present invention is to develop such a method for detaching a monolith from rock massif with diverse compactness and in different geological conditions characterizing the massif and dividing the monolith into sections and blocks that would allow for detaching and dividing with omitting both the process of detonation of chemical charges in drilled holes and generation of the deflagration occurring at high linear velocity by the charges. A further objective of the invention is to develop a simple and compact design of the device for application of the above method, provided with a technical means allowing to ignite quickly the surrounding chemical mixture generating gas with pressure amounting to about 100 MPa that would ensure absolute safety in the course of its storage and transport. Further, the technical problem that required to be solved consisted in developing such compatible composition of ternary chemical mixture that would not show the tendency to deflagration and evolution of the mixture combustion into detonation (explosion), and having high sensitivity to the mixture burning initiation impulse without evolving of said burning into the deflagration process.

[0009] According to the invention, the method of detaching a monolith from rock massif with diverse compactness and separating monoliths into sections and blocks, especially in seismically sensitive regions, as well as splitting concrete blocks, consists in that depending on length and volume of monolith to be detached from rock massif or concrete block, shot holes are drilled in them with identical diameter ranging from 25 mm to 75 mm, identical distance between them ranging from 10 cm to 25 cm, identical distance of the outermost holes from the main massif edge ranging from 10 cm to 15 cm, and identical distance from lower plane of the monolith to be detached ranging from 10 to 20 cm, after which, depending on diameter and number of the drilled holes, the same number is prepared of identical gas-generating devices having their casings, made preferably of polyethylene, adapted to diameter and height of the holes. The devices are equipped with initiating device provided with pyrotechnic igniter equipped with electric wires, with said igniter being surrounded with a binary mixture containing 88-105 parts by weight of sodium chlorate (NaClO_3) and 0.8-1.5 parts by weight of iron oxide functioning as a catalyst of burning, and then, 7.8-13.5 parts by weight of fuel oil for diesel engines is injected to the mixture using any commonly known method. The gas-generating devices prepared this way and tightly closed

are placed, depending on height of shot holes, in at least one row on bottoms of the holes so that their electric wires protrude over surface of the monolith to be detached, and then further commonly known operations are carried out relating to sealing the holes with clay, sand, or mixture of clay and sand, and ignition of the ternary mixture initiated by initiating devices, generating heat and gas with pressure amounting to 95-105 MPa, causing detachment of monolith from rock massif or avalanche massif or splitting the concrete block. The density of the ternary mixture is favorably 2.0-2.5 g/cm³, and depending on mass of sodium chlorate contained in the ternary mixture of the gas-generating device designed to be located in the drilled hole, the time of saturating the binary mixture with fuel oil is 30-90 minutes. It is also preferable that in order to detach a monolith from the rock massif, the gas-generating device contains 60-120 g/m³ of ternary chemical mixture per each cubic meter of the winning depending on its type, preferably 100 g per m³ of the winning. Moreover, according to the invention, depending on type and volume of the detached massif, holes are drilled with height of 0.7-5 m, and gas-generating devices are located at one, two, or three levels, preferably at the same distance with respect to each other.

[0010] Further, the essence of the gas-generating device to be used for detaching monolith from rock massif with diverse compactness and separating monoliths into sections and blocks, used especially in seismically sensitive regions, as well as for splitting concrete blocks, consists in that in the course of storage and transport, the device has in its polymer casing a coaxially placed initiating device provided with pyrotechnic igniter surrounded along the whole of its length with binary chemical mixture containing preferably 88- 105 parts by weight of sodium chlorate (NaClO_3) and 0.8- 1.5 parts by weight of iron oxide (Fe_2O_3), and further, the device is accompanied by a loosely attached container filled with fuel oil for diesel engines constituting the third component of the mixture in the amount of 7.8- 13.5 parts by weight of the total mass of this ternary chemical mixture.

[0011] On the other hand, in the state designed to start operation of the device, its initiating device is surrounded with ternary chemical mixture containing sodium chlorate, iron oxide, and oil for diesel engines in the weight proportion as (88- 105) : (0.8- 1.5) : (7.8- 13.5), whereas the initiating device is made of elastic tape provided with longitudinally cotton threads situated on it, saturated with flammable substance and connected on one end with pyrotechnic igniter provided with electric wires protruding outside, whereas the tape is rolled into the form of an inseparable sleeve. The component completing the binary mixture composed of sodium chlorate (NaClO_3) and iron oxide (Fe_2O_3) is preferably the petroleum.

[0012] The conducted derivatographic experiments proved that injection of fuel oil or petroleum into the mixture of sodium chlorate and iron oxide does not influence thermal decomposition of sodium chlorate in the temper-

ature range of up to 220°C, which confirms compatibility of the components. Placing the mixture in a casing made of a thermoplastic material does not result in explosion initiated by the pyrotechnic igniter which means that it does not operate in the detonation mode, and the mixture of these components does not show the tendency to transition from combustion to explosion.

[0013] Further advantages of the method and the device according to the invention include the fact that application thereof in variable geological conditions, especially in seismically sensitive regions, on landslides, and in densely developed areas allows to eliminate entirely such flaws of processes used in the prior art as:

- generation of air shock wave;
- hazard related to scattering of rock chips;
- generation of waves excited by detonation;
- creation of artificial fissures and micro-cracks.

[0014] In fact, application of the method and device according to the invention causes the increasing gas pressure generated from combustion of intentionally composed ternary chemical mixture and amounting to about 100 MPa which results in cracking and breaking the rock medium along the straight line connecting the drilled shot holes, and the excess of the pressure throws aside a definite volume of the rock material without allowing fragments to be scattered. Actually, pressure obtained from gas-generating devices according to the invention reaches much less values than in processes used according to the prior art, which results in reduction of the stone cracking zone, less scattering of fragments, and significant decrease or elimination of interaction of paraseismic waves inducing vibrations of building structures. Further, application of the initiating device rolled out of a tape provided with cotton threads situated along the whole length of the device and saturated with a flammable material in the gas-generating devices allowed for fast ignition of the ternary chemical mixture surrounding the initiating device and thus for significant reduction of its operating time. Moreover, a simple design of the device has facilitated significantly the process of its fabrication and allowed to reduce the manufacturing costs.

[0015] The use of iron oxide in the gas-generating device as one of the three components of the chemical mixture as the catalyst of burning of the mixture and the use of cotton threads in the initiating device, resulted in significant increase of the combustion rate of the mixture and improvement of safety of work with the device, as after completion of separation of the detached massif, pressure of the gas generated as a result of combustion of the mixture instantaneously decreases. Moreover, introducing the fuel oil or petroleum to the chemical mixture as its third component directly before placing the gas-generating devices in the drilled shot holes eliminated the hazard of igniting the devices in the course of both storage and transport.

[0016] The performed tests and experiments proved

that application of the method and the device allows to eliminate hazards related to cavings, effects of landslides, effects of mudslides, and harmful erosive action of rivers and streams, liquidation of effects of earthquakes, elimination or reconstruction of reinforced concrete or concrete structures, as well as to carry out excavation works in vicinity of buildings and prepare investment plans in seismically sensitive regions.

[0017] The subject of the invention is more closely explained in example embodiments and in figures, of which Fig. 1 shows an outline of a rock massif with shot holes drilled in it in the perspective view; Fig. 2 - an outline of a rock massif with shot holes drilled in it and gas-generating devices placed in the holes at one level on bottoms of the holes in the perspective view; Fig. 3 - an outline of a rock massif with shot holes drilled in it and gas-generating devices placed in the holes at two levels in the perspective view; Fig. 4 - an outline of a rock massif with shot holes drilled in it and gas-generating devices placed in the holes at three levels in the perspective view; Fig. 5 - the gas-generating device in the form of cylindrical sleeve closed tightly on both ends by means of plugs in axial cross-section designed for storage and transport; Fig. 6 - the gas-generating device in the form of a cylinder provided with bottom, closed on the opposite side tightly with a plug in axial cross-section, also designed for storage and transport; Fig. 7 - the device initiating ignition of the ternary chemical mixture and constituting equipment of both gas-generating devices, in the developed state with its inner surface visible; and Fig. 8 - the container constituting additional equipment of gas-generating devices shown in Figs. 5 and 6 containing fuel for diesel engines making the third component of the chemical mixture contained in the device.

Example 1

[0018] In the massif to be detached (1) from the main massif (2), holes (3) with height $H = 700$ mm and diameter $d = 30$ mm have been drilled with the use of commonly known drilling equipment, with the distance between the holes $c = 10$ cm, the distance of the outermost holes (4) from edges (5 and 6) of the main massif $e = 10$ cm and at a distance $k = 10$ cm from the lower plane (7) of the detached massif (1). Next, after opening plugs (10) of the gas-generating devices (8) having their casings made of polyethylene with diameter $s = 25$ mm, equipped with initiating device (11) surrounded with binary chemical mixture (12) containing 89% by weight of sodium chlorate (NaClO_3) and 1.0% by weight of iron oxide functioning as a catalyst of burning, 10% by weight of fuel oil for diesel engines was injected to the mixture so that the mass of the mixture amounted to 100 g per each cubic meter of the rock to be detached. After completion of uniform distribution of the fuel inside the binary mixture and obtaining the ternary mixture with proportions as 89 : 1 : 10, which lasted about 30 minutes, the gas-generating device (8) was closed tightly with plugs (10). The gas-

generating device (8') prepared this way was placed at the same level (21) on bottoms of drilled holes (3) so that the electric wires (17) of initiating devices (11) protruded outside the holes, and the holes were filled and sealed with damp clay-sand mass (24). Next, the electric wires were connected by means of the commonly known method with a source of electric current, as a result of which the pyrotechnic igniters (16) gas-generating devices (8') were activated that by means of their initiating devices (11) caused initiation of burning of the ternary chemical mixture (12') contained in these devices, generation of heat, and instantaneous burning of this ternary mixture that in the process of burning was transformed into gas with pressure amounting to 95 MPa that as a result of acting of so high pressure, transformed the sand with clay (24) placed in holes (3) into a very hard substance that prevented the gas from getting out from these holes. As a result of such blocking, the gas started to act along the whole length and width of the detached massif (1) along the line connecting drilled holes (3) resulting, as a consequence, in breaking the massif off from the main massif (2), and the excess pressure resulted in moving the detached massif away by a distance of about 20 cm, whereas as a result of parallel orientation of the gas-generating devices in this detached massif, its surfaces after detaching had appearance similar to this obtained by cutting with a diamond saw. As a result of action of that type it was found that spread of rock fragments was significantly less than observed in similar phenomena generated by charges known from the prior art. Further, it was found that pressure and impulse generated by the detonation were much higher and depended on the detonation development velocity and that the pressure in the explosive detonation wave front could be described by means of the relationship

$$p = \rho \times D^2/8$$

where ρ denotes the density of the explosive that in the case of the used ternary mixture was 2.35 g/cm³, and D denotes the detonation velocity in m/s.

[0019] It follows from the above relationship that the pressure obtained from gas-generating devices reaches lower values compared to the methods known in the prior art, which results in reduction of the cracking zone, minimized spread of rock fragments, and significantly weaker action of paraseismic waves inducing vibrations of building structures.

Example 2

[0020] In the massif to be detached (1) from the rock massif (2), holes (3) with height $H = 2.20$ m and diameter $d = 35$ mm were drilled with the use of commonly known drilling equipment, with the distance between the holes $c = 18$ cm, the distance of the outermost holes (4) from

edges (5 and 6) of the main massif $e = 12$ cm, and at distance $k = 15$ cm from the lower plane (7) of the detached massif (1). Next, after opening plugs (10) in gas-generating devices (8) having their casings made of a polymer plastic with diameter $s = 30$ mm, equipped with initiating device (11) surrounded with binary chemical mixture (12) containing 88% by weight of sodium chlorate (NaClO_3) and 0.8% by weight of iron oxide functioning as a catalyst of burning, 11.2% by weight of fuel oil contained in a separate container (18) was injected into the mixture so that the mass of the mixture amounted to 100 g per each cubic meter of the rock massif to be detached. After completion of uniform distribution of the fuel inside the binary mixture (12) and obtaining ternary mixture (12') in the proportion as 88 : 0.8 : 12, which lasted about 45 minutes, gas-generating devices (8') were closed tightly with plugs (10), and then the devices prepared this way were placed at the same lower level (21), i.e. on bottoms of all of the holes (3). Next, the holes were filled with damp sealing clay mass (24), and the mass was compacted so that it filled holes up to height (H_1) making about a half of their total height (H), and on the compacted mass in every second hole (3) identical gas-generating devices (8') were placed so that they were at the same level (22), whereas all electric wires (17) of initiating devices (11) were led out over the outer surface of the detached massif (1), and upper ends of the holes at height (H_2) were filled and compacted with the same damp clay mass (24). Next, the electric wires (17) were connected by means of the commonly known method with a source of electric current, as a result of which the pyrotechnic igniters (16) of the gas-generating devices (8') were activated resulting in further detaching action analogous to this presented in Example 1, whereas in this case the process of combustion of the ternary chemical mixture (12') resulted in its transformation into gas pressure of which amounted to 105 MPa.

Example 3

[0021] In the massif to be detached (1) from concrete block (2), by means of commonly known drilling devices holes (3) were drilled with height $H = 4.50$ m, diameter $d = 40$ mm, with spaces between them amounting to $c = 25$ cm, and with distance of the outermost holes (4) from the edges (5 and 6) of the concrete block $e = 15$ cm and at distance $k = 20$ cm from lower plane (7) of the massif. Next, after opening plugs (10) in gas-generating devices (8) having their casings with diameter $s = 35$ mm made of a thermoplastic material and equipped with initiating device (11) surrounded with binary chemical mixture (12) containing 105 parts by weight of sodium chlorate (NaClO_3) and 1.5 parts by weight of iron oxide acting as a burning catalyst, 13.5 parts by weight of oil fuel contained in separate container (18) was injected into the mixture. After completion of uniform distribution of the fuel inside the binary mixture (12) and obtaining ternary mixture (12') in proportion as 105 : 1.5 : 13.5, which last-

ed about 60 minutes, gas-generating devices (8') were closed tightly with plugs (10), and then the devices prepared this way were placed at the same lower level (21), i.e. on bottoms of all holes (3). Next, the holes were filled with damp sand-clay mass (24) and the mass tightly compacted at height (H1) equaling about 1/3 of the whole height (H) of the holes, and then in an analogous way further gas-generating devices (8) were prepared but filled with binary chemical mixture (12) containing 90 parts by weight of sodium chlorate (NaClO_3), 1.0 part by weight of iron oxide, and to this mixture 9 parts by weight of fuel oil were injected. After the fuel being evenly distributed within the binary mixture (12) and the ternary chemical mixture (12') obtained in proportions as 90 : 1 : 9, which lasted about 40 minutes, gas-generating devices (8') prepared this way were tightly closed with plugs (10), and then placed at the second level (22) made of compacted sand-clay mass (24) and filled up to the height (H2) of holes (3) with the same damp sand-clay mass (24) tightly compacted and creating the same level (23) on which further analogous gas-generating devices (8') were placed as those at the level (22), and the holes were also completely filled with the same damp sealing mass (24) up to the whole remaining height (H3) of holes (3) making also about 1/3 of their whole height (H), whereas all electric wires (17) of initiating devices (11) were led out over the external surface of the detached block (1). Next, electric wires (17) were connected by means of the commonly known method with a source of electric current, as a result of which the pyrotechnic igniters (16) of gas-generating devices (8') resulting in further detaching action analogous to this described in Example 1, whereas in this case the process of burning of the ternary mixture (12') resulted in its transformation into gas pressure of which amounted to 100 MPa.

Example 4

A gas-generating device (8) designed only for storage and transport

[0022] The gas-generating device comprises a sleeve casing (9) with diameter of 25 mm made of polyethylene, closed tightly on both sides with plugs (10) also made of polyethylene, the initiating device (11) located concentrically in said casing (11), and the binary chemical mixture (12) surrounding said device composed of 89 g of sodium chlorate (NaClO_3) and 1.0 g of iron oxide (Fe_2O_3), functioning as a catalyst of burning, whereas the initiating device constitutes an elastic tape (13) rolled into a form of a sleeve and having on its surface (14) longitudinally situated cotton threads (15) saturated with flammable material, connected with pyrotechnic igniter (16) provided with electric wires (17) used for connecting the device to a source of electric current, not shown in the figure, whereas ends of the elastic tape (13) rolled into a sleeve are permanently glued to each other. Moreover, equipment of this device includes a loosely attached container

(18) containing fuel oil (19) for diesel engines or petroleum.

Example 5

A gas-generating device (8') designed to be placed in a shot hole

[0023] It constitutes the device (8) construction of which was described in Example 4, and a ternary chemical mixture (12') composed of 89 g of sodium chlorate (NaClO_3), 1.0 g of iron oxide, and 10 g of oil for diesel engines (19) injected into them from container (18).

Example 6

[0024] The gas-generating device (8) comprises the monolithic cylindrical casing (20) with bottom (20') closed tightly on one end by means of plug (10) which is also made of polyethylene, the initiating device (11) located concentrically in said casing, and the binary chemical mixture (12) surrounding said device and composed of 88 g of sodium chlorate (NaClO_3) and 0.8 g of iron oxide (Fe_2O_3), whereas the initiating device (11) has design identical to this described in Example 4, whereas an integral part of device is the container (18) containing fuel oil (19) that immediately before placing the device in drilled hole (3) is being injected, in amount of 11.2 g, into the device in order to complete the binary mixture contained therein, thus creating ternary mixture in proportion as 88 : 0.8 : 11.2.

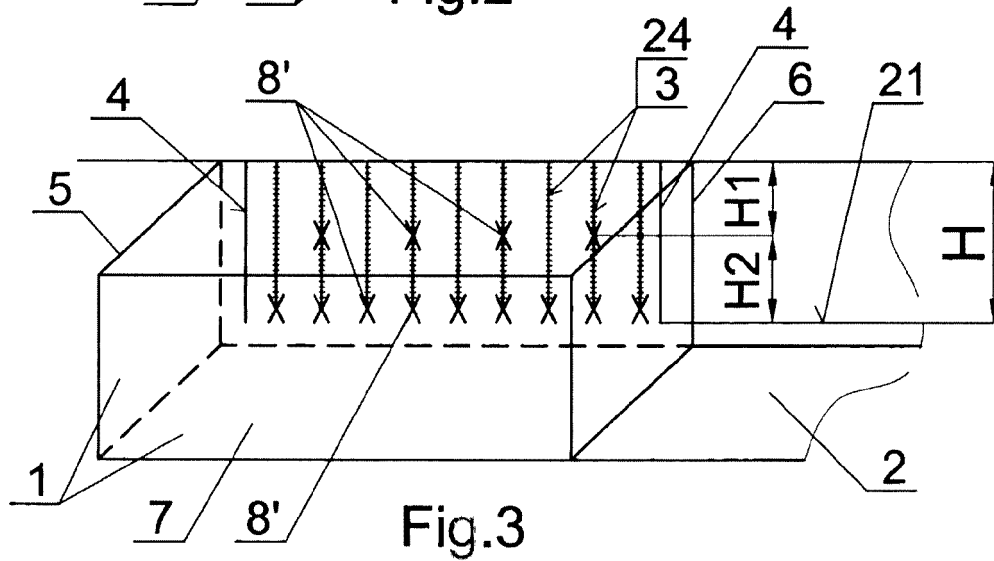
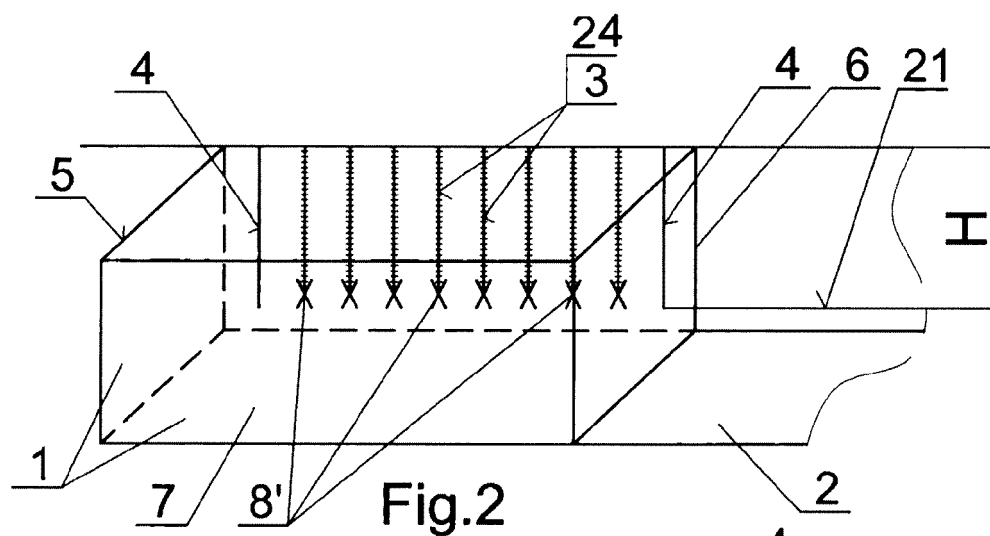
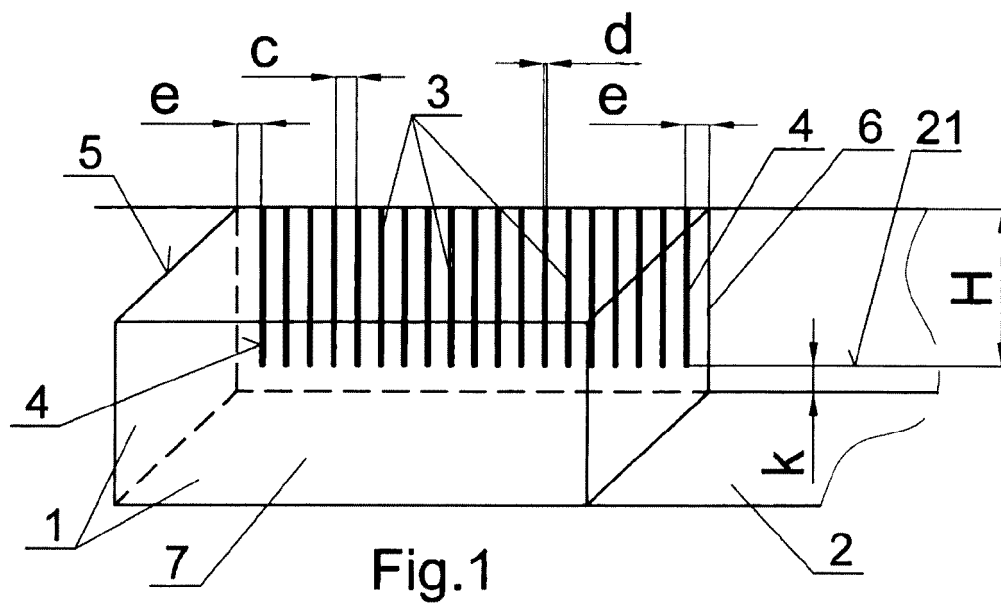
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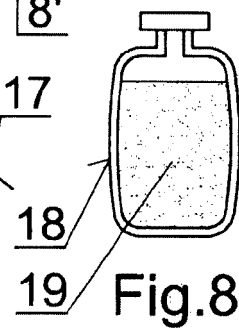
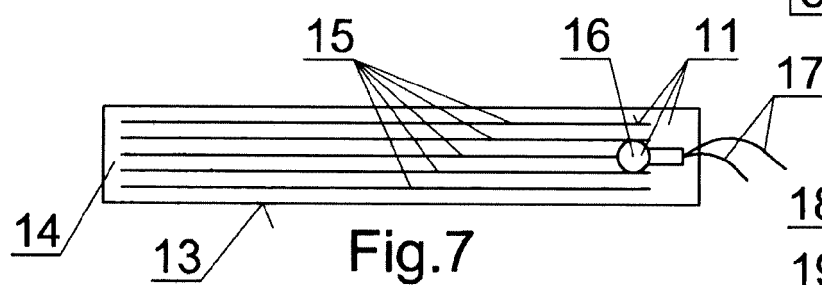
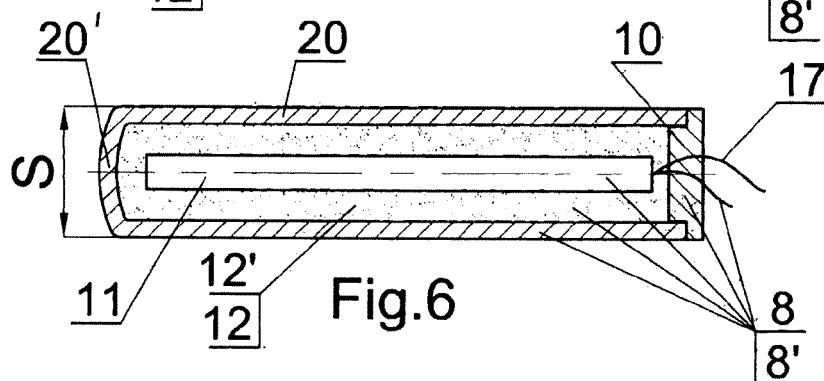
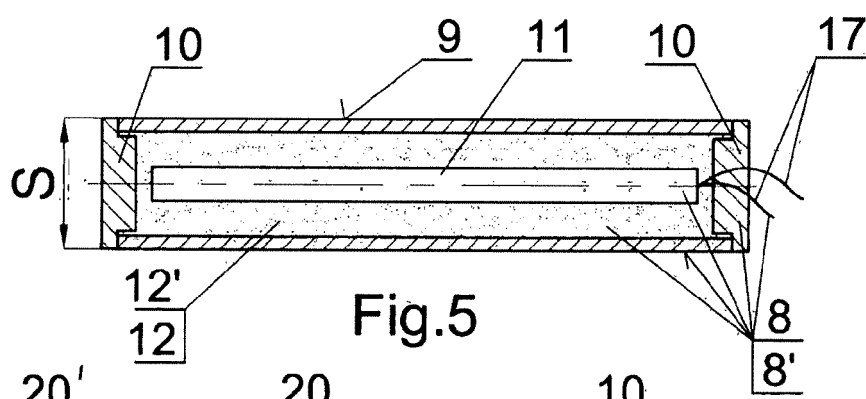
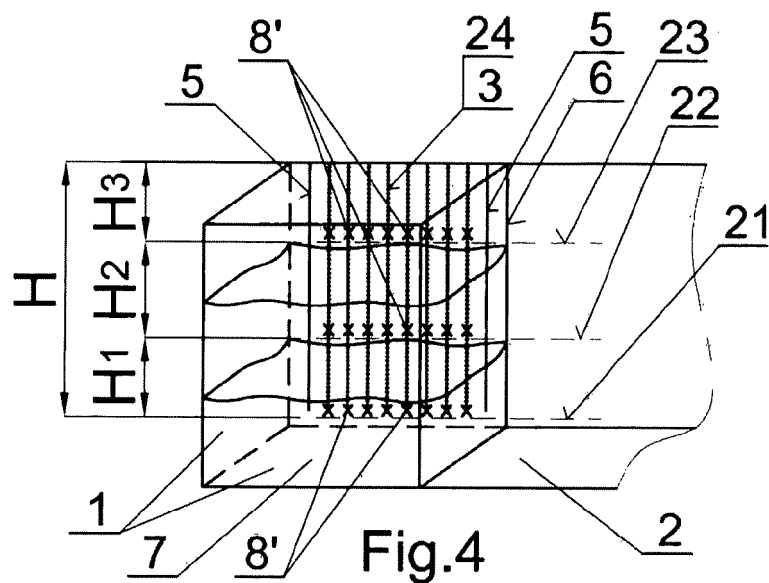
[0025] Also, gas-generating devices (8') were constructed designed for placing them in drilled shot holes (3), with their construction analogous to this described in Example 4, but with different chemical compositions of the ternary mixture, namely containing: 91 g of technically pure sodium chlorate, 1.2 g of iron oxide, and 7.8 g of oil fuel in overall proportion as 91 : 1.2 : 7.8

Claims

1. A method of detaching monoliths from a rock massif with diverse compactness and separating monoliths into sections and blocks, especially in seismically sensitive regions, as well as splitting concrete blocks, consisting in drilling shot holes in such massif or concrete block positioned in a single row and having the same depth or positioned in several rows at the same level, preparing charges equipped with means causing ignition of these charges, installing said charges in said holes and sealing the holes with clay, sand, or their mixture, connecting said means causing ignition of said charges and their burning as a result of which the monolith is split off from the rock

- massif **characterized in that** depending on length and volume of the monolith (1) to be detached from the rock massif (2) or the concrete block (1), shot holes (3) are drilled in said monolith or block with identical diameter $d = 25-75$ mm, identical distance between them $c = 10-25$ cm, identical distance $e = 10-15$ cm of the outermost holes (4) from edges (5 and 6) of the main massif (2), and identical distance $k = 10-20$ cm from lower plane (7) of the monolith (1) to be detached, whereas depending on diameter (d) of holes (3) and their number, the same number is prepared of identical gas-generating devices (8) having their casings, made preferably of polyethylene, adapted to diameter and height of the holes and equipped with initiating device (11) provided with pyrotechnic igniter (16) equipped with electric wires (17), that is surrounded with binary mixture (12) containing 88-105 parts by weight of sodium chlorate (NaClO_3) and 0.8-1.5 parts by weight of iron oxide functioning as a catalyst of burning, and thereafter 7.8-13.5 parts by weight of fuel oil for diesel engines (19) are injected to the mixture by means of any commonly known method and the so prepared and tightly closed gas-generating devices (8') are placed, depending on height (H) of shot holes (3), in at least one row on bottoms of the holes in such a way that electric wires (17) protrude over the surface of the monolith to be detached, and further the commonly known operations are performed related to sealing the holes by means of clay, sand, or their mixture and igniting said ternary mixture initiated by initiating devices (11) generating heat and gas with pressure amounting to 95-105 MPa and causing detachment of monolith (1) from rock massif (2) or avalanche massif or splitting the concrete block (1).
2. The method according to claim 1 **characterized in that** the density of the ternary mixture (12') should be $2.0-2.5 \text{ g/cm}^3$.
 3. The method according to claim 1 **characterized in that** depending on mass of sodium chlorate contained in the ternary mixture, the time of saturating the binary mixture of the gas-generating device (8) with diesel oil is 30-90 minutes.
 4. The method according to claim 1 **characterized in that** for detaching monolith (1) from rock massif (2) the gas-generating device should contain 60-120 g of the ternary chemical mixture per one cubic meter of the obtained material depending on its type, preferably 100 g per each cubic meter of the obtained material.
 5. The method according to claim 1 **characterized in that** depending of the type and volume of the detached massif (1), holes with height $H = 0.7-5$ m are drilled, and gas-generating devices (8') are placed on one, two, or three levels (21, 22, and 23).
 6. A gas-generating device for detaching monolith from rock massif with diverse compactness and separating monoliths into sections and blocks, to be used especially in seismically sensitive regions, as well for splitting concrete blocks, comprising a cylindrical casing made of a polymer and closed tightly on both sides by means of plugs, with the flammable chemical mixture placed in the casing and generating, as a result of combustion, gases with high temperature, with such mixture remaining in direct contact with the means initiating its ignition **characterized in that** during the time of its storage and transport, in its polymer casing (9) there is an initiating device (11) located axially, provided with pyrotechnic igniter and surrounded along the whole of its length with binary chemical mixture containing preferably 88-105 parts by weight of sodium chlorate (NaClO_3) and 0.8-1.5 parts by weight of iron oxide (Fe_2O_3), and the device is accompanied by a loosely attached container (18) containing fuel oil (19) for diesel engines constituting the third component of the chemical mixture in amount of 7.8-13.5 parts by weight of the total mass of the ternary chemical mixture (12').
 7. The device according to claim 6 **characterized in that** in the state designed for initiation of its operation, the initiating device (11) constituting its equipment is surrounded with ternary chemical mixture (12') containing sodium chlorate, iron oxide, and fuel oil (19) for diesel engines in the weight ratio with respect to the overall mass representing the proportion as (88- 105) : (0.8- 1.5) : (7.8- 13.5) ;
 8. The device according to claim 6 **characterized in that** its initiating device (11) is an elastic tape (13) provided with cotton threads (15) situated longitudinally on the tape, saturated with flammable substance, and connected on one end to the pyrotechnic igniter (16) provided with electric wires (17) protruding outside, whereas the tape is rolled into the form of an inseparable sleeve.
 9. The device according to claim 6 **characterized in that** the component completing the binary mixture composed of sodium chlorate (NaClO_3) and iron oxide (Fe_2O_3) is petroleum.





REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- UA 13373 [0006]
- UA 13372 [0007]

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- **SHUKIN JU. G. et al.** Industrial explosive substances based on recycled ammunition. Publishing House, 1998, 54-62 [0005]