

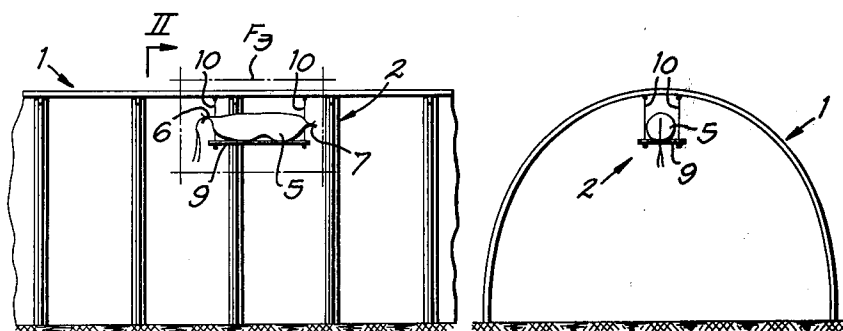


Fig. 1

Fig. 2

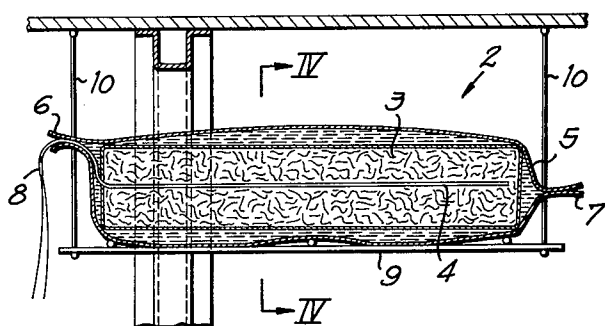


Fig.3

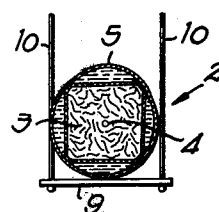


Fig. 4

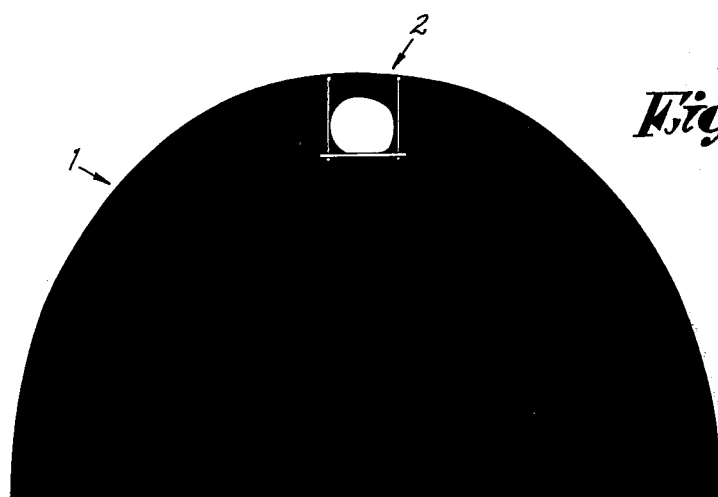


Fig. 5

Fig. 6



Fig. 7



Fig. 8

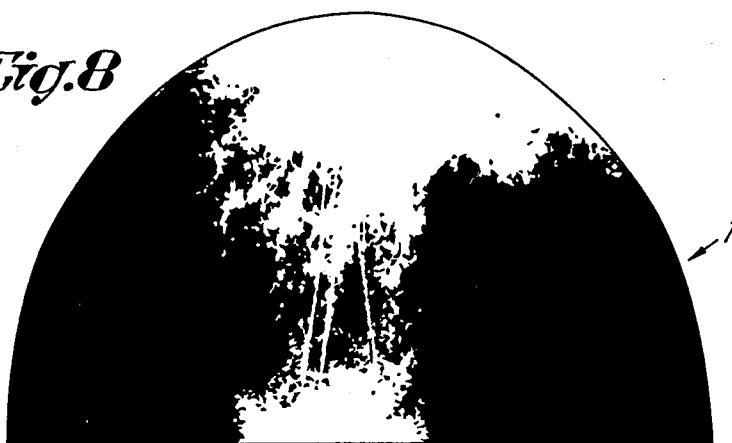


Fig. 9

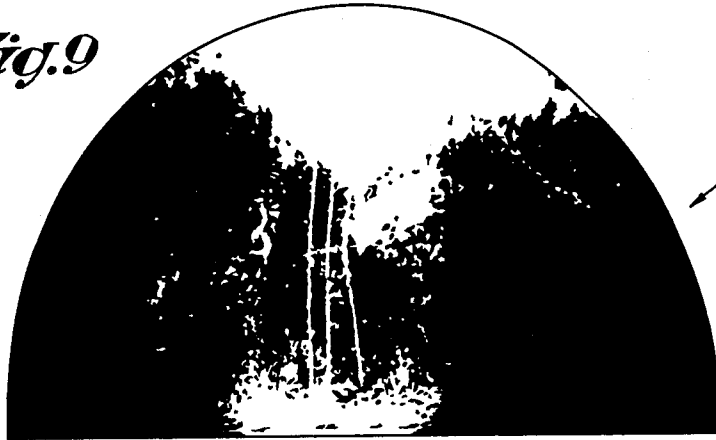


Fig. 10

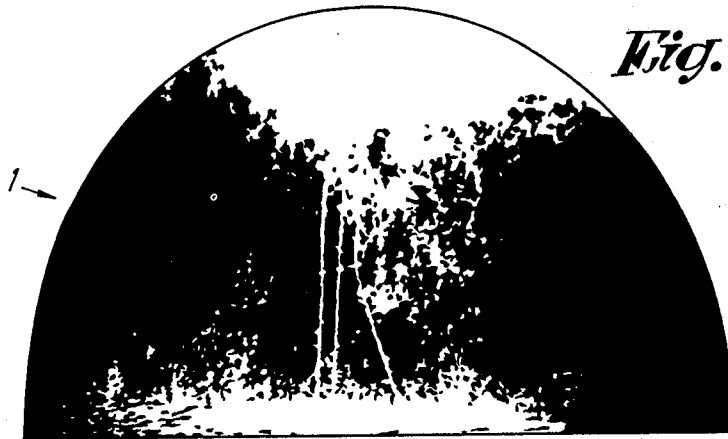


Fig. 11



PROCESS AND DEVICE FOR CREATING TRIGGERED STOP BARRIERS IN MINES AND IN VARIOUS UNDERGROUND WORKS

In mines, the galleries and the various underground works may harbour firedamp and/or dusty atmospheres which are inflammable and in which a flame may progress at speeds which are variable according to whether the phenomenon at hand is a combustion, a deflagration or even a detonation. This is then either called a blaze, or a firedamp or coaldust explosion, according to the speed of the flame and the extent of the underground works open to the fire.

The prevention of blazes and firedamp explosions consists in sufficient ventilation of the underground works and of all their locations, so as to prevent all accumulations of gas and to assure a sufficient dilution of the firedamp in air down to contents which are clearly below the lower limits of inflammability. The protection against dust explosions consists in rendering inoffensive the deposited dust, which it may always feared would be brought into suspension by some displacing influence of air or other medium, such as for instance the blast produced by a blaze or a firedamp explosion; an inflammable dusty medium may then be created for the intensification of the fire and/or for the spreading thereof; this is then called a firedamp explosion complicated by a coaldust explosion. As a preventive measure, the coaldust may either be neutralized, for instance by adding a large quantity of inert dust to it (in such a manner that the cloud which it might form with air would no longer be inflammable), or else it may be fixed to the ground or to the walls of the galleries by the application of an appropriate substance (so as to prevent it from being brought into suspension in the atmosphere).

When a firedamp and/or a coaldust explosion takes place despite the preventive measures, attempts are made to stop the spreading of the fire by means of special devices called "stop barriers."

Traditionally, the stop barrier consisted of a certain quantity of incombustible dust distributed in heaps on several boards placed in unstable equilibrium and at a small distance from each other across the upper part of the mine gallery: this is the sterile dust type of stop barrier.

Although they have been used less frequently in the past than the systems with incombustible dust, the water stop barriers have been known for a long time; the extinguishing liquid is contained in troughs placed under the vault of the galleries, troughs which the blast of the explosion turns over or breaks, thus dispersing their content.

The trough systems have been properly studied during the last ten years and have become operational, either in the form of resting troughs or in that of suspended troughs, or as a combination of both these types of forms, so as to build up a stop barrier with concentrated water troughs (i.e., at a small distance from each other). Recently, stop barriers with spread out water troughs, which are more convenient and of a more flexible and practical application with respect to the modification in length of the galleries caused by the advance of the underground excavation operations, have revealed technical advantages which are particular to them: namely, any explosion occurring on the works will travel over a smaller length of gallery before

being stopped when the protection is provided by means of water trough stop barriers which are spread out, rather than by water trough stop barriers which are concentrated.

Generally speaking, in the known operational types of water stop barriers, the liquid is contained in troughs which liberate their content under the influence of the blast of the explosion; it is hoped in this way to be able to put out the flame, the front of which reaches the section where the troughs concerned are installed a few instants after the blast wave front has passed.

In fact, the desired effect is obtained as long as the propagation speed of the explosion does not exceed a few hundred meters per second. On the other hand, in the case of a wave characterized by a particularly high speed, for instance of the order of 1,000 m/s, the stop barrier will be ineffective, and the flame front, practically coupled with the blast front, will pass beyond. In order to check the progression of the explosion in a specified section of the gallery which is equipped in this manner, it will then be necessary to predisperse a sufficient quantity of extinguishing agent there (preferably water) at the appropriate time. For this purpose, a blast front and/or flame front detector is installed upstream of the gallery section containing the extinguishing device; the latter will then be operated by means of energy liberated from a source provided for this purpose by the action of aforesaid detector; in this manner we have a triggered stop barrier, made up of a detector and of an extinguishing device.

Extinguishing devices for triggered stop barriers are also known which consist of troughs of water or of sterile dust, each containing a detonator with detonating cord located within the extinguishing matter to be dispersed. The troughs of such a system may of course be placed in the gallery either in concentrated or in spread out fashion.

Providing the water be dispersed in sufficient quantity and at the appropriate time, stop barriers built up in this manner in gallery sections of more or less great length (according to the locating system of the troughs) may be efficient, except however in one or other of the following cases:

1. when the explosion progresses at such a great speed, that the combination blast and flame front has passed beyond the extinguishing device before the time of operation of the latter (this time being namely dependent upon the time of response of the detector and upon the start-up time of the extinguisher);

2. when the flame front is delayed to such an extent with respect to the blast front, that the water of the upset or broken troughs has already fallen to the floor of the gallery by the time the fire zone to be extinguished arrives.

Over and above the efficiency which is expected of the triggered stop barrier, it is also required that the source of energy used for dispersing the extinguishing agent should not be harmful to the security at the spot or to the safety of the personnel in case of operation, and in the case of an accidental triggering. Such is not the case for a detonating cord located with its detonator within the mass of liquid contained as such in a container located in an underground gallery, even if the detonating cord is fitted in an appropriate pipe which is intended to break in order to allow the explosion products to be dispersed in the liquid. In such a case, the operation does indeed cause a pressure peak in the

vicinity of the container which, according to the characteristics of the device used, is:

-either too high and intolerable for the personnel when the detonation cord is sufficiently powerful to ensure the dispersion of the water;

-or admissible for the personnel when, all other circumstances remaining the same, a sufficiently weak detonating cord is used, whereby however the dispersion of the water becomes insufficient.

The purpose of the present invention is to eliminate all the inconveniences of the previously known devices and also to present new advantages in the field of extinguishing devices for triggered stop barriers. For this purpose, a first object of the invention is concerned with a process for the setting up of triggered stop barriers as extinguishing means in the galleries of underground works, characterized by the fact that it consists in expelling by expansion of gas or of steam under pressure and by means of an appropriate source of energy, an extinguishing product contained in the cells of a mass of some reticular substance.

A further subject of the invention consists of any extinguishing device which applies aforesaid process and which is characterized by the fact that it is made up of at least one mass of reticular substance, an extinguishing product housed in the cells of aforesaid mass and a means for producing the expansion of a gas or of steam under pressure, causing the expulsion of aforesaid extinguishing product.

This process and this device can be put to work in various forms of embodiment of which a preferred one is described hereinafter, without the slightest intent at limitation, with reference to the appended drawings in which:

FIG. 1 schematically shows a longitudinal cross-section of part of a gallery which is equipped with a device according to the invention;

FIG. 2 shows a cross-section on line II—II in FIG. 1;

FIG. 3 shows, to a larger scale, that part of FIG. 1 which is indicated at F3;

FIG. 4 shows a cross-section on line IV—IV in FIG. 3;

FIGS. 5 to 11 reproduce the main features of various photographs taken at high speed and showing the progressive space occupation of the extinguishing product.

FIGS. 1 to 4 schematically illustrate a section of gallery 1 and an extinguishing device 2 according to the invention.

Gallery 1 is supposed to be of the average kind and to be built under circumstances and with the means which are traditionally known.

In the present case the extinguishing device consists of a prismatic mass 3 of reticulated polyurethane foam, of $100 \times 20 \times 20$ cm, threaded on a detonating cord 4 and enveloped in a thin polyethylene skin 5. This skin 5 is closed at its ends by bindings shown schematically at 6 and 7; at least one of aforesaid cord is extended to the outside of aforesaid skin and is provided with a detonator (known) schematically shown in 8. Skin 5, as well as all the cells of reticular mass 3, are filled with an extinguishing liquid, for instance water, in the case under consideration to the extent of some 45 liters.

It is obvious that variable shapes and dimensions can be given to aforementioned device, either one single length of considerable dimensions or a series of successive elements, for instance such as has just been described. The extinguishing device may appropriately be

located in the gallery in any adequate manner. In the present case it is borne by a shelf 9 which is slung by cables 10 from the ceiling of gallery 1.

Aforesaid device may also be protected by a network or by some thin wall of any appropriate material.

The device of chosen length, which may eventually consist of several elements grouped in series and/or in parallel, may be located along the mine galleries starting from the detector, downstream as well as upstream so as to take into account the direction of progression of an eventual firedamp and/or coaldust explosion, so as to form a continuous or noncontinuous extinguishing device, which starts to operate over its entire length when the detonation cord is fired at its own detonation speed (4,000 to 8,000 m/s according to type). It can thus be understood that:

1. In case of a firedamp and/or coaldust explosion which spreads at high speed (1,000 m/s and over), the downstream extinguisher will operate in pursuit of the flame front as soon as triggered by the detector, will catch up with and even pass it, considering the detonation speed of the cord, swamping the entire length of the gallery over which it has been installed.

2. In case of a firedamp and/or coaldust explosion, characterized by a great delay of the flame front with respect to the blast front, and when only a flame detector is fitted, the downstream extinguisher will operate as in (1), and when moreover a blast detector is also fitted, it will be the upstream extinguisher which will operate most effectively as it disperses the water further and further in upstream direction, i.e. towards the flame front which it must necessarily encounter.

3. In all cases, regardless of the explosion of the detonation cord, the power of which is adapted to the remaining characteristic of the reticulated foam device so as to obtain an efficient dispersion of the water, there will only be a very brief pressure peak of limited intensity in the vicinity of the device, in consideration of the lamination of the extinguishing product and of the gases which propel it through the pores of the cellular matter.

EXAMPLE

With a device having the dimensions described above, built over one meter length and by means of reticulated foam having 8 to 15 cells per linear inch, a normal detonation cord of 11 grams of penthrite per metre, these elements being contained with 45 litres of water in a polyethylene skin with a thickness of 3/10 mm (skin with a flat width of 40 cm), the lot being placed along the symmetry axis of a vaulted gallery with 9 m² cross-section upon a cradle of metal rods at 50 cm under the crown, as indicated in FIGS. 1 to 4; it was found by filming at 4,000 images per second that the dispersed water occupies (FIGS. 6 to 11): 18.5 percent of the cross-section of the gallery at time 20 ms (FIG. 6); approximately 50 percent starting at time 65 ms (FIG. 7) up to time 150 ms (FIGS. 8 and 9); approximately 100 percent as from time 200 ms (FIG. 10) up to time 500 ms (FIG. 11).

On the other hand it was found that the pressure peak at a distance of 20 cm from the polyethylene skin had not exceeded 1 kg/cm².

It can thus be seen, that in the above described example the water fills the cross-section in 150 milliseconds and that such is still the case after 500 ms. The front of droplets progresses from top to bottom at speeds of the

order of 50 m/s to start with and of 10 m/s afterwards, but the finely divided state of the water prevents all harmful action; it has indeed been discovered that a polyethylene screen with a thickness of 0.09 mm stretched on a frame placed at 25 cm distance from the device was not destroyed by the explosion, and that at 10 cm from the polyethylene sleeve filled with water, the momentary pressure peak (duration of approximately 200 microseconds) is too weak by half to burst the most fragile human ear drum ever observed (275 g/cm²; 50 percent of eardrums burst at 1,000 g/cm²). The results are similar at 10 cm distance from a section without water, the cord of which is protected by a 40 × 40 cm prism of very fine foam.

It is comprehensible, that an extinguishing device of this sort, installed near to the gallery walls so as to assure a widely free passage for circulation in the galleries and so as to be best possibly protected from the effects of blast to which it offers but little grasp, procures novel technical advantages by its efficiency and by the fact that it does not threaten the safety of the personnel, even if the water should have leaked out of one or more sections.

What I claim is:

1. The method of extinguishing fires and explosions in an underground passage, comprising the steps of: positioning a mass of frangible cellular material at a predetermined location in said passage; filling the cells of said material with a fluent extinguishing medium; and creating an internal pressure in said mass sufficient to expel the extinguishing medium therefrom and disperse the same in said passage.
2. A device for extinguishing fires and explosions in an underground passage, comprising: a mass of frangible cellular material;

a fluent extinguishing medium filling the cells of said mass; and pressure means embedded within said mass for creating internal pressure therein to expel said medium from said mass and disperse the same in said passage.

3. A device as defined in claim 2 wherein said cellular mass is a body of polyurethane foam.

4. A device as defined in claim 2 wherein said cellular mass has between 5 and 50 cells per linear inch.

5. A device as defined in claim 2 wherein said extinguishing medium is a liquid.

6. A device as defined in claim 2 wherein said extinguishing medium is a powder.

7. A device as defined in claim 2 wherein said pressure means is an explosive device.

8. A device as defined in claim 7 wherein said explosive device comprises a detonator cord extending through said mass and having a detonator on at least one end thereof.

9. A device as defined in claim 2 including an envelope of readily rupturable material enclosing said mass of cellular material.

10. A device as defined in claim 2 wherein said mass is an elongated mass positioned to extend along an underground passage.

11. A device as defined in claim 2 wherein a plurality of said devices are positioned to define a row thereof extending along an underground passage.

12. A device as defined in claim 2 wherein said mass is a prismatic body of polyurethane foam of about 20×20×100cm enclosed in polyethylene envelope and having a detonating cord extending longitudinally therein, one end of said cord having a detonator thereon.

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