Title: WATER SPRAY MEANS AND METHOD

Abstract: This invention provides a water spray means (10) including a frame (24) including at its front end, a suitable water spray device (14) connected to a water supply and an air pressure supply via a valve system (12,11, 12,12), a blast detection device (22) included on the frame and adapted, when an explosive blast is detected, to activate the valve system to open the water supply and the air supply to the spray device, and a timer device (29) mounted on the frame and adapted to deactivate the valve system thereby to close the water supply and the air supply after a suitable time period. The invention further provides a method including the step of locating a water spray means adjacent a blast site, sensing and using an explosive blast to automatically activate said water spray directed at the blast site and then using a timer device to automatically stop or shut off the spray.
TITLE OF INVENTION: WATER SPRAY MEANS AND METHOD

INTRODUCTION:

This invention relates to a water spray means and method. More particularly, this invention relates to an improved water spray means and method that is adapted for use, for example, in mines or confined spaces, or in quarries.

BACKGROUND TO THE INVENTION:

Particularly in mines or confined spaces, when explosives blasting has released dust and noxious gases into the air in such a space, a major problem arises in clearing the space of dust and noxious gases as soon as practically possible so that further working can continue safely and without extended interruption. The problem is also generally experienced in quarries and other blasting sites.

The practice in mining has generally been to spray water by hand into such spaces, after blasting, to wet down the walls and attempt to lay the dust particles, and especially the fine dust particles which are particularly hazardous to miners. Various means and methods have been used in practice, or have been proposed, to deal with this problem, or at least to reduce the problem. However, these have generally not been very successful.
What is required ideally is a means and method that will automatically spray water without human intervention viz automatically into a blast area after an explosives blast. Ideally such a water spray means and method should be activated immediately after an explosives blast, and should shut off when such spraying has been completed.

**OBJECTS OF THE INVENTION:**

It is therefore an object of the present invention to avoid or prevent, at least partly, the problem(s) associated with the state of the art.

It is also an object of the present invention to provide a new and improved water spray means and method, which involves an inventive step.

**SUMMARY OF THE INVENTION:**

According to one aspect of the present invention, there is provided a water spray means including a frame including at its front end, a suitable water spray device connected to a pressurized water supply and optionally to an air pressure supply via a valve system, a blast detection device adapted, when an explosives blast is detected, to activate the valve system to open the water supply and the optional air supply to the spray device, and a timer device adapted to de-activate the valve system thereby to close the water supply and the optional air supply to the spray device after a suitable time period.
The frame may be integral with, and form part of, the water spray means or it may be separate from the water spray means.

The water spray means and its frame may, in practice, be mounted on a mine side wall and connected to a pressurized water supply and optionally an air pressure supply, suitably close to the rock face where drilling and blasting is taking place in a mine, quarry, or the like. This may typically be about 20 to 30 metres from the rock face depending on the spray means being able to project its spray over such a distance. The water spray means may, in practice, be advanced along a side wall in the mine as the rock face is advanced.

At or in sites where a compressed air supply is not available, the water spray device, and hence the water spray means, may use, and hence be connected to, a pressurized water supply only (and not also to an air pressure supply).

The water spray head may preferably be adapted to produce a spray that includes a sufficient amount of atomized water particles that are fine enough to attract, and to hold in suspension and/or dissolve fine dust particles and noxious gas fumes and molecules, respectively, producing a water/dust/gas mixture in the form of a sludge that falls or flows to the ground, thereby rendering the air relatively clean and safe within a short period. The sludge may thereafter be removed from the site by any suitable means, and disposed of in a safe manner.
The water spray head may be protected from damage by large blast particles or fragments by a suitably sturdy screen or mask placed in front of the spray head. The water spray means body may be protected from damage by blast particles by being surrounded along its length by a suitable large sturdy tube mounted on the frame that may, for example, be made from a suitable polyethylene or other plastics material, having one, or optionally two, slot(s) in its upper part for movement of its levers, or a larger slot, respectively, in its lower part for weights to drop or move through the tube wall.

The blast detection device may be provided on the frame as a moveable baffle, or a plate or dish, that is adapted to be moved backwards automatically by the force of an explosives blast and includes a lever adapted to activate the valve system. In an alternative arrangement, the blast detection device may be a pressure sensitive device or switch adapted to activate the valve system.

When an explosives blast pushes the blast detection device backwards, its lever may automatically activate and open the second pair of valves, or the second valve, respectively, thereby opening the water conduit and the optional air conduit to release a spray of water through the spray device towards the blasted rock face and the adjacent side walls and roof hanging.

The valve system may include, and be operated by, a lever and tension spring system or by a weight-induced or weight-based system, respectively.

In a water spray means that uses both pressurized water and air pressure, the valve system may include two pairs of valves, the first pair being located
upstream of the second pair, with one valve of each pair being located along a pressurized water conduit and the corresponding valve being located along an air pressure conduit. The valves of each pair of valves may operate together viz either both valves are open or both are closed. When the water spray means is in a ready state, the first pair of valves will be in an open condition, while the second viz downstream pair of valves will be in a closed condition. When an explosives blast pushes the blast detection device backwards, its lever may automatically activate and open the second pair of valves, thereby opening the water conduit and the air pressure conduit to the spray device to release a spray of water through the spray device towards the blasted rock face and the adjacent side walls and roof hanging

Alternatively, in a water spray means that uses pressurized water only, the valve system includes only two valves (instead of two pairs of valves), the first valve being located upstream of the second valve along the pressurized water conduit. When the water spray means is in a ready state, the first valve will be in an open condition, while the second viz downstream valve will be in a closed condition. When an explosives blast pushes the blast detection device backwards, its lever may automatically activate and open the second valve, thereby opening the water conduit to the spray device to release a spray of water through the spray device towards the blasted rock face and the adjacent side walls and roof hanging

The timer device may be any suitable timer device. More particularly, the timer device may include a container connected to the water supply and adapted to fill with water after a pre-determined period, for example after 5 to
10 minutes, whereafter it may activate the first pair of valves, or the first valve, respectively, to close such valve(s) and thereby to close the water supply and the optional air supply.

After the water spray means has stopped spraying, the means may be manually re-set viz the second pair of valves, or the second valve, respectively, is re-closed and the first pair of valves, or the first valve, respectively, may be re-opened. The blast detection device may also be reset and the timer device is reset by emptying the water therefrom. In this state the water spray means is reset to its ready or stand-by mode viz for the next explosives blast.

According to another aspect of the present invention, there is provided a water spray method adapted to activate automatically after an explosives blast in a mine, quarry, or the like, including the step of using a water spray means as herein described.

According to a further aspect of the present invention, there is provided a water spray method adapted to be used after blasting in a mine, quarry, or the like, including the steps of suitably locating a water spray means adjacent a blast site, using a blast detection device to sense an explosives blast and to automatically activate a suitable water spray directed at a blast site for a predetermined time, and then using a timer device to automatically stop or shut off the water spray.
DETAILED DESCRIPTION OF THE INVENTION:

The invention will now be described in greater detail, by way of non-limiting examples, with reference to the following drawings, in which:

Figure 1 shows a water spray means, according to one form of the present invention, that is operated by, and uses, pressurized water and compressed air, and that includes a lever and spring system to activate its valves, in a reset and ready state or mode. More particularly, Figure 1(a) shows a schematic side sectional view of this water spray means and Figure 1(b) shows an external plan view of this water spray means;

Figure 2 shows a water spray means, according to another form of the present invention, that is operated by, and uses, pressurized water only (and not additionally compressed air), and that also includes a lever and spring system to activate its valves, in a reset and ready state or mode. More particularly, Figure 2(a) shows a schematic side sectional view of this water spray means and Figure 2(b) shows an external plan view of this water spray means;

Figure 3 shows a schematic side view of a water spray means, according to yet another form of the present invention, that is operated by, and uses water and compressed air, and that utilizes a lever and weight-based system to activate its valves, in a reset and ready state or mode;
Figure 4 shows a schematic side view of the water spray means of Figure 3, having been activated by an explosives blast in a mine, and hence in an activated mode viz spraying water on a blast site and mine face;

Figure 5 shows a schematic side view of the water spray means of Figure 4, viz after spraying and having been de-activated, and hence in a de-activated mode viz before being reset; and

Figure 6 shows a three dimensional schematic side view of the water spray means of Figure 3, including, and enclosed within, a suitably protective tube or pipe and fitted with a protective front screen or mask.

In Figures 1 and 2, like reference numerals refer to like parts, unless otherwise indicated. Similarly in Figures 3 to 6, like reference numerals also refer to like parts, unless otherwise indicated.

Referring firstly to Figure 1, reference numeral 10 refers generally to a water spray means, according to one form of the invention, for use in a mine, for example. The means 10 includes an integral frame 12 including a pressurized water inlet pipe 12.1 and a pressurized air inlet pipe 12.2. At their free ends, the pipe 12.1 is connected to a pressurized water supply (not shown) while the pipe 12.2 is connected to a pressurized air supply (also not shown).

At the front (viz opposite) end of the frame 12, it has mounted thereon and connected operatively to the opposite ends of the pipes 12.1 and 12.2 a suitable spray device or head 14 including a plurality of spray and atomizing
nozzles 14.1, as shown in the detail drawing insert, adapted to spray a substantial quantity of water including a substantial quantity of atomized water droplets. The spray head 14 and its spray nozzles 14.1 are protected from damage by larger stones and rock fragments by way of a suitable stone guard 26.

The pipes 12.1 and 12.2 each have a valve system provided therein including two serial valves viz in pipe 12.1 a valve 12.11 (upstream) and a valve 12.12 (downstream), and in pipe 12.2 a valve 12.21 (upstream) and a valve 12.22 (downstream), respectively. The valves 12.21 and 12.22 in the pipe 12.2 (not shown) are hidden behind the pipe 12.1 in side view and hence cannot be seen in Figure 1(a). However, if reference is had to Figure 3, these valves can be visualized and their operation can be readily understood. Each corresponding valve pair viz 12.11, 12.21 are interconnected and operate together, with both valves being either open simultaneously or being closed simultaneously. Likewise the valve pair 12.12, 12.22 are also interconnected and also operate together, with both valves either being open simultaneously or being closed simultaneously. However, each valve pair 12.11, 12.21 and 12.12, 12.22, respectively, operates oppositely to the other pair, as will become clear from the description hereunder.

Each valve pair 12.11, 12.21 and 12.12, 12.22 is activated viz opened or closed by means of a lever and (tension) spring system. The system includes for the upstream valve pair 12.11, 12.21 a first (single) lever 16 located between these valves and connected to and linking these two valves together in their operation. Similarly for the the downstream valve pair 12.12 and 12.22
the system includes a second (single) lever 18, located between these valves and connected to and linking these two valves together in their operation. Each of these two levers 16 and 18 is adapted to be swiveled, as shown in dotted lines in Figure 1(a), viz when the spray means 10 detects an explosives blast and is required to start spraying and also when the water spray is shut off, respectively.

The first lever 16 is adapted and tensioned to swivel from its position shown in solid lines, by means of an elongate spring 16.1 to the position shown in dotted lines, when released from its normal or reset position as shown in solid lines in Figure 1(a), which shows the spray means 10 in its reset and ready mode. In this mode the upstream valve pair 12.11, 12.21 (shown in solid lines) are both open. The second lever 18 is tensioned to swivel by means of an elongate spring 18.1 to the position shown in dotted lines in Figure 1(a) when released from its reset position as shown in solid lines in Figure 1(a), which shows the spray means 10 in its reset and ready mode. In this mode the downstream valve pair 12.21, 12.22 (shown in solid lines) are both closed.

The first lever 16 is connected via a suitable lever system 16.2 that firstly holds the lever 16 in its reset position, as shown in solid lines in Figure 1(a), with its valve pair 12.11, 12.21 in their open condition; and that secondly is adapted to swivel the lever 16.1 to its position shown in dotted lines. When this occurs, and as will be explained hereunder, the piston rod extension 20.1 of timer piston 20 pushes the lever system (16.2) upper end and releases the lever 16 from a hook 16.3 in the lever 16.2 thereby enabling the spring 16.1 to
swivel the lever 16 to its dotted position, and thereby moving the valve pair 12.11, 12.21 to their closed condition.

The second lever 18 is connected via a suitable lever system 18.2 that firstly holds the lever 18 in its reset position, as shown in solid lines in Figure 1(a), with its valve pair 12.12, 12.22 in their closed condition; and that secondly is adapted to swivel the lever 18.1 to its spraying position as shown in dotted lines. This occurs when an explosives blast swivels a blast (triggering) baffle 22 backwards away from the blast, and the connected lever system 18.2 releases the lever 18.1 from a hook 18.3 in the lever 18.2, thereby enabling the spring 18.1 to swivel the lever 18 to its dotted (spraying) position. This swivels the valve pair 12.12 and 12.22 to their open condition allowing water and air to pass along each of the respective pipes 12.1 and 12.2 (of which only the pressurized water pipe 12.1 is shown in side view) to the spray head 14 and its spray nozzles 14.1 which in turn spray water and atomized droplets on a blast site (not shown).

Referring briefly to Figure 1 (b), the cut-away opening shows a needle valve 20.2 provided in the cylinder 20 to adjust the flow of water into the cylinder 20 in order to extend or reduce the time taken for the cylinder 20 to fill with water and hence to adjust the spraying time of the spray means 10. The opening also shows a drain valve 20.3 provided in the cylinder for manually draining the cylinder 20 of water prior to resetting the spray means 10. Figure 1(b) also shows two slots provided in the upper part of the protective casing 24, the first slot 24.1 allowing the first lever 16 to swivel from its reset position (with both of its associated valves open), as shown in full lines in Figure 1(a), to its cut-
off (closed) position as shown in dotted lines in Figure 1(a); while the second slot 24.2 allows the second lever 18 to swivel from its reset position (with both of its associated valves closed), as shown in full lines in Figure 1(a), to its (open) spraying position as shown in dotted lines in Figure 1(a).

In use, the spray means 10 will be located about 20 to 30 metres from a mine rock/working face and mounted about 2 meters above the floor, with the spray head 14 facing the rock face. The spray means 10 via its pipes 12.1 and 12.2, respectively, will then be connected to a pressurized water supply (not shown) and to a pressurized air supply (also not shown). Prior to any explosives blasting, the levers 16 and 18 will be manually reset to their reset or ready positions as shown in full lines in Figure 1(a). The spray means 10 is then in its reset or ready mode and accordingly is primed to react to an explosives blast in the mine.

When an explosives blast takes place (not shown), such blast will swivel the blast baffle 22 backwards and away from the blast. This will activate the lever system 18.2 which swivels the lever 18 to its dotted position and thereby opens the valve pair 12.12, 12.22, thereby allowing pressurized water and air to flow through the respective pipes 12.1 and 12.2 to and through the spray head 14 and its spray nozzles 14.1. This sprays water towards the blast site and onto the blast face and adjacent floor and roof (not shown). This flow of water along the pipe 12.1 also allows water to flow along the pipe 12.3 and into the empty cylinder 20 via the needle valve 20.2. When the cylinder 20 fills with water, after about 5 to 10 minutes, according to the adjustment of the needle valve 20.2, the piston rod extension 20.1 will move outwardly and
away from the cylinder 20, and its free end will engage and push the lever 16.2, causing the lever 16 to be released from its locked condition and to be swivelled by the tension spring 16.1 towards its position shown in dotted lines, thereby closing its valve pair 12.11, 12.21. This cuts off the flow of water and air through the spray means 10, stopping the spray of water on the blast site.

The spray means 10 is then reset manually to its reset or ready mode by emptying the cylinder 20 via the drain valve 20.3, drawing the piston 20.1 back to its previous position viz in the empty cylinder, resetting the lever 16 to its previous position with its valve pair 12.11, 12.21 closed (viz in the position shown in full lines in Figure 1(a)), and resetting the lever 18 to its previous position with its valve pair 12.12, 12.22 open (viz in the position shown in full lines in Figure 1(a)). The spray means 10 is then restored to its reset and ready mode, prepared for the next blast after being re-positioned close to the next blast site and suitably re-connected to the pressurized water supply and to the pressurized air supply.

Referring next to Figure 2, it will be seen that the spray means 10 is generally and otherwise similar to the spray means 10 of Figure 1, as described above, except that it has no pressurized air supply and hence it has no air pressure pipe or its associated valves and no associated lever system included in this spray means 10. Hence the water spray means 10 of Figure 2 operates solely on pressurized water (and not on the combination of pressurized water and air pressure). Accordingly this form of the spray means 10 can be used in or at sites that do not have a compressed air supply.
In use, the spray means 10 of Figure 2 operates in generally the same manner as that of Figure 1, as described above, except that, in operation, it does not have an air pressure line but it has a pressurized water line 12.1 that functions as described in Figure 1 above. An explosives blast will trigger the blast baffle 22 and its linked lever system 18.2 will release the lever 18 from its hook 18.3 in the lever system 18.2 allowing the spring 18.1 to swivel the lever 18 to the position shown in dotted lines, thereby opening the valve 12.12 and allowing pressurized water to flow through the water pipe 12.1 to the spray head 14 and its atomizing nozzles. This flow of water will also fill the cylinder 20 with water which, when filled, will activate the lever system 16.2 by releasing the lever 16 from its hook 16.3 in the lever system 16.2, which allows the spring 16.1 to swivel the lever 16 to the position shown in dotted lines. This closes the valve 12.11 which shuts off the water flow through the spray means 10 after a preset time of about 5 to 10 minutes. The spray means 10 then needs to be reset manually by emptying the cylinder 20, and resetting the levers 16 and 18, and hence each associated valve viz 12.11 and 12.12, respectively. This resets the spray means 10 to its reset and ready mode, for the next explosives blast, after the spray means has been suitably re-positioned and re-connected to a pressurized water supply (not shown).

Referring next to Figures 3 to 6 generally, the water spray means 30 in this form of the invention is constructed and operates essentially in similar fashion to that of the water spray means 10 of Figure 1, except that the water spray means 30 includes and is operated by a valve and weight system instead of a valve and lever and spring system. The respective levers are also different
and are two-legged levers with each leg operating a separate valve, as will be seen from the drawings and description below.

In Figures 3 to 6, reference numeral 30 refers generally to a water spray means that includes an integral frame 32 including a pressurized water pipe 32.1 and a pressurized air pipe 32.2. The water pipe 32.1 includes an upstream valve 32.11 (that is closed in the reset mode of the means 30) and a downstream valve 32.12 (that is open in the reset mode of the means 30). The air pipe 32.2 likewise includes an upstream valve 32.21 (that is closed in the reset mode of the means 30) and a downstream valve 32.22 (that is open in the reset mode of the means 30). The upstream valve pair 32.11, 32.21 are linked and operate together by way of a dual lever 38.3 viz these two valves are either both closed or both open simultaneously. In the reset mode of the spray means 30 as shown in Figure 3, the upstream valve pair are (both) open. In similar fashion, the downstream valve pair 32.12, 32.22 are linked and operate together by way of a dual lever 36.3 viz these two valves are either both closed or both open simultaneously. In the reset mode of the spray means 30 as shown in Figure 3, the downstream valve pair are (both) closed.

Each valve pair is activated by means of a weight-induced or weight-based system. The system includes for the downstream valve pair, a weight in the form of a metal ball 36 and for the upstream valve pair, a weight in the form of a ball 38, each ball being adapted to be released and dropped, viz when the spray means 10 detects an explosives blast and is required to commence spraying, or when the water spray is shut off, respectively. More particularly, the ball 36 is cradled in an angled rotatable bracket or cradle 36.1 and is tied
by a cable 36.2 to a dual lever 36.3 that is adapted to open the closed (in reset mode) valve pair 32.12, 32.22. In similar fashion, the ball 38 is cradled in an angled rotatable bracket or cradle 38.1 and is tied by a cable 38.2 to a dual lever 38.3 that is adapted to close the open (in reset mode) valve pair 32.11, 32.21. Accordingly Figure 3 shows the spray means 30 in its reset and ready state or mode, awaiting an explosives blast.

Near the front of the frame 32, a blast detection device is provided and mounted in the form of a plate or dish 40 to which is secured a pivotal arm 40.1 which controls a Z-shaped lever 40.2 that can likewise pivot to allow the rotatable cradle 36.1 that is biased to rotate so that it releases and thereby drops the ball 36. The ball 36, via the cable 36.2 pulls down the dual lever 36.3 to open the pair of linked valves 32.12, 32.22, thereby allowing air and water both under pressure to flow to and out of the spray head 34. See Figure 4 that shows the means 30 in its spraying state or mode.

Referring next to Figure 4, when the valve pair 32.12, 32.22 are open, the pipe 32.3 also allows water to flow under pressure to a water-operated timer device 42 that is adapted to fill with water after a suitable time of about 5 to 10 minutes. By means of an internal piston, the timer device 42 advances its piston lever 42.1 until the lever 42.1 pushes the Z-shaped bracket 38.4 to the left, thereby tilting the biased rotatable bracket 38.1 so that the ball 38 is released and drops out of the bracket 38.1 and, via the cable 38.2, pulls the dual bracket 38.3 downwardly. This closes the open valve pair 32.11, 32.21, thereby cutting off the supply of pressurized air and water, and thereby shutting off the spray of water from the spray head 34 (and its nozzles). See
Figure 5 that shows the means 30 in its shut-off state or mode after it has sprayed the blast area with atomized water.

Referring next to Figure 5, it will be seen that both balls 36 and 38 are in a dropped mode that indicates that spraying of the blast site has been completed. This also indicates that the spraying means 30 needs to be reset. This is done manually by replacing each of the balls 36 and 38 in their respective brackets or cradles 36.1 and 38.1 tilted back correctly, and resetting the respective valve pairs in their reset positions, as shown in Figure 3. Relative to the ball 36, the blast plate or dish 40 is also tilted up and the relevant Z-backet 40.2 is reset accordingly. Relative to the ball 38, the timer device 32 is emptied of water and the relevant Z-bracket 38.4 is reset accordingly. This resets and restores the spray means 30 to its ready state or mode, as shown in Figure 3.

Referring lastly to Figure 6, the spray means 30 is shown encased in a sturdy tube or pipe 44 (indicated in dotted lines) made of a suitable polyethylene or other plastics material, for example, to protect the mechanism thereof from damage by larger flying particles or fragments of of rock caused by blasting. The tube or pipe 44 includes one or two suitable opening(s) or slot(s) along its underside (not shown) to permit the balls 36 and 38 to drop and move through such opening(s) or slot(s), as explained above, during the operation of the spray means 30.
In addition, the front of the spray means 30 is provided with a sturdy metal screen or mask 46 to protect the spray head 34 from damage by larger flying rock fragments caused by the blasting.

In use, the spray means 30 will be mounted (and after subsequent blasting, it will be re-mounted) at a suitable distance of about 20 to 30 metres from a rock face to be blasted, for example in a mine (not otherwise shown) and at a suitable height viz about 1.5 to 2 metres from ground level. It is then reset in respect of its valve system and other components as shown in Figure 3, and suitably connected to a pressurized water and a pressurized air supply, respectively (not shown). The spray means 30 is then in a ready state or mode, as shown in Figure 3, to operate in respect of blasting in a mine for example.

When an explosives blast takes place, the spray means 30 will operate automatically to commence spraying, as explained above, and it will change its state or mode from that shown in Figure 3 to that shown in Figure 4 viz to its spraying mode for about 5 to 10 minutes. Then it will automatically, as also explained above, change its state or mode from that shown in Figure 4 to that shown in Figure 5 viz to its shut-off state or mode. It then requires manual re-setting to reset or restore it to its reset or ready state or mode, as shown in Figure 3, whereafter it is ready to operate again and to repeat the above cycle - subject of course to it being relocated at a suitable distance from the rock face and being reconnected to the water and air supply, respectively.
It will be seen that the above-mentioned water spray means provides an effective and relatively simple but robust means and method for automatically spraying a blast area in a confined area such as in a mine tunnel. The water spray means includes mechanical valves that are generally dust-proof and blast-resilient and includes an improved but simple lever and spring system, alternatively a weight-induced or weight-based system, to activate the valve systems. It will therefore be seen that the water spray means and method described herein have certain advantages over existing or prior art means/systems and methods, respectively. It will also be seen that the invention is relatively simple and inexpensive to manufacture and to maintain, and that it is rugged in use and simple and convenient to operate in situ.

Although various embodiments of the invention have been described above, it will be readily understood by any person skilled in this field that other modifications, variations or possibilities of the invention are possible. Such modifications, variations and possibilities are therefore to be considered as falling within the spirit and scope of the present invention as herein claimed or described and/or exemplified, and hence are to be considered as part of the present invention.
CLAIMS:

1. A water spray means including a frame that includes at its front end, a suitable water spray device connected to a pressurized water supply, and optionally to an air pressure supply, via a valve system, a blast detection device adapted to detect an explosives blast, thereby to automatically activate the valve system thereby to open the water supply, and the optional air supply, to the spray device, and a timer device adapted to de-activate the valve system thereby to automatically close the water supply, and the optional air supply, to the spray device after a suitable time period.

2. A water spray means as claimed in claim 1, in which the frame is integral with, and forms part of, the water spray means.

3. A water spray means as claimed in either claim 1 or claim 2, in which the water spray means and its frame is adapted to be mounted on a mine side wall, for example, and connected to a pressurized water supply, and optionally to an air pressure supply, suitably close to a rock face where drilling and blasting is taking place in a mine, quarry, or the like.

4. A water spray means as claimed in any one of the preceding claims, in which the water spray means, uses, and hence is connected to, a pressurized water supply and to a pressurized air supply.
5. A water spray means as claimed in any one of claims 1 to 3, in which the water spray means, uses, and hence is connected to, a pressurized water supply only, and not additionally to an air pressure supply.

6. A water spray means as claimed in any one of the preceding claims, in which the water spray head is adapted to produce a spray that includes a sufficient amount of water and atomized water particles that are fine enough substantially to attract, and to hold in suspension and/or dissolve fine dust particles and noxious gas fumes and molecules, respectively, producing a water/dust/gas mixture in the form of a sludge that falls or flows to the ground, thereby rendering the air relatively clean and safe within a short period.

7. A water spray means as claimed in any one of the preceding claims, in which the water spray head is protected from damage by blast fragments by a suitably sturdy screen or mask provided in front of the spray head.

8. A water spray means as claimed in any one of the preceding claims, in which the water spray means body is protected from damage by blast fragments by being surrounded along its length by a suitably large sturdy tube mounted on the frame, having one, or optionally two slots in its upper part for movement of levers, or a larger slot, or optionally two slots, respectively, in its lower part for weights to drop or move through the tube wall.
9. A water spray means as claimed in any one of the preceeding claims, in which the blast detection device is provided on the frame as a baffle, or a plate or dish, that is adapted to be moved backwards automatically by the force of an explosives blast and includes a lever system adapted to activate the valve system.

10. A water spray means as claimed in any one of claims 1 to 8, in which the blast detection device is a pressure sensitive device or switch adapted to activate the valve system.

11. A water spray means as claimed in any one of the preceeding claims, in which the blast detection device is adapted, when an explosives blast pushes it backwards, to automatically activate and open the second pair of valves, or the second valve, respectively, thereby opening the water conduit and the optional air conduit to release a spray of water through the spray device towards the blasted rock face and the adjacent side walls and roof hanging.

12. A water spray means as claimed in any one of the preceeding claims, in which the valve system includes, and is operated by, a lever and tension spring system or by a weight-induced or weight-based system, respectively.

13. A water spray means as claimed in any one of the preceeding claims, in which, for a water spray means that uses both pressurized water and air pressure, the valve system includes two pairs of valves, the first pair
being located upstream of the second pair, with one valve of each pair being located along a pressurized water conduit and the corresponding valve being located along an air pressure conduit, each valve pair being adapted to operate together viz either both valves are open or both are closed, and when the water spray means is in a ready state, the first valve pair being in an open condition, while the second viz downstream valve pair being in a closed condition.

14. A water spray means as claimed in any one of claims 1 to 12, in which, for a water spray means that uses pressurized water only, the valve system includes two valves only, the first valve being located upstream of the second valve along the pressurized water conduit, and when the water spray means is in a ready state, the first valve being in an open condition and the second valve being in a closed condition.

15. A water spray means as claimed in either claim 13 or claim 14, in which, when an explosives blast pushes the blast detection device backwards, its lever automatically activates and opens the second pair of valves, or the second valve, respectively and as applicable, thereby opening the water conduit, and optionally the pressurized air conduit, to the spray device to release a spray of water through the spray device towards the blasted rock face and the adjacent side walls and roof hanging

16. A water spray means as claimed in any one of the preceeding claims, in which the timer device is a container connected to the water supply
and adapted to fill with water after a pre-determined period, whereafter it is adapted to activate the first valve pair, or the first valve, respectively, to close such valve pair or valve, respectively, and thereby to close the water supply and the optional air supply.

17. A water spray means as claimed in any one of the preceding claims, in which, after the water spray means has stopped spraying, the spray means is adapted to be re-set manually viz the second valve pair, or the second valve, respectively, is re-closed and the first valve pair, or the first valve, respectively, is re-opened, the blast detection device is reset and the timer device is reset by emptying the water therefrom, whereby the water spray means is reset to its ready or stand-by mode.

18. A water spray method adapted to activate automatically after an explosives blast in a mine, or a quarry, or the like, including the step of using a water spray means as claimed in any one of the preceding claims and/or as herein described and exemplified.

19. A water spray method adapted to activate automatically after an explosives blast in a mine, or a quarry, or the like, including the steps of suitably locating a water spray means adjacent a blast site, using a blast detection device to sense an explosives blast and to automatically activate a suitable water spray directed at a blast site for a pre-determined time, and using a timer device to automatically stop or shut off the water spray.
### INTERNATIONAL SEARCH REPORT

**INTERNATIONAL CLASSIFICATION OF SUBJECT MATTER**

INV. E21F5/02 E21F5/14 B05B7/12 B05B12/02 B05B12/12

**ADD.**

According to International Patent Classification (IPC) or to both national classification and IPC

### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E21C E21F F42D B05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>CN 2 316 051 Y (WANG LIHONG [CN]) 28 April 1999 (1999-04-28) abstract; figure 1 pages 2-3</td>
<td>1-4, 6, 7, 9, 10, 12, 16, 18, 19</td>
</tr>
<tr>
<td>X</td>
<td>CN 202 768 053 U (JIZHONG ENERGY FENGFENG GROUP CO LTD) 6 March 2013 (2013-03-06) abstract; figures 1-2 pages 4-6</td>
<td>1-7, 9-12, 15, 18, 19</td>
</tr>
<tr>
<td>X</td>
<td>CN 101 798 937 A (YANZhou COAL MINING CO LTD) 11 August 2010 (2010-08-11) abstract; figures 1-2 page 5</td>
<td>1-7, 9, 10, 12, 16, 18, 19</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box O.

See patent family annex.

* Special categories of cited documents:
  * "A" document defining the general state of the art which is not considered to be of particular relevance
  * "E" earlier application or patent but published on or after the international filing date
  * "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
  * "O" document referring to an oral disclosure, use, exhibition or other means
  * "P" document published prior to the international filing date but later than the priority date claimed

### Date of the actual completion of the international search

20 September 2016

### Date of mailing of the international search report

06/10/2016

Name and mailing address of the ISA/Authorized officer

European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3018

Brassart, P

---

Form PCT/SA/210 (second sheet) (April 2005)
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>CN 102 797 493 A (JIZHONG ENERGY FENGFENG GROUP CO LTD) 28 November 2012 (2012-11-28) figures 1-4 abstract</td>
<td>1</td>
</tr>
<tr>
<td>A</td>
<td>CN 2 097 903 U (YIN DAIHUA [CN]) 4 March 1992 (1992-03-04) abstract; figures 1-4</td>
<td>1</td>
</tr>
<tr>
<td>Patent document cited in search report</td>
<td>Publication date</td>
<td>Patent family member(s)</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>----------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>CN 2316051</td>
<td>Y</td>
<td>28-04-1999</td>
</tr>
<tr>
<td>CN 202768053</td>
<td>U</td>
<td>06-03-2013</td>
</tr>
<tr>
<td>CN 101798937</td>
<td>A</td>
<td>11-08-2010</td>
</tr>
<tr>
<td>CN 102797493</td>
<td>A</td>
<td>28-11-2012</td>
</tr>
<tr>
<td>CN 2097903</td>
<td>U</td>
<td>04-03-1992</td>
</tr>
</tbody>
</table>