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(54) Emulsion explosives

(57) A method of producing an emulsion explosive for use in an underground mining operation is provided. The method includes feeding, by means of gravity, an emulsion explosive oxidizer from an oxidizer source to an underground oxidizer holding zone in a mine, while separately feeding, by means of gravity, an emulsion explosive fuel from a fuel source to an underground fuel holding zone in the mine. Oxidizer and fuel are withdrawn from the oxidizer holding zone and the fuel holding zone respectively, and separately fed, under gravity, to an underground emulsion explosive production zone which is thus located at a lower level in the mine than the oxidizer holding zone and the fuel holding zone. An emulsion explosive is produced by admixing the fuel and the oxidizer in the emulsion explosive production zone.

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Description

[0001] THIS INVENTION relates to emulsion explosives. More particularly, the invention relates to the production of emulsion explosives. Still more particularly, the invention provides a method of producing an emulsion explosive for use in an underground mining operation, and an emulsion explosive production arrangement for producing an emulsion explosive for use in an underground mining operation.

[0002] The Applicant is aware that, particularly in relation to underground mining operations, supply or conveyance of emulsion explosives to underground mining sites, i.e. explosives use sites, is conventionally effected batch-wise, either by conveying the emulsion explosives along a mine shaft using a mine cage or along a ramp or descending road system using a motor vehicle-based transportation system. Typically, the explosives so supplied are in the form of a packaged and ready to use explosive product, such as an emulsion; an ammonium nitrate (AN) prill, for example Anfex (trade name) prills; or a bulk emulsion. The Applicant has found that supply systems of the type described have disadvantages, including the fact that these systems cause a decrease in efficiency of the mine's "shaft time" due to the fact that the explosives are transported in ready-to-use form. More particularly, it will be appreciated that, due to safety concerns, people and mined ore cannot be transported in the same cage or motor vehicle simultaneously with explosives. The transport of explosives therefore potentially restricts mines to after hours conveyance of explosives. Further, transporting explosives in loading vehicles down inclined road systems has a significant cost implication with regards to wear on vehicles, as only one to two tons of explosive can, from a practical point of view, be transported at a time. One approach which can be followed to alleviate the abovementioned difficulties is to drop the explosives, particularly emulsion explosives, vertically down to the mining site along a pipeline. However, this approach in itself presents further difficulties in that emulsion explosives have minimum burning pressures (MBP), generally in the range of 20 to 70 bar; if the explosive is subjected to a pressure in excess of its MBP, it could detonate spontaneously. In other words, if such explosives are subjected to pressures above their M B P, as could happened if they are conveyed vertically downwardly for long distances, spontaneous detonation could occur. Deep vertical dropping of emulsion explosives is therefore extremely hazardous due to the increase in pressure that takes place, even if pressure control is exercised.

[0003] The Applicant believes that the present invention addresses the problems expressed hereinbefore, and presents a viable approach to providing emulsion explosives safely at underground mining operations.

[0004] Thus, according to a first aspect of the invention, there is provided a method of producing an emulsion explosive for use in an underground mining operation, the method including,

feeding, by means of gravity, an emulsion explosive oxidizer from an oxidizer source to an underground oxidizer holding zone in a mine, the oxidizer holding zone thus being located at a lower level than the oxidizer source;

separately feeding, by means of gravity, an emulsion explosive fuel from a fuel source to an underground fuel holding zone in the mine, the fuel holding zone thus being located at a lower level than the fuel source;

withdrawing oxidizer from the oxidizer holding zone, and fuel from the fuel holding zone;

separately feeding, under gravity, the oxidizer and the fuel withdrawn from their respective holding zones to at least one underground emulsion explosive production zone which is thus located at a lower level in the mine than the oxidizer holding zone and the fuel holding zone; and

producing an emulsion explosive by admixing the fuel and the oxidizer in the emulsion explosive production zone.

[0005] The gravity feeding of the oxidizer and the fuel from their respective sources to their respective holding zones may be along a shaft of the mine. Similarly, the gravity feeding of the oxidizer and the fuel from their respective holding zones to the emulsion explosive production zone may be along a shaft of the mine, preferably along the same shaft as that in which they are gravity fed from their respective sources to their respective holding zones.

[0006] The oxidizer and fuel are thus fed downwardly along the mine shaft, which typically extends vertically so that the oxidizer and fuel thus are fed or conveyed vertically downwardly under gravity, i.e. drop vertically under gravity. The method may, however, also include some horizontal conveyance of the oxidizer and the fuel from their sources to their holding zones and/or from their holding zones to the emulsion explosive production zone, in addition to the vertical conveyance thereof. Preferably, any such horizontal conveyance of the oxidizer and/or the fuel is effected without the need for any mechanical assistance, such as pumping. In other words, horizontal conveyance of the oxidizer and/or the fuel is preferably achieved by utilizing the pressure differential created through the vertical drop of the oxidizer and/or the fuel from their respective sources to their holding zones, and, where applicable, from their holding zones to the emulsion explosive production zone. The feeding or conveyance of the oxidizer and fuel typically takes place along pipes.

[0007] More particularly, the feeding of the oxidizer and/or fuel from their respective holding zones to the emulsion explosive production zone may include dropping each of them vertically down a pipe as well as, optionally, conveying them horizontally along a pipe, without any pumping thereof.

[0008] The method may include conveying or supplying the emulsion explosive from the emulsion explosive production zone to an explosives use zone. At least part of this conveyance may be horizontally along a pipe. Preferably, any horizontal conveyance of the emulsion explosive from the production zone to the use zone along a pipe is for a shorter distance than the distances that the oxidizer and the fuel are conveyed horizontally along their pipes from their respective holding zones to the production zone.

[0009] Preferably, no pumping of the oxidizer and the fuel is effected between their respective sources and the emulsion explosive production zone. At least part of the conveyance of the emulsion explosive from the production zone to the use zone may be effected by dropping the emulsion explosive vertically down a pipe, with the vertical distance that the emulsion explosive is dropped being less than that which the oxidizer and fuel are dropped from their respective holding zones to the production zone. In particular, conveyance of the emulsion explosive from its production zone to the use zone may be effected without any mechanical assistance, e.g. pumping thereof.

[0010] The oxidizer may be a cold oxidizer, i.e. an oxidizer which is in liquid form at ambient temperature.

[0011] The oxidizer may be selected from ammonium nitrate, sodium nitrate, sodium percolate, calcium nitrate and urea. Typically, the oxidizer may comprise a mixture of any two or more of ammonium nitrate, sodium nitrate, sodium percolate, calcium nitrate and urea. Preferably, the oxidizer comprises a mixture of ammonium nitrate and any one or more of sodium nitrate, sodium percolate, calcium nitrate and urea.

[0012] The fuel may be a fuel oil. The fuel oil may be virgin fuel oil. Instead, the fuel oil may be waste or used fuel oil and may thus contain impurities such as polyisobutylene succinic anhydride (Pibsa) based surfactants and mining solvents.

[0013] The method may include maintaining the maximum pressure of the oxidizer at between 5 bar and 40 bar, preferably at about 10 bar. The method may also include maintaining the maximum pressure of the fuel at between 5 bar and 40 bar, preferably at about 10 bar. The method may thus include controlling the pressure of the oxidizer and the fuel by means of one or more pressure control systems. However, it is expected that the pressure will normally be controlled by locating the holding zones at appropriate levels in the mine to ensure that the maximum pressure of the oxidizer and the fuel in their respective systems and, for that matter, in the production zone, is between 5bar and 40bar, typically 10bar.

[0014] The oxidizer and the fuel may thus each be fed into the production zone at a pressure suitable for producing the emulsion explosive. More particularly, the oxidizer and the fuel may each be fed to the production zone at a pressure of between 5 bar and 40 bar, preferably at about 10 bar. Preferably, the method includes generating the pressure required for producing the emulsion explosive in the oxidizer and the fuel streams by dropping the oxidizer and fuel from the oxidizer and fuel holding zones; respectively, a sufficient vertical distance so as to generate the required pressure head in oxidizer and fuel at the production zone. Thus, the pressure head should be sufficient to drive the oxidizer and the fuel through an emulsification device or emulsator, e.g. a mixer, and, optionally, a homogenizer.

[0015] The method may thus also include subjecting the produced emulsion explosive to secondary refinement, such as homogenization, in the production zone.

[0016] The method may further, as hereinbefore stated, include supplying or distributing the produced emulsion explosive from the emulsion production zone to the use zone, which may comprise one or more underground explosive loading zones the emulsion explosive can be transported, e.g. by means of loading vehicles, to one of more mined rock faces or other mining sites where the explosive is required. Alternatively, or additionally, the method may include distributing or conveying the emulsion explosive directly from the emulsion production zone to a use zone comprising one or more mined rock faces, or other mining sites where the explosive is required, typically along a vertical pipe and, optionally, a section of horizontal pipe, and loading the emulsion explosive into blast holes.

[0017] Instead, or additionally, the use zone, may comprise one or more underground emulsion explosive storage zones in which the emulsion explosive is stored for use as required at various mining sites. Preferably, in such a case, distribution of the emulsion to the one or more storage zone occurs under gravity. The method may also include transferring emulsion explosive from the storage zones to one or more underground loading zones or mined rock faces as hereinbefore described.

[0018] The emulsion production zone thus comprises an emulsion explosive production facility. This facility may be mobile. Thus, in such a case, the method may include displacing or advancing the emulsion production facility, and hence the zone, as mining of an underground mined rock face progresses.

[0019] According to a second aspect of the invention, there is provided an emulsion explosive production arrangement for producing an emulsion explosive for use in an underground mining operation, the arrangement including

an oxidizer source from which a supply of an emulsion explosive oxidizer can be sourced;

a fuel source from which a supply of an emulsion explosive fuel can be sourced;

an underground oxidizer holding vessel located in a mine, with the oxidizer holding vessel being at the lower level than the oxidizer source;

an oxidizer supply line leading from the oxidizer source to the oxidizer holding vessel and along which oxidizer can pass under gravity;

an underground fuel holding vessel located in the mine, with the fuel holding vessel being at a lower level in the mine than the fuel source;

a fuel supply line leading from the fuel source to the fuel holding vessel and along which fuel can pass under gravity; and

an underground emulsion explosive production facility, which is located at a lower level than the oxidizer and fuel holding zones, and to which an oxidizer distribution line and a fuel distribution line lead respectively from the oxidizer holding vessel and the fuel holding vessel and along which oxidizer and fuel respectively can pass under gravity from their holding vessels to the emulsion explosive production facility.

[0020] The oxidizer supply line and the fuel supply line may pass along a shaft of the mine. The oxidizer distribution line and the fuel distribution line may also pass along a shaft of the mine, preferably the same mine shaft as that in which the oxidizer supply line and the fuel supply line are located.

[0021] The oxidizer supply line and/or the fuel supply line and/or the oxidizer distribution line and/or the fuel distribution line may include, in addition to vertical sections, also horizontal sections. Preferably, no pumps are provided in either the horizontal or the vertical pipe sections.

[0022] The production arrangement may include an emulsion explosive transfer line leading from the emulsion explosive production facility to an explosives use zone. At least part of the emulsion explosive transfer line may extend horizontally; preferably, this horizontally extending section may then be shorter than the lengths of the horizontal sections of the oxidizer distribution line and/or the fuel distribution line.

[0023] Preferably, there is no pump in the horizontal of the emulsion explosive transfer line.

[0024] The oxidizer and the fuel may be as is hereinbefore described.

[0025] The oxidizer source may comprise an oxidizer storage container, in which the oxidizer may be provided in bulk. Similarly, the fuel source may comprise a fuel storage container in which the fuel may be provided in bulk.

[0026] The oxidizer holding vessel or container is thus in flow communication with the oxidizer source by means of the oxidizer line or pipe. Similarly, the fuel holding vessel of container is in flow communication with the fuel source by means of the fuel supply line or pipe.

[0027] The oxidizer holding vessel and the fuel holding vessel are accordingly located at a lower level in the mine than the oxidizer and fuel sources. In one embodiment of the invention, the oxidizer and fuel holding vessels may be located in unused mining galleries or in side tunnels of the mine shaft.

[0028] The emulsion explosive production facility may include a mixing device, or emulsator, such as a mixing tank, a jet mixer, pin mill, stirpot and the like, to which the fuel and oxidizer may, in use, be fed respectively along the fuel distribution line and the oxidizer distribution line. The emulsion explosive production facility may also include secondary refinement means, typically comprising a homogenizer, as well as other ancillary equipment required for production of the emulsion explosive.

[0029] The emulsion explosive production facility may be mobile. In one embodiment of the invention, the production facility may be mounted on a carriage, thereby rendering the production facility mobile. The carriage may be a wheeled carriage. Preferably, however, the carriage is provided with skids which render the carriage, and thereby the production facility, slidably displaceable along a floor of a mining gallery.

[0030] The use zone may comprise one or more emulsion explosive loading zones to which emulsion explosive is distributed along the emulsion explosive transfer line for transport to mined rock faces and other underground mining sites.

[0031] The production arrangement may also include one or more emulsion explosive storage zones in which emulsion explosive, which has been produced in the emulsion explosive production facility, can be stored for later usage in the mine. It will be appreciated that, in such a case, an emulsion explosive may also be supplied to an emulsion explosive loading zone from the storage zone, along an emulsion explosive distribution line or pipe.

[0032] The production arrangement may further include one or more loading vehicles, to which emulsion explosive may be provided in the loading zone.

[0033] The invention will now be described in more detail by way of illustrative example only with reference to the accompanying diagrammatic drawings.

[0034] In the drawings:

FIGURE 1 shows a sectional view of an emulsion explosive production arrangement in accordance with the invention; and

FIGURE 2 shows a perspective view of an emulsion production facility forming part of the production arrangement shown in Figure 1.

[0035] Referring particularly to Figure 1, reference numeral 10 generally indicates an emulsion explosive production arrangement in accordance with the invention. The arrangement 10 is provided in a mine shaft 12. The mine also comprises various mining galleries 14 and side tunnels 15 which extend into an ore-carrying ground body 17 at various levels down a vertical mine shaft 16.

[0036] The arrangement 10 includes an oxidizer source 18, a fuel source 19, first and second oxidizer holding zones 20.1, 20.2 respectively, a fuel holding zone 22, an emulsion explosive production zone 24 and an emulsion explosive holding zone 25.

[0037] The oxidizer source 18 comprises an oxidizer storage container or tank 26, typically having a twenty ton capacity. Similarly, the fuel source 19 comprises a fuel storage container or tank 28, typically having a 2 to 5 ton capacity. The tanks 26, 28 are located above ground, i.e. at the surface of the mine 12.

[0038] The first oxidizer holding zone 20.1 is provided by a first underground gallery 14. The holding zone 20.1 is provided with a first oxidizer holding tank 32 typically also having a capacity of twenty tons. The second oxidizer holding zone 20.2 is provided by a second underground lower gallery 14. The holding zone 20.2 is provided with second and third series-connected oxidizer holding tanks 34.1, 34.2. The holding zone 20.2 is located at a lower level in the mine than the holding zone 20.1.

[0039] The fuel holding zone 22 is provided in a third underground gallery 14. The holding zone 22 is provided with first and second series-connected fuel holding tanks 36.1, 36.2, each typically having a capacity of 2 to 5 tons.

[0040] All of the holding tanks 32, 34.1, 34.2, 36.1, 36.2 are ISO-tanks.

[0041] The explosive production zone 24 is provided by a still lower gallery 14. A mobile explosive production facility 37, as shown in more detail in Figure 2, is provided in the zone 24. The production arrangement 37 includes an emulsator, typically in the form of a jet mixer 38, and a secondary refinement device such as a homogenizer 40 which is series connected with the mixer 38. The explosive production facility 37 further includes a control panel 42 which is operatively connected to the mixer 38 and the homogenizer 40. In other versions of the invention, the emulsator may be in the form of a pin mill, stir pot, or the like.

[0042] The explosive holding zone 25 comprises an explosives holding tank 27, typically having a capacity of at least 20 tons.

[0043] From the oxidizer storage tank 26, an oxidizer feed line or pipe 44 leads down the mine shaft 16 to the first oxidizer holding tank 32 in the first oxidizer holding zone 20.1. A first vented oxidizer distribution line or pipe 46 leads from the tank 32, down the mine shaft 16, to the second oxidizer holding tank 34.1 in the second oxidizer holding zone. An oxidizer transfer line or pipe 48 leads from the tank 34.1 to the third oxidizer holding tank 34.2, while a second vented oxidizer distribution line or pipe 50 leads from the holding tank 34.2, down the mine shaft 16, to the emulsion explosive production zone 24. The lines or pipes 44, 46 and 50 have horizontal sections as well as vertical sections. No pumps are provided in any of the oxidizer lines or pipes.

[0044] From the fuel storage tank 28, a fuel transfer line or pipe 52 leads down the mine shaft 16 to the first fuel holding tank 36.1. A fuel transfer line or pipe 53 leads from the first fuel holding tank 36.1 to the second fuel holding tank 36.2, while a fuel distribution line or pipe 54 leads from the second fuel holding tank 36.2, down the mine shaft 16 to the emulsion explosive production zone 24. The line or pipes 52 and 54 have horizontal sections as well as vertical sections. Cumulatively, the length of the vertical section is much greater than the length of the horizontal section. No pumps are provided in any of the fuel lines or pipes.

[0045] From the emulsion explosive production zone 24, a first explosive distribution line or pipe 56 leads to the explosive holding tank 27 in the explosive holding zone 25 while an explosive transfer line or pipe 58 leads to a first explosive loading zone 60 in a side tunnel 15. A second explosive distribution line or pipe 62 leads from the explosive holding tank 27 to a second loading zone 64 in a lower side tunnel 15. The lines or pipes 56, 58 and 60 have vertical as well as horizontal sections. No pumps are provided in any of the emulsion explosive lines or pipes.

[0046] In use, oxidizer is provided to the oxidizer storage zone 18, more particularly to the oxidizer storage tank 26, from an oxidizer production facility 66 by means of a loading vehicle, in the illustrated embodiment being represented as a tanker 68.

[0047] Initially, oxidizer, preferably comprising a mixture of ammonium nitrate and at least one of sodium nitrate, sodium percolate, calcium nitrate and urea, is withdrawn from the oxidizer storage tank 26 and is conveyed or dropped, under gravity, to the first oxidizer holding tank 32 along the oxidizer feed line 44. To achieve this, a twenty ton batch metering system 70 is provided in the oxidizer feed line 44 for dispensing batch quantities of oxidizer. From the first oxidizer holding tank 32, oxidizer is then withdrawn and is subsequently fed to the second holding tank 34.1 along the first oxidizer distribution line 46. Oxidizer is transferred from the second oxidizer holding tank to the third oxidizer holding tank 34.2 along transfer line 48. Finally, oxidizer is withdrawn from the third oxidizer holding tank 34.2 along the second oxidizer distribution line 50 and is fed to the emulsion explosive production zone.

[0048] Fuel, in the form of a fuel oil, is withdrawn from the fuel storage zone or dropped, under gravity, 19, more particularly from the fuel storage tank 28, along fuel feed line 52 and is fed to the first fuel holding tank 36.1. Fuel is then transferred to the second fuel holding tank 36.2, and is subsequently withdrawn along fuel distribution line 54. The fuel withdrawn along distribution line 54 is fed to the emulsion explosive production zone 24.

[0049] In the emulsion explosive production zone, the oxidizer and the fuel are fed to the jet mixer 38 respectively along the second oxidizer distribution line 50 and the fuel distribution line 54. In the jet mixer 38, the oxidizer is emulsified in the fuel to provide a base emulsion explosive product. The base emulsion explosive product is transferred to the homogenizer 40 where the product is refined further by means of homogenization. Typically, the explosive product comprises oxidizer and fuel in a mass ratio of 700 kg fuel to 10 tons oxidizer.

[0050] A formulated emulsion explosive passes (under pressure as generated by the gravity drops to which the oxidizer and fuel were subjected less the pressure drops through the jet mixer 38 and the homogenizer 40) from the homogenizer 40, respectively along explosive distribution lines 56 and 58. The formulated emulsion explosive can be distributed, along distribution line 58, to the first explosive loading zone 60, where it is loaded on a first transport vehicle 61 for transport to a desired mining site. Similarly, the formulated emulsion explosive can be distributed, along distribution line 56, to the emulsion explosive holding tank 27. From the emulsion explosive holding tank 27, emulsion explosive is withdrawn along second emulsion explosive distribution line 62 and is distributed to the second emulsion explosive loading zone 64, where it is loaded on a second transport vehicle 65 for transport to a desired mining site.

[0051] It will be appreciated that horizontal transport of the fuel and the oxidizer occurs respectively along fuel distribution line 54 and oxidizer distribution line 50, when these lines 54, 50 enter the mining gallery 14 in which the fuel production zone is provided. Thus, horizontal transport of emulsion explosive is limited to a distance from the emulsion explosive production zone 24 to the first loading zone 60 and from the storage zone 25 to the second loading zone 62. Usually, the distance that the emulsion explosive must be transported along pipe lines is much smaller than the distance that the oxidizer and the fuel are conveyed along their pipe lines. In particular, the horizontal sections of the lines or pipes 56, 58 along which the explosive is conveyed, are much shorter than the horizontal sections of the oxidizer line or pipe 50 and the fuel line or pipe 54.

[0052] Furthermore, the levels or depths at which the holding zones 20.1, 20.2 and 22 are located are selected so as to control the pressure of the oxidizer and fuel. Typically, their levels will be selected so that the maximum pressures of the oxidizer and fuel in their respective lines and/or holding tanks, and on entry into the production facility, is at a predetermined value, typically about 10 bar. This pressure will permit non-hazardous conveyance of the oxidizer and fuel along their lines or pipes, and will be sufficient to force the oxidizer and fuel through the jet mixer 38 and homogenizer 40, and along the resultant emulsion explosive along the lines or pipes 56, 58 without further mechanical input, e.g. pumping, being required.

[0053] The Applicant regards it as a particular advantage of the invention as described that the vertical conveyance along a pipe of a cold oxidizer phase, i.e. at ambient temperature, does not present the same potential dangers associated with increased pressure as is the case in vertical conveyance along a pipe of an emulsion explosive.

[0054] It is further regarded as particularly advantageous that the oxidizer and fuel phases can be piped horizontally easily and for long distance, if required; this is not the case with emulsions which are notoriously difficult to pipe horizontally. In accordance with the invention, horizontal piped conveyance of emulsion explosive underground can be minimized, since the emulsion explosive can be produced at a location where it is required, due to the displaceability of the explosive production zone. It is also possible for multiple production zones to be employed.

[0055] The vertical conveyance of the oxidizer phase also permits much deeper penetration into the mine, since the dangers associated with exceeding the MBP's of emulsion explosives are avoided.

[0056] A further advantage of the invention as described is that a more cost effective, short shelf live emulsion explosive can be produced, since there will be little delay between the production of the explosive and usage thereof. The Applicant is aware that a normal emulsion has a 3 to 6 month shelf life. Emulsions manufactured underground would only need a shelf life of days. A short shelf life would also be desirous, since there would be limited product storage as it is envisaged that explosives would be, so to say, "on tap" and ready for use as and when required.

[0057] It is envisaged that the emulsion explosive production zone, and more particularly the production arrangement, would be considerably more cost effective to provide than conventional emulsion explosive manufacturing production arrangements. It is also expected that elimination of heat generating processes, pumps, storage tanks and control systems may enable the usage of a portable production arrangement. It is also envisaged that, once commissioned, the need for skilled operators of the explosive production arrangements would be obviated.

[0058] It is regarded as yet another advantage of the invention that the manufacture of explosives at a mined rock face is expected to eliminate the requirement of sensitizing and loading equipment. The pressure delivered by the static head, due to vertical spacing of the fuel and oxidizer holding zones relative to the production zone, to produce the emulsions could also be used to sensitize and load the explosive, thereby to produce a "sensitized emulsion on tap". It is envisaged that a loading hose with a sensitising device could be sufficient to load manufactured explosive into a blast hole.

[0059] Further, calculation of the volumes needed underground at a specific site, with the assumption that emulsions could be manufactured on a continuous basis, reveals that the production arrangements would likely be very small in comparison to existing processes, i.e. of the order of 15kg/min as opposed to 250kg/min. This would also reduce not only the operating costs of the production arrangement but also the size of the raw material supply lines to the production arrangement.

Claims

1. A method of producing an emulsion explosive for use in an underground mining operation, the method including,

   feeding, by means of gravity, an emulsion explosive oxidizer from an oxidizer source to an underground oxidizer holding zone in a mine, the oxidizer holding zone thus being located at a lower level than the oxidizer source;

   separately feeding, by means of gravity, an emulsion explosive fuel from a fuel source to an underground fuel holding zone in the mine, the fuel holding zone thus being located at a lower level than the fuel source;

withdrawing oxidizer from the oxidizer holding zone, and fuel from the fuel holding zone;
separately feeding, under gravity, the oxidizer and the fuel withdrawn from their respective holding zones to at least one underground emulsion explosive production zone which is thus located at a lower level in the mine than the oxidizer holding zone and the fuel holding zone; and
producing an emulsion explosive by admixing the fuel and the oxidizer in the emulsion explosive production zone.

2. The method according to Claim 1, wherein the gravity feeding of the oxidizer and the fuel from their respective sources to their respective holding zones is along a shaft of the mine.

3. The method according to Claim 2, wherein the gravity feeding of the oxidizer and the fuel from their respective holding zones to the emulsion explosive production zone is along the same shaft as that in which they are gravity fed from their respective sources to their respective holding zones.

4. The method according to any one of Claims 1 to 3 inclusive, wherein the feeding of the oxidizer and/or the fuel from their respective holding zones to the emulsion explosive production zone includes dropping each of them vertically down a pipe as well as conveying them horizontally along a pipe, without any pumping thereof.

5. The method according to Claim 4, wherein the emulsion explosive is conveyed from the emulsion explosive production zone to an explosives use zone, with at least part of this conveyance being horizontally along a pipe, and with the horizontal conveyance of the emulsion explosive along the pipe being for a shorter distance than the distances that the oxidizer and the fuel are conveyed horizontally along their pipes from their respective holding zones to the production zone.

6. The method according to Claim 5, wherein no pumping of the oxidizer and the fuel is effected between their respective sources and the emulsion explosive production zone.

7. The method according to Claim 5 or Claim 6 inclusive, wherein at least part of the conveyance of the emulsion explosive from the production zone to the use zone is effected by dropping the emulsion explosive vertically down a pipe, with the vertical distance that the emulsion explosive is dropped being less than that which the oxidizer and fuel are dropped from their respective holding zones to the production zone.

8. The method according to any one of Claims 4 to 7 inclusive, wherein the oxidizer and the fuel enter the production zone at a pressure of between about 5 bar and about 40 bar.

9. The method according to Claim 8, wherein the production of the emulsion explosive in the production zone includes passing the oxidizer and the fuel through an emulsator and, optionally, a homogenizer, with the pressure required to pass the oxidizer and fuel through the emulsator and, if applicable, the homogenizer so as to produce the emulsion explosive being generated by dropping the oxidizer and the fuel a sufficient vertical distance from their respective holding zones to obtain the required pressure head for the oxidizer and fuel to pass through the emulsator, thereby being emulsified, and if present, through the homogenizer, and with no pumping of the emulsion explosive from the production zone to the use zone being effected.

10. An emulsion explosive production arrangement for producing an emulsion explosive for use in an underground mining operation, the arrangement including
an oxidizer source from which a supply of an emulsion explosive oxidizer can be sourced;
a fuel source from which a supply of an emulsion explosive fuel can be sourced; an underground oxidizer holding vessel located in a mine, with the oxidizer holding vessel being at the lower level than the oxidizer source;
an oxidizer supply line leading from the oxidizer source to the oxidizer holding vessel and along which oxidizer can pass under gravity;
an underground fuel holding vessel located in the mine, with the fuel holding vessel being at a lower level in the mine than the fuel source;
a fuel supply line leading from the fuel source to the fuel holding vessel and along which fuel can pass under gravity; and
an underground emulsion explosive production facility, which is located at a lower level than the oxidizer and fuel holding zones, and to which an oxidizer distribution line and a fuel distribution line lead respectively from the oxidizer holding vessel and the fuel holding vessel and along which oxidizer and fuel respectively can pass under gravity from their holding vessels to the emulsion explosive production facility.

11. The production arrangement according to Claim 10, wherein the oxidizer supply line and the fuel supply line pass along a shaft of the mine.

12. The production arrangement according to Claim 11, wherein the oxidizer distribution line and the fuel distribution line pass along the same mine shaft as the oxidizer supply line and the fuel supply line.

13. The production arrangement according to any one of Claims 10 to 12 inclusive, wherein the oxidizer distribution line and the fuel distribution line include, in addition to vertical sections, also horizontal sections, with no pumps being provided in either the vertical or the horizontal sections.

14. The production arrangement according to Claim 13, which includes an emulsion explosive transfer line leading from the emulsion explosive production facility to an explosives use zone, with at least a part of the emulsion explosive transfer line extending horizontally and with this horizontally extending section being shorter than the lengths of the horizontal sections of the oxidizer distribution line and the fuel distribution line.

15. The production arrangement according to any one of Claims 10 to 14 inclusive, wherein the oxidizer and fuel holding vessels are each located in an unused gallery or side tunnel of the mine shaft.

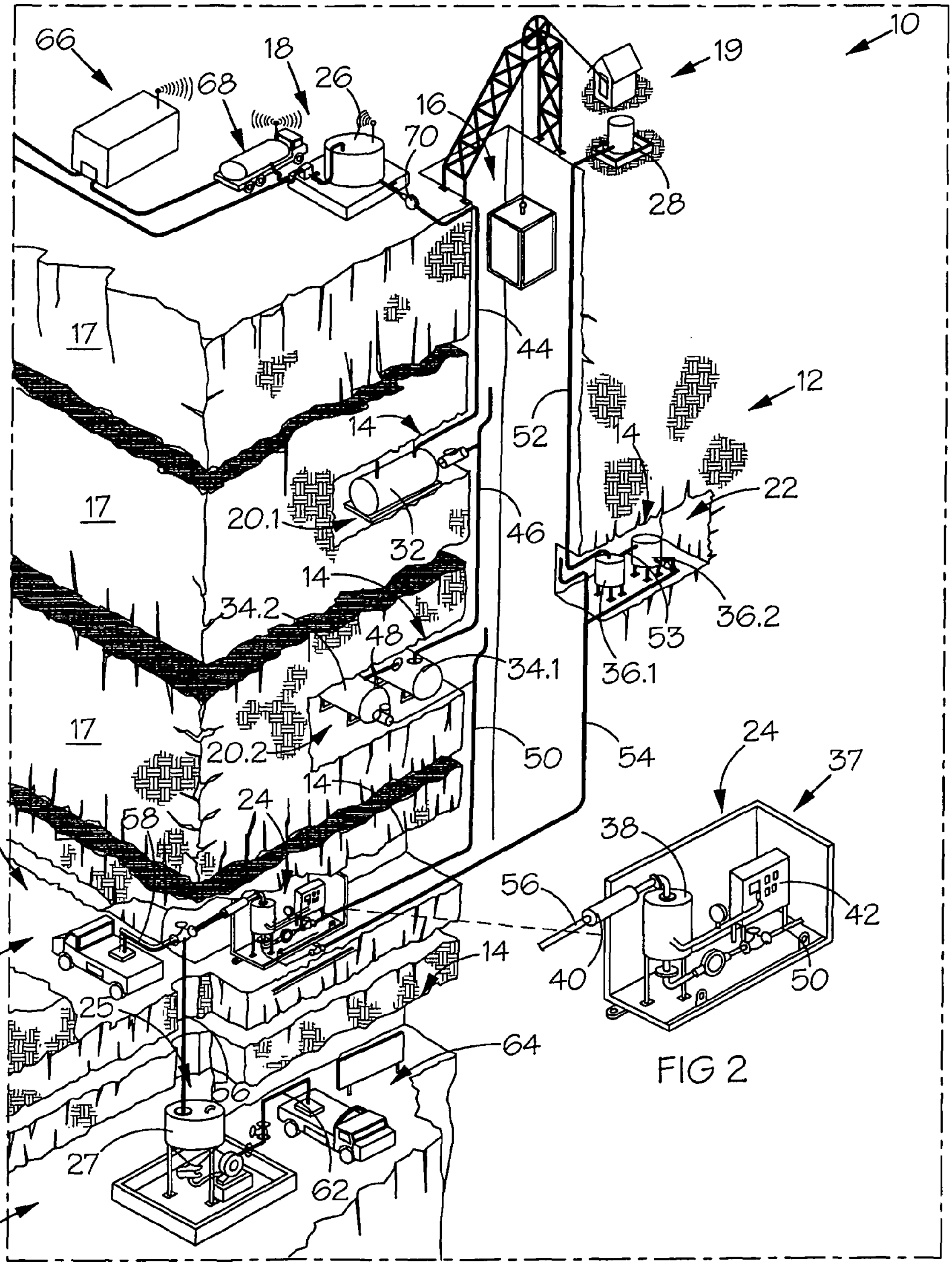
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FIG 2

FIG 1