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(54) **Title:** A METHOD OF REDUCING SUBSIDENCE OR WINDBLAST IMPACTS FROM LONGWALL MINING

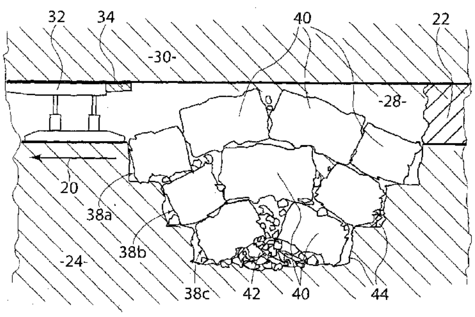

FIG 7

(57) **Abstract: A** method of reducing subsidence or windblast impacts from longwall mining (20). The method comprising the steps of: drilling at least one hole (36) across all or part of a footwall region (24) beneath a goaf (28); loading the hole or holes (36) with explosive; and firing the explosive(s) to upwardly expand material in the footwall adjacent the holes or holes (36) into the goaf (28).

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A METHOD OF REDUCING SUBSIDENCE OR WINDBLAST IMPACTS FROM LONGWALL MINING

Field of the Invention

The present invention relates to a method of reducing subsidence or windblast impacts from longwall mining.

The present invention has been developed primarily for use in longwall mining of coal but is also applicable to mining other materials including metalliferous ores and Gold. The invention also finds application in filling tunnels for underground caverns and the creation of stable underground liquid storage caverns.

Background of the Invention

Longwall mining involves the mechanical extraction, under protective hydraulic roof supports, of a horizontal or a sub-horizontal material strata such as a coal seam. The roof supports are moved in the direction of extraction as the strata is extracted, and the overhanging rock (known as a hanging wall) is allowed to collapse into a void (known as a goaf) remaining behind the mining operation. This collapsing of the rock in the hanging wall can propagate to the ground surface above the mining operation and cause: subsidence; compressive and tensile horizontal strains; surface cracking and sink holes; cliff and valley rockfalls; and in certain incised valley terrains compressive stresses can cause rising ground surface levels (known as "upsidence").

The ground movements referred to above cause damage to buildings and other infrastructure, and can alter the flow patterns in natural and constructed drainage. Subsidence caused by longwall mining can also have effect below ground surface and, for example, fracture rock and allow gas and ground water to escape confining layers. This can lead to surface gas emissions and changed aquifer conditions. This can also result in bores into deeper aquifers being lost when movement occurs across horizontal or sub-horizontal fractures. Deep fractures can also drain natural rockfalls and streams into sub-surface fractures, with consequent loss in aquatic and riparian habitat and stream flows.

There have been several known attempts to manage or reduce subsidence impacts from longwall mining. The main management method does not directly minimise the subsidence but instead minimises the consequence of such subsidence impacts on structures and the environment by requiring developments oyer a mining area to be built to withstand the predicted subsidence impacts. A disadvantage of this approach is it increases the cost of the development. Further, in New South Wales, when a new mine, or an extension to an existing mine is proposed, the mining company must typically develop or has imposed on it a subsidence management plan that attempts to manage impacts by all or some of the following measures: predicting mine subsidence impacts; planning the longwall mine to either avoid sensitive areas or planning longwall panel alignment or width to minimise impact on critical areas; conducting pre-mining dilapidation surveys on buildings, infrastructure and natural features; pre-strengthening buildings and infrastructure to withstand the predicted subsidence impacts; setting aside funds during mining operation to cover mine subsidence impacts; monitoring subsidence impacts after the longwall panel is extracted; and repairing damaged buildings, infrastructure and natural features during the time that subsidence impacts persist. Disadvantages of this approach include that it is very time consuming, expensive, requires a large number of personnel and often results in resources being unable to be extracted.

A known method of directly reducing mine subsidence is to backfill the void before the hanging wall collapses into the goaf. The disadvantages associated with this method include: the requirements for a large amount of material to fill the void; the associated two-way handling of the material being difficult in the confined and progressively and unpredictably collapsing space of the goaf; difficulties with completely filling the void with compacted material suitable to resist the collapsing hanging wall; the injury risk associated with working in the goaf void due to imminent and unpredictable roof collapse; and the placement of the backfill material slowing down the longwall mining process.

An alternative method has been to hydraulically backfill the mining void with a slurry or grout. For example, it is known to fill a void with sand, tailings and coal-fired power station ash mixed with cement to provide strength when cured. The disadvantages of this method include: the relatively high cost; the requirement for, and cost of, impoundments to be progressively constructed behind the longwall extraction face with a second longwall system and crew; and the difficulty in the backfill being able to develop suitable compressive strength to resist collapse before the longwall mining can progress and filling of another section begin. This significantly slows the speed and increases the cost of longwall mining.

US Patent No. 4,044,563 and US Patent No. 4,968,187 disclose filling the goaf from above after drilling into it from the surface with a slurry and a dry granular material respectively. Another surface based approach involves injecting grout into the overlying strata as voids are created by weaker strata separating from stronger strata. Disadvantages associated with such surface based approaches include that they: are expensive; require a large height of overburden over the longwall panel with differentially weak and strong layers; require large volumes of fine material of certain specification and water to form the grout; and require surface access over the mined area for drilling and injection which can be problematic in urbanised or protected areas.

Underground longwall mines are also subject to a hazard known as windblast. Windblast is a sudden rush of air or gas created in underground workings due to the sudden collapse of a void. In longwall mines with competent rock strata over the extracted seam, the roof or hanging wall will resist collapse when the hydraulic roof supports advance, and a large area (up to several hectares) of open goaf can develop. When the area of roof does does collapse, often will minimal warning, the displaced air or gas occupying the goaf void creates a blast of air and an over pressure wave that propagates through the mine tunnels, often quickly followed by a "suck back" of negative pressure as the air pressure equalises with the low pressure created by voids created higher in the hanging wall.

Windblast is one of the most serious events that can occur in an underground mine. They are violent, uncontrolled and their prediction is not yet a certain science. The effects of a windblast include: large displacements of atmosphere from mined out areas into the working place; a shock wave associated with increased air pressures; abnormal pressure differentials; and high velocity (hurricane force) winds. The risks associated with windblast include: objects, from particle size up to in some instances hundreds of kilograms in weight, becoming projectiles; violent displacement of persons including the possibility of being drawn back into the goaf; flammable, noxious and/or irrespirable gases that have accumulated in the goaf inundating the working place; water that has accumulated in the goaf inundating the working place; dusts being raised into suspension including coal dust which can become explosive; massive roof, containing quartz, generating incendive sparks hot enough to provide ignition sources; damage to electrical apparatus during the course of the windblast providing ignition sources.

Windblasts have lead to injuries and fatalities. Measures taken by mines with windblast risks to minimise these risks include redesign of tunnels and roadways, monitoring of micro-seismic activity that may indicate an imminent collapse, requiring mine personnel to wear protective gear and have access to safe areas, having sensors that detect windblasts and cut off all electrical power, and careful geotechnical design of the mining. Some mines in Australia have also injected water into the overlying rocks under high pressure to create fractures and reduce the size of the roof collapses.

Object of the Invention

It is the object of the present invention to substantially overcome or at least ameliorate one or more of the above known disadvantages.

Summary of the Invention

Accordingly, in a first aspect, the present invention provides a method of reducing subsidence or windblast impacts from longwall mining, the method comprising the steps of:

drilling at least one hole across all or part of a footwall region beneath a goaf;

loading the hole or holes with explosive; and

firing the explosive(s) to upwardly expand material in the footwall adjacent the holes or holes into the goaf.

In a second aspect, the present invention provides a method of reducing subsidence impacts from longwall mining, the method comprising the steps of:

drilling at least one hole across all or part of a footwall region beneath a goaf;

loading the hole or holes with explosive; and

firing the explosive(s) to upwardly expand material in the footwall adjacent the holes or holes into the goaf.

In a third aspect, the present invention provides a method of reducing windblast impacts from longwall mining, the method comprising the steps of:

drilling at least one hole across all or part of a footwall region beneath a goaf;

loading the hole or holes with explosive; and

firing the explosive(s) to upwardly expand material in the footwall adjacent the holes or holes into the goaf.

The hole or holes is/are preferably substantially horizontal. The holes or holes is/are preferably horizontal, slightly angled to horizontal or a combination of horizontal and slightly angled to horizontal. The at least one holes is/are preferably drilled with a directional drilling rig or a non-directional drilling rig.

The hole or holes preferably extend across all of the footwall region.

The hole(s) preferably extend in a direction substantially normal to a direction of mining.

The hole or holes are preferably arranged to upwardly expand the material in the footwall into a ridge or arch into the goaf.

The holes preferably extend between chain pillars either side of the footwall.

The method preferably includes drilling one or more holes a first depth beneath the footwall and one or more holes at a second depth, the second depth deeper than the first depth, and firing the explosive in the hole or holes at the first depth prior to the holes or holes at the second depth.

The methods preferably includes drilling one or more holes at plurality of depths beneath the footwall, and firing the explosive in the hole or holes sequentially from lowest depth first to deepest depth last.

In one form, the holes are preferably arranged in a triangular pattern with a downwardly facing apex.

In another form, the holes are preferably arranged in a substantially vertical line.

The method preferably includes upwardly expanding material in the footwall with a plurality of explosive firings to form a series of said ridges or arches that are spaced apart in, and most preferably perpendicular to, the direction of mining.

The method preferably includes supporting the hanging wall above the goaf to minimise collapse during the drilling, loading and firing of the holes or holes.

The supporting of the hanging wall preferably includes spacing the explosive firings or controlling the goaf width between blasts.

The method preferably includes directly supporting of the hanging wall with one or more hydraulic roof support mechanisms, with sacrificial timber props or with rock bolts.

Detailed Description of the Drawings

Preferred embodiments of the invention will now be described, by way of examples only, with reference to the accompanying drawings in which:

Fig. 1 is a schematic cross-sectional side view of a typical longwall mining operation;

Fig. 2 shows a longwall mining operation after the drilling and charging of a hole with explosives;

Fig. 3 shows the longwall mining operation shown in Fig. 2 after firing of the explosives;

Fig. 4 shows a longwall mining operation after the drilling and charging of 3 holes with explosives;

Fig. 5 shows the mining operation of Fig. 4 after firing of the explosives;

Fig. 6 shows a longwall mining operation of Fig. 1 after the drilling and charging of 6 holes with explosives;

Fig. 7 shows the mining operation of Fig. 6 after firing of the explosives;

Fig. 8 shows the longwall mining operation of Fig. 7 after firing of several groups of explosives, each similar to those shown in Figs. 4 and 5;

Fig. 9 is a schematic cross-sectional end view of a longwall mining operation showing holes for explosives;

Fig. 10 is a schematic cross-sectional end view of a longwall mining operation showing alternate holes for explosives;

Fig. 11 is a schematic cross-sectional top view of a longwall mining operation showing holes for explosives;

Fig. 12 shows a longwall mining operation after the drilling and charging of 2 holes with explosives;

Fig. 13 shows the mining operation of Fig. 12 after firing of the explosives;

Fig. 14 shows a longwall mining operation after the drilling and charging of 3 holes with explosives; and

Fig. 15 shows the mining operation of Fig. 14 after firing of the explosives.

Detailed Description of the Preferred Embodiments

Fig. 1 shows a schematic cross-sectional side view of a typical longwall coal mining operation proceeding in a mining direction 20. Fig. 1 shows a seam 22 being mined above a footwall 24. A longwall mining face 26 has a goaf 28 created behind it by the extraction of mined material and results in a hanging wall 30 being created above the goaf 28. The hanging wall 30 is supported by a hydraulic roof support mechanism 32.

In a typical longwall mining operation, the hydraulic roof support 32 is configured with the objective of having the hanging wall 30 collapse into the goaf 28 as soon as possible, so as to reduce the load on the hydraulic roof support. However, for the methods that will be described below, it is desirable for the hydraulic roof support 32 to include an extension 34, in the opposite direction to the direction of mining 20. The extension 34 is used support the hanging wall 30 and keep the goaf 28 largely free of collapse, as will be explained in more detail below. This process can also be assisted by adding fingers to the back of the hydraulic roof support 32, similar to those on a tunnel boring machine, installing sacrificial timber props in the goaf 28, or rock bolting in the hanging wall 30.

An embodiment of the method of reducing subsidence in longwall mining shall now be described with reference to Figs. 2 and 3.

Fig. 2 shows a longwall mining operation after the drilling of a hole 36 across most or all of the footwall 24 and beneath the goaf 28. The hole 36 extends across the footwall in a direction which is approximately normal to the direction of mining 20. The hole 36 is then charged with an explosive. Fig. 3 shows the longwall mining of Fig. 2 after the firing of the explosive in the hole 36. As is shown, the firing of the explosive causes the material adjacent the hole to fracture and expand upwardly and into the goaf 28. The extension 34 supports the hanging wall 30 and keeps the goaf 28 largely free of collapse during the drilling, loading and firing steps.

The fractured material takes the general form of a ridge or arch 38 formed from: rock segments 40; expanded rock fragments or rubble 42; and voids 44. When longwall mining recommences, the hanging wall 30 begins to collapse into the remaining space in the goaf 28 and loads the (expanded) footwall rock and the arch 38 of expanded footwall rock. The arch 38 advantageously resists the hanging wall collapse and reduces the effective height of the collapse. As a consequence, any subsidence over the mined longwall panel is also reduced.

The progress of the mining operation is preferably optimised between blasts in order to minimise collapse of the hanging wall. The optimisation can depend on the competency of the hanging wall strata and the width of the goaf, as the goaf may stay open or have minimal collapse without support for a considerable distance. The (modified) hydraulic roof supports mentioned above can be used to support one edge of the hanging wall. Alternatively, the goaf can be supported by sacrificial wooden props or rock-bolting. Regardless of the type support, the aim is to keep the goaf substantially open and for the footwall material to expand into a stable arch or ridge within the goaf. If too much collapse of the hanging wall occurs, the firing of the explosive can be confined and ineffective.

Fig. 4 shows a longwall mining operation after the drilling and charging of a triangular pattern of 3 holes 36 with explosive. The explosive in the shallowest hole are then fired first and the explosives in the deeper holes are subsequently fired after a delay.

This results in a three part arch 38a being formed over a two-part arch 38b, similarly locked in place with the rubble 42 and the voids 44.

Fig. 6 shows a longwall mining operation after the drilling and charging of a triangular pattern of 6 holes 36 with explosive. The explosive are fired sequentially, in layers from shallowest hole to deepest holes. As shown in Fig. 7 this results in the formation of the three layers of arches 38a, 38b and 38c.

Fig. 8 shows a longwall mining operation similar to that described with reference to Figs. 4 and 5 after the creation of four arched regions 38, each being created one after another after a subsequent advancement of the mining operation. Fig. 8 also shows ridges 46 of unfractured footwall that are left between each of the arched regions 38. The ridges 46 also assist in supporting the arched regions 38. Fig. 8 also shows that whilst some collapse of the hanging wall 30 into the goaf 28 has occurred, the resulting subsidence has been minimised.

Fig. 9 shows a directional drill rig 50 being used to drill holes 36 through the footwall 24 and beneath the goaf 28. The holes 36 have an initial minority downwardly directed section 36a followed by a majority horizontal section 36b.

Fig. 10 shows a pair of conventional drilling rigs 52 being used to create slightly downwardly angled holes 36 from extending into the footwall 24 beneath the goaf 28 from opposite directions.

Fig. 11 is a top view of longwall mining operation showing the holes 36 behind longwall equipment 60 and unmined seam 22. Support material is also left unmined either side of the seam 22, in the form of chain pillars 62.

Fig. 12 shows a longwall mining operation after the drilling and charging of a substantially vertical pattern of 2 holes 36 with explosive. The explosive are fired sequentially, in layers from shallowest hole to deepest hole. As shown in Fig. 13, this results in the formation of the arches 38a and 38b.

Fig. 14 shows a longwall mining operation after the drilling and charging of a substantially vertical pattern of 3 holes 36 with explosive. The explosive are fired sequentially, in layers from shallowest hole to deepest hole. As shown in Fig. 15, this results in the formation of the arches 38a, 38b and 38c.

The advantages of the methods of reducing subsidence in longwall mining described above include:

- It is a cost effective way to minimise subsidence, with relatively small amounts of material required (typically less than 1% of the material required for dry or hydraulic backfilling):
- It causes minimal disruption to the longwall mining cycle;
- A limited amount of material is required to be bought underground - typically less than a kilogram of high explosive can fracture a cubic metre of rock, which can be easily handled in the confined spaces of an underground longwall mine;
- The process is confined underground, and surface access is not required. This means that this process could be adopted in urban environments, adjacent sensitive structures and in protected areas such as National Parks or under stored waters where surface access is difficult or not possible;
- No direct access is required to the hazardous environment of the goaf, with the drilling, loading and firing process being undertaken from the side or sides of the longwall panel;
- The method has minimal impact on the longwall mining cycle. The blast holes can be drilled from the chain pillars prior to or during mining, and the only disruption to longwall mining is the time taken to load and fire the explosives in the holes;
- Can be used in combination with grouting, with such grouting of the voids above and between the arches or in the fractured rock further minimising subsidence impacts;
- The minimised subsidence impacts could potentially allows mining under areas previously restricted areas. For example, within the Southern Coalfield south of Sydney there is an estimated AU$ 100B worth of coal to be longwall mined, and large additional areas adjacent to these mines can not be accessed using existing methods as it is beneath National Park, water storage dams, residential areas, cliffs, or deeply incised creeks or rivers.

The above advantages result in the methods described above being cost-effective techniques for minimising longwall mining subsidence impacts.

In addition to reducing subsidence in longwall mining, the above described methods can also mitigate windblast risks in two ways. Firstly, the methods result in the void being filled with broken rock, thereby reducing/minimising the amount of air that can be displaced if the roof collapses. Secondly, the broken rock will decelerate the collapsing roof, reducing the over-pressure and shock wave.

Although the invention has been described with reference to the preferred embodiments, it will be appreciated by persons skilled in the art that the invention can be embodied in many other forms. For example: rock-bolting or placing sacrificial timber props can be used to minimise collapse of the hanging wall to allow for wider, less frequent blasting of the footwall. Also, directional drilling can be from one chain pillar to break out in the other. This is followed by inserting a plastic pipe liner in the hole, blowing through a string and then, when ready, to blast pulling a string of explosives through the hole. This can reduce the downtime required to load the blast holes.

The primary application for the invention is coal mines and the invention performs best with the footwall geology found in coal mines. Around 99% of longwall mining operations are for coal. However, it is also applicable for use in non-coal longwall mining operations, for example Gold mines in South Africa.

Claims

1. A method of reducing subsidence or windblast impacts from longwall mining, the method comprising the steps of:

drilling at least one hole across all or part of a footwall region beneath a goaf;

loading the hole or holes with explosive; and

firing the explosive(s) to upwardly expand material in the footwall adjacent the holes or holes into the goaf.

2. A method of reducing subsidence impacts from longwall mining, the method comprising the steps of:

drilling at least one hole across all or part of a footwall region beneath a goaf;

loading the hole or holes with explosive; and

firing the explosive(s) to upwardly expand material in the footwall adjacent the holes or holes into the goaf.

3. A method of reducing windblast impacts from longwall mining, the method comprising the steps of:

drilling at least one hole across all or part of a footwall region beneath a goaf;

loading the hole or holes with explosive; and

firing the explosive(s) to upwardly expand material in the footwall adjacent the holes or holes into the goaf.

4. The method as claimed in claim 1, 2 or 3, wherein the hole or holes is/are substantially horizontal.

5. The method as claimed in claim 1, 2 or 3, wherein the holes or holes is/are slightly angled to horizontal.

6. The method as claimed in claim 1, 2 or 3, wherein the hole or holes is/ are a combination of horizontal and slightly angled to horizontal.

7. The method as claimed in any one of the preceding claims, wherein the hole or holes is/are drilled with a directional drilling rig.

8. The method as claimed in any one of claims 1 to 6, wherein the at least hole or holes is/are drilled with a non-directional drilling rig.

9. The method as claimed in any one of the preceding claims, wherein the hole or holes extend across all of the footwall region.

10. The method as claimed in any one of the preceding claims, wherein the hole or hole(s) extend in a direction substantially normal to a direction of mining.

11. The method as claimed in any one of the preceding claims, wherein the hole or holes are arranged to upwardly expand the material in the footwall into a ridge or arch into the goaf.
12. The method as claimed in any one of the preceding claims, wherein the hole or holes extend between chain pillars either side of the footwall.
13. The method as claimed in any one of the preceding claims, wherein the method includes drilling one or more holes at a first depth beneath the footwall and one or more holes at a second depth, the second depth deeper than the first depth, and firing the explosive in the hole or holes at the first depth prior to the holes or holes at the second depth.
14. The method as claimed in any one of claims 1 to 12, wherein the methods includes drilling one or more holes at plurality of depths beneath the footwall, and firing the explosive in the hole or holes sequentially from lowest depth first to deepest depth last.
15. The method as claimed in claim 14, wherein the holes are arranged in a triangular pattern with a downwardly facing apex.
16. The method as claimed in claim 14, wherein the holes are arranged in a substantially vertical line.
17. The method as claimed in any one of the preceding claims, wherein the method includes upwardly expanding material in the footwall with a plurality of explosive firings to form a series of said ridges or arches that are spaced apart in the direction of mining.
18. The method as claimed in any one of claims 1 to 16, wherein the method includes upwardly expanding material in the footwall with a plurality of explosive firings to form a series of said ridges or arches that are spaced apart in, and perpendicular to, the direction of mining.
19. The method as claimed in any one of the preceding claims, wherein the method includes supporting the hanging wall above the goaf to minimise collapse during the drilling, loading and firing of the holes or holes.
20. The method as claimed in claim 19, wherein the supporting of the hanging wall includes spacing the explosive firings or controlling the goaf width between blasts.
21. The method as claimed in claim 19 or 20, wherein the method includes directly supporting of the hanging wall with one or more hydraulic roof support mechanisms, with sacrificial timber props or with rock bolts.

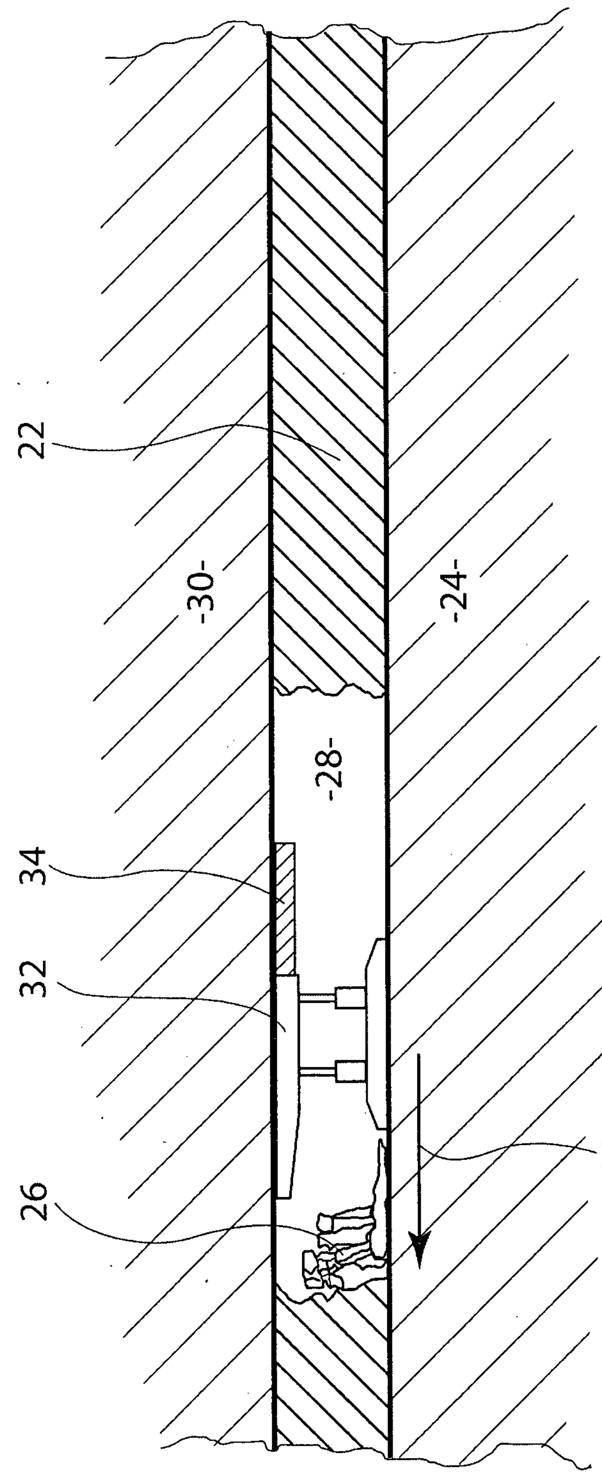


FIG 1

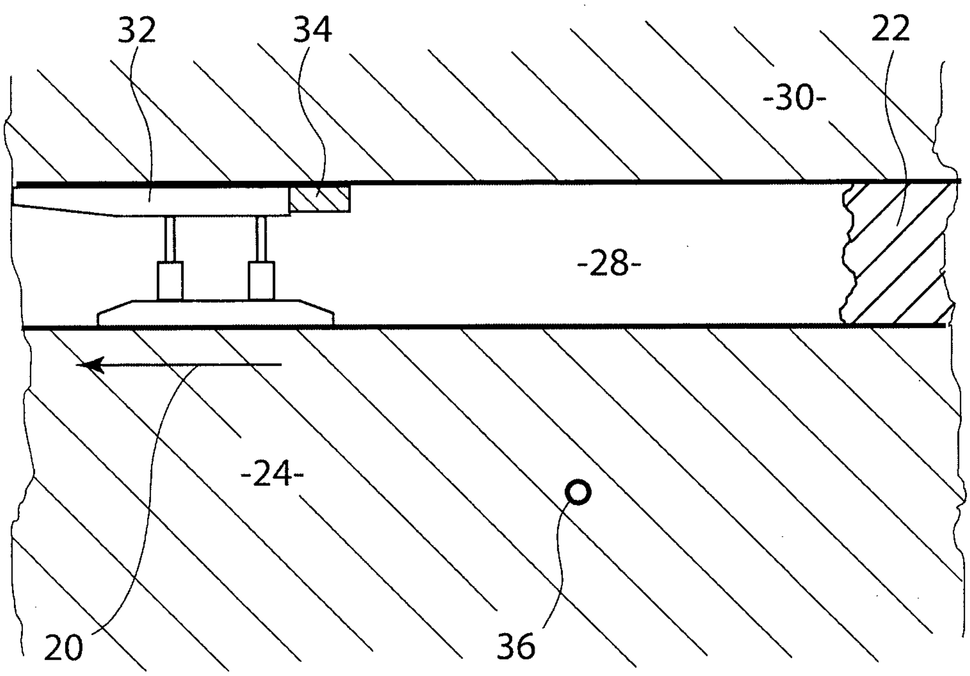
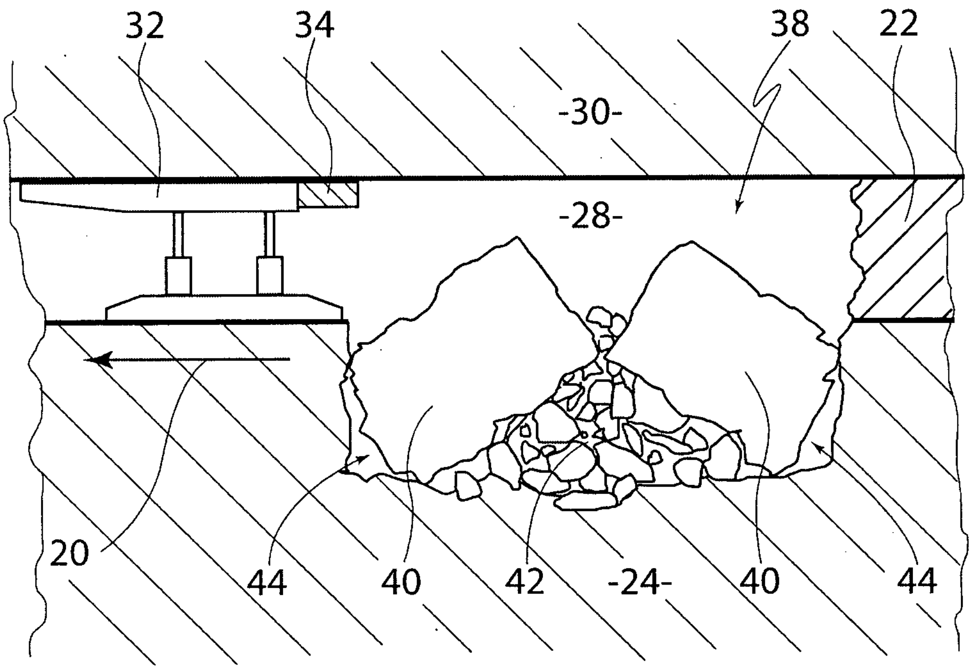


FIG 2



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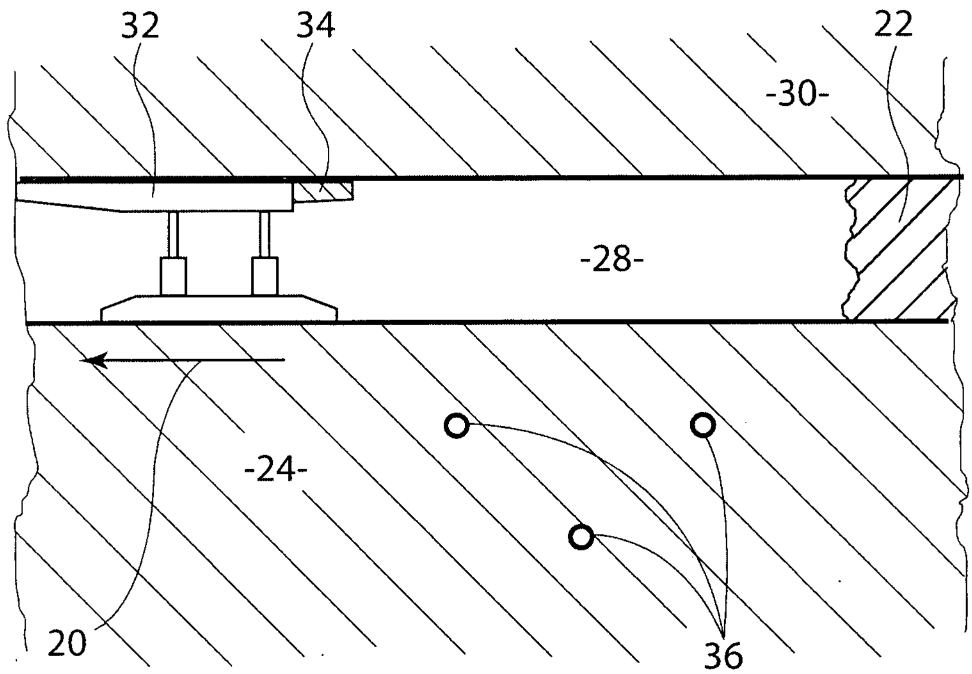

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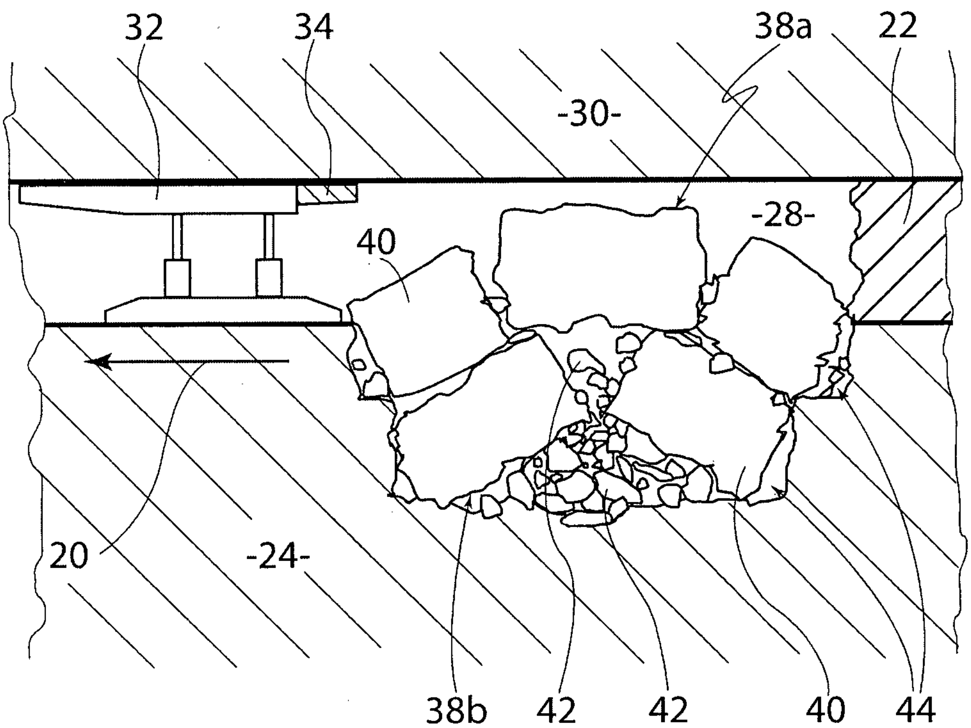

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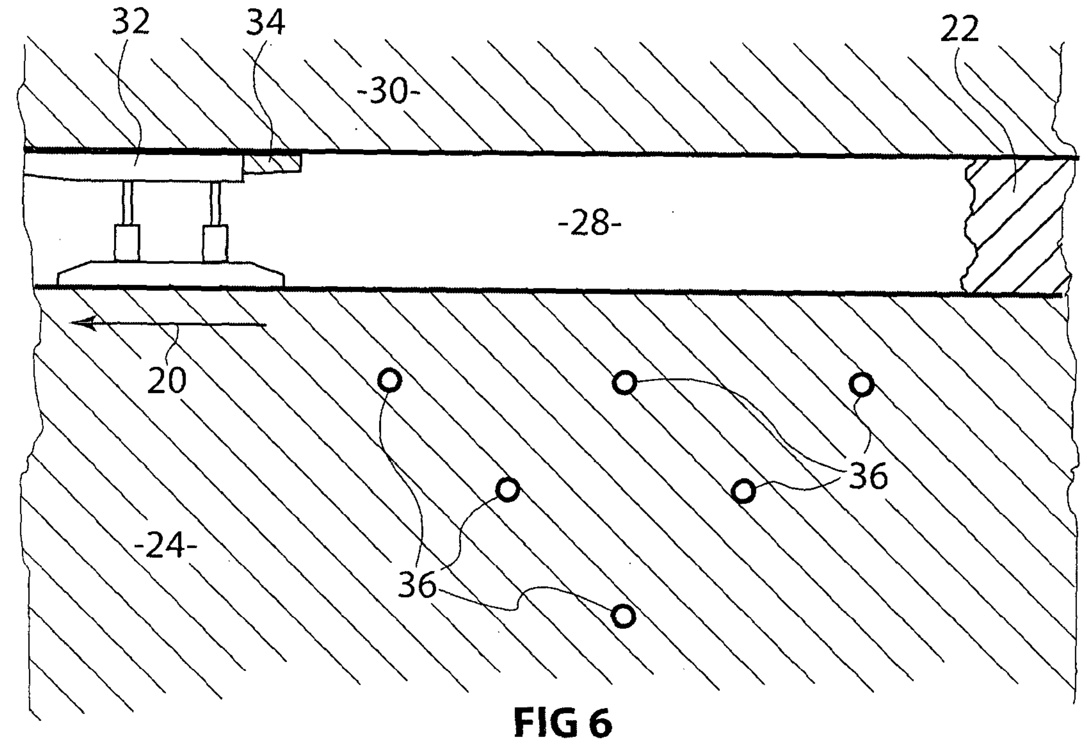

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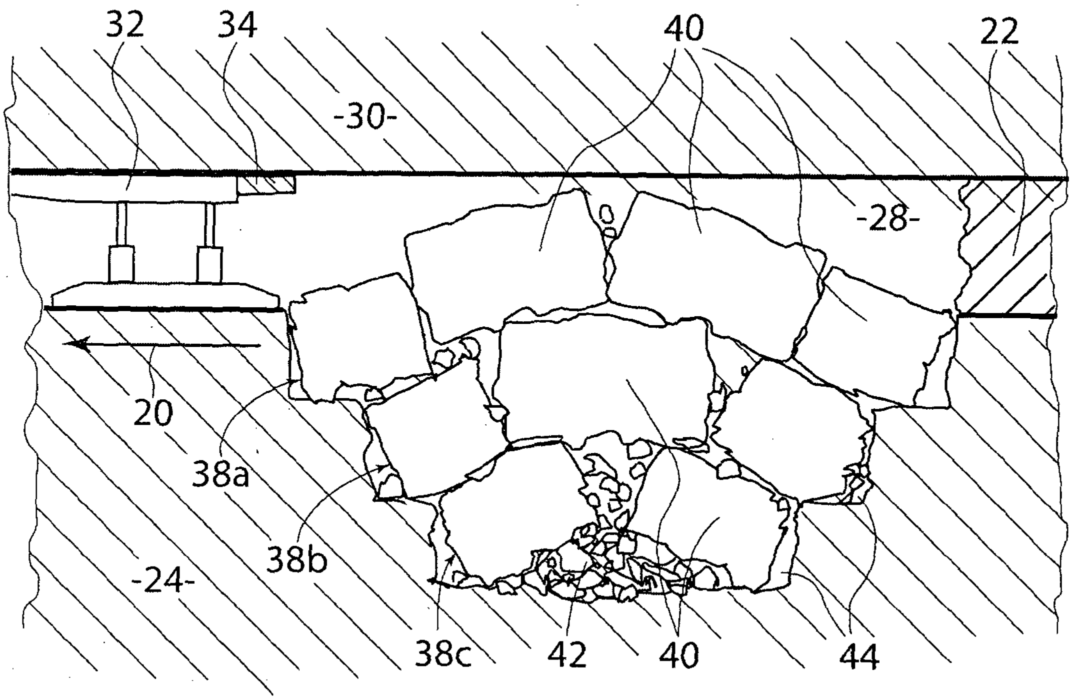

FIG 7

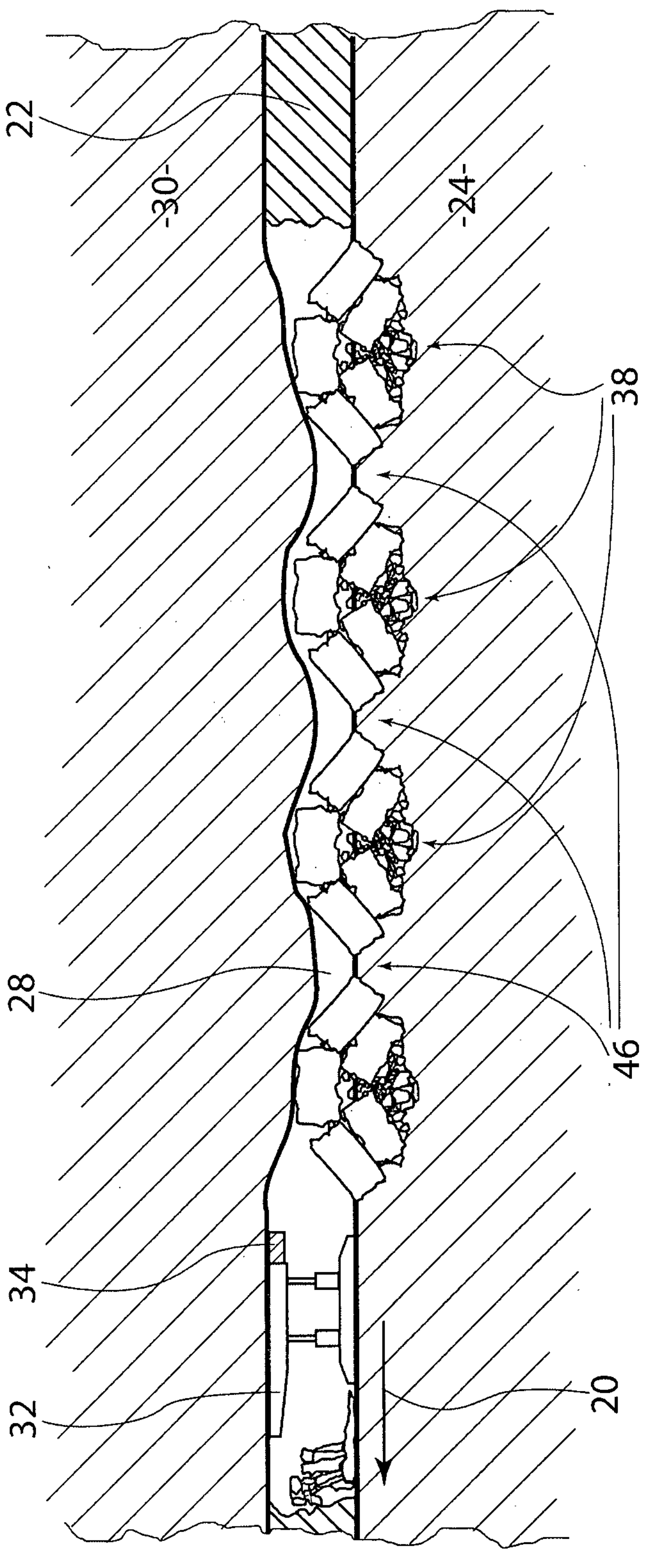

FIG 8

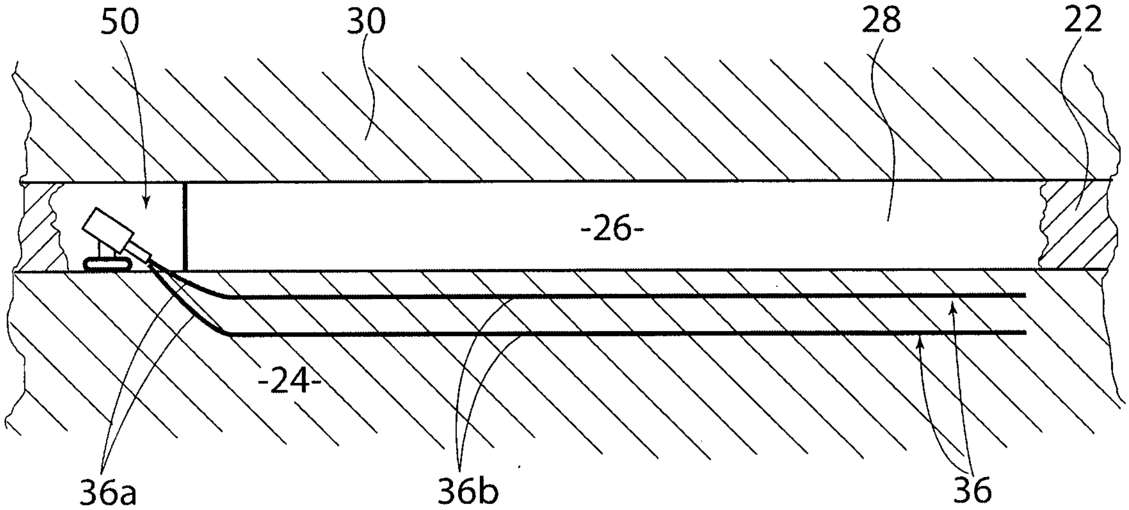

FIG 9

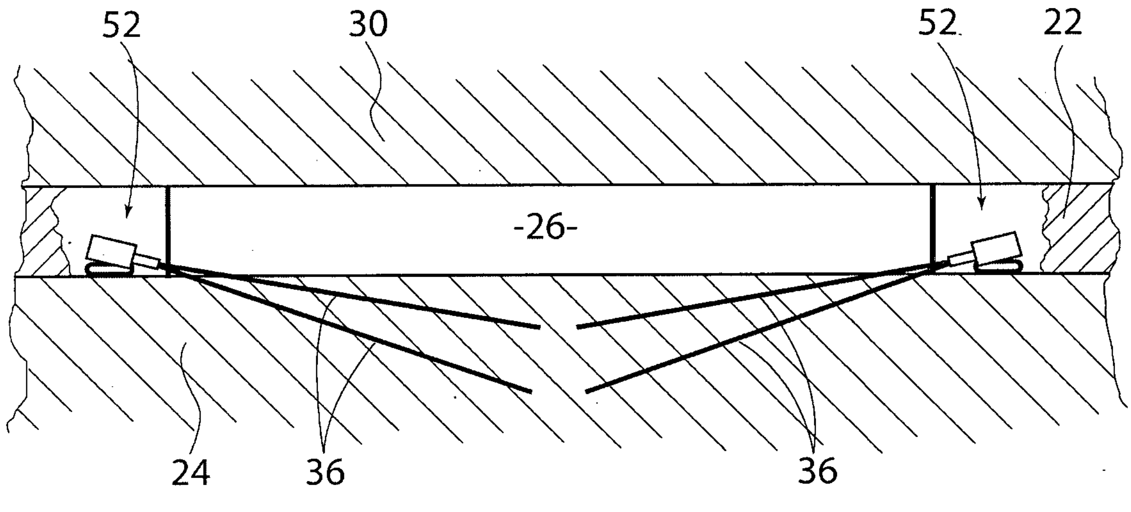

FIG 10

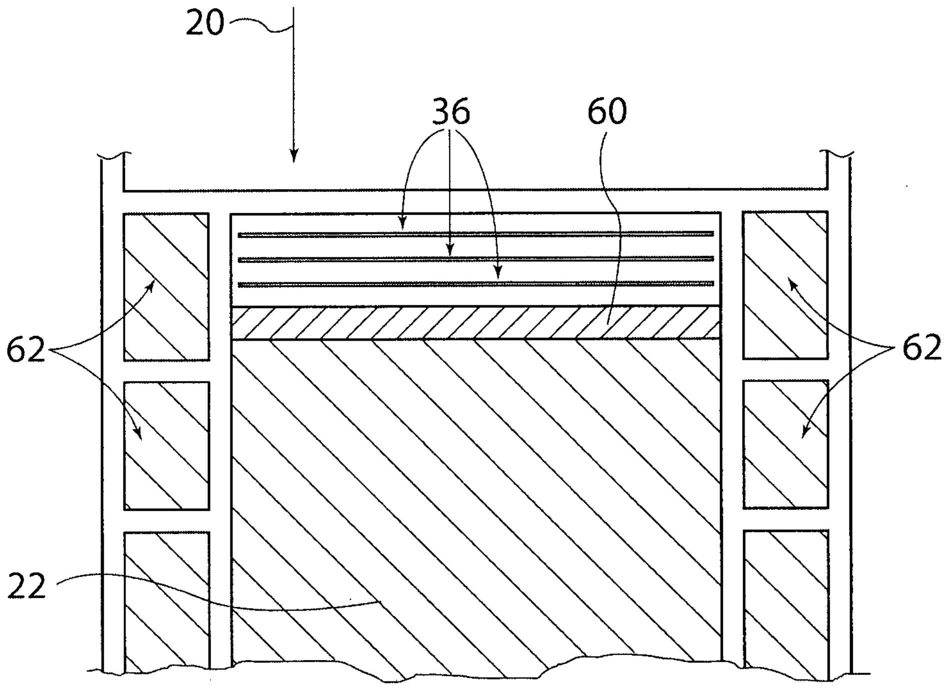

FIG 11

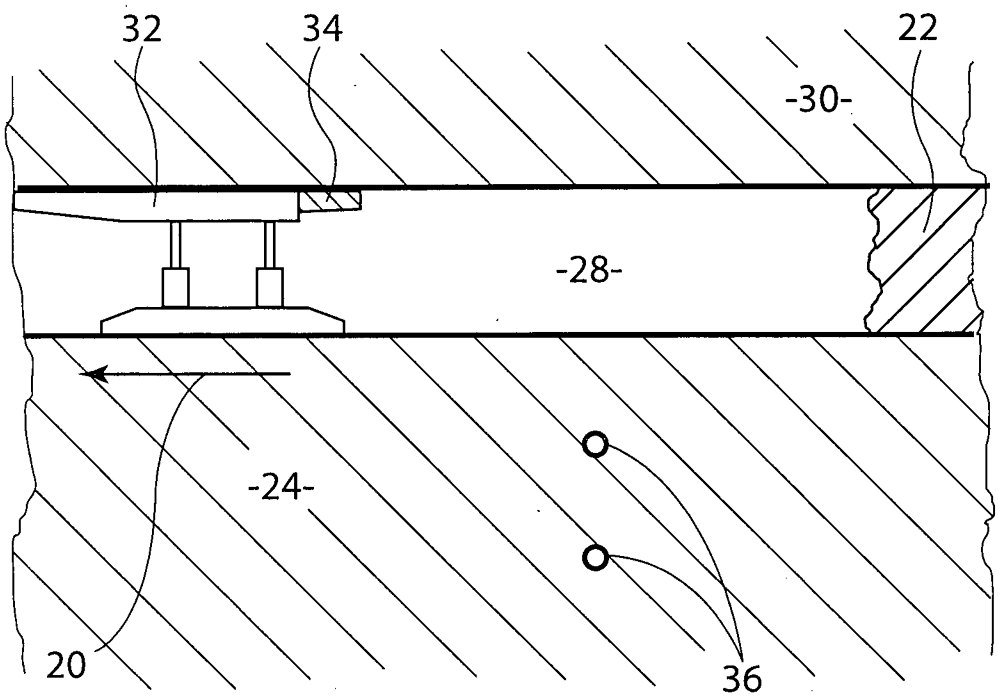

FIG 12

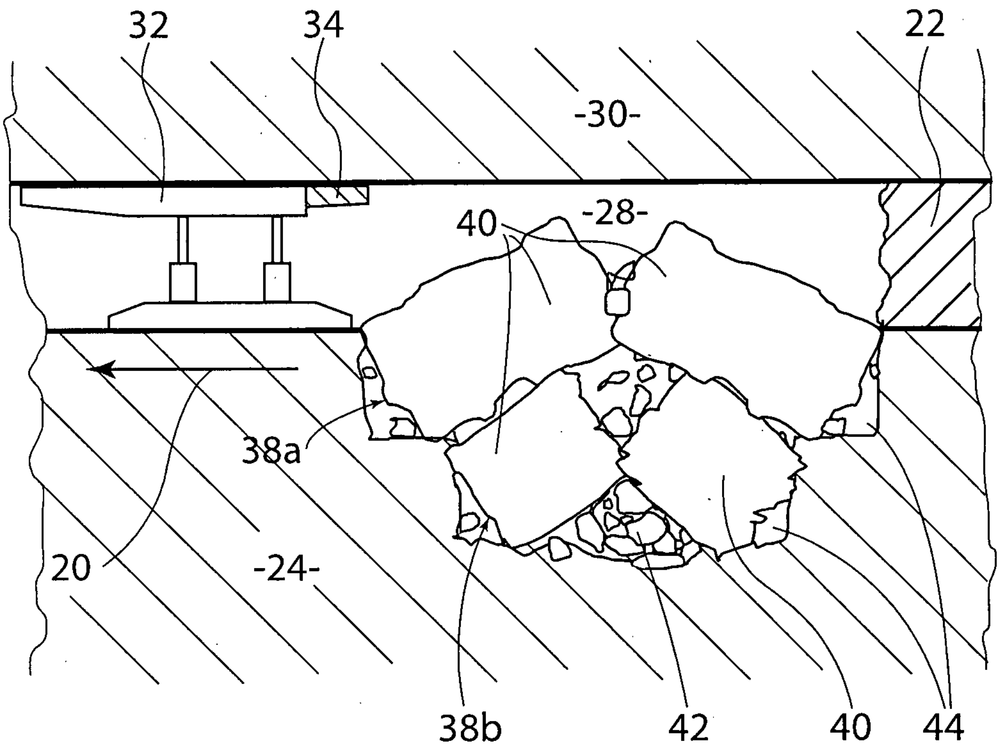

FIG 13

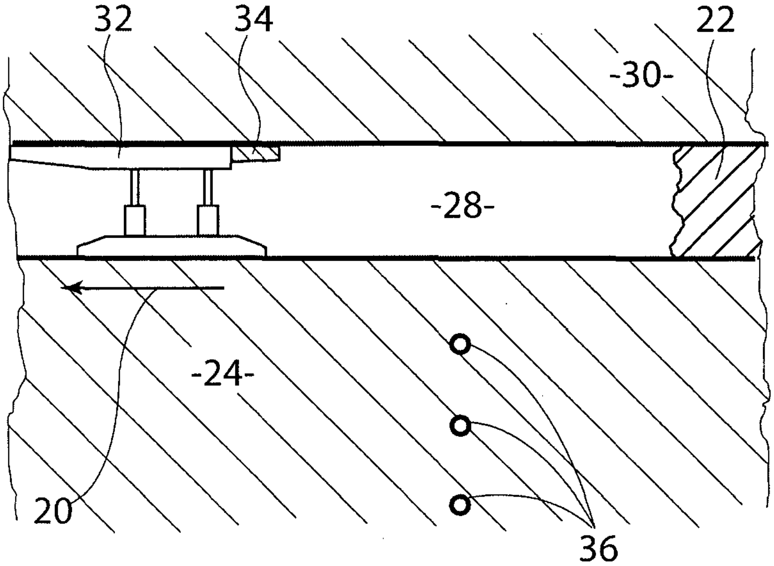

FIG 14

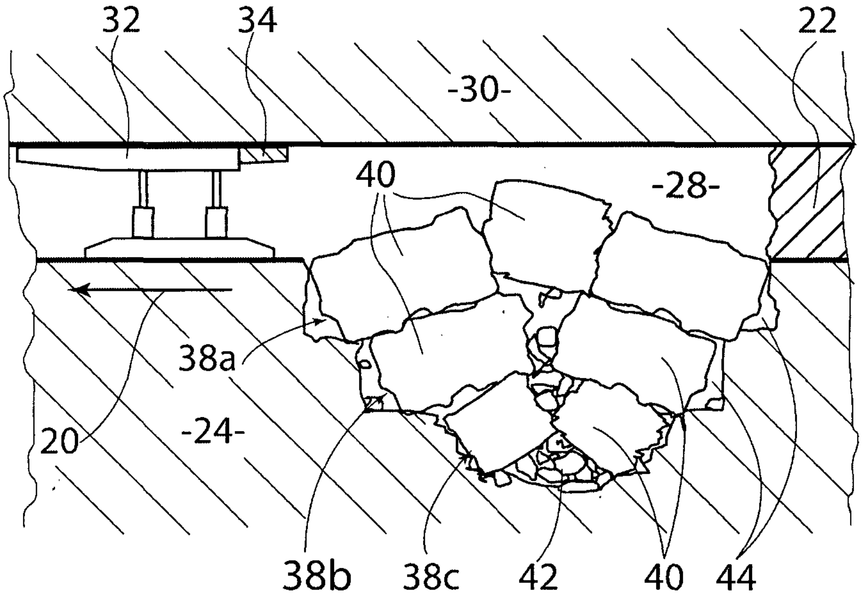

FIG 15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2011/000190

A. CLASSIFICATION OF SUBJECT MATTER

Int. CI.

E21F 15/00 (2006.01) *E21F 15/02* (2006.01)
E21C 41/16 (2006.01) *E21F 15/04* (2006.01)

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)

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPODOC, WPI, IPC mark: E21-, using keywords (subsid+, collaps, upsid+, hang+, sink+, goaf, gob, goff, longwall, underground, coal, seam, blast, explo+, fracture+, charg+, expan+, aerat+, fragments, lift+, rais+, drill+, hole, under+, beneath, footwall, below, behind, rear, aft, support+, face, chock+, roof, reduc+, alleviat+, prevent+, manage, avoid+, backfill, and like terms).

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 1004418 A (GRIFFITH) 26 September 1911 Figures 1 to 5; page 1, lines 18 to 20, and 83 to 110; also, claim 1.	1-3
A	US 2846205 A (BUCKY) 5 August 1958 Claim 1, Figures 1 to 3.	1-2

[X] Further documents are listed in the continuation of Box C [X] 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	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E"	earlier application or patent but published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"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)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family
"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	Date of mailing of the international search report
16 April 2011	21 APR 2011

Name and mailing address of the ISA/AU	Authorized officer
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C (Continuation).	DOCUMENTS CONSIDERED TO BE RELEVANT	
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	AIMONE, C.T. et al., 'Rock Breakage: Explosives', SME Mining Handbook. Edited by H. Hartman et al., 1992, Vol. 1, 2nd ed., ISBN 0-87335-100-2, pages 722 to 745	
A	pages 722 to 745	1-3

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information,

Patent Document Cited in Search Report		Patent Family Member
US	10044 18	NONE
US	2846205	NONE

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 200 1.

END OF ANNEX