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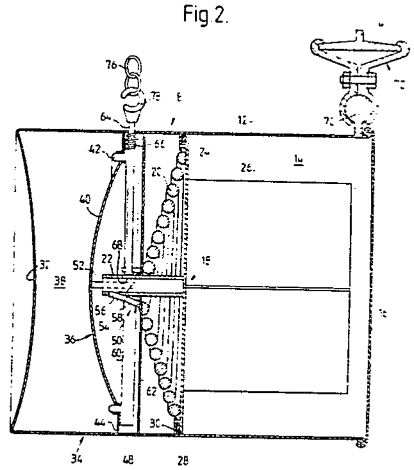
(54) **Barrier systems for mines.**

(57) A triggered barrier system comprises a plurality of self-contained units each incorporating a static pressure change sensor (38) which releases a spring (20) to cause a piston (18) forceably to eject particulate suppressant material from an hermetically-sealed chamber. Preferably, the piston rotates as it moves laterally so that angular momentum is imparted to the particles in order for them to be dispersed more widely.

Fig 2.



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Description

BARRIER SYSTEMS FOR MINES

This invention relates to barrier systems for suppression of explosions in mines, and is particularly concerned with triggered barrier systems.

Barrier systems for the suppression of coal mine explosions have been known for a long time. The systems are predominantly passive barriers in which the energy of the mine explosion is used to cause the dispersal of an agent, referred to herein as a suppressant, which causes suppression or extinction of the explosion, or at least mitigation of the effects of the explosion. The suppressant normally takes the form of an inerting agent which is caused by the blast of the explosion to be distributed into the path of the flame of the explosion in order to prevent ignition of coal dust. In some cases the suppressant is water contained in troughs on shelves near the top of the mine roadway or gate, and in other cases the suppressant is stone dust, also supported by shelves. In all cases, the suppressant is dispersed by the combined force of the blast from the explosion and gravity. The blast from the explosion usually acts directly upon the suppressant or the troughs or shelves supporting the suppressant to start the dispersal, although it has also been proposed to provide a passive water barrier in which a static pressure sensor detects the blast of the explosion and either releases the door of a container or a support for the container so that water falls from the container.

Passive barriers suffer from a number of problems. In order to cope with varying strengths of explosion, it has been found necessary to install barriers of different sizes at different distances from the likely point of ignition (e.g. the coal face or a hazardous transport point such as where coal is shifted between conveyors). Also, because the time between the arrival of the blast and the flame front tends to vary, it is necessary for a heavy barrier to consist of both heavy and light loadings of suppressent to ensure that effective dispersal takes place over a large time window. Passive barriers are not always effective at preventing the propagation of explosions along the roof of the roadway, where coal dust may have collected. It is also very difficult in many circumstances to avoid obstructing the roadway when installing shelves large enough to support adequate amounts of suppressant; the shelves have to be spaced considerably from the roof of the roadway in order to allow sufficient room for installation, loading and removal.

Movement of the passive barriers, which is required as the likely source of ignition (e.g. coal face) moves, is also a problem. This has to be done regularly because positioning is critical. The barriers are very bulky and removal and replacement of the shelves is difficult and time consuming. It is necessary to bring equipment down into the roadway, including timber for the shelves and suppressant material. The quantities of suppressant are large, and the suppressant is generally discarded each time the barrier is moved in order to make this operation slightly easier. Because of the way they operate, passive barriers are ineffective to prevent explosions very close to the source. Additionally, maintenance of the barriers is necessary due to evaporation of water (where this is the suppressant), or due to the stone dust becoming damp and thus less dispersable, or erosion of the stone dust.

Attempts have been made to deal with some of these problems by using triggered barriers. Triggered barriers have means for sensing an explosion, and separate means triggered by the sensor for generating energy to disperse a suppressant. Generally, the dispersal is achieved by an explosive material which either acts directly upon the suppressant, or causes the release of compressed gas which disperses the suppressant. Although some of the triggered barriers deal with some of the problems mentioned above, they have met with limited success. The reliance upon explosives is not favoured by users. The explosives have to be powerful enough to disperse the suppressant effectively (and also to rupture a container where the suppressant is water), yet not sufficiently powerful to be harmful in themselves. The barriers, which normally use water as a suppressant, tend to be expensive, large, heavy and very difficult to move.

According to one aspect of the present invention there is provided a triggered barrier unit having a sensor responsive to detection of an explosion for releasing a spring to cause the ejection of a suppressant. The suppressant is preferably particulate, e.g. stone dust. According to another aspect of the invention there is provided a triggered barrier unit in which the suppressant is particulate material sealed against ingress of moisture. Sealing the material, preferably hermetically, ensures that there is no ingress of moisture to impair the dispersibility of the suppressant, and also facilitates the design of a self-contained and easily portable unit. Such an arrangement also lends itself to the design of units according to the first-mentioned aspect of the invention, in that it ensures a good dispersal of the spring-ejected suppressant material.

According to a further aspect of the invention there is provided a triggered barrier unit which is activated by a static pressure change sensor. According to a still further aspect of the invention there is provided a triggered barrier unit having means for ejecting a suppressant, and dispersal means for spreading the suppressant in order to produce relatively wide dispersal thereof. The dispersal means is preferably arranged to impart angular velocity to the suppressant in order to produce the wide dispersal. Such arrangements are particularly advantageous when used in conjunction with a triggered barrier unit according to the first-mentioned aspect of the present invention in that the stored spring energy can be used to disperse as well as to eject the material. In one of the embodiments described below some of the stored energy in the spring is used to impart angular velocity to the suppressant material, and in other embodiments the spring ejects not just the suppressant material but also a member which redirects the suppressant material.

The various aspects of the invention mentioned above are all independently advantageous. However, preferably at least some of and more preferably all of these aspects are combined to produce a triggered barrier unit which is compact, self-contained and relatively easily portable, which is inexpensive, and which reliably disperses suppressant without the need for an explosive.

In the preferred embodiment, the triggered barrier unit has particulate suppressant, e.g. stone dust, contained in an enclosure which is sealed against ingress of moisture. Preferably the enclosure forms a water-tight, or more preferably hermetic, seal. An ejection member is biased by a spring so that, upon release of a latch, the member pushes the dust out of the enclosure. Preferably, the suppressant forces its way out of the enclosure under the action of the ejecting member. Alternatively, however, the enclosure could be provided with opening means operated in response to the sensing of the explosion. The enclosure may be rigid, with an openable lid or door, and/or may incorporate a flexible bag which is ruptured as the suppressant is ejected.

The unit preferably comprises a chamber, e.g. a cylinder, and a piston which can move under the force of the spring through the chamber to force the suppressent out of an end of the chamber.

The unit preferably has a dispersal means which alters the path of the suppressant when it is ejected. Preferably, this is achieved by imparting angular velocity to the suppressant so that as it is ejected forwardly from the unit it spreads out laterally.

Alternatively, a grid or other member may be placed in the path of the suppressant so as to divert it laterally.

The unit is preferably provided with a sensor having a pressure-sensing chamber with a diaphragm which moves in response to an alteration in pressure caused by an explosion so as to release a latch and thereby cause the spring to act upon the ejecting member in order to eject the suppressant.

The invention also extends to a method of installing triggered barrier units according to any of the above aspects of the invention. A series of such units at different spacings from the likely source of ignition may be installed, the units preferably being arranged in successive groups with individual units within each group facing in different directions. The method may involve altering the position of the barrier system as the likely source of ignition moves by removing the unit or a group of units situated at one end of the barrier and replacing it or them at the other end.

Arrangements embodying the invention will now be described by way of example with reference to the accompanying drawings, in which:

FIGURE 1 illustrates triggered barrier units in accordance with the invention when installed in a mine roadway or gate;

FIGURE 2 is a sectional view showing details of one of the units;

FIGURE 2a shows a modification of the FIGURE 2 arrangement;

FIGURES 3a and 3b schematically illustrate the way in which the unit of FIGURE 2 operates in order to eject suppressant;

FIGURES 4a and 4b are schematic illustrations of a modified version of the unit having a different mechanism for dispersal of the suppressant;

FIGURES 5a and Sb schematically illustrate a further modification of the unit which employs another mechanism for dispersal;

FIGURES 6a and 6b schematically illustrate a further modification of the unit having a different latching mechanism; and

FIGURES 7a and 7b schematically show a still further modification of the unit with another form of latching mechanism.

Referring to FIGURE 1 this shows a mine roadway 2 of a common, arched construction, with the walls and roof supported at regular intervals by I-section beams 4. A conveyor 6 is located at the bottom and to one side of the roadway 2.

In the past, passive barriers have been installed in such roadways. The barriers had to be relatively wide in order to accommodate sufficient suppressant material, and had to be located at a high position in order to ensure adequate dispersal. The manner of installation of the shelves, involving slats which have to be lifted up to mount or dismount them, and the need to leave room to allow suppressant to be placed on the shelves both place limits on how close the barriers can be to the top of the roadway, and this problem is exacerbated if an arched roadway construction is used. The consequence is that the roadway is obstructed and/or barriers of inadequate size are used.

In place of such a system, triggered barrier units 8 according to the present invention are installed in the roadway 2 as shown in FIGURE 1. These are individual, compact, easily-transportable units which can be located at any of a number of desired positions but nevertheless provide effective dispersal of suppressant material due to the manner in which this is ejected from the unit. This makes it possible to locate the units in proximity to regions, such as the conveyor 6, where coal dust may accumulate in dangerous quantities, while nevertheless being effective to disperse stone dust to other areas, such as the roof of the roadway. Because the barrier system comprises individual units, and because, as explained below, these are of a type in which the suppressant is in a closed container, it is possible to have a number of units in different orientations, if this is felt to be most effective. It is preferred that the units be oriented such that the general direction of ejection of the suppressant is upward to increase the amount of time that the suppressant is in the air. In the illustrated embodiment, each I-section beam 4 carries two units 8, one at each side of the roadway and both at a fairly high position, and each unit faces generally away from the coal face 10 at an elevation of about 30° and inclined toward the centre of the tunnel by about 30°. A single barrier system may for example comprise one hundred such units, fifty along each side of the roadway, spaced at intervals of about one meter along the roadway. Of course, many variations of this arrangement are possible, although it is preferred that the units can be arranged in successive groups of at least two, with units in each group facing in different directions. However, the units could be positioned in a single line, each substantially in the centre of the roadway and near the roof. If desired one or more additional units may be mounted under the conveyor.

FIGURE 2 is a cross-section through one of the units 8. The unit comprises a cylinder 12, which could be made of resilient but strong material, having a main compartment 14 containing suppressant in the form of stone dust. The unit has an end wall 16 which is attached to the cylinder 12 in such a manner as to form an hermetic seal. The end wall can however be detached from the cylinder by sufficient pressure applied to its inner side.

A piston 18 is disposed in the cylinder 12 and is movable under the action of a spiral spring 20 toward the end wall 16. The spring could take any of a variety of different forms, e.g. helical, leaf, etc. In the position shown in FIGURE 2, the piston 18 is held against the bias of the spring 20 by a latching mechanism to be described below. The piston comprises a central shaft 22, a base 24 and set of vanes or impellers 26. In the position shown in FIGURE 2, an hermetic seal is formed by means of a O-ring 28 between the underside of the base 24 and an inwardly-extending ledge 30 of the cylinder 12. The chamber 14 is therefore air-tight and accordingly no moisture can cause coagulation of the stone dust.

At the opposite end of the unit from the end wall 16 there is provided a second end wall 32 integrally formed with the cylinder 12. This end wall 32, the end part 34 of the cylinder 12 and a diaphragm 36 define a chamber of a static pressure sensor indicated generally at 38. The diaphragm 36 comprises a rigid central portion 40 and a flexible outer portion 42, which is secured to an inwardly-extending support ledge 44 of the cylinder 12. The cylinder 12 is provided with an aperture 48 so that increases in pressure cause the inner portion 40 of the diaphragm 36 to move toward the end wall 32.

The inner diaphragm portion 40 is coupled to a latching mechanism 50 by a rod 52. The mechanism 50 comprises a latch member 54 located in a notch 56 of the piston shaft, and an actuating member 58 disposed between the latch member 54 and a notch 60 in an intermediate wall 62 of the cylinder 12. In the position shown in FIGURE 2, as the spring 20 pushes on the piston 18, the shaft 22 is prevented from moving by the latch member 54, which cannot move laterally because of the reactive forces of the actuating member 58 which are tending to push the latch member 54 in an anti-clockwise direction as shown in the drawing. However, on an increase in static air pressure, the diaphragm 36 moves to the left, so that the rod 52 tends to pivot the actuating member 58 about its point of contact with the intermediate wall 62. This causes an over-centre action between the actuating member 58 and the latch member 54 so that the reactive forces on the latch member 54 no longer prevent it from moving laterally away from the shaft 22 and thus releasing the piston.

The piston 18 thus moves to the right, forcing the stone dust in the chamber 14 to push the end wall 16 off the end of the cylinder 12, whereby the stone dust is then ejected.

A locking plunger 64 may be provided to disable the unit while it is being moved. The plunger 64 is biased by a spring 66 to a position in which its end is inserted into an aperture 68 in the shaft 22 so that the piston cannot move to the right as shown in the drawing. When in position, the unit is supported by a member 70 at the forward end of the cylinder 12 which is attached by a clamp 72 to an I-section beam 4, and is further supported by a chain 76 fitted onto a hook 78 at the end of the plunger 64, so that the plunger is withdrawn from the aperture 68 in the shaft 22 and the unit is thereby automatically rendered operative.

The above arrangements for automatically rendering the unit are operable described only by way of example and other arrangements are possible. For example, there could be a manually operated device, e.g. a key, for arming the unit to make it operable. If an arming arrangement is used, it is preferred that the condition of the unit be easily visible.

FIGURE 2a is a partial sectional view showing a modification of the latching mechanism 50, in which parts corresponding to those of FIGURE 2 have corresponding reference numbers. In FIGURE 2a, the actuating member 58 is attached by a pivot l00 to a link 102. The link 102 and the rod 52 are attached by a pivot 104 to a plate 106, which is itself mounted by pivot 108 to the intermediate wall 62. The plate 106 is biased in an anti-clockwise direction about the pivot 108 to the position shown in FIGURE 2a by a spring 110. Further anti-clockwise movement is prevent by the engagement of the plate with a protrusion 112 of the intermediate wall 62.

In operation, as the diaphragm 36 moves to the left on an increase in static air pressure, the bias of the spring 110 is overcome and the plate 106 moves in a clockwise direction about pivot 108. This draws the actuating member 58 upwardly, thus moving it away from the latch member 54 and accordingly releasing the piston 18.

It will be noted that in this case there is no need for an over-centre action between the actuating member 58 and the latch member 54. However, the piston will only be released if the static air pressure rises sufficiently to overcome the bias of the spring 110. As soon as the actuating member 58 starts to shift, the spring 20 will assist further movement, so that releasing of the piston 18 occurs very quickly.

A counterweight 114 is provided on the plate 106, on the opposite side of the pivot 108 from the rod 52, to balance the mass of the rod and diphragm 36. In this way, vibration or dropping of the unit is unikely to result in accidental triggering, because the masses on the opposite sides of the pivot 108 will tend to act in opposite rotational senses.

It will be noted also that in the arrangement of FIGURE 2a, the diaphragm 36 has a diameter which is substantially smaller than that of the cylinder 12, and the spring 20 has a constant diameter.

FIGURE 3a is a schematic representation of the triggered barrier unit of FIGURE 2, with the unit in the same condition as it is in FIGURE 2, and FIGURE 3b shows how on operation of the unit the stone dust is dispersed. The opposite ends of the spring 20 are fixed against relative rotation with respect to the intermediate wall 62, on the one hand, and the piston 18, on the other hand. Before the unit is loaded with stone dust, the piston 18 is pushed to the left in order to compress the spring 20, and at the same time it is rotated about its axis. Accordingly, the spring 20 is wound up as well as compressed, so that it can exert forces which are torsional and longitudinal with respect to its axis. When the unit is operated by the pressure sensor 38, the piston 18 ejects the stone dust and at the same time the vanes 26 of the piston rotate so as to impart angular velocity to the stone dust, which is then ejected in a pattern as indicated at 80 in FIGURE 3b. It will be noted that the general direction of ejection of the stone dust is parallel to the axis of the cylinder 12 but that the vanes 26 impart a lateral component of movement to the dust. Because the suppressant is formed of particulate material and because the material is kept dry in its hermetically sealed chamber, it is relatively easy to disperse under the action of a spring.

Referring to FIGURES 4a and 4b, these illustrate another technique for achieving dispersal of the stone dust. In this case, the end wall 16 of the cylinder 12 has a substantially conical inner surface, and is attached to the base of the piston 18 by a cord 82. Upon operation of the unit, the end wall 16 forms a barrier so that stone dust is diverted laterally away from the axis of the cylinder 12 and thereby disperses. In an alternative arrangement, a barrier which is separate from the end wall 16 is attached to the piston 18, instead of relying upon the end wall for dispersing the dust. The barrier could take the form of a mesh.

FIGURES 5a and 5b show a still further technique for achieving dispersal. A member, which in this case is the end wall 16, is attached to the piston 18 by means of a long, wide, flexible ribbon 84. When the dust is ejected, the ribbon is straightened by the member moving away from the piston 18 so that dust is caused to be flicked in different directions.

FIGURES 6a and 6b illustrate schematically the sensor arrangement of a modified embodiment of the invention. In this modification, both of the opposed walls 32,36 of the sensor chamber are movable diaphragms, and each is linked to a respective one of a pair of rods 86,88 which extend into the shaft 22 of the piston 18 and lie alongside a detent member 90 engaged in an aperture 92 of the shaft. The rods have interengaging surfaces 94,96 which are inclined to the direction in which the rods extend. When the air pressure increases and the opposed diaphragms 32,36 move toward each other, as shown in FIGURE 6b, the relative longitudinal movement of the rods 86,88 causes them to move apart laterally. This lateral expansion pushes the detent member 90 out of the aperture 92 and thus releases the piston 18. However, if both the diaphragms 32,36 move in the same direction, no lateral movement of the rods 86,88 occurs and thus the piston is not released. Accordingly, this arrangement avoids accidental actuation of the unit resulting from, e.g. vibration or mishandling.

The mechanism shown in FIGURES 7a and 7b uses a pair of pivoted pawls 98,100 between which the piston shaft 22 is located. The frictional contact between the pawls 98,100 and the shaft 22 tends to pivot the pawls toward the right as shown in the drawings, thus wedging the shaft 22 more tightly between the pawls and holding the shaft in position. Both pawls 98,100 are pivoted in the opposite directions in response to an increase in air pressure resulting in movement of a diaphragm 102 as shown in FIGURE 7b, thus releasing the piston. Although it is preferred to have a pawl on each side of the shaft as shown in the drawings, it would be possible to redesign so that only one pawl is necessary.

Obviously, any of the release mechanisms shown in FIGURES 2,2a,6a,6b,7a and 7b may be used with any of the ejection mechanisms shown in FIGURES 2,3a,3b,4a,4b,5a and 5b. It is obvious also that alternative ejection and release mechanisms are possible. If a static pressure change sensor such as those described above is to be used, it is preferred that a small by-pass port be provided so that gradual changes in air pressure will not actuate the mechanism. A static pressure change sensor is preferred because, unlike sensors used previously in triggered barriers, they do not rely on electrical power sources or cables.

Although stone dust is a desired suppressant, other materials could be used. If stone dust is used, it is preferably limestone, and is preferably of the "water proof" type which has an additive, e.g. stearic acid, to improve dispersability under humid conditions. Other possible explosion suppressants include ammonium dihydrogen phosphate, potassium chloride, potassium bicarbonate, sodium chloride and sodium bicarbonate. In certain arrangements according to the invention water may also be a possible suppressant.

Although it is possible to design a triggered barrier unit in accordance with the invention to have a large size, it is preferred that it be small in order to facilitate installation and movement of the unit, and to reduce problems in the unlikely event of an accidental triggering of an unit. Preferably, the mass of suppressant per unit is less than 50kg, and is preferably about 25kg.

Because of the self-contained nature of the unit, it is quite possible to design the units for mounting directly onto a machine which may form a likely source of ignition of an explosion. For this purpose, suitable mounting means would be provided on the unit. It would be preferred to use a smaller unit for these purposes, e.g. one containing up to 10 to 15kg of suppressant.

Referring again to FIGURE 1, it will be appreciated that as the coal face moves the barrier system can be effectively moved by detaching only those units 8 in an area of the barrier system furthest from the coal face and remounting them in a region in front of the remaining units (or vice versa in the case of a retreating coal face). It is envisaged that because a barrier system using such units can be made as effective as a heavy passive stone dust barrier, but as responsive as a light passive stone dust barrier, it will be possible to replace a barrier system consisting of both light and heavy passive stone dust barriers at different distances from the likely source of ignition by a single system of triggered barrier units according to the invention positioned roughly where the light passive stone dust barrier would be located.

Although the units have been described above in the context of their use in a coal mine, clearly they would be useful also in other forms of mine, and references herein to "coal face" should be construed accordingly.

Claims

1. A triggered barrier unit having means for sensing an explosion and means responsive thereto for releasing a spring to cause suppressant material to be ejected under the force of the released spring energy.

2. A triggered barrier unit as claimed in claim 1, including dispersal means for spreading the suppressant material as it is ejected from the unit.

3. A triggered barrier unit as claimed in claim 2, wherein the dispersal means comprises means for imparting an angular velocity to the material.

4. A trigger barrier unit as claimed in claim 3, wherein the spring is arranged both to eject the material and to impart angular velocity to the material.

5. A triggered barrier unit as claimed in any preceding claim, including a chamber containing the suppressant material, and a piston movable through the chamber to eject the material upon operation of the barrier unit.

6. A triggered barrier unit as claimed in claim 5 when dependent upon claim 3 or 4, wherein the dispersal means comprises vanes attached to the piston, and wherein the piston is arranged to rotate as it moves laterally through the chamber.

7. A triggered barrier unit as claimed in claim 5 when dependent upon claim 2, wherein the dispersal means comprises a member attached to the piston so that as the suppressant material is ejected it moves relative to the member and is thus redirected by the member.

8. A triggered barrier unit as claimed in any preceding claim in which the suppressant material is particulate material sealed against ingress of moisture.

9. A triggered barrier unit as claimed in any preceding claim, including a flexible bag sealing the suppressant material.

10. A triggered barrier unit as claimed in any preceding claim, including a static pressure change sensor for actuating the unit.

11. A triggered barrier unit having an energy source which when activated releases energy to cause dispersal of a suppressant material, and change sensor for actuating the energy source.

12. A triggered barrier unit having a chamber containing suppressant material, and an impeller disposed in the chamber, the impeller being arranged to move laterally to eject the material and to rotate while moving laterally to spread the material.

13. A triggered barrier unit as claimed in any preceding claim, in which the suppressant material is stone dust.

14. A triggered barrier unit as claimed in any one of claims 1 to 12, in which the suppressant material is ammonium dihydrogen phosphate.

15. A triggered barrier unit as claimed in any preceding claim, including mounting means for mounting the unit to a machine forming a likely source of ignition.

16. A barrier system comprising a plurality of triggered barrier units as claimed in any preceding claim, the units being arranged within a mine.

17. A barrier system as claimed in claim 16 wherein the units are arranged in successive groups, each group comprising at least two units disposed in different orientations.

18. A method of installing a barrier system in a mine, the method comprising locating a triggered barrier unit according to any one of claims 1 to 15 at a predetermined position in the mine.

19. A method as claimed in claim 18, the method comprising locating a plurality of such units within the mine.

20. A method as claimed in claim 19, wherein the units are arranged in successive groups, each group comprising at least two units disposed in different orientations.

21. A method as claimed in claim 19 or 20 including the step of repositioning the system by dismounting one or more units at one end of the system and repositioning them at the other end.

Fig.1.

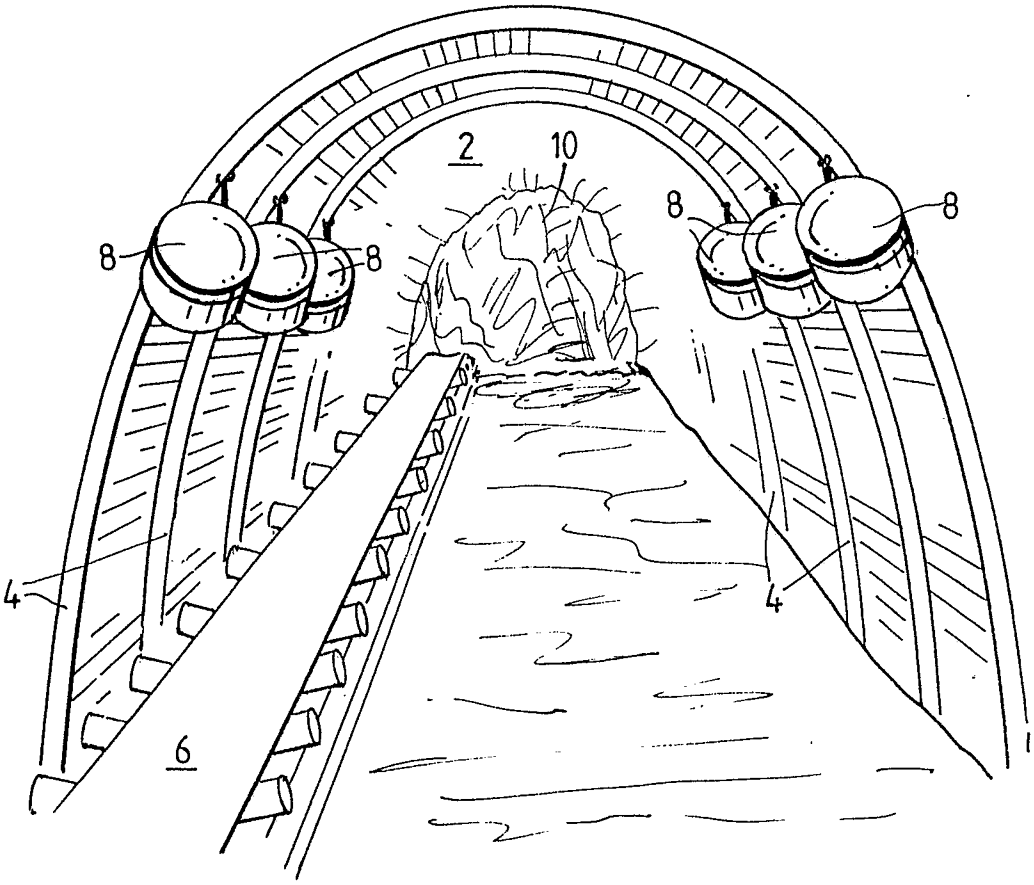

Fig.2.

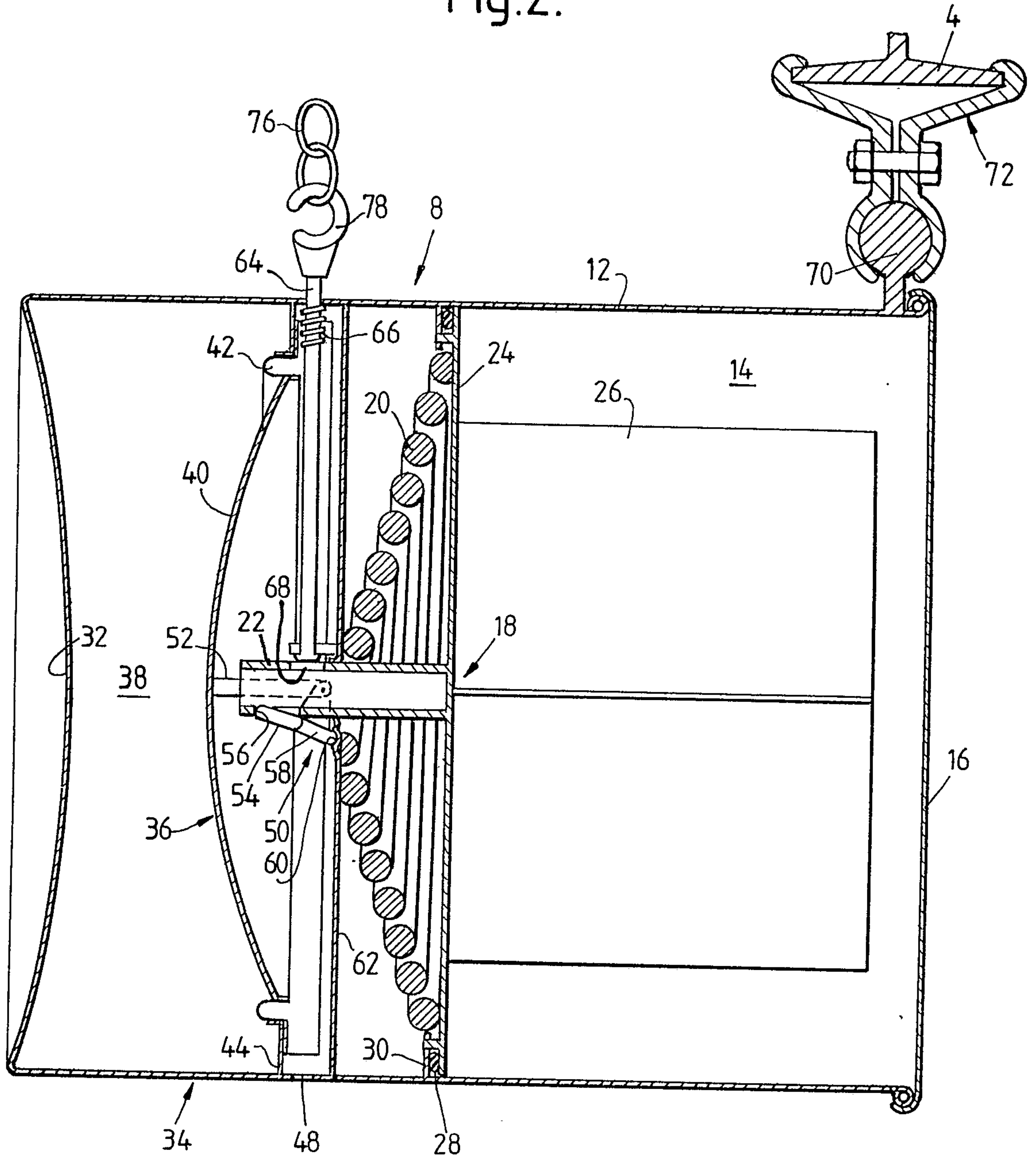
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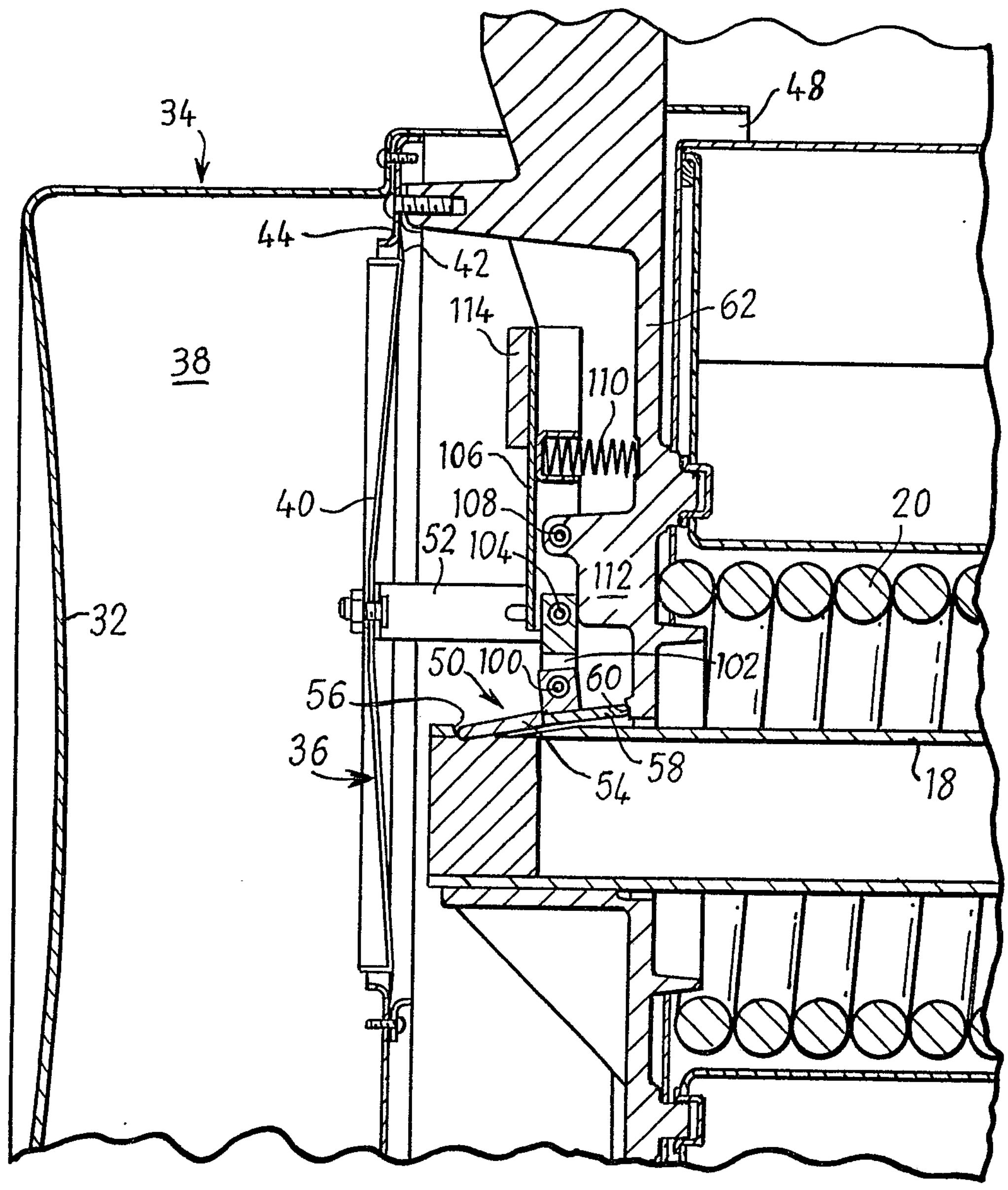
Fig.2a.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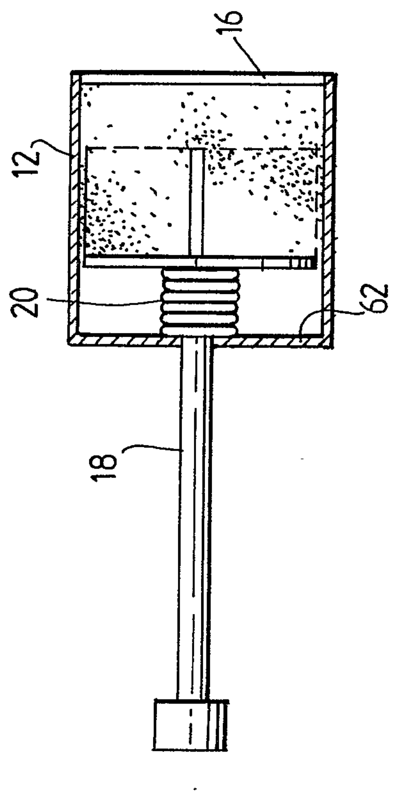


Fig.3a.

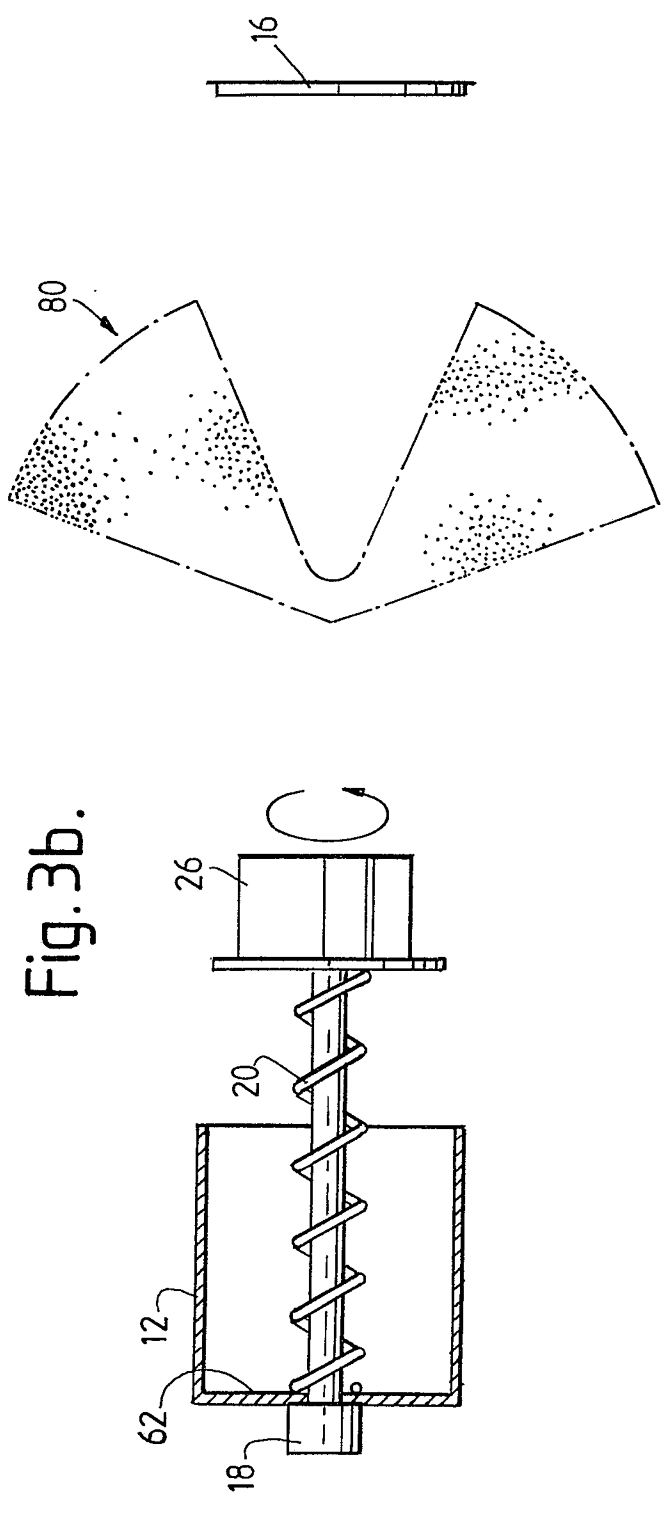


Fig.3b.

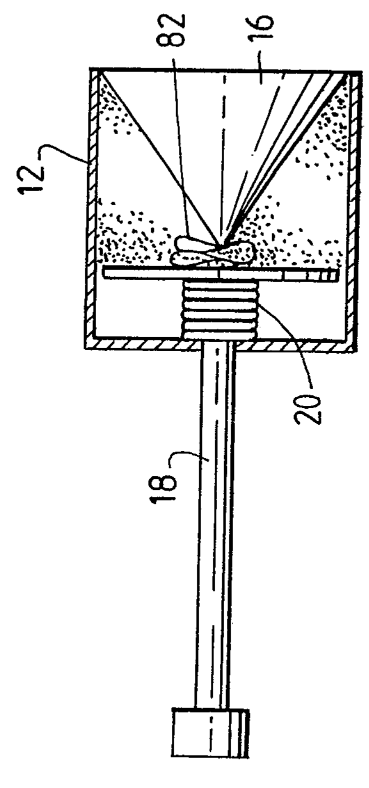


Fig.4a.

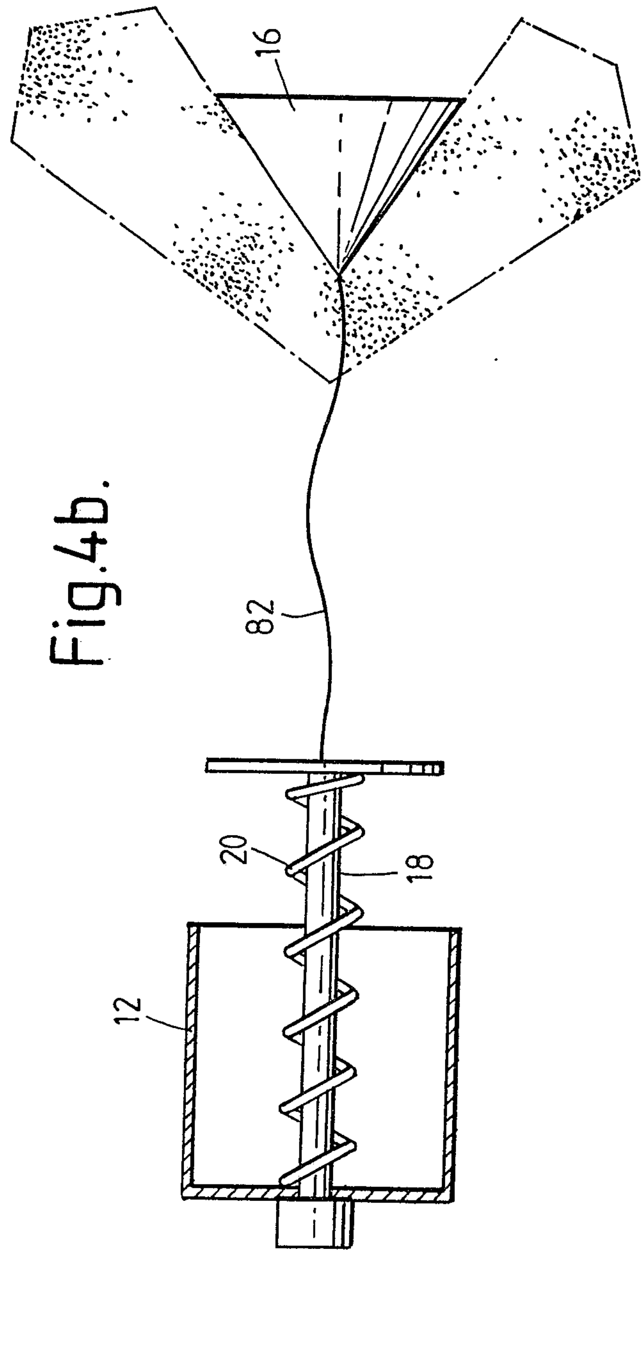


Fig.4b.

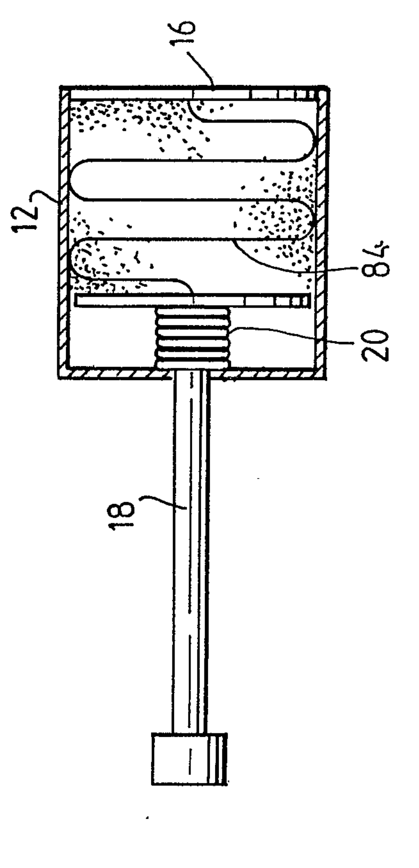


Fig.5a.

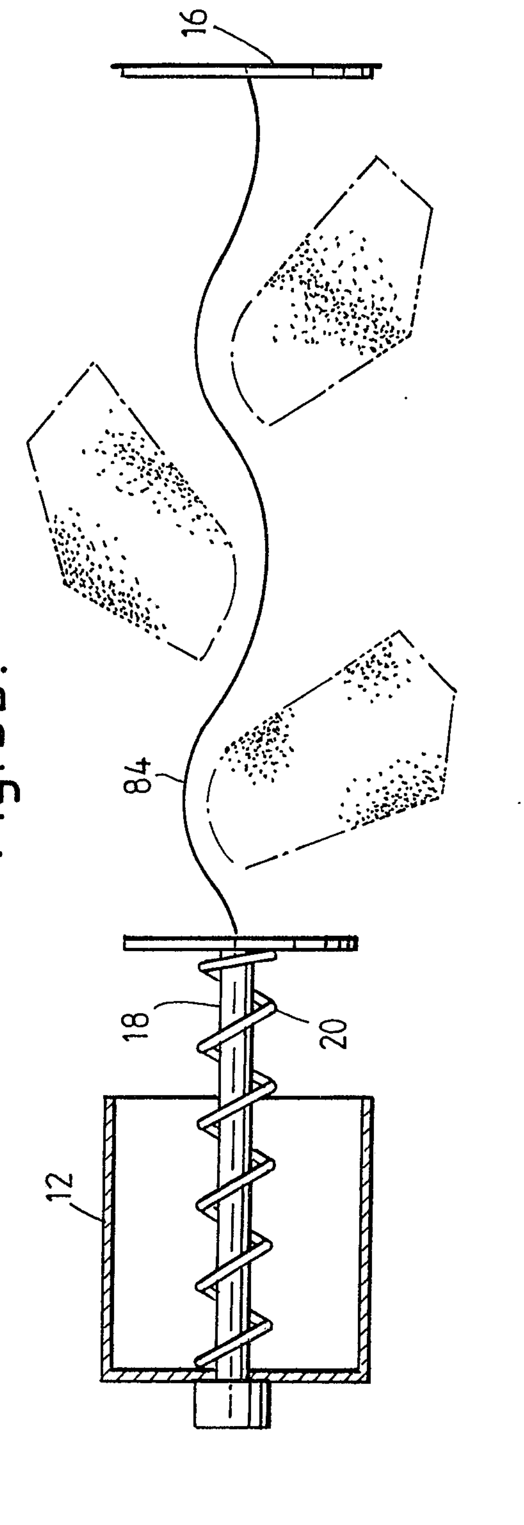


Fig.5b.

Fig.6b.

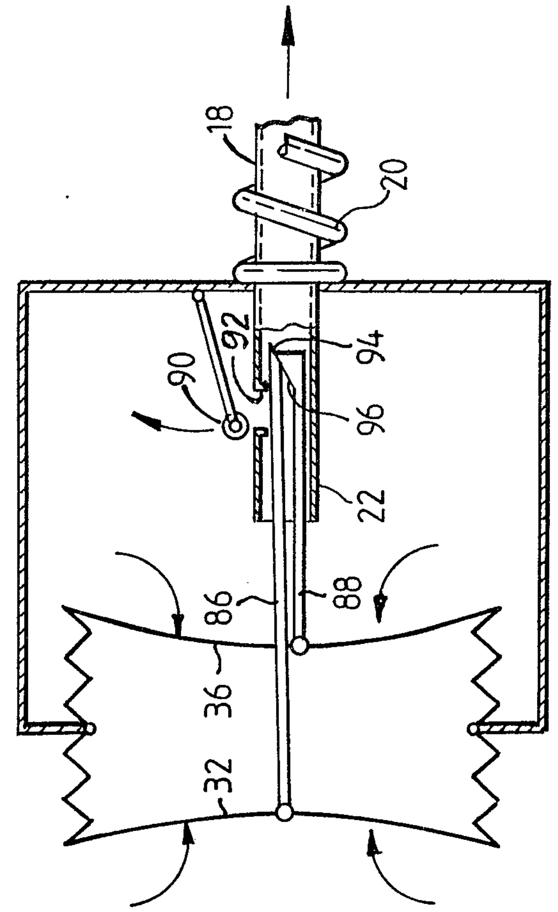
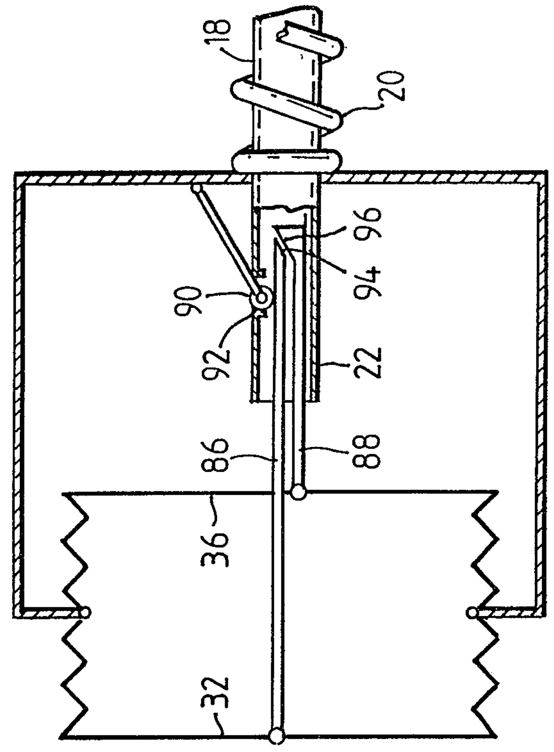


Fig.6a.



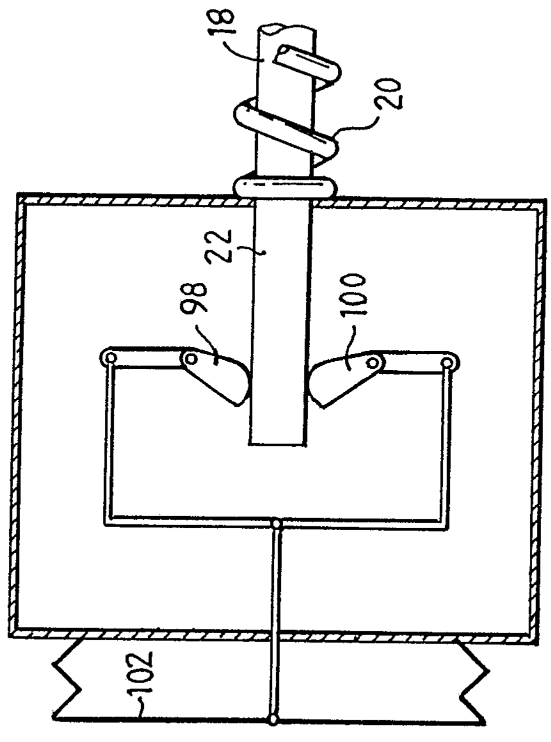


Fig.7a.

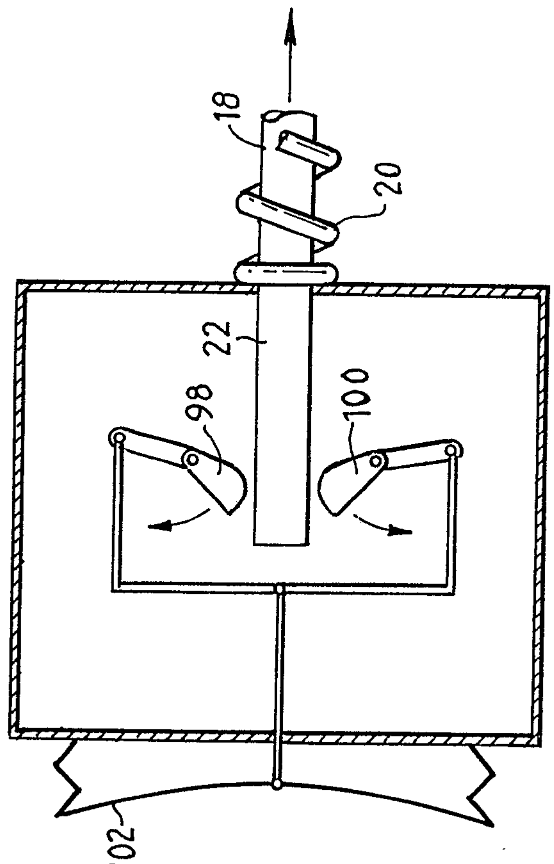


Fig.7b.

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 89301885.3

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	DERWENT ACCESSION NO. 83-799 160, Questel Telesystemes (WPIL) DERWENT PUBLICATIONS LTD., London * Abstract * & SU-A-968 474 (AS SIBE MINING INST.) --	1,11	E 21 F 5/14 F 42 D 5/00
X	US - A - 3 958 644 (LIEBMAN et al.) * Claims * ----	1,11	

TECHNICAL FIELDS SEARCHED (Int. Cl 4)

F 42 D
E 21 F
A 62 C
A 62 D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	30-05-1989	BECK

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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