Feb. 23, 1971 HANS-JOACHIM VON HIPPEL 3,564,857

APPARATUS FOR PROTECTING UNDERGROUND EXCAVATIONS AGAINST COLLAPSE

Filed Oct. 2, 1969 2 Sheets-Sheet 1

Fig. 1

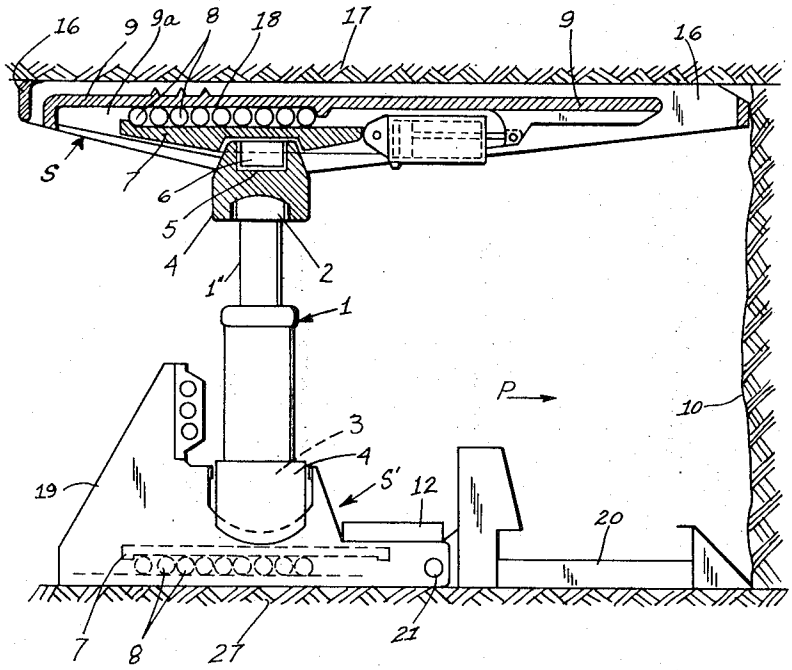
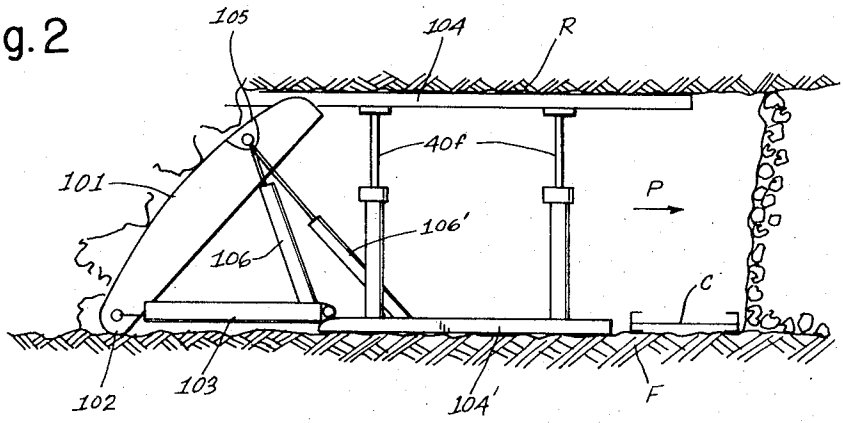


Fig. 2



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Fig. 3

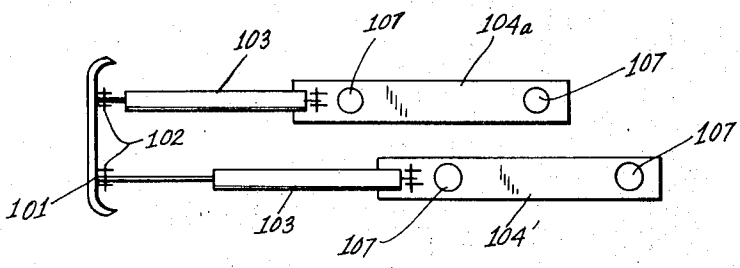
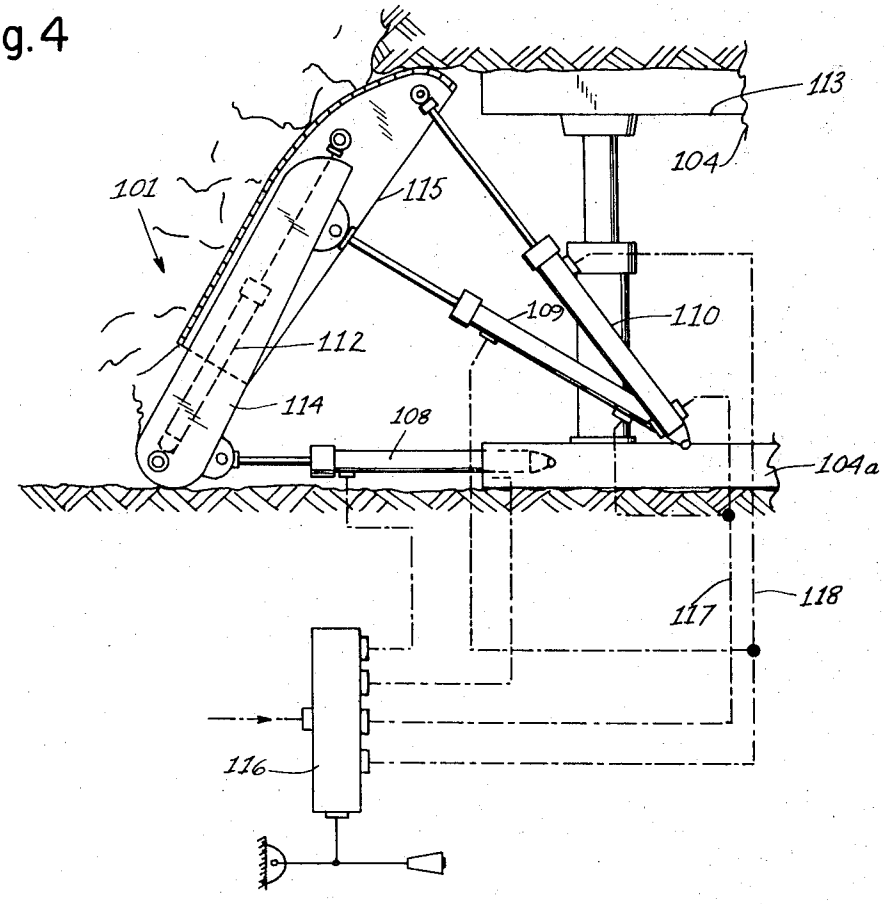


Fig. 4



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APPARATUS FOR PROTECTING UNDERGROUND EXCAVATIONS AGAINST COLLAPSE

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U.S. Cl. 61—45 10 Claims

ABSTRACT OF THE DISCLOSURE

An apparatus for protecting underground excavations against collapse includes roof support means, advancing means which advances longitudinally along the floor of the respective excavation, and connecting arrangements which connect the roof support means with the advancing means for movement of the latter. Upright shield means is arranged so as to trail the roof support and advancing means and extends transversely of the direction of movement thereof. The shield means has an upper and a lower end portion. At least two cylinder and piston means are provided each having one end connected to the advancing means and another end articulately connected to the shield means at the upper and lower end portions thereof, respectively.

BACKGROUND OF THE INVENTION

The present invention relates generally to apparatus for protecting mining galleries and other underground excavations against collapse. More particularly the invention relates to improvements in so-called walking mine roof supports which are movable stepwise toward the mine face in an underground excavation and wherein the moving parts are preferably actuated by hydraulic and/or pneumatic systems.

Known supports of this type "walk" along the floor of the excavation towards the mine face in stepwise manner. Such an apparatus is fully disclosed in my U.S. Pat. No. 3,372,551 to which reference may be had for background information. It is merely pointed out here there are at least two roof supports which are provided which are associated with corresponding advancing units which advance stepwise along the floor of the excavation. The advancement of the advancing unit takes place alternately, that is one advancing unit releases its associated roof support from the roof of the excavation, advances and replaces its roof support into abutment with the roof of the excavation at a location downstream of its previous location, then the next advancing unit releases its associated roof support and advances in similar manner. Thus, the roof is always supported by one of the roof supports and the associated advancing unit.

However, behind the roof supports, that is at the locations immediately upstream of the roof supports and which are no longer being supported by them, there is of course the danger that the roof will collapse. This need not take place but the danger exists constantly and if such collapse takes place, the collapsing matter would thrust forwardly under the roof supports, damaging or jamming the same and threatening continued operations.

SUMMARY OF THE INVENTION

It is, accordingly, an object of the present invention to overcome this disadvantage.

A more particular object of the invention is to provide an apparatus of the type in question which protects the rear of the walking mine roof support.

Still a further object of the invention is to provide such an apparatus wherein the components protecting the rear are controllable independently of the remainder of the apparatus, that is independently of the actual roof support structures.

In pursuance of the above objects, and others which will become apparent hereafter, one feature of my invention resides in the provision of an apparatus for preventing cave-ins of mining galleries and other underground excavations. This apparatus includes roof support means, advancing means which advances longitudinally along the floor of the respective excavation, and connecting arrangements which connect the roof support means with the advancing means for movement with the same. Thus far, the structure of the apparatus is known.

In accordance with my invention, I further provide upright shield means which trails the roof support means and the advancing means and which extends transversely of the direction of movement thereof. The shield means has an upper end portion and a lower end portion. Further, I provide at least two cylinder and piston means each of which has one end connected to the advancing means and its other end articulately connected to the shield means, with the other end of one of the cylinder and piston means being connected to the shield means at the upper end portion thereof, and with the other end of the other of the cylinder and piston means being connected to the shield means at the lower end portion thereof.

By supporting the shield means via the cylinder and piston means, the shield means is controllable independently of the remainder of the apparatus and can be made to aid in supporting the roof of the excavation, and in preventing any matter—if a cave-in does occur upstream of the apparatus—from thrusting underneath the mine roof supports, particularly at such times as one of the roof supports is released to perform a stepwise advancement.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic side elevational view of a mine roof support known from the prior art, with the upper advancing unit being shown in longitudinal vertical section;

FIG. 2 is a schematic side elevational view of an apparatus embodying the present invention;

FIG. 3 is a diagrammatic plan view illustrating operation of the novel aspects of the present invention; and

FIG. 4 is a fragmentary illustration analogous to that of FIG. 2, but showing a further embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Discussing now the drawing in detail, and firstly FIG. 1 thereof, it is pointed out that this figure has been included for purposes of better explanation of the basic apparatus in conjunction with which my present invention finds use. This apparatus is fully disclosed in my U.S. Pat. No. 3,372,551. As shown in FIG. 1, the basic apparatus comprises a single hydraulic pit prop 1 which includes a lower tube 1' and an upper tube 1'' with the latter being reciprocably telescoped into the lower tube 1' so that the prop can be extended and retracted. The

tubes 1', 1'' are provided with cooperating cylinder and piston means to extend or retract the prop in response to controlled admission or evacuation of a hydraulic fluid. The upper end portion 2 of the tube 1'' constitutes a male coupling member which extends into a socket provided in an operating cylinder 4. The lower end portion 3 of the lower tube 1' extends into a socket provided in an operating cylinder 4'.

The apparatus comprises two advancing units S, S' which can cause the mine roof support to "walk" along the mine floor 27 toward or away from the mine face 10, and to shift an evacuating conveyor 20 which extends transversely of the mine roof support along the front part of the mine floor 27 and serves to evacuate material which is being removed from the mine face. The two advancing units S, S' are of similar or identical construction and the operating cylinders 4, 4' respectively form part of the units S, S'.

The upper advancing unit S comprises the aforementioned operating cylinder 4 which may be rigidly or tiltably secured to the upper end portion 2 of the tube 1'' and defines a cylinder chamber 5 for a plunger or ram 6 which is rigid with a slide or runner 7. This runner can travel lengthwise along a track constituted by rolls, balls or other friction-reducing elements 8 installed in a first roof-engaging member or cap 9. In the illustrated embodiment, the elements 8 are rolls which are accommodated in a cage including a first portion constituted by the runner 7 and a second portion constituted by the lower part 9*a* of the cap 9. The latter is of preferably U-shaped configuration and extends lengthwise of the mine roof support at right angles to the mine face 10. The downwardly extending flanges of the cap 9 form the side walls of the cage portion 9*a* and shield the friction-reducing elements against debris falling off the mine roof 17.

The upper advancing unit S comprises a shifting device including a double-acting hydraulic cylinder 12 which is articulately connected to the front end portion of the runner 7 by a horizontal pin 11 and accommodates a reciprocable piston whose piston rod 13 is connected with a downwardly extending bracket 15 of the cap 9 by a second horizontal pivot pin 14. The shifting device includes the cylinder 12 and piston rod 13 and can move the cap 9 with reference to the runner 7, or vice versa. The cap 9 protects this shifting device with its flanges.

In addition, the advancing unit S comprises a second roof-engaging cap including two elongated I-beams 16 which are fixedly secured to the cylinder 4 at the opposite sides of cap 9. The upper side of the cap 9 is preferably provided with teeth 18 or other protuberances which can bite into the material of the mine roof 17 to prevent sliding of the cap 9 when the latter bears against the mine roof.

The lower advancing unit S comprises the aforementioned operating cylinder 4' which is fixedly connected with a floor-engaging cap composed of two spaced parallel I-beams 16'. The operating cylinder 4' has a chamber which is not shown and which serves to accommodate a vertically reciprocable plunger which can displace a U-shaped cap 9' corresponding to the cap 9 and movable into and from firm engagement with the mine floor 27. The cap 9' extends lengthwise between the I-beams 16' and its front end portion is articulately connected with the double-acting cylinder 12' of a hydraulic shifting device serving to move the cap 9' with reference to the beams 16' or vice versa. A horizontal pivot pin 21 connects the front end portions of the beams 16' with the evacuating conveyor 20 which is slidable sideways along the mine floor 27. The friction-reducing rollers 8' are disposed between cap 9' and a runner or slide 7' which is connected with the ram in the cylinder 4'.

Because the cap 9' and the beams 16' are shorter than the cap 9 and beams 16, they provide room for the evacuating conveyor 20. A shield 19 on the rear end portions of the beam 16' protects the operating cylinder 4' from filling which is used to fill up the gallery rearwardly of the mine roof support, or from collapsing portions of the mine roof rearwardly of the mine roof support.

It is evident that the shield 19 does not adequately protect against forwardly-thrusting material in the gallery upstream of the mine roof support apparatus, that is material which is used either to fill the gallery or which, more usually, falls into the gallery if portions of the roof 17 collapse behind the mine roof support apparatus and thrust forwardly in the direction of the arrow P underneath the upper cap 9.

According to the present invention this problem is now solved.

Discussing firstly my novel apparatus according to the present invention as shown in FIGS. 2 and 3, it will be seen that reference numeral 104 identifies a diagrammatically illustrated cap analogous to the cap 9 in FIG. 1, which supports the roof R of the gallery, whose floor is identified with reference character F. A cap 104 moves over the floor F and corresponds to the cap 9' of FIG. 1. It is immaterial for purposes of my invention whether the details of the construction of the caps 104 and 104', and of the supports 107 which are associated with them, are identical with those of the apparatus shown in FIG. 1. Essential is only that the apparatus is capable of "walking" in the manner discussed with respect to FIG. 1, that is that the two floor-engaging caps 104' and 104*a*' (compare FIG. 3) which are provided in the apparatus of FIGS. 2 and 3 and which each support one of the caps 104 via the associated supports 107, are capable of advancing stepwise in the direction of the arrow P. Parenthetically it should be pointed out that reference character C identifies the conveyor corresponding to that identified with reference numeral 20 in FIG. 1.

In accordance with the present invention I provide a shield 101 which in the illustrated embodiment of FIGS. 2 and 3 is unitary. I further provide cylinder and piston arrangements, preferably hydraulically or pneumatically operated, which are identified with reference numerals 103 and 106. These are associated at one end with the trailing end portion of the cap 104', and the other end of the cylinder and piston arrangement 103 is connected to the lower end 102 of the upright shield 101, whereas the other end of the cylinder and piston arrangement 106 is connected with the upright shield 101 in the region of the upper end 105 thereof. The connections between the cylinder and piston arrangements 103 and 106 and the cap 104' as well as the shield 101 is articulate. One possibility of an articulate connection of this type is diagrammatically suggested in FIG. 3. A cylinder and piston arrangement 103', analogous to the arrangement 103, connects the trailing end of the cap 104*a*' with the shield 101 in the same manner in which this is explained above with respect to the arrangement 103. A second arrangement 106' (compare FIG. 2) corresponds to the arrangement 106 but is associated with the arrangement 103' and accordingly with the cap 104*a*'.

As shown in FIG. 3, if one of the caps which engage the floor F travels in the direction of the arrow P—here the cap 104'—the piston rod of the arrangement 103 is extended which serves to advance the cap 104' forwardly in this embodiment, whereas the piston rod of the arrangement 103' does not change position and thus maintains the shield 101 unchanged in the position illustrated in FIG. 2. Of course, the associated arrangement 106 has its piston rod simultaneously extended and assumes the position of the arrangement 106' illustrated in FIG. 2, it being assumed in FIG. 2 that it is the cap 104*a*' which has advanced with respect to the cap 104', whereas the reverse is shown in FIG. 3.

It is evident that shifting of the shield 101 is entirely independent of the movement of the remainder of the apparatus except, of course, in so far as the shield 101 naturally can never lag behind by more than one stepwise ad-

vance of the apparatus. However, it is quite evident that the shield **101** can remain unchanged in its position whenever the apparatus performs one stepwise advancement and this is advantageous because it provides the desired protection and support of the roof R immediately upstream of the upper caps **104**, particularly at precisely the critical moment when the apparatus advances by a step.

It would also be possible to utilize a single one of the cylinder and piston arrangements **106, 106'**, and to omit the second one. Similarly, a single one of the arrangements **103, 103'** could be provided which would then have to have its one end connected with the two caps **104'** and **104***a'* via an articulated traverse member. In the latter case, however, it is advantageous to provide both the arrangements **106** and **106'** and to have them connected with one end to the traverse member in the region where the single arrangement **103** is connected thereto, with the arrangements **106** and **106'** extending upwardly in substantially V-shaped configuration and being connected with their other ends at the upper lateral portions of the shield **101**.

A particular advantage of my invention is the fact that it can be added to a walking mine roof support apparatus, for instance of the type shown in FIG. 1, whenever this is desired because its construction is entirely independent from the basic apparatus. A further advantage is the fact that the arrangements **103** and/or **103'** may themselves serve as the means for stepwise propelling the caps **104'** and **104***a'* in the direction of the arrow P, which constitutes a simplification over the arrangement shown in FIG. 1, for instance. Of course, while the arrangements **103** and **103'** have been shown as connected to the trailing ends of the caps **104'** and **104***a'*, they could also be connected to the supports **107** if desired.

The shield **101** may be constituted of an upper and a lower section which are telescoped one into the other and secured to one another by a screw connection or the like. In this manner the height of the shield **101** can be made adjustable so as to accommodate the shield to galleries of different height, that is galleries of different distances between the floor F and the roof R.

According to a further embodiment of the invention, illustrated in FIG. 4, it is also possible to make the shield **101** in this telescopic manner where it is composed of two telescoped sections **114** and **115**, but to eliminate the aforementioned screw connection. As shown in FIG. 4, the section **114** is telescoped into the upper section **115** in known manner. A requisite number of cylinder and piston arrangements **112** connect the sections **114** and **115** with one another in the illustrated manner and serve to maintain them in predetermined relationship, that is to prevent them from telescoping to a greater degree than is desired. The fluid supply and control means for these arrangements **112** are so well known that they require no detailed discussion.

In this embodiment I provide three cylinder and piston arrangements **108, 109** and **110** which are each connected pivotally at one end with the trailing end portion of the cap **104***a'* and/or **104'** and whose other ends are pivotally connected with the shield **101** in the manner illustrated in that the other end portion of the arrangement **108** is connected to the lower end of the section **114**, the other end portion of the arrangement **109** is connected to the upper end of the section **114**, and the other end of the arrangement **110** is connected to the upper end of the upper section **115**. In this manner the section **114** is directly supported by two of the arrangements, namely the arrangement **108** and the arrangement **109**, whereas the upper section **115** is also supported by two of the arrangements, namely directly by the arrangement **110** and indirectly by the arrangement **109**. Of course, it is advantageous to provide two sets of the cylinder and piston arrangements **108, 109** and **110**, located at opposite lateral sides of the shield **101** and each set associated with one of the caps **104'** and **104***a'*, respectively, analogous to the showing in the embodiment of FIG. 3. This provides for better support of the shield **101**.

All of the arrangements **108–110** may be controlled in known manner independently of one another by a control valve **116** which is diagrammatically illustrated. It may, however, be advantageous to connect the interior spaces or fluid chambers **111** of the arrangements **109** and **110** with one another via the conduits **117** and **118** so as to control the arrangements **109** and **110** in unison, whereas the arrangement **108** is separately controllable via the conduits **119** and **120**. The drawing shows that by proper operation of the arrangements **108–110** the upper section **115** may be permitted to forwardly incline over the upper rounded end of the lower section **114**. It is an advantage of the embodiment in FIG. 4 that with the upper section **115** forwardly inclined in this manner, the lower end of the lower section **114** may be drawn forwardly in the direction of the arrow P under the protection of the upper section **115**, this being accomplished in the same manner as discussed with respect to FIGS. 2 and 3. In the next-following step, the upper section **115** may then be drawn forwardly. With this arrangement the shield **101** can be accommodated to any and all loading conditions which may occur as a result of collapse of the roof R rearwardly of the apparatus.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of constructions differing from the types described above.

While the invention has been illustrated and described as embodied in a mine roof support apparatus, it is not intended to be limited to the details shown since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

I claim:

1. In an apparatus for preventing cave-ins of mining galleries and other underground excavations, and including roof support means, advancing means advancing longitudinally along the floor of the respective excavation, and connecting arrangements connecting said roof support means with said advancing means for movement with the same, the improvement comprising upright shield means trailing said roof support means and advancing means and extending transversely of the direction of movement thereof, said shield means having an upper end portion and a lower end portion; and at least two cylinder-and-piston means each having one end connected to said advancing means, and an other end articulately connected to said shield means at said upper and lower end portions thereof, respectively.

2. In an apparatus as defined in claim **1**, wherein said shield means is of one-piece construction.

3. In an apparatus as defined in claim **1**, wherein said shield means comprises an upper section and a lower section one of which overlaps the other, each of said sections having an upper end and a lower end and one of said sections being movable relative to the other.

4. In an apparatus as defined in claim **3**, wherein said cylinder and piston means comprises at least three cylinder and piston arrangements each having one end connected to said advancing means, and an other end, and wherein said other end of one of said arrangements is connected to the lower end of said lower section, said other end of the second of said arrangements is connected to the upper end of said lower section, and said other end of the third of said arrangements is connected to the upper end of said upper section.

5. In an apparatus as defined in claim **4**, wherein one of said sections is telescopically slidable in and with reference to the other.

6. In an apparatus as defined in claim **4**, wherein said sections are of slightly arcuately curved configuration.

7. In an apparatus as defined in claim **4**; and further

comprising operating means connecting said second and third arrangements for simultaneous operation.

8. In an apparatus as defined in claim **5**; and further comprising support means engaging said sections for preventing undesired telescopic sliding movement of the same relative to one another.

9. In an apparatus as defined in claim **4**; and further comprising operating means associated with said arrangements and operable for permitting movement of said upper section to a position of inclination in direction of movement of said advancing means and with reference to said lower section.

10. In an apparatus as defined in claim **4**, wherein said one ends of said second and third sections are connected to said advancing means at a locus common to both of them.

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