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[54] **MINE ROOF GAUGE AND INDICATOR**
3 Claims, 8 Drawing Figs.

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[51] Int. Cl. **G08b 21/00**

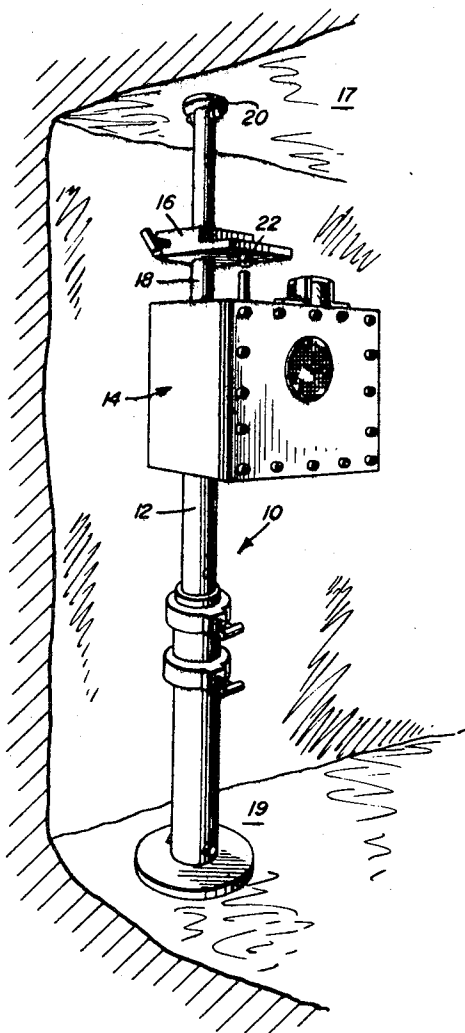
[50] Field of Search **340/282,**
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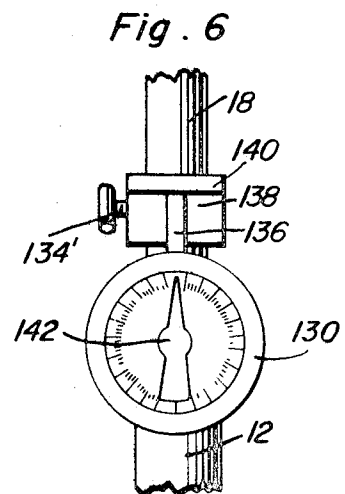
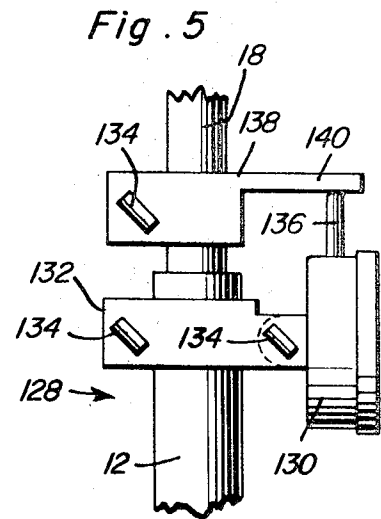
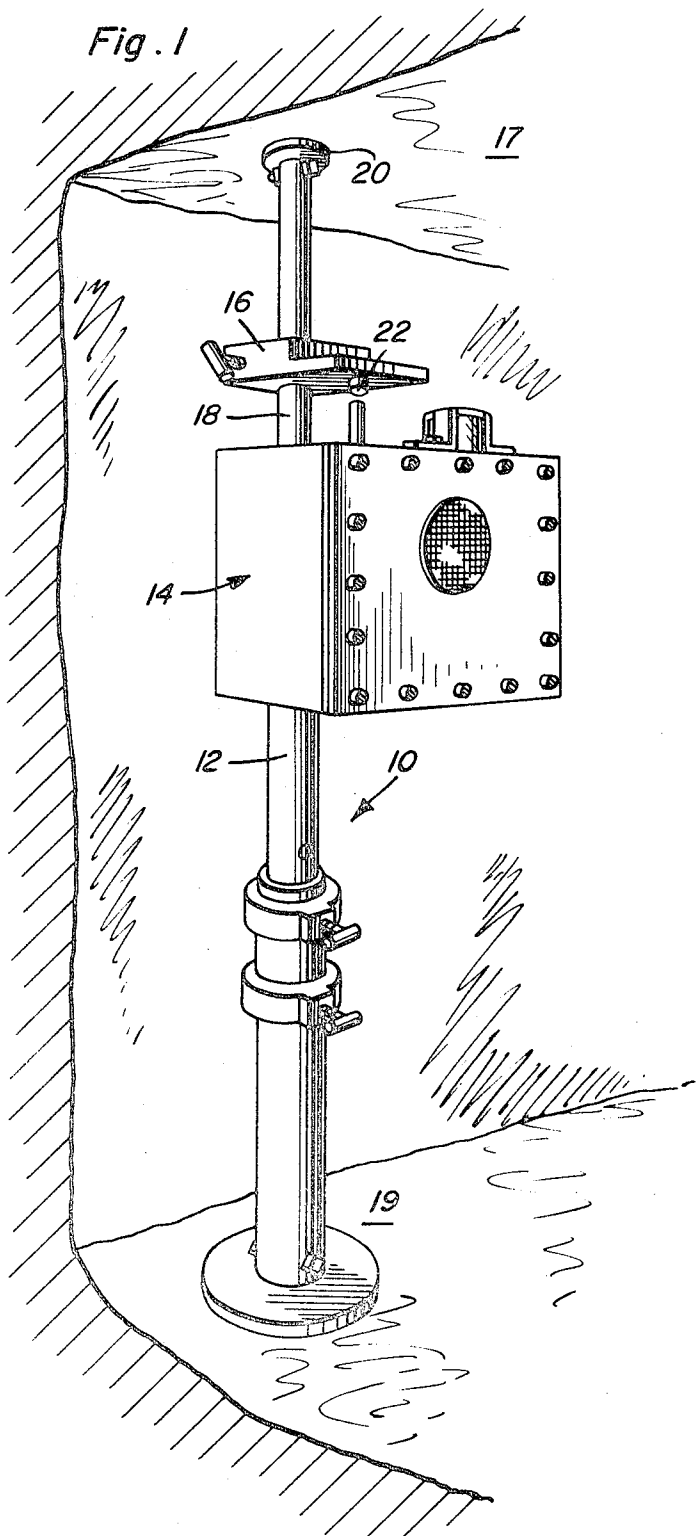
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ABSTRACT: Two telescoping sleeves are disposed between the roof and floor of a mine. Switch trigger means is secured to a first sleeve and a detector actuator is secured to the second sleeve. The trigger and the detector actuator are positioned in registry with one another and separated by a predetermined distance. Displacement of a mine roof by a distance exceeding the predetermined space between the trigger and actuator causes operation of an alarm circuit thus signaling the occurrence of an emergency situation. A second embodiment utilizes the telescoping sleeves and a displacement gauge mounted thereto for monitoring roof displacement.





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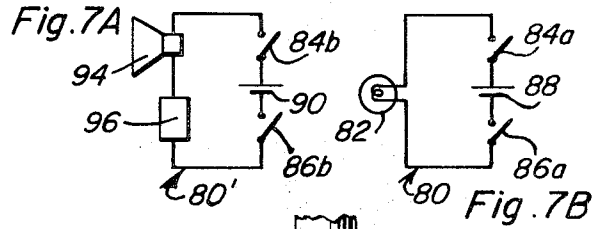
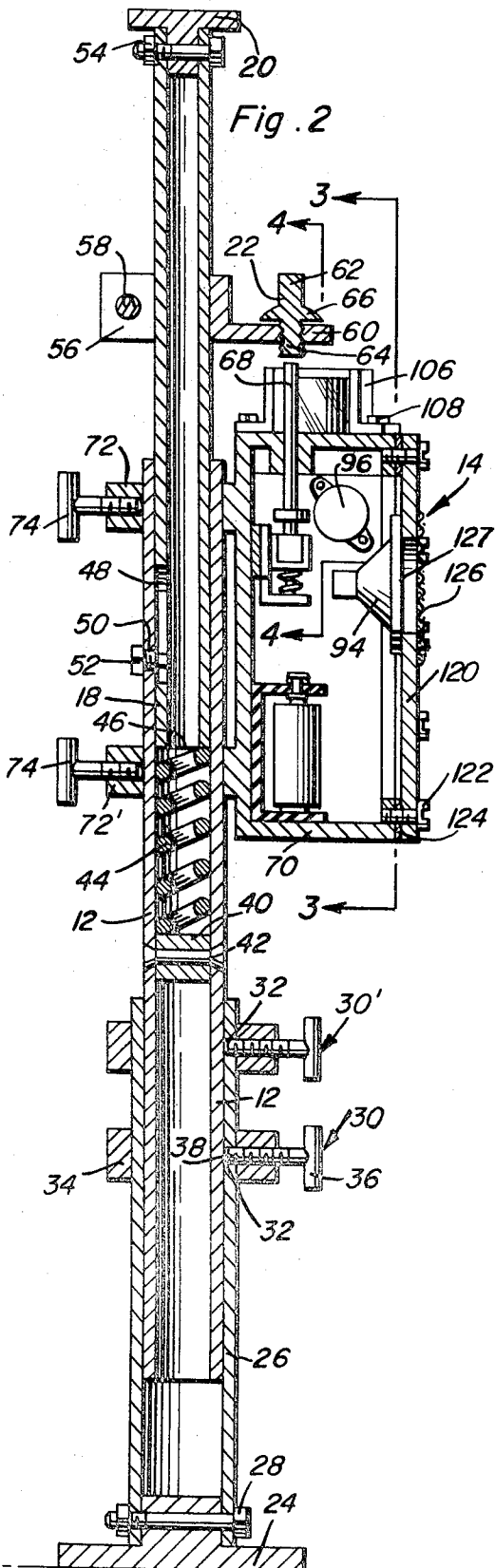


Fig. 3

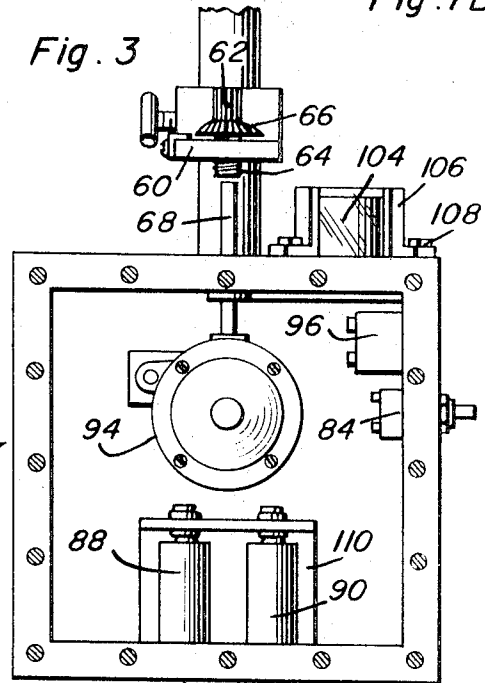
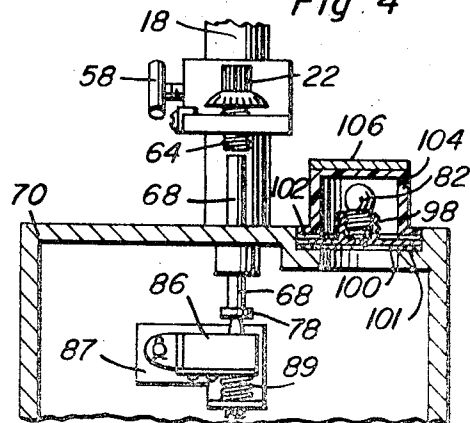


Fig. 4



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MINE ROOF GAUGE AND INDICATOR

The present invention relates to displacement measurement apparatus and more particularly to an apparatus for detecting the lowering of a mine roof beyond a safe limit.

One of the foremost dangers to men working in a mine is the possibility of cave-in. This can occur when a mine roof becomes weakened beyond a certain point which results in the falling of the ceiling or roof material into the space occupied by workers. A cave-in of this sort can cause men to be trapped or buried at a distance far from the mine entrance. Rescue operations require the removal of cave-in material until a point is reached permitting the freeing of the men. As will be appreciated, such a process is relatively slow and inasmuch as trapped men are confined to a space having low air content, rescue operations are generally a race against the clock which often fails. In certain instances, a cave-in results in the physical crushing of miners due to the heavy weight of falling material. The mining industry has not developed an inexpensive instrument to detect the slightest loosening of a mine roof. Complicated and expensive gear for sensing a dangerous condition discourages use of the same and the complexity of some prior art instruments decreases their reliability in a vibration and dust environment.

The purpose of this invention is to save lives. In the event of mine roof loosening, the invention warns working men, by sight and sound to move to a safe place. The invention includes an adjustment that permits the presetting of the device to an initial condition which corresponds to a certain allowable variation in mine roof displacement. A certain amount of roof displacement is normal because a mine settles as material is removed therefrom. Of course, the displacement depends upon the size of the mine and to some extent the rate of material removal. A first embodiment of the present invention includes a device for measuring a preselected minimum displacement between two telescoping sleeve members. Switch means are connected between the sleeves, the switch means being actuated when the preselected minimum displacement occurs. An alarm device is coupled to the switch means for alerting working men of a dangerous condition. The device itself is relatively inexpensive and rugged so that its reliability is maintained for an extended period of time in the vibration and dust environment of a mine.

A second embodiment of the invention includes the telescoping sleeve arrangement of the first embodiment without the alarm detector. In its stead, a displacement gauge actuator is secured to a first sleeve and a displacement gauge is secured to the second sleeve. Thus, relative displacement of the sleeves, indicative of roof displacement, permits workmen to view gradual roof movement over a period of time which permits them to detect trends or patterns in roof displacement.

Although the present invention is explained in terms of a mine roof displacement detector, a shortened version of this device could be used in deep ditches in which case, the telescoping sleeves would be laid in a horizontal position between diametrically opposite walls. When inward displacement of the ditch walls occurs above a preselected minimum, the detector would signal an alarm alerting the working men to get out. In a similar manner, ditch wall movement could be monitored by utilizing a displacement gauge in place of an alarm actuator.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

FIG. 1 is a perspective view illustrating an alarm detector embodiment of the present invention in the environment of a mine.

FIG. 2 is a longitudinal sectional view exposing the interior components of the device shown in FIG. 1.

FIG. 3 is a transverse sectional view taken along a plane passing through section line 3-3 of FIG. 2.

FIG. 4 is a transverse sectional view taken along a plane passing through section line 4-4 of FIG. 2.

FIG. 5 is a side elevational view illustrating the second embodiment of the present invention which includes the utilization of a displacement gauge instead of the alarm detector of the first embodiment.

FIG. 6 is a front elevational view of the device shown in FIG. 5.

FIG. 7a is an electrical schematic diagram of the audio alarm utilized in the first embodiment of the present invention.

FIG. 7b is an electrical schematic diagram of a visual alarm device employed in the first embodiment of the present invention.

Referring to the figures and more particularly to FIG. 1, the first embodiment of the present invention is generally denoted by reference numeral 10 and in brief, is seen to include a first fixed sleeve 12 mounting a displacement detector alarm device generally indicated by numeral 14. A second sleeve 18 is retained in telescoping relation with the first fixed sleeve 12 and is spring-biased to cause the outward engagement of oppositely disposed sleeve ends against the mine roof and ceiling, 17 and 19 respectively. A head 20 connected to the upper end of sleeve 18 contacts the roof. A bracket 16 is mounted upon the second sleeve, the bracket including an adjustment screw 22 which serves as a switch trigger for a detector switch enclosed within the displacement detector alarm 14. When the roof 17 falls by a predetermined minimum amount, a preselected gap between trigger 22 and the switch of the detector alarm 14 is closed thereby causing operation of the switch and a connected alarm circuit.

The first embodiment is illustrated in greater detail in FIG. 2 wherein there is shown a base plate 24 having a central upright flange portion inserted within the lower end of the lowermost sleeve 26. The base plate is secured to the sleeve by means of a threaded bolt 28 passing diametrically through sleeve 26 and the received flange portion of base plate 24. The second telescoping sleeve is disposed within the first sleeve 26, the sleeve members being retained in fixed relation by means of two identical vertically aligned fastening assemblies 30 and 30'. The first sleeve 26 includes several vertically aligned apertures 32 formed therein to accommodate the fastener assemblies 30 and 30'. Considering one of the assemblies 30, the assembly is seen to include a cylindrical collar member 34 having a threaded T-bolt 36 threadingly inserted therein. The T-bolt 36 has an inward end 38 which is adapted to pass through aperture 32 and frictionally engage the confronting surface of sleeve 12. Thus, the degree of telescoping engagement between sleeves 12 and 26 is variable by unloosening the T-bolts 36 of fastener assemblies 30 and 30', and positioning sleeve 12 in a preselected position within sleeve 26. By tightening the T-bolts, the height of sleeve 12 becomes fixed. An intermediate point along the length of sleeve 12 receives a disc-like spring retainer 40 being secured within sleeve 12 by means of a diametrically inserted rivet 42. A coil spring 44 is inserted within sleeve member 12, above the spring retainer member 40. The lower end of the spring is adapted to bear against the upper surface of the retainer member 40. A third sleeve 18 is adapted to be slidingly or telescopically received by the second sleeve 12 so that the lower end 46 of sleeve 18 bears against the upper end of coil spring 44. Thus, coil spring 44 having its lower end fixed by spring retainer member 40 causes an upward biasing of sleeve 12 when the latter engages a mine ceiling.

When setting up the present invention, the fastening assemblies 30 and 30' are adjusted so that compressive biasing of the spring takes effect. A longitudinal slot 48 is formed in the third sleeve 18 and a threaded fastener 52 extends inwardly through an aperture 50 formed in sleeve 18 thereby serving as a mechanical stop between the vertical extreme points of slot 48. The limit stop mechanism prevents injury to the telescoping sleeve members in the event of a large and forceful displacement of a mine roof.

Contact between the third sleeve 18 and the mine roof is achieved through a pad or head member 20 which is suitably attached to the upper end portion of sleeve 18 by a diametrically received fastener 54.

The adjustment screw 22 which serves as an alarm trigger is received within a collar or plate 56 encircling an intermediate length of sleeve 18. The encircling collar is split and receives a T-bolt 58 therein for the purpose of closing the split and clamping the collar 56 to a desired point on sleeve 18. The collar includes an appending flange portion 60 having an aperture therein through which the adjusting screw 22 passes vertically. The lower end 64 of the screw is adapted to engage an alarm actuator and the upper portion of the adjusting screw includes gradation marks 62 thereon as seen in FIG. 3. An annular flange 66 extends outwardly from the angular marked portion 62, the angular portion including a continuation of the marks thereon. A reference mark is inscribed on the upper surface of flange portion 60 to permit the setting of the adjusting screw 22 to a preselected gradation mark which corresponds to a particular vertical position of the screw relative to collar 56. The marks typically denote variations in increments of one-thousandths of an inch so that the gap between the adjustment screw 22 and the detector actuator 68 can be adjusted by a preselected number of one-thousandth inch increments. As will be appreciated, upon displacement of a mine ceiling and a commensurate downward displacement of sleeve 18, the collar 56 secured to the latter mentioned sleeve will experience a similar vertical displacement. If for example, the gap or space between the adjusting screw 22 is seven-thousandths of an inch above the detector actuator 68, the alarm will remain inactive until a time when the roof is displaced a distance of seven-thousandths of an inch below the initial position. At this point, an alarm is sounded as hereinafter explained.

Referring to FIGS. 2-4 the detector alarm indicated by 14 is seen to include a housing 70 having vertically aligned collars 72 and 72' concentrically engaging sleeve 12. Thus, the housing 74 is adapted to be fixed relative to sleeve member 12. T-bolts 74 are inserted within the collars 72 and 72', each bolt having an inward end adapted to frictionally engage the exterior surface of sleeve 12 thereby fastening the collar to the sleeve.

As seen in FIG. 4, the detector or alarm switch actuator 68 is seen to include a vertically elongated rod having an upper end in registry with a confronting end 64 of adjusting screw 22. The inward end of the switch actuator mounts a shoulder element 78. Upon depression of the switch actuator, the shoulder element 78 depresses an alarm switch thereby alerting workmen in the area of a dangerous condition.

In order to better understand the electrical operation of the present invention, reference is made to FIG. 7b which schematically represents an auxiliary visual alarm indicator generally denoted by 80. The circuit is seen to include a lamp 82 connected in series with an on-off switch 84a and a microswitch 86a. A battery voltage source 88 is serially connected to provide energization of lamp 82 when the switches 84a and 86a are closed.

The main alarm of the present invention includes an audio alarm generally indicated by 80' which is seen to include a series circuit comprising an on-off switch 84b, a microswitch 86b, a conventional audio alarm transducer such as a horn 94, speaker or the like, and an associating conventional oscillator-amplifier combination circuit 96. A serially connected battery source 90 energizes the oscillator-amplifier 96 which in turn drives the speaker or horn 94. In actual construction of the electrical circuits 80 and 80', the on-off switches 84a and 84b may be in the form of a dual switch associated with a single ganged switch. Likewise, the microswitches 86a and 86b may be in the form of two sections of a single microswitch assembly.

Referring to FIG. 4, the mechanical placement of the electrical components diagrammatically illustrated in FIGS. 7a and 7b are shown. The bulb 82 is mounted within a socket 98 which is received within a recess 100 formed in the upper sur-

face of housing 70. An insulating strip 101 separates the undersurface of socket 98 and the surface of the recess. An insulating washer 102 is disposed above socket 98 so that the socket is sandwiched between the insulating elements 101 and 102. A colored cylindrical lens 104 is inverted over lamp 82 and is supported upon the upper surface of insulating washer 102. In order to retain the colored lens in position, a spider holder 106 seen in FIGS. 2 and 3 is mounted in overlying securement to the colored lens 104 by means of suitable fasteners 108.

The batteries 88 and 90 are retained within a battery holder 110 which is secured to the interior of housing 70 by suitable means. As will be noted, the wiring between electrical components has been omitted from FIGS. 2-4 in order to render the figures more understandable. However, the circuits for including the electrical components are shown in FIGS. 7a and 7b and accordingly, the physical wiring between electrical components well within the abilities of one ordinarily skilled in the art.

Referring to FIG. 4, a microswitch 86 having two internal switch sections 86a and 86b is spring mounted to a bracket 87 which in turn is secured to housing 70. The spring mount includes a coil spring 89. The switch depressor for microswitch 86 is adapted to be positioned in normal spaced relation to shoulder 78 of actuator 68. Upon downward displacement of actuator 68 in excess of the preset amount, the microswitch is closed. However, should the downward displacement of the actuator bear heavily against microswitch 86, the spring mount permits the microswitch to "give" thereby preventing injury to the switch component. As seen in FIG. 3, the on-off switch 84 is received within an aperture in a wall of housing 70 and includes a manual depressor which is exteriorly exposed. Thus, with the switch 84 in the on position, lamp 82 is caused to light when microswitch 86 is closed under the influence of sufficient downward actuator displacement. If desired, a lamp blinker may be connected to lamp 82 so that upon the blinking of the lamp, an emergency situation is indicated to workmen in the immediate vicinity.

Referring to FIGS. 2 and 3, the audio alarm aspect of the present invention includes the horn or speaker 94 mounted to an apertured removable wall or partition 120. The removable partition 120 is separated from the remainder of the housing by means of a suitable gasket 124 which serves as a seal. Fasteners 122 secure the partition to the housing. A sealing grill or cover 126 is disposed over an aperture 127 formed in partition 120, the material of the cover being such to permit transmission of sound from the horn or speaker 94. The oscillator-amplifier 96 is preferably in the form of a conventional printed or integrated circuit retained in a container 96 which is suitably fastened to the interior surface of housing 70. Once again, it is mentioned that the wiring between the electrical components of the audio alarm is eliminated from FIGS. 2-4 for purposes of clarity. However, FIG. 7a demonstrates the circuit connection between the components. The operation of the audio alarm is simultaneous with that of the visual or lamp alarm. In fact, with the on-off switch in the on state and upon depression of microswitch 86, both audio and visual alarms will become energized thereby emphasizing the dangerous condition in two alarm forms.

The second embodiment of the present invention is used primarily for purposes of monitoring mine ceiling or roof displacement. As seen in FIGS. 5 and 6, the audiovisual detector 14 is removed from the interconnected telescoping sleeves and instead, a displacement gauge assembly generally indicated by 128 is substituted therefor. This assembly includes a displacement gauge 130 fixedly attached to a split collar 132 having a number of T-bolts 134 fastened therein, for purposes of securing the collar 132 to sleeve 12. The gauge 130 includes a depressor 136 which is normally retained in contacting engagement with a flange portion 140 of a second collar 138. The collar 138 is adjusted on sleeve 18 by means of T-bolts 134'. The collar is moved along sleeve 18 until engagement between flange 140 and depressor 136 of gauge 130 is

effected. The gauge 130 is initially adjusted to read zero displacement. As a mining operation proceeds, the dial 142 of displacement gauge 130 can be observed and the condition of the roof monitored over a period of time. When the dial indicates a displacement in excess of the allowable amount, a dangerous situation occurs and an alarm is announced before the condition consummates into a cave-in.

As previously mentioned, a number of telescoping sleeve assemblies with displacement gauges respectively attached thereto may be placed along the length of a mine shaft for purposes of determining displacement trends or patterns along the mine shaft.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.

What we claim as new is as follows:

1. An apparatus for detecting a dropping roof condition comprising trigger means coupled to a ceiling, a detector actuator coupled to an oppositely disposed floor surface, the trigger means and the actuator being normally retained in preselected spaced registry, the trigger means causing operation of the actuator after relative displacement of the surfaces results in the closing of the space between the actuator and the trigger means, and means for indicating the occurrence of actuator operation, together with first and second telescoping sleeve sections retained in contacting engagement between confronting ceiling and roof surfaces, the trigger means being mounted to the first sleeve section, the detector actuator being mounted to the second sleeve section so that relative displacement between the first and second sleeve sections results in a commensurate displacement between the trigger means and the detector actuator, wherein the trigger means

includes mounting means connected to the first sleeve section, and an adjustable screw threadedly engaged within the mounting means for registry with the detector actuator, the screw having gradation marks thereon to be aligned with a fixed reference mark on the mounting means, turning of the screw between adjacent gradation marks causing a corresponding displacement of the screw with respect to the detector actuator thereby enabling one to preset the distance that the ceiling must drop before the detector actuator becomes operative.

2. The apparatus set forth in claim 1 together with a displacement gauge connected between sleeve sections and responding to actuating forces imparted by the trigger means, the gauge permitting continuous monitoring of displacement of the roof.

3. An apparatus for detecting a dropping roof condition comprising trigger means coupled to a ceiling, a detector actuator coupled to an oppositely disposed floor surface, first and second telescoping sleeve sections retained in contacting engagement between confronting ceiling and roof surfaces, the trigger means being mounted to the first sleeve section, the detector actuator being mounted to the second sleeve section so that relative displacement between the first and second sleeve sections results in a commensurate displacement between the trigger means and the detector actuator, wherein the trigger means includes mounting means connected to the first sleeve section, and an adjustable screw threadingly engaged within the mounting means for registry with the detector actuator, the screw having gradation marks thereon to be aligned with a fixed reference mark on the mounting means, turning of the screw between adjacent gradation marks causing a corresponding displacement of the screw with respect to the detector actuator thereby enabling one to preset the distance that the ceiling must drop before the detector actuator becomes operative.

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