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[54] **METHOD OF SUPERVISING THE FILLING LEVEL IN HOPPERS, SHAFTS, SILOS AND THE LIKE FOR MISCELLANEOUS MATERIALS AND MEANS FOR PERFORMING THE METHOD**

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[52] **U.S. Cl.** ..... **73/290 V**; 116/114 B
[58] **Field of Search** ..... 73/290 V, 290 B, 290 R; 116/114 B

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[57] **ABSTRACT**

For supervising the filling level in an elongated space, such as hoppers, shafts, silos and the like, for miscellaneous granular material, the movement of the material is transformed into vibrations and the vibrations are converted into indicating signals which indicate the filling level. This may be accomplished by a plurality of rods which extend through the wall of the space and are subjected to the vibrations produced by solid materials falling through the space. This may be done by providing rods which extend beyond the wall into the space, and by accelerometers or the like which detect the vibrations and convert them into electrical signals which may control the discharge from the shaft.

12 Claims, 3 Drawing Figures

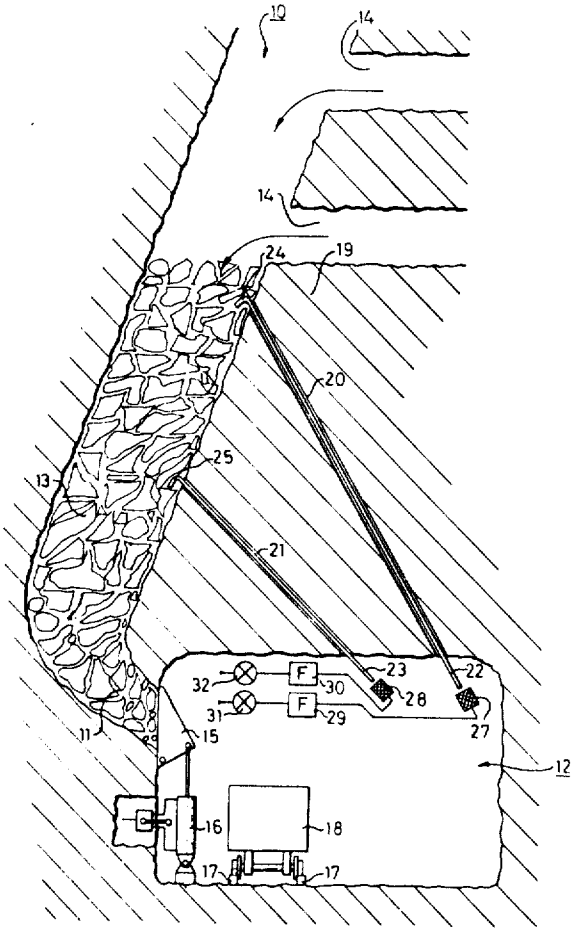


Fig. 1

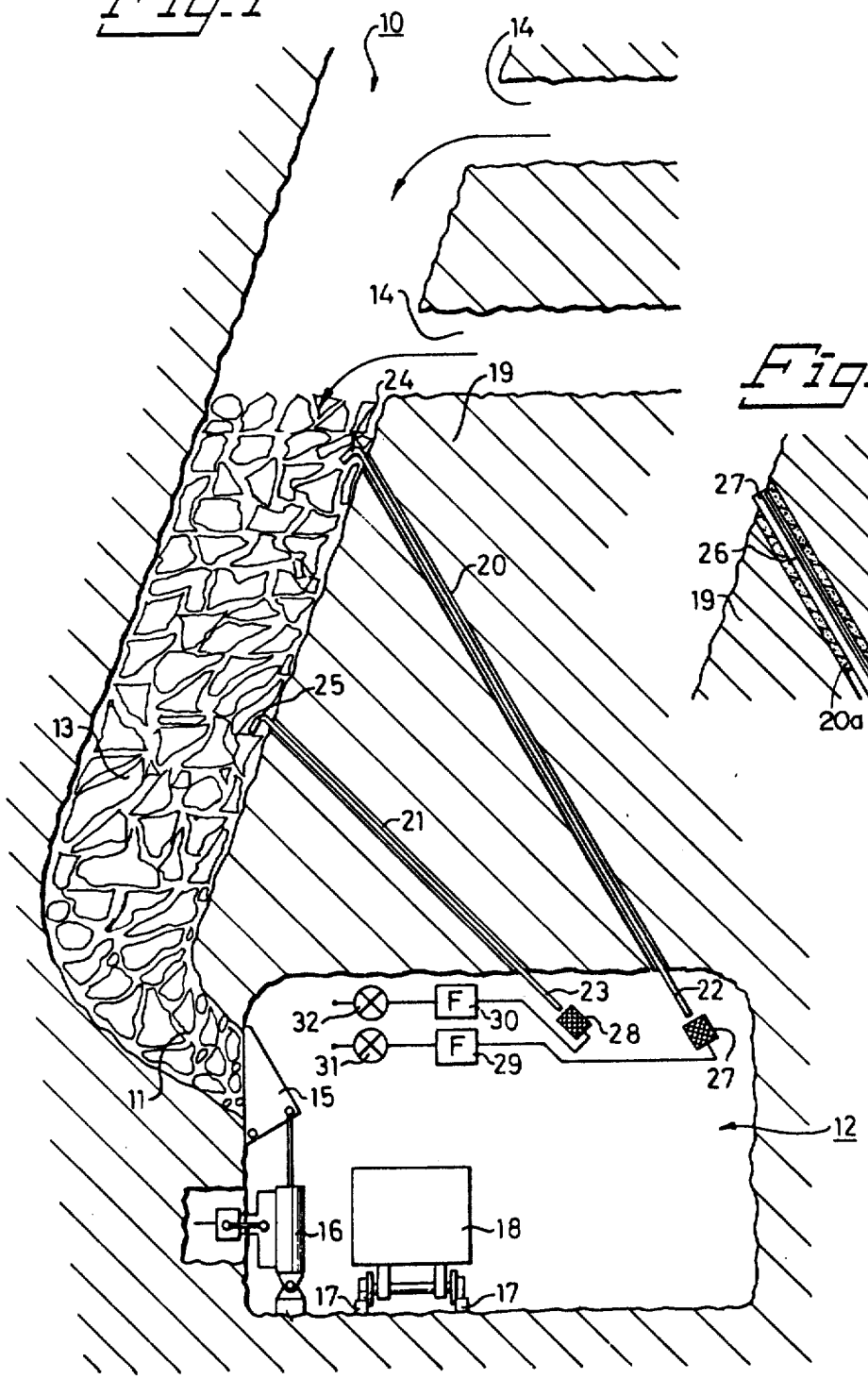
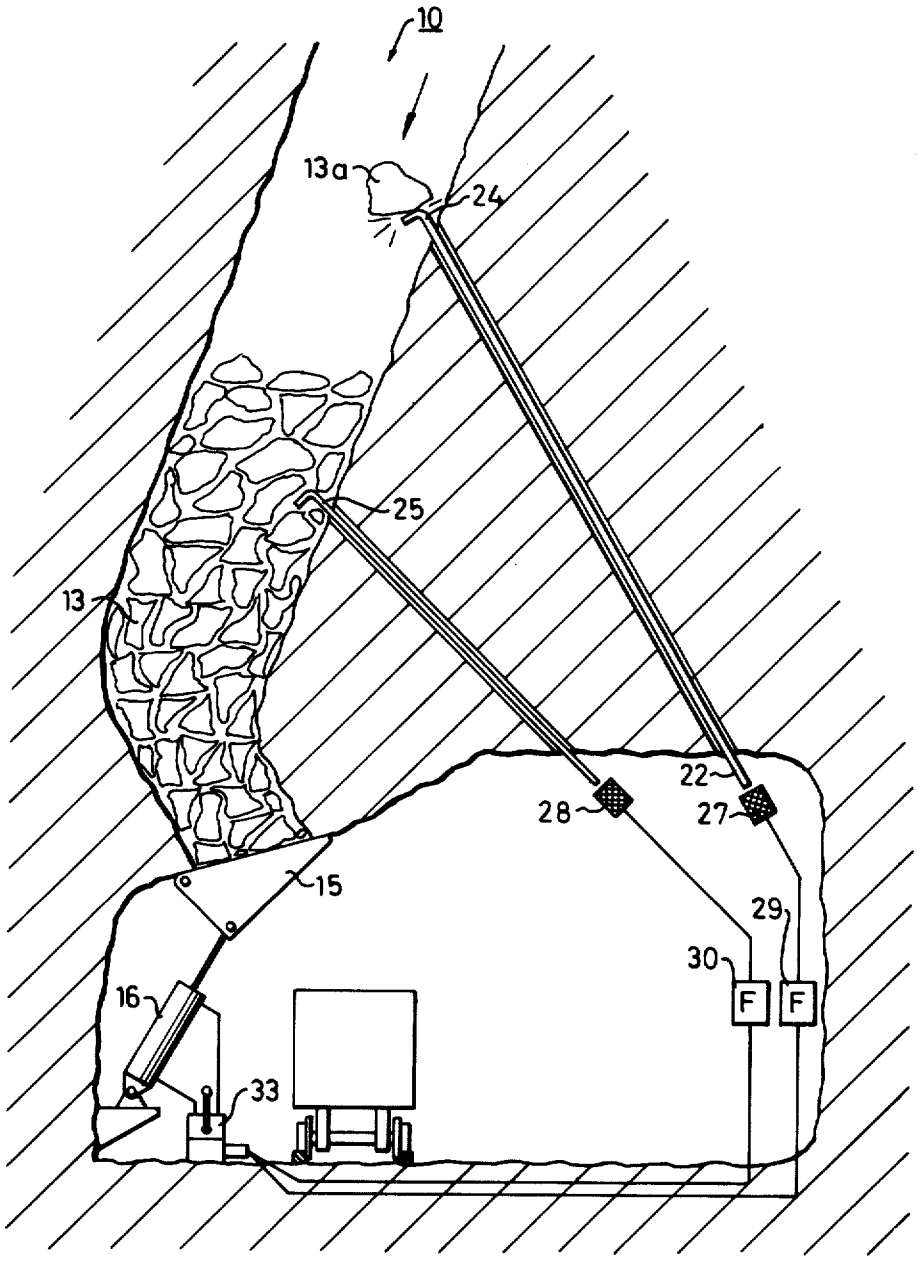

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Fig. 2

27
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20a
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Fig. 3



METHOD OF SUPERVISING THE FILLING LEVEL IN HOPPERS, SHAFTS, SILOS AND THE LIKE FOR MISCELLANEOUS MATERIALS AND MEANS FOR PERFORMING THE METHOD

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method of supervising the filling level in hoppers, shafts, silos and the like for miscellaneous materials, such as blaststone, broken and crushed mineral products.

2. The Prior Art

Previously a plummet has often been used to supervise the filling level in hoppers, this being lowered to the surface of the material which has been poured in and the length of the plummet line then being measured or recorded. In general this method can only be used in vertical hoppers or the like, and it also means that the flow of material must be discontinued before the plummet is lowered, which causes practical drawbacks.

Another method used for the same purpose is that of emitting an acoustic signal towards said surface, receiving the reflected echo and, from the transmission time of the sound, determining the level of said surface. However, the use of this method is limited to hoppers of about 30 m deep and furthermore they must be at least substantially straight if the method is to be reliable. Furthermore, the use of this method is complicated in the case of magnetic materials such as iron ore, because the emitters used are provided with permanent magnets and these become coated with magnetic dust which disturbs the measuring function in an unacceptable manner.

Other methods using conducting or capacitive sensing members which are lowered into the hopper to be influenced by the material cannot be used for chunky objects which are often thrown down from a considerable height, as the sensing members would very quickly be destroyed. It has therefore been impossible to use these methods in practice.

Another method, which however has its limitations, is to locate radioactive elements at various levels down one side of the hopper, the radiation from these elements being recorded by a sensing member on the opposite side of the hopper. However, it has not been found practical to use this method for chunky objects in view of the risk of damage to both the radioactive elements and the sensing members, with consequent risk to personnel. Furthermore, it is often difficult to gain access to the various levels in the hopper to assemble the equipment.

Recently a method has been used, particularly in mining shafts, in which the weight and/or volume of material fed in is recorded, from which the filling level in the hopper can be calculated. However, this method may give considerable measuring errors which are gradually accumulated.

SUMMARY OF THE INVENTION

The object of the present invention is consequently to effect a method of supervising the filling level in collecting hoppers and the like, which does not have the limitations and drawbacks mentioned above and which offers a simple solution to the present problem by enabling simple and inexpensive mechanical and electrical components to be used which will withstand rough treatment from the miscellaneous moving objects and which can otherwise be fitted in a sheltered position.

In accordance with this the invention is substantially characterised in that the movement of the material is transformed to vibrations and these are converted to indicating signals which are brought to indicate the level to which the hopper or the like has been filled.

The invention also relates to a means for performing the method, said means being substantially characterised in that the hopper, etc. cooperates with at least one member which is arranged to be set in vibration by the passing objects and that this member communicates with an indicating mechanism which indicates the level to which the hopper has been filled.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be further explained with reference to a number of embodiments illustrated schematically in the accompanying drawings and in connection herewith additional features characteristic to the invention will be discussed.

FIG. **1** of the drawings is a vertical section, shown schematically, of a collection hopper for miscellaneous material, in this case represented by a mining shaft, the use of the invention being described in connection therewith.

FIG. **2** is a view of a modified detail of FIG. **1** and FIG. **3** a modified embodiment of FIG. **1.**

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIGS. **1** and **3**, **10** generally designates a mining shaft which in the example shown is at an angle to the vertical line. However, this does not exclude the possibility of the shaft being vertical. At the bottom of this shaft **10** is a curve **11** which is arranged to communicate with an unloading point, generally designated **12**, for the miscellaneous material **13** collected in the shaft **10, 11.** Openings **14** are provided at the top of the shaft, through which the material **13** can be poured in.

Between the curve **11** and the unloading point **12** is a pivotable hatch **15** of conventional type which is operated in the example shown by a hydraulic or pneumatic motor **16** of suitable type. Rails **17** are arranged on the unloading station, on which transport trucks **18** are moved to be filled through the hatch **15** when this is in its open position.

The object of the present invention is to be able to supervise the filling level in the shaft **10, 11,** partly to prevent it from being completely emptied and partly to determine when the level falls below at least one predetermined level in order, for example, that at least one transport truck or set of trucks can be loaded without risk of loading from an empty hopper.

In order to perform this supervision, holes **20** and **21** are drilled through the wall **19** of the shaft **10,** joining the unloading station **12** to the shaft **10.** Through each of these holes a tube **22** or rod **23** is passed, preferably of some metal, metal alloy or the like, particularly steel.

The lower ends of these tubes or rods project into the unloading point **12** designed as a transport station, and in the example shown in FIG. **1** the top ends **24, 25,** respectively, project into the path of movement of the material **13** in the shaft **10.** These ends are shown as hooks bent downwards and have acquired this shape naturally because of the action of the falling material **13.**

However, it is not absolutely necessary for the rods or tubes **22** and **23,** respectively, to project into the path of movement of the material since the only condition which must be fulfilled for a successful result is that the movement of the material being tapped from the shaft sets the rods or the like in vibration, said vibration to be used for supervision of the level.

Reference is made in this respect to the detailed view according to FIG. **2** shown by way of example, of a modified embodiment of the device according to the invention, where the upper end **27** of the rod **26** finishes substantially against the surface of the shaft wall **19.** In this example the upper part of the rod is cast in the hole **20,** for example, according to FIG. **1** by means of concrete *20a as shown in FIG. 2* or the like in order to anchor it firmly in the shaft wall. Because of this arrangement, the end of the rod will be worn substantially to the same extent as the shaft wall. *The rod is otherwise out of contact with the wall of the hole 20.*

To return to the arrangement according to FIG. **1,** the vibrations are transmitted through the rods or tubes to suitable indicating instruments **27** and **28,** respectively. Such instruments are, for example, accelerometers, microphones or the like. Each such instrument is shown connected in an individual circuit including an amplifier **29, 30,** respectively, and a signal lamp **31, 32,** respectively, for example. The amplifiers **29** and **30** are arranged so that the signal lamp **31** lights up when the level of the material falls below the rod end **24** and the signal lamp **32** lights up if the level of the material falls below the rod end **25.** Of course, instead of the lamps **31** and **32** acoustic arrangements, pointers, recorders or the like may be used. According to the invention said circuits are only connected while tapping is in progress since their function is dependent on the movement of the material **13.**

FIG. **3** illustrates a modified application of the invention when automatic control of a tapping hatch is desired as long as the filling level in the shaft is below a certain predetermined level.

In this Figure, which agrees in principle with FIG. **1,** the indicating instruments **27** and **28** and the amplifiers **29, 30,** respectively, are electrically connected to a magnetic valve **33** which regulates the supply of operating medium to the motor **16** so that this cannot start and open the tapping hatch **15** as long as the level of the material in the shaft **10** is below the rod end **24,** that is as long as the material **13a** shown can fall freely directly onto the rod end **24,** thus causing extremely strong vibrations. It is assumed that the supply of said operating medium to the motor **16** was previously cut off by the level of material falling below the rod end **25** so that the amplifier **30** closed the magnetic valve **33.**

When so much material **13** has thereafter been poured into the shaft that the level rises above the rod end **24,** the vibrations along the rod **22** will decrease in a characteristic manner. The amplifier **29** is arranged so that when this new strength of signal is received, it will cause the magnetic valve **33** to open again so that the motor **16** can start.

Of course more than two filling levels can be supervised by the device described according to the invention.

The invention is not limited to the embodiments shown and described but can be varied in many ways within the scope of the following claims.

We claim:

1. Method of supervising the filling level and downward movement of granular material in a vertically elongated space, which comprises pouring said material into said space past and in engagement with at least one sensing mechanism placed at a level substantially above the bottom of said space located in the downward path of said material, transforming the movement of the material engaging said sensing mechanism when falling down into said space into vibrations, converting said vibrations into indication signals denoting the falling of material past said sensing mechanism, whereby, when material in the space has reached a level above said sensing mechanism, substantially no vibration is transmitted.

2. Method according to claim **1,** which comprises transforming said movement of the material mechanically into vibrations.

3. Method according to claim **2,** in which the sensing mechanism includes an elongated body influenced by the movement of the material to produce vibrations thereof.

4. Method according to claim **3,** in which the body has its end in the path of movement of the material.

5. Method according to claim **3** which includes sensing oscillatory movements of the other end of the body.

6. Method according to claim **1,** which includes transforming the movement of the material when it passes various levels in the space into individual indicating signals which indicate in stages how far the space has been filled.

7. Means for supervising the filling level and downward movement of granular material in a vertically elongated space, said space having a filling opening above the bottom thereof, comprising at least one sensing member arranged in the wall of said space above the bottom and located in the downward path of material fed into said space through said filling opening, *said sensing member comprising a rod device placed substantially spaced from the walls in the hole and being axially fastened near its end in the hole* whereby such material will come into contact with the member when falling down into the space as long as the level of the material in the space is below said member, said member being provided with vibration transmitting means responsive to the fall of material against said member when passing into said space, and an indicating mechanism connected to said vibration transmitting means to indicate the movement of material and filling level in the space[.] *other vibrations being substantially not sensed in the member because of the spaced positioning of the rod means in the hole.*

8. Means according to claim **7,** in which said member comprises a [sensing member] *rod* which is mechanically influenced by the material.

9. Means according to claim **8,** in which the sensing member is located at least partially in the path of movement of the material in the space.

10. Means according to claim **8,** in which the sensing member is in indirect communication with the path of movement of the material.

[11. Means according to claim 7, in which the sensing member comprises an elongated body, one end of which is at least indirectly influenced by the movement of the material.]

12. Means according to claim [11,] 7, in which the other end of the elongated body is connected with the indicating mechanism.

13. Means according to claim 7, in which a plurality of members caused to vibrate by the movement of the material are located at various levels along the space, each being connected to its own indicating instrument.

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