

May 17, 1960 **HIROSABURO OSAWA** **2,937,049**
METHOD OF AND AN APPARATUS FOR CARRYING COALS OUT OF
A VERTICAL SHAFT WITH THE AID OF HEAVY
LIQUID IN THE COAL MINE

2,937,049

2 Sheets-Sheet 1

Fig. 1

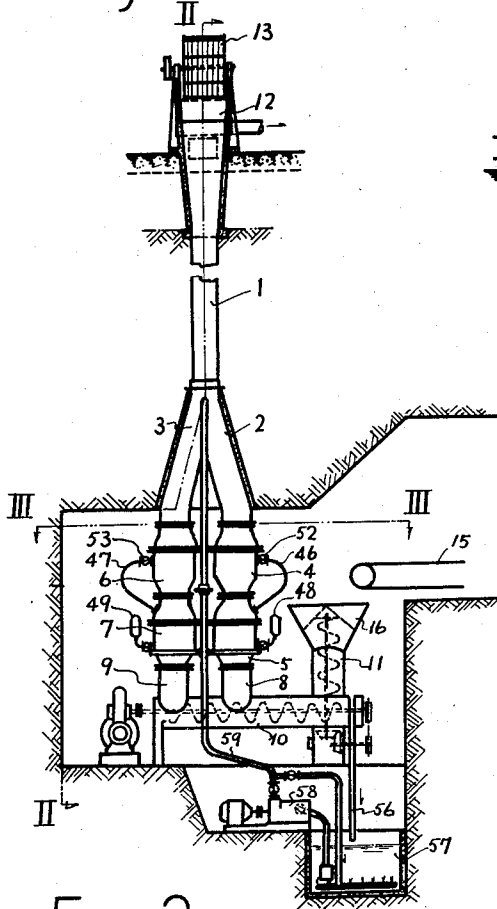


Fig. 2

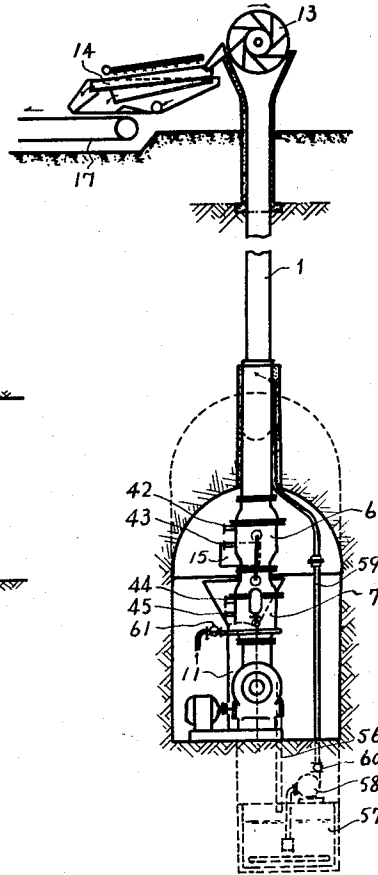
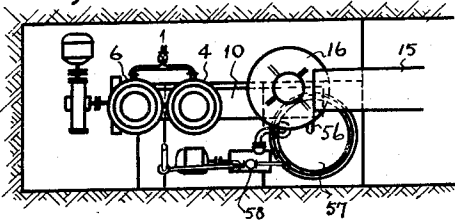


Fig. 3



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Fig. 4

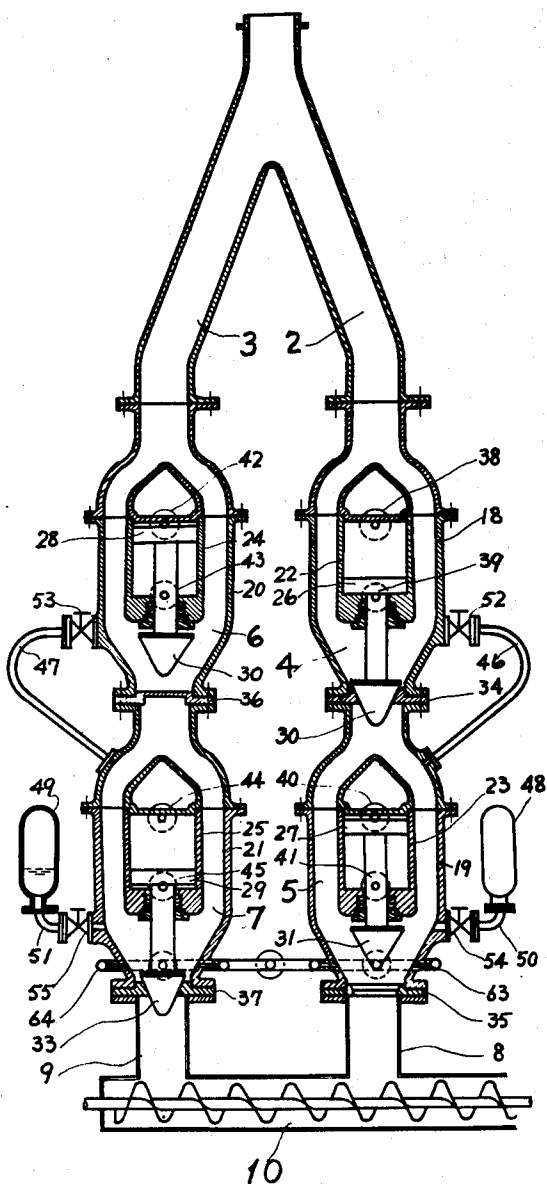


Fig. 5

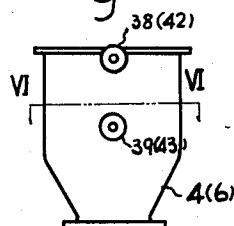


Fig. 6

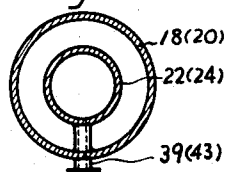


Fig. 7

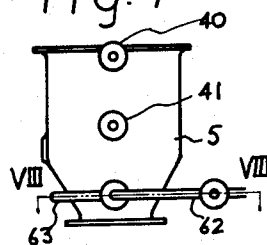
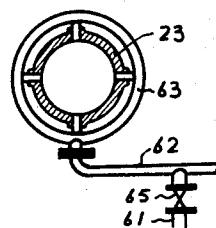


Fig. 8



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METHOD OF AND AN APPARATUS FOR CARRYING COALS OUT OF A VERTICAL SHAFT WITH THE AID OF HEAVY LIQUID IN THE COAL MINE

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5 Claims. (Cl. 302—14)

The present invention relates to a method of and an apparatus for transporting or carrying coals out of a vertical shaft by utilizing the buoyancy of heavy liquid in the coal mine.

An object of this invention is to carry out coals out of a vertical shaft, by utilizing buoyancy of heavy media or heavy liquid in the coal mine.

Another object of this invention is to simplify the equipment and its operation for carrying coal out of the vertical shaft in the coal mine and to save the cost of installation and transportation.

Further objects, features and advantages will be apparent from the following description.

The present invention is intended to bore in a coal mine a vertical shaft of a small bore hole which is filled with heavy liquid or heavy media so as to feed coal into the vertical shaft through valves at the lower bottom of the shaft and to permit the coal to rise within the shaft by utilizing the buoyancy of the heavy liquid.

Accordingly, the specific gravity of heavy liquid to be employed in the present invention must be larger than that of coal to be transported.

It is desired that the heavy suspension is stable and, thus, an aqueous heavy suspension is preferred which is produced by dispersing silt and at least one of the group consisting of pulverized pyrite cinder, hematite, limonite, magnetite, ferrosilicon, galena, and the like and a silt produced by the disintegration of shale, and which silt consists mainly of particles of 300–1500 mesh and has a specific gravity of 2.1–2.7. Thus, the specific gravity of the heavy suspension is, for instance, set at 1.6 or more, assuming the specific gravity of coal to be 1.5.

A vertical shaft employed in this invention need not necessarily be exactly vertical and may incline or bend within the extent that the object to be transported is not hindered from floating or rising. The diameter of the vertical bore or shaft depends upon the size of the object to be transported, the carrying capacity per hour, the difference in specific gravity between the heavy liquid employed and the object to be transported, and the like, being required to be more than some 200 millimeters for the transportation of coal. Thus, a bore hole made by a boring machine can be utilized as it stands for the vertical shaft.

For an alluvial deposit such as soil, the vertical shaft is provided with a concrete or iron pipe for the prevention of the fall of the bore wall, whereas, it does not necessarily require any walling work by cement, iron members and the like in the event there is no danger of falling of the vertical shaft wall as the vertical shaft in the rock seam.

The bottom portion of the shaft, including the part provided with a valve mechanism and the upper part adjacent thereto, must, however, be constructed so as to resist the heavy liquid pressure within the shaft and to prevent the leakage of the liquid. This vertical shaft usually divides at a point near the bottom into two or more branches, each of which necessitates a set of at least

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two valves arranged vertically in series. However, if only a small capacity is required for the shaft, the vertical shaft need not branch off and only the provision of the above set of valves arranged in series is required. Further, when one main vertical shaft is used in common for coal transportation in several coal seams, a heavy liquid vertical shaft provided in each seam is used with its upper inclined portion in communication with the main shaft.

Now an embodiment of the present invention will be described with reference to the accompanying drawings, wherein a vertical shaft divides near its bottom portion into two branches which are each provided with a set of two valves arranged vertically in series, the two branches being arranged in parallel.

Fig. 1 is a front view of the embodiment of the invention;

Fig. 2 is a sectional side view taken on the line II—II of Fig. 1;

Fig. 3 is a sectional plan view taken on the line III—III of Fig. 1;

Fig. 4 is a longitudinal sectional view illustrating the relationship between the valve mechanisms and a screw conveyor;

Fig. 5 is a elevational front view illustrating of the upper valve fitted with pressure oil tubes;

Fig. 6 is a sectional plan view taken of the line VI—VI of Fig. 5;

Fig. 7 is an elevational front view of the lower valve fitted with pressure oil tubes and inlet pipe, through which heavy liquid or compressed air is introduced in order to prevent precipitation of the heavy liquid.

Fig. 8 is a sectional plan view taken on the line VIII—VIII of Fig. 7.

In the drawings, the vertical shaft 1 is divided near its bottom portion into branches 2 and 3, which are provided with a pair of series of valves 4 and 5 or 6 and 7 respectively, these valves being all of the same construction. Valves 5 and 7 are connected downwardly to communicating chambers 8 and 9 respectively, which connect with the delivery openings above the casing of a screw conveyor 10 which in turn is connected to a vertical screw conveyor 11. On the other hand, at the exit of the vertical shaft is provided a receptacle 12 to receive coal floated up, in which are provided a scraper 13 for scraping the coal floated and a washing machine 14 for the floatings. The above-described valves comprise respectively outer cylinders 18, 19, 20 and 21, inner cylinders 22, 23, 24 and 25, pistons 26, 27, 28 and 29, and needle valves 30, 45. Further, the pairs of valves in series 4, 5 and 6, 7 being respectively shown at 34, 35, 36 and 37. Each of these valves communicates with two oil or water pressure pipes as shown at 38, 39, 40, 41, 42, 43, 44 and 45. Further, the pairs of valves in series 4, 5 and 6, 7 are respectively connected to communicating pipes 46 and 47, an air chamber 48 or 49 and its connecting pipe 50 or 51 being attached to the valve 5 or 7 respectively. Also, to the communicating pipes 46 and 47 are attached cocks 52 and 53 respectively, and to the pipes 50 and 51 cocks 54 and 55 respectively.

Opening and closing of each set of valves 4 and 5 or 6 and 7 is properly effected with the aid of the pressure of oil or water.

The manner of operation to open or close the valves 4 and 5 by oil pressure will now be described. First, assume that valve 4 is open, and valve 5 is closed, high heavy liquid pressure being applied on the needle valve 31 of the valve 5. In this case, to effect opening and closing of the valves at once through oil pressure will bring about sudden pressure change in the valves to cause some accident.

Therefore, in order to open the valve 5, the valve 4 is

first closed. To the purpose, pressure oil is first introduced into the upper chamber of the piston 26 through pipe 38, while the pressure oil in the lower chamber of the piston is at the same time led out through pipe 39 to slide the piston 26 downwardly so that the needle valve 30 connected thereto reaches its seat 34 to bring in the state of perfect closure. The cock 52 is then opened to allow the pressure of heavy liquid within the valve 5 to be drawn into air chamber 48. Thirdly, pressure oil is introduced into the lower chamber of the piston 27 through pipe 41 while the pressure oil in the upper chamber of the piston is at the same time led out through pipe 40 to slide the piston 27 of the valve 5 upwardly so that the needle valve 31 is opened to the required position, thus the valve 5 being opened. Next, to open the valve 4, similar steps are required as when the valve 5 is opened.

That is, pressure oil is first introduced into one piston chamber through pipe 40, while the pressure oil in the other piston chamber is led out through pipe 41 to slide the piston 27 downwardly so that the needle valve 31 reaches its seat 35 to bring the valve in the state of perfect closure. The cock 52 in the communicating pipe 46 is secondly opened to equalize the upper and lower pressures on the needle valve 30. Thirdly, pressure oil is introduced into one piston chamber through pipe 39, while the pressure oil in the other piston chamber is led out through pipe 38 to slide the piston 26 of the valve 4 so that the needle valve 30 is raised to the required position, thus, completing the operation to open the valve 4. Similar steps are thus repeated to effect such an operation to close and open the valves 4 and 5.

The process in which coal dug out in a mine is carried out of the mine by means of the method and the apparatus according to the present invention will now be detailed.

The coal dug out in a mine is crushed into sizes such that it causes no troubles as it passes through the valves in the bottom portion of the aforesaid vertical shaft, and then, if required, is subjected to separation by heavy liquid, sinkings being separated, if necessary, from heavy liquid attached thereto and then used for packing waste mines, while floatings or coal floated being transferred onto a transporter 15 and then fed into a hopper 16 provided at near the bottom of the heavy liquid vertical shaft to be delivered to the communicating chambers 8 and 9 positioned under each of the above mentioned valves by means of conveyors 11 and 10. As the coal delivered by the said conveyors tends to float up to the upper surface of the heavy liquid due to its buoyancy, the coal entering communicating chamber 8 floats up in that chamber, but when the chamber has been filled with coal subsequent coal is carried further by the said conveyor to be caused to float up in the communicating chamber 9 and an electrically or mechanically known means is installed in a manner that stop, start and revolutions per minute of the conveyor can be controlled in case of necessity; for instance, a buoy or float is provided in the communicating chamber in such a way that the coal entering into said chamber is caused to operate the buoy to indicate a quality of the said coal, or the control of electric motor is conducted through an electrically or mechanically known means by transmitting the aforesaid operation to the outer side, or the revolutions per minute of the conveyor are regulated artificially or mechanically by transmitting the said operation of the buoy. The coals floated up in the communicating chambers 8 and 9 enter upwardly the chambers of the valves 5 and 7 as soon as these valves are opened, and further pass through the upper valves 4 and 6, as soon as these valves are opened, thus the coals rise within the vertical shaft to enter the receptacle 12 for floatings provided at the shaft exit. As described above, the coals delivered into the communicating chambers 8 and 9 at the bottoms of the vertical shaft pass only due to the buoyancy of the heavy liquid

through valves 4, 5 and/or 6, 7 and rise also due to the buoyancy through the vertical shaft, and then reach the shaft exit. The coal floated up to the shaft exit is delivered to the washing machine 14 for floatings by the scraper 13 to be washed by sprinkling and other methods, thus the heavy liquid attached to the coal being washed away.

The coal thus washed is sent to a definite place by means of a coal transporter 17. On the other hand, the heavy liquid diluted by washing is subjected to the heavy liquid recovering process, in which nonessential material intermingled with the heavy liquid is eliminated and essentials are recovered to be reused.

A pair of two above-described valves in series to be employed in the present invention is arranged and operated as described hereinbefore in such a way that, in use, one of the two valves is sure to be in the state of perfect closure.

Consequently, the pressure due to the heavy liquid in the vertical shaft is always held by the valve in the closed state.

When coal enters valves 5 and 7, the same volume of the heavy liquid as that of the coal falls from the valves 5 and 7 into the communicating chambers 8 and 9 connected to the valves 5 and 7, accordingly the volume of the heavy liquid in the conveyor 10 being increased as much, which is introduced from an overflow hole provided at the side of the conveyor 10 through overflow pipe 56 into a heavy liquid reservoir 57. The heavy liquid in the reservoir 57 is made uniform in its density by mixing and other methods, if necessary, and is returned to the bottom of the vertical shaft 1 through pipe 59 and cock 60 by means of a high pressure pump 58. Further, when the heavy liquid in the vertical shaft 1 is employed in the form of heavy suspension, heavy liquid or compressed air is forced into the bottoms of the mechanisms of the valves 5 and 7 to prevent precipitation in the heavy liquid in the shaft, since the suspending matter may otherwise precipitate while the transporting operation of the vertical shaft is stopped. Shown at 61, 62, 63 and 64 in Figs. 4 and 8 are pipes for introducing high pressure heavy liquid or compressed air, and a stop valve is shown at 65.

As can be seen from the above description, the present invention intends to float up coal in a mine to the vertical shaft exit in the coal mine by the buoyancy of heavy liquid filled in a vertical shaft, by utilizing ingeniously the difference in specific gravity between the coal and the heavy liquid. Thus, it is possible to dispense with elevators, railroad tracks, coal tubs and the like for carrying coal out of the vertical shaft in the coal mine, and the power and operation necessary for reciprocating tubs between the outside and inside of the mine, and also sharply save the expenditure of digging vertical shaft, thus bringing in extremely important effects such as extreme simplification of the equipment and its operation for carrying coal out of the vertical shaft in the coal mine and remarkable saving of the costs of installation and transportation.

While the invention has been described in connection with coal as an object to be transported, it will be understood that the method and the apparatus according to the present invention may also be employed to transport such objects as ores other than coal, mine-pillars, and the like out of mines in a same manner as when coal is to be transported.

What I claim is:

1. A process for carrying coal dug in a mine to the earth's surface which comprises establishing a relatively long, narrow coal transport zone extending downwardly from the earth's surface to a coal supply zone, filling said coal transport zone with a heavy liquid having a greater specific gravity than said coal and comprising a dispersion of silt and at least one material selected from the class consisting of pulverized pyrite cinder, hematite, limonite,

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magnetite, ferrosilicon and galena in water, introducing said coal into said liquid at the level of said coal supply zone whereby said coal is caused to float upwardly toward the top of said coal transport zone by virtue of the buoyancy of said coal in said liquid, and removing the coal from said coal transport zone at about the top thereof.

2. An apparatus for transporting coal up to an exit of a vertical shaft by the buoyancy of a heavy liquid, comprising in combination: an open ended vertical shaft as a bore hole forming a tube filled with heavy liquid having greater specific gravity than that of the coal to be treated, a receiving hopper and a screw conveyor for feeding coal dug in the coal mine under the vertical shaft and one set of at least two valves arranged vertically in series at the bottom portion of the vertical shaft for supporting heavy liquid pressure and feeding the coal into the said shaft.

3. An apparatus for transporting coal up to an exit of a vertical shaft by the buoyancy of a heavy liquid, comprising in combination: a vertical shaft forming a tube at its lower part and adapted for being filled with a heavy liquid having greater specific gravity than that of the coal to be treated, a communicating chamber connected to the bottom of the said shaft, a receiving hopper at the bottom of the said shaft, a regulatable screw conveyor under said hopper and connected to the communicating chamber above the casing of the conveyor and filled with a heavy liquid and one set of at least two valves arranged vertically in series at the bottom portion of the said shaft and being operated alternately.

4. An apparatus for transporting coal up to an exit of a vertical shaft with the aid of a heavy liquid comprising in combination: means defining a vertical shaft adapted to be filled with a heavy liquid having greater specific gravity than that of the coal, said vertical shaft being divided into branches, a communicating tube connected to the bottom of the aforesaid shaft, an apparatus for feeding coal to the bottom of said communicating tube; said apparatus being composed of a conveyor for

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carrying the coal to be treated, a screw conveyor adjacent said conveyor for receiving coal therefrom and conveying the same to the communicating tube, and an enclosed cylindrical body for the screw conveyor filled with the heavy liquid; a set of valves arranged vertically in series in a branch of the vertical shaft for controlling the floating of the coal and means for operating said valves alternately.

5. An apparatus for transporting coal up to an exit of a vertical shaft with the aid of a heavy liquid, comprising in combination: means defining a vertical shaft adapted to be filled with a heavy liquid having greater specific gravity than that of the coal, said vertical shaft being divided into branches, a communicating tube connected to the bottom of the aforesaid shaft; an apparatus for feeding coal to the bottom of said communicating tube, said apparatus being composed of a conveyor for carrying the coal to be treated, a screw conveyor adjacent said conveyor for receiving coal therefrom and conveying the same to the communicating tube, and an enclosed cylindrical body for the screw conveyor filled with the heavy liquid; a set of two valves arranged vertically in series in a branch of the vertical shaft for controlling the floating of the coal, means for operating said valves alternately and a receptacle for receiving coal floated up to the top of the vertical shaft.

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