ABSTRACT: A method and apparatus to accomplish underground mining and to convey the mined material from locations within the mine such as the mine face to other locations, e.g., in a coal mine to convey the material to a more convenient disposition location, such as a furnace. The machine utilizes fluid movement in a conduit, the fluid being either liquid such as water or gases such as air, both of which are normally being pumped in substantially all underground mines, the fluid entraining mined materials including particles and fines as well as mine gases at the inlet end of the conduit at or near the face of the mine and carrying the entrained material to the egress of the machine conduit. Wetting or soaking of the fines is provided. The conduit can be sufficiently large to enable emergency escape passages of a person and when serving such purpose, is provided with a personnel bypass around the fluid pump. It is envisaged that the inlet end of the conduit can be incorporated directly into existing mine face mining machinery or devices which digs, loosens, cuts, rips, grinds, augers, pulverizes, crushes or otherwise works on the material being mined. Emergency protective operators enclosures for mining machinery, with access to entries into the conduit are provided.
BACKGROUND OF THE INVENTION

The present invention relates to underground mining and more particularly to the transportation or moving of coal from locations within a mine such as the immediate or near face of the mine to another location or point inside of the mine or all the way outside of the mine to storage or even to a place of consumption such as directly into a furnace or furnaces. The method and apparatus relate especially to mines which use air and reclaimed to ventilate the mine or use pumps out of necessity to pump water from the mine. The apparatus can be used as the main or an auxiliary ventilating or water pumping system and will use the same air or water and pumps and the main conduit or auxiliary conduit as the agent for conveying the mined material. Gases other than air, for example, inert gases to minimize explosions, could be used as the conveying medium in this new system. If water is used as a liquid conveying medium, it could be introduced from external sources. This may be necessary in some mines which have no water or those which have some water but need an additional source. If an external source of liquid or inert gases are used, such fluids could be reclaimed and reused if economy so dictates.

The fines and coal particles are not only important sources of revenue but include the more dangerous of explosive elements in coal mines. The present system keeps the mine cleaned of such elements as well as the explosive gases and those elements and gases can be reclaimed for use or sale. The spraying or soaking of the fines in the conduit reduces their explosive tendency as well as imparting a beneficial end effect in recovery. Open storage of fines leaves them free to be blown away by winds and the outbursting gases from a pneumatic conveying system. Untold tons of fines are lost in that manner whereas if the fines are watered before leaving the system, loss by blowing is materially reduced.

The present method and system creates safety as well as efficient containment of the useful elements from a mine. It reduces mining costs due to labor, equipment and expenses involved in reducing or eliminating explosive situations by spraying with water or rock dusts which are acceptable.

The present method can be used simultaneously with other known methods, such as cars and belts, being used for removing the coal.

SUMMARY OF THE INVENTION

Accordingly, a primary object resides in the provision of a safe novel method of moving coal within the mines and of bringing coal out from mines rather than using rail mine cars, rubber tired cars, belts, drag conveyors, and other devices.

Another object resides in providing a novel mined material conveying method and apparatus which is less expensive than previously known mechanical removal methods.

Another object resides in a novel method of removing mined material from underground mines which decreases the loss of working time that regularly occurs when using continuous miners and when using loading machines and other devices.

Another object resides in providing a novel emergency escapeaway from mines. In connection with this object, further objects reside in providing a dependable fluid conveying system which serves as an auxiliary and dependable escape route for personnel trapped by cave-ins and explosion disasters.

In conjunction with the foregoing object, further objects reside in providing sufficient access and inspection doors which enable entry into the conduit system at selected desirable locations. Furthermore, any underground mining machinery or working devices can be provided with personnel safety enclosures equipped with emergency food and oxygen, and such enclosures, if desirable, can be made explosive and heat resistant and when used with machinery as part of the conduit conveying system, enabling convenient adjacent entry through an access door or opening into the conduit. Such access openings, by variation in their open condition, can be used as a control of the pressures and velocities of flow in the system, either supplementing or as a substitute for conventional pump speed controls.

Another object resides in the provision of a novel mining method and apparatus which enables getting as much as possible of the fines, small particles of coal, and the gases present along the underground mine and particularly at the face of the mine and to contain such elements, in other words, to collect them and convey them from the mine for direct use or sale and that such materials are not spread over the mine thereby creating dangerous conditions conducive to explosions.

Further novel features and other objects of this invention will become apparent from the following detailed description, discussion and the appended claims taken in conjunction with the accompanying drawing showing a preferred structure and embodiment, in which:

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a pictorial schematic elevation view illustrating a portion of a coal mine tunnel with apparatus components of a conveyor conduit system in accord with the present invention, some components being broken away to show details; and FIG. 2 is a layout diagram of a strata in a coal mine illustrating some of the various ways in which the conveyor conduit system and subsystems are used in conjunction with the mine.

GENERAL DESCRIPTION

FIG. 1 depicts a section through a mine tunnel 10, the left-hand portion showing the mine face 12 of a seam of coal, with an exemplary portion of a fluid operated conveying system with mine safety provisions. The inlet end 14 of the conduit in the illustrated example is located at or near the mine face 12 and connects to the conduit system through suitably arranged coupled sections of conduit such as the flexible section 16 and the telescoping conduit arrangement 18.

It is to be understood that the sections of telescoping conduit 18 and the flexible conduit 16 can be used at other locations, etc., they can be interconnected so the telescoping conduit arrangement is at the conveyor inlet. Combinations of flexible conduit and telescoping conduits are desirable to enable shifting of the inlet end as the face is worked either by hand or by some primary mining machinery.

The telescoping arrangement which includes an outer section 20 and a concentric inner section 22 is preferably rendered mobile by mounting the telescoping arrangement on a wheeled cart 26. Suitable known forms of conduit seals and roller devices 28 can be incorporated at the respective cooperating ends of the two telescoping sections 20 and 22 to maintain conduit sealed arrangement and make telescoping easier.

Other sections in the system include rigid conduit pipe sections 30, a portion of one being shown in FIG. 1, and large check or pivoted gate valves 32, as needed depending on the length of the conveyor system. Such valves are used to prevent kickback of material or explosion forces, back through conduits 30, 18 and 16 to the inlet 14 or the face of the mine passage. The flap valves 32 are sufficiently large to permit a man to raise it and pass the valve. A counter-balance weight 33 can be secured to the pivoted flap valve 32 to make it easier to swing it open.

Also, any desired branch-off fitting 34 with branch 36, either a T or Y, can be inserted where necessary and connected through an auxiliary or subsystem conveyor conduit including components similar to the main system. Such auxiliary branches can lead to branch passages of the mine such as 38 and have inlets at other mine faces or other pickup points.

Following the section of conduit which includes the gate 32 and branch-offs 34 is a pump 40 which draws the fluid such as gases or liquid, or a mixture of gases and liquid with mine
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3. Gases and entrained mined material through the conduit sections 16, 18, 30, etc. and forces it out through an additional conduit or duct 42 to the desired destination.

Downstream of the pump is located a unit 44 which includes a nozzle arrangement with water inlet line 46 by which the material such as the small coal particles and fines can be sprayed or soaked with water to reduce danger of explosion, and to help prevent the fines from blowing away when they are conveyed to open storage areas.

A bypass conduit 48 is provided around the pump 40 from adjacent its inlet to enable miners to crawl, via the conduit system, through the bypass 48 around the pump 40 and on out through the outlet conduit 42. A pump bypass 48 includes a bypass check gate 50, similar to gate 32, which enables movement of miners along the escape path. If desired, a personnel safety screen or barrier can be installed at the pump inlet. Inasmuch as the conveying conduit is intended to be used for an emergency escape or rescue route, it will be understood that the conduit and pump bypass diameters will be of sufficient size to enable passage of a miner or other trapped person. It is to be understood that pumps can be installed anywhere along the system, within or outside of the mine.

While it is desirable that the conduit dimensions be large enough for a man to pass through, that would be one criteria for the size. The amount of airflow needed to ventilate large mines when confined in relatively small return ducts could place the down much higher than is necessary, with the method of this invention and in such cases only a part of the ventilating air need be used. The system would be constructed and designed with an appropriate cross section and to utilize the airflow which would give the best conveying of the material being conveyed. While in the larger mines, operation may go on for 24 hours a day, the same method and systems can be used in small mines operating the same way.

In smaller mines the coal might be stockpiled and the system placed in operation for a short time to remove all elements in a short period.

At various locations along the conduit system, access doors 60 and 60' such as shown in conduit section 30 are provided for inspection, repair, personnel entry for escape and other reasons. Pressure and flow measurements are obtained for purposes by varying the amount of opening of the inspection and safety doors. The number and sizes of the doors 60 will be dictated by various conditions and the type of the mine in which the system is installed. For example, in some mines where the characteristics of the material being mined causes falls and cave-ins, some may need a greater number of safety doors at such locations and in mines where the characteristics of the coal are conducive to explosive situations, more of safety doors and access openings may be required along the length of the conduit. When a number of these access and inspection doors are located throughout the length they can be used as auxiliary pressure regulators to reduce the high pressures and velocities of the air being used for conveying the material in the event the conduit has to be used as an emergency exit for personnel, in other words, the doors just ahead of the pumps could be opened to substantially reduce and possibly even negate the pressure ahead of the pumps where the trapped miners may have to enter the system.

The conduit may be used as a safety shelter in case the roof of the mine is falling and the miners wish to get some place where they are not subject to the falling material or which would afford them an emergency shelter until rescue efforts could be undertaken.

Other features which can be located at spaced points along the conduit system as needed are drain devices such as 64 and 64' and injection locations as at 66. The drain devices can be removable plugs or submergible valves and will be located in systems where moisture is prevalent and collector at the low points. The drain locations would be at those points and can be used to keep water levels from clogging and disrupting the operation of the system. A further use for the drains would be in a system using liquid as the conveying medium and when the system is needed as an emergency exit. The entire conduit would have to be drained and the low points in which liquid collects after such drainage would need provision for localized draining.

Injection openings 66 could be used for several purposes. As many pumps as necessary can be used in this system and in such instance, particularly in a system using liquid conveying medium additional flow pressures and velocities could be generated by injection jets of the fluid into the conduit at selected locations. In a pneumatic system, the injection ports could be used to attach auxiliary suction lines and nozzle pickup devices to clean up any area of the mine, such as bottoms, ribs, tops posts and the outside of the conduit itself, in a manner similar to a central conduit vacuum cleaner system.

The various sections of conduit pipe whether rigid, flexible or telescoping preferably so constructed and connected to enable the sections or the entire conduit to be rotated to distribute wear more evenly around the entire circumference of the conduit. The conduit could be rolled, rotated or turned for any reason which may arise during operation. This can be accomplished by using section couplings 68 which could be loosened or even disconnected so the various sections of the conduit could be rotated.

In providing for rotating the sections of conduit, it must be kept in mind that when access doors 60 and drain holes 64 are provided in the conduit, that conduit section which is rotated may place the doors at the bottom and the drain at some location other than the bottom. To avoid that problem the section which includes the doors and/or the drain could have such door 60' and drain device 64' made at several locations around the conduit section.

If necessary, provision can be made for shaking, vibrating or revolving of the transport conduit, with or without revolving or spiralling the mines operating 8 hours a day. This feature if important to prevent clogging of the conduit by material collecting at certain low points such as point A in FIG. 2, where a shaker or vibrator device 70 can be installed.

In addition to the mine face coal digging, loosening and removal machinery, e.g., loader 52 shown in FIG. 1, material processing machinery such as pulverizers and cleaners such as the scrubby scrubber 77 shown in FIG. 1 can be suitably arranged within the flow path of the complete system. These processing components can be located at any desired point in the system, e.g., at locations where unwanted components can be dropped back into worked out shafts and entries.

Any mine machinery such as 52 and 72 used to dislodge the coal at the working face of the mine or to load the dislodged coal can be provided with a protective cabin or enclosure 74 (see FIG. 1) for one or more operators. Such an enclosure could be substantially explosion proof and heat resistant and provide protection against rock falls and coal falls resulting from explosions and other causes and be equipped with emergency substance provisions such as oxygen, food and water as well as an emergency access into either the inlet 14 to the conduit system or a closely adjacent access door 60 which could be located immediately along one side of the enclosure. The cabin 74 could be made to share a common wall with a conduit section located at the machine and in which common wall, the safety access door could be located.

If desired, all or any portion of the transportation system could be mounted on wheels, endless track or some other conventional carrying device. Up to certain lengths, the entire system, where no branch-offs are used, and including the pumps and the correlating mine face and mined material processing machinery could be made mobile and could progress into the mine right along with progression of the mining operation.

FIG. 2 is a layout of part of a mining operation showing some of the numerous aspects which can be included in a system. A main mine face 12 is shown at the end of a long mine shaft 10. A mine face workings machine 52 is shown at the face 12 and connected to machine 52 is the inlet end of a
flexible section 16 of conduit conveyor system. The telescoping section 18 with several flexible sections 16 enables the machine 52 freedom to move along and nearby the mine face. If desirable, a small vacuum attachment 76 can be connected to an injection or suction fitting 66 in the conduit. Fig. 2 shows several branch shafts with branch-offs 34 from the conduit system. Numerous check valves 32, access doors 60 and pumps 40 with personnel bypasses 48 can be seen throughout the mine and a pump 40 is shown exterior of the mine.

In addition, various locations are provided with spray units 44 to wash the fines. At one point X a vibrator 70 is noted. Depending upon practice, a processing unit 72, such as a scrubber, or a cleaner, can be installed in the conduit system either as a single unit or in several successive sections along the mine shaft. A large single processing unit such as some cleaners, could be located in an offset of the system in a side room along the mine shaft.

If feasible in the mine being worked, at least a portion of the conduit system can consist of tunnels and passages through the strata being mined. These conduits could be previously formed tunnels, as shown by passage 80 in FIG. 2, which would not be currently used or the passage could be a natural tunnel found during the course of mining. It is also possible to intentionally drive a tunnel or passages through the strata for use only as a portion of the conveyance.

Use of the present method and apparatus combined with conventional, known mining methods and apparatus, as has been mentioned hereinbefore, will result in the mine tunnels and passages being used as the conduit through which the conveying fluid passes, and in such instances, the mine tunnels, of course, can and may include known conventional mining equipment such as cars, belt conveyors, drag conveyors, and other mining machinery. The fines which are developed by a fall off and normally collect in areas on and around such machinery will, when the present method and apparatus is used, be entrained in and conveyed by the air and other gases passing through the tunnel or passage portion of the conveyor conduit.

The conduit conveying system will contain and convey both the fines, small particles and gases which go right along with various particles of coal and can be conveyed to a furnace 82 and will be turned and the power utilized. If the material being conducted outside of the mine is not being fed to a furnace, the coal, fines, particles, etc. can be spread over the ground or stored on a stockpile. The material can be conveyed to a gas-separating plant, of which one kind can be a structure at an outlet of which the gases would flow and the solids be guided to be processed or discarded.

If the gases are to be used, an outlet of the conduit system can lead to a separator 84 which separates the solids and passes the useful gases into a storage tank 86 for later use or sale. The separated fine particles can also be stored in a bin 88. When storing the very fine particles in opened spaces the previously mentioned spraying and soaking which occurs within the system leaves the fines damp so that in their stored condition the very fine particles and dust are inhibited from being blown away. In this system a far greater amount of the smaller particles are accumulated than occur as a result of normal mining methods, and thus there is a greater tendency for the wind and also for the air which is coming out of the exit end of the conduit to cause the fines and dust to float away.

In FIG. 1, the inlet end 14 of the conduit is fastened on the outlet end of machine 52. The inlet end 14 can be flanged and made to rest in a cradle 90 on the mine car. It can be coupled by lifting it out of the cradle and could be manually carried to and placed on the mine floor at desired locations where materials are piled to thereby pick up the fines and small particles. If a liquid conveying medium is used, the fines and small particles would usually be loaded into a hopper with the liquid or injected into the liquid filled conduit ahead of a pump. By using a combination of gas and liquid conveying medium, the gases, fines and other particles can be passed through a water or other liquid bath or a spray at the inlet. In such a liquid bath, provision can be made for cleaning the mixture or otherwise breaking up any bubbles of gas or clusters of the material being conveyed. The trapped particles and fines with the liquid which has trapped them can then be introduced into the conveying system.

The method of transporting coal through pipe, conduit or duct by a pump or pumps involves sucking or pushing the mined coal material through the conduit entombed with fluid such as air or other gas or gases or water or other liquid or mixtures of the gases and liquids. This is accomplished after the coal has been loosened or separated from the mine face by digging, blasting, cutting, ripping, grinding or augering or after being processed by a crushing or pulverizing machine or use of loading machines or other devices or combinations such as schematically shown at 52.

The transportation method can, if desired, be incorporated with or into gas or air or into a pump or pumps for the aforementioned machines or devices by using articulated, hinged, swiveled, flexible or telescoping conduit or a combination of such conduits or by other known connections. On the other hand it can be made so that the aforementioned machines or devices will place the coal on or into a hopper or feeder or some other such device to which the conduit transportation apparatus is connected from whence it can convey and transport the material by gas or liquid to a desired destination. The gas used can be inert in which case, the system could be a closed cycle system. Alternatively, the hereinbefore mentioned machines or devices could drop the mined material such as particles of coal on the mine floor or bottom near the worked mine face and a powered mobile loading, gathering or feeding or the like device 52 can be incorporated at the end of the conveying and transportation conduit system, as desired, which would then convey the material to a fixed destination.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be included therein.

What I claim and desired to be secured by United States Letters Patent is:

1. A method of transporting coal separated from the face of an underground mine and enabling personnel escape comprising:
   - providing a conduit system from a conduit inlet at a source of mined material in the mine to a conduit outlet at a disposition side located way from the mine face area;
   - creating a pressure differential through the conduit system from the inlet to the outlet, utilizing a fluid medium available at the mine site as the material carrier inside of the mine and with in the conduit;
   - providing, at least adjacent the inlet end of the conduit system, conduit flexibility for manipulation and location of the inlet end of the conduit system, by virtue of the flexibility provision at the inlet end of the conduit system, entraining substantially all separated and loosened coal particles, fines and surrounding gases at least in the mine area adjacent the source of mined material and transporting all such entrained material to a point of disposition;
   - and providing means in the conduit system enabling through passage at a coast from adjacent the inlet to beyond and bypassing the means for creating the pressure differential;

2. A method of transporting coal as defined in claim 1, further comprising the steps of having the inlet of the conduit system disposed adjacent and receiving mined material directly from mine face working equipment.
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3. A method as defined in claim 2, further comprising rendering mobile, portions of the conduit system at least adjacent mine face working equipment.

4. A method as defined in claim 1, further comprising rendering mobile, the entire conduit system.

5. A method as defined in claim 1, further comprising the steps of incorporating the inlet end of said system with and thereby receiving mined material including surrounding gases into said conduit and while said material is being conveyed through the system to accomplish at least one processing step on the mined material.

6. A method of transporting coal as defined in claim 1, further comprising disposing of the conduit system outlet at a location external of the underground mine and causing the entrained materials to egress into a combustion device and burning the entrained material.

7. A method of transporting coal and gases as defined in claim 1, further comprising using underground water appearing in the mine as the liquid conveying medium.

8. A method of transporting coal as defined in claim 1, wherein the mine ventilating air is used as the fluid-conveying medium and entrains and conveys the mined material and gases.

13. A method of transporting coal as defined in claim 1, wherein the conveyor system serves as at least a portion of the mine ventilating system.

14. A method of transporting coal as defined in claim 1, wherein the conduit system and bypass means are provided and the conduit system is used as an emergency exit system.

15. A method of transporting coal as defined in claim 1, wherein at least one of said personnel entry devices incorporates emergency food and oxygen and shelter which is resistant to fire and explosions.

16. Apparatus for transporting coal or the like as defined in claim 16, wherein said conduit system includes at least one mine material processing machine and personnel shelter means are provided on said machine, said shelter being provided with means for resisting emergency conditions.

17. Apparatus as defined in claim 16, wherein all conduit sections and portions of said conduit system including said valve means and said gated bypass means around said pump means are made with sufficient cross section to enable utilization of said system as a personnel emergency escape, said shelter means being located closely adjacent a conduit section and provision being made between said shelter means and said conduit system enabling passage of personnel into said conduit system.

18. Apparatus as defined in claim 17, wherein said means for resisting emergency conditions include emergency supplies of food and oxygen and enclosure structure for resisting explosion and heat.

19. Apparatus for transporting coal or the like as defined in claim 16, wherein mine face working machinery is connected directly to the inlet end of said conduit system; and means are provided in said system enabling mobility at least of the components in the area of the mine face.

20. Apparatus for transporting coal or the like as defined in claim 16, wherein at least one branch inlet means is provided in said conduit means and a branch conduit system with conduit sections including inlet means is coupled to said branch inlet means.

21. Apparatus as defined in claim 16, wherein a said telescoping conduit section is located at the terminal inlet end and flexible conduit section connects between said telescoping conduit section and the succeeding section in said conduit system.

22. Apparatus as defined in claim 16, wherein means are included which couple said conduit sections and other components in said conduit system which enables rotation of said conduit sections to distribute wear.

23. Apparatus as defined in claim 16, wherein means are provided in said conduit system for spraying and soaking the fine particles entrained in the carrier fluid.

24. Apparatus as defined in claim 16, wherein means are provided to convey conveyor sections and portions of said conduit system and said gated bypass means around said pump means are made with sufficient cross section to enable utilization of said system as a personnel emergency escape.

25. Apparatus as defined in claim 16, wherein a plurality of access doors is provided in various sections of said conduit system and at least some of said access doors enable passage of personnel into and out from said conduit system.

26. Apparatus as defined in claim 16, wherein auxiliary mined material entraining devices are provided and means in at least one of said conduit sections ahead of a said pump means enable a fluid inlet coupling from said auxiliary device into said conduit system.
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,602,551 Dated August 31, 1971

Inventor(s) John L. Veleghol

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the Abstract, line 14, change "passages" to --passage--.
Column 1, line 14, change "reclaimed" to --pumps--.
Column 4, line 14, put a comma (,) after the word "tops";
, line 17, insert the word --are-- after "telescoping".
Column 6, line 53, change "side" to --site--; change "way" to --away--;
, line 57, change "with in" to --within--.

Signed and sealed this 28th day of March 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR. ROBERT GOTTSCALK
Attesting Officer Commissioner of Patents