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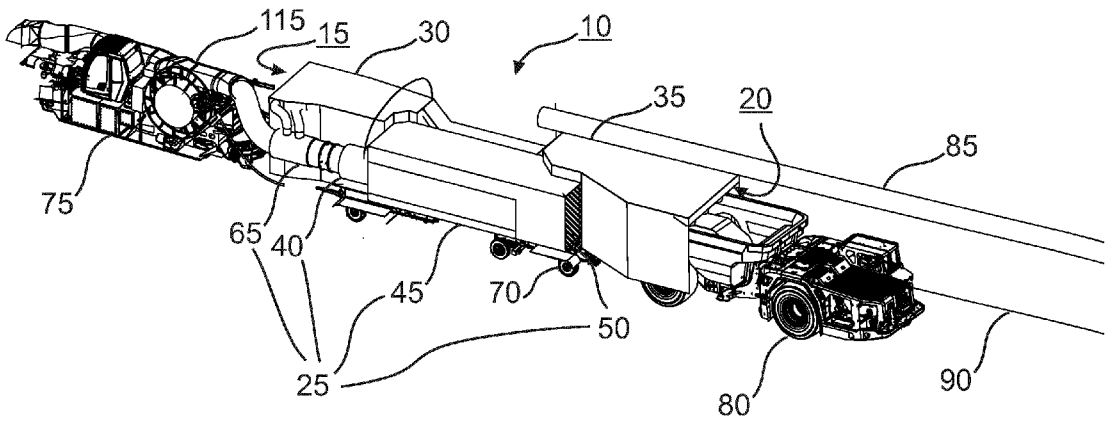


Fig. 3

(57) Abstract: The present invention relates to handling of dust-laden air in a mine tunnel and particularly to a mobile unit (10) for a mine tunnel comprising a dust extraction system (25) and a method of conveying material and removing dust in a mine tunnel. In order to allow a removal or replacement of mining equipment from a working face of a tunnel without unduly limiting the size (in particular the cross section) of the mining equipment or without an unduly excessive cross section of the tunnel, a mobile unit (10) for a mine tunnel is proposed, comprising a conveying system (95) having a first and a second transfer area (15, 20), and a dust extraction system (25), wherein the conveying system (95) is arranged to receive mined material in the first transfer area (15), to convey the received mined material to the second transfer area (20) and to dispense the received and conveyed mined material at the second transfer area (20), wherein the dust extraction system (25) is arranged to receive dust-laden air, to extract dust from the dust-laden air and to discharge air from which dust is extracted, wherein the mobile unit (10) further comprises a first and/or a second dust collector (30, 35) for collecting dust-laden air from the first and/or second transfer area (15, 20), respectively, with the first and/or second dust collector (30, 35) being arranged to supply the collected dust-laden air to the dust extraction system (25) for dust extraction.

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Mobile unit and method of conveying material and removing dust

Field of invention

The present invention relates to handling of dust-laden air in a mine tunnel and particularly to a mobile unit for a mine tunnel comprising a dust extraction system and a method of conveying material and removing dust in a mine tunnel.

Background art

Conventional approaches on extraction of dust generated in the mining process include a use of exhaust tubing in combination with a stationary dust extractor. The dust extractor generates a negative pressure and causes dust-laden air to be collected through the exhaust tubing, which typically is rigid (so to withstand the negative pressure) and has a rather large diameter (to allow passage of a large enough air volume). In the process of further developing the tunnel, as the working face proceeds, the mining equipment is successively also brought forward, while eventually the tubing for the dust-laden air is also extended.

Typically, a mining access or production tunnel is developed having a profile between 4x4 m and 5x5 m. When the work on the tunnel is complete, the overall dust collection arrangement (in particular the tubing) is removed, so that there is sufficient clearance also for removal of the mining equipment from the working face (e.g. to a new location). The rigid tubing might otherwise not allow passage of the mining equipment.

There are also arrangements for transport of dust-laden air with positive pressure and flexible tubing, while these require the installation of additional ventilators on or near the mining machine that blow the required airflow to the filter direction. Such arrangement demands extra power and space. Still, similar problems to those of the rigid tubing apply also for these arrangements.

In a situation where the intended tunnel is rather long, the ratio of time of production (during which the mining equipment needs not to be removed from the working face) and the time needed for disassembling the dust collection arrangement is of such nature that the latter time is – if at all – only of minor concern.

In situation, however, where there are only rather short tunnels, e.g. branching off of a main tunnel, or where there would be a need or desire for replacing or exchanging the mining equipment rather frequently, the above mentioned ratio becomes smaller, so that the effort and time needed for disassembling the dust collection arrangement becomes of concern.

Summary of the Invention

It is an object of the present invention to provide an alternative to the conventional approach discussed above, which allows a removal or replacement of mining equipment from a working face of a tunnel without unduly limiting the size (in particular the cross section) of the mining equipment or without an unduly excessive cross section of the tunnel.

According to a first aspect, the object is solved by a mobile unit for a mine tunnel as defined in claim 1, namely a mobile unit comprising a conveying system having a first and a second transfer area, and a dust extraction system, wherein the conveying system is arranged to receive mined material in the first transfer area, to convey the received mined material to the second transfer area and to dispense the received and conveyed mined material at the second transfer area, wherein the dust extraction system is arranged to receive dust-laden air, to extract dust from the dust-laden air and to discharge air from which dust is extracted, wherein the mobile unit further comprises a first and/or a second dust collector for collecting dust-laden air from the first and/or second transfer area, respectively, with the first and/or second dust collector being arranged to supply the collected dust-laden air to the dust extraction system for dust extraction.

In the conventional arrangement as discussed above, a truck or another means for transporting the mined material may directly approach the mining equipment. The present invention allows for the dust extraction system to be arranged between the mining equipment and the truck or transport means, as the conveying system allows for receiving and dispensing mined material in such way that the dust extraction system does not block the flow of material.

The dust collector(s) provide(s) that additional dust occurring at the first and/or second transfer area is also brought – in the form of dust-laden air – to the dust extraction system, so the additional transfer point(s) do not (significantly) counteract the dust extraction.

The mobile unit, furthermore, can be repositioned in accordance with the respective need of the mining process, e.g. can be forwarded so to follow the mining equipment in its progress or can be removed so to make way for a removal (or replacement) of the mining equipment.

The mobile unit has also a slim design, i.e. not requiring much space. It is also power efficient, thus less power is consumed in comparison to conventional arrangements.

According to a further aspect, in alternative to or in combination with the above, the object is solved by a mobile unit as defined in claim 11, namely a mobile unit comprising a conveying system having a first and a second transfer area and a dust extraction system, wherein the conveying system is arranged to receive mined material in the first transfer area, to convey the received mined material to the second transfer area and to dispense the received and conveyed mined material at the second transfer area, wherein the dust extraction system is arranged to receive dust-laden air, to extract dust from the dust-laden air and to discharge air from which dust is extracted, wherein the dust extraction system includes a dry filter unit for dust extraction.

In some conventional moveable or mobile mining equipment, wet filter systems are provided as parts of the equipment itself. It was realized by the inventors that in the context of the invention, i.e. in an arrangement of a conveying system and a dust extraction system provided in combination, advantageously a dry filter unit may be used instead of known wet filters in other mining equipment.

In a preferred embodiment, the mobile unit further comprises a heat exchanger arranged for being connected to an external unit, the external unit being external to the mobile unit, wherein the heat exchanger is arranged to receive a fluid having a first temperature from the external unit, to cause a heat transfer from the fluid to air flowing inside the dust extraction system and to return the fluid having a second temperature lower than the first temperature to the external unit.

The flow of either dust-laden air or air from which dust is extracted in or around the dust extraction system allows for a transport also of heat, so that a heat exchanger can transfer heat received from the external unit (e.g. via a cooling liquid like water or oil) to the flowing air, such that the transferred heat is transported away by the air. The heat exchanger is preferably arranged such that heat is transferred to the air from which dust is (at least partially) already extracted, allowing for a higher efficiency and avoiding interacting between the dust and the heat exchanger (e.g. avoiding or at least reducing clogged ducting, abrasion, or other potential damage). Known heat exchangers, which are, for example, used in mining environments in an air stream generated by an axial ventilator,

may be used without need for much modification, other than placing the heat exchanger in the air flow of the dust extraction system instead of that of the ventilator.

According to a further preferred embodiment, the dust extraction system includes a fan unit, a filter unit and a diffuser unit.

The fan unit may suck air through the filter unit and/or push air into the filter unit, while the diffuser unit directs the air into a desired direction, together with forming a desired flow profile, for example to allow for an exchange with fresh air supplied by the mine.

The diffuser unit is preferably on the downstream side of the arrangement, providing a direction to the discharged air so not to disturb the overall mining operation. A way to preserve and extend the lifetime of the fan unit is to locate the filter unit upstream to the fan unit, so that the fan unit operates with a clean(er) air ambience. Provided that, however, the fan unit is resistant to the dust in the dust-laden air, the order of fan unit and filter unit may also be reversed. It is additionally possible to provide multiple instances of either of the units in series.

According to a preferred variant of the above embodiment, the fan unit includes at least one of a radial fan, an axial fan and a silencer.

The details of the fan may be selected in accordance with the particulars of the environment in which the mobile unit is used, while the silencer contributes to a noise reduction, thereby allowing for a reduced stress on any personnel in the vicinity of the mobile unit.

According to a preferred variant of the above embodiment, the filter unit is a dry filter unit.

While in some conventional moveable or mobile mining equipment, wet filter units are provided in "on board" mobile applications, this does not apply to dry filters, as dry filters are conventionally considered as demanding to much space, so that dry filter are provided only in stationary applications.

A significant advantage of dry filters, however, lies in the potentially higher efficiency of dust removal (almost 99,999%), having capacity that is higher than the wet filter dust removal capacity. Another aspect are limitations to wet filters in terms of dust concentration levels and the need for a liquid (typically water) in the dust extraction process, which, however, can typically not be completely removed from the discharged air. In other words, there are environments where the use of a wet filter is not even possible due to process or environmental conditions.

In a further preferred embodiment, the first and second dust collectors each include a channel for at least partially enclosing the first and second transfer area, respectively.

Such channel defines an area around the transfer area, from which the respective dust collector, e.g. by means of negative pressure, collect the dust-laden air, while the channels furthermore ensure that dust-laden air reaches the dust collector. The channel is a partially enclosed passage. The walls, i.e. the limitations to create the channel may be rigid or flexible, e.g. a box shaped enclosure made of steel or a curtain made of rubber hung on a cable.

A possible form for the dust collectors (possibly including the curtains, steel boxes or similar elements) may be an inverted U-form or gate form.

The skilled person will appreciate that designing the forms (the first and second dust collector may be designed differently), in particular with the aim of an improved air velocity and good dust absorption capacity, may be done using computerized fluid dynamics simulations, i.e. by adapting the design to the particular needs of each implementation.

According to a further preferred embodiment, the dust extraction system is arranged for being connected to an exhaust channel for receiving dust-laden air.

While the dust extraction system, in principle, may collect dust-laden air from a general area (e.g. in front of the mobile unit), it is beneficial to provide a forced transfer of dust-laden air from its point of origin (i.e. the working face or the head of the mining equipment) to the dust extraction system, while the means for such forced transfer may already be provided in conventional mining equipment in case such equipment is arranged to connect to a tubing for transporting the dust-laden air to a conventionally known stationary dust extraction system.

In a further preferred embodiment, the second transfer area is arranged for a dispensing of mined material to a truck.

The present invention is not limited to dispensing material to a truck, as, for example, also a further conventional conveying system may be provided for further transporting the mined material. Transport by truck, however, gives the benefit that there is no or only little need for further equipment to be removed, for example, in case the mining equipment is to be removed from the working face.

In a preferred embodiment, the mobile unit further comprises an undercarriage allowing a movement of the mobile unit.

The undercarriage may be self-propelled or passive (i.e. not provided with a drive of its own) and allows for an easy and convenient mobility of the mobile unit. Alternatively, the mobile unit may be arranged for being picked-up (e.g. raised up by a jack and moved away) or may include other means for movement, e.g. a slide, a skid or the like. Even though, in particular in terms of ease of handling, a mobility of the mobile unit by itself is preferred, the term “mobile unit” is to be understood as also including units without an undercarriage or a slide or a skid, as long as such unit can be handled and moved in the confines of a mining tunnel without need for major dissembling.

According to a further preferred embodiment, the dust extraction system is arranged in parallel to the conveying system and arranged to receive dust-laden air from an area

forward to the first transfer area and to discharge air from which dust is extracted to an area rearward of the second transfer area.

Preferably, the general direction of the flow of air through the dust extraction system and the direction of the transport of mined material in or on the conveying system coincide (i.e. are parallel), so that the conveying system and the dust extraction system are arranged next to each other and thus share the cross section of the available space.

According to a further aspect, the object is solved by a method of conveying material and removing dust in a mine tunnel as defined in claim 12, namely a method comprising the steps of moving a mobile unit having a conveying system and a dust extraction system in the mine tunnel such that a first transfer area of the conveying system is located to receive mined material from a mining machine, receiving, by the conveying system, mined material in the first transfer area, conveying, by the conveying system, the received mined material to a second transfer area of the conveying system, dispensing the received and conveyed mined material at the second transfer area, receiving, by the dust extraction system, dust-laden air from an area of the mining machine, extracting dust from the dust-laden air, and discharging air from which dust is extracted, wherein the method further comprises collecting dust-laden air from the first and/or second transfer area, respectively, and supplying the collected dust-laden air to the dust extraction system for dust extraction.

As to the advantages, preferred embodiments and details of the method and its preferred embodiments, reference is made to the corresponding aspects and embodiments described above with respect to the cutter assembly.

Brief description of the drawings

Preferred embodiments of the invention shall now be described with reference to the attached drawings, in which

Fig. 1: shows a perspective view of a mobile unit according to an embodiment of the invention;

Fig. 2: shows a side elevation of the mobile unit illustrated in Fig. 1;

Fig. 3: shows a perspective view of the mobile unit shown in Fig. 1 and 2 together with a mining machine and a truck;

Fig. 4: shows a schematic illustration of a mobile unit according to another embodiment of the invention and

Fig. 5: shows a flow diagram of a method of conveying material and removing dust in a mine tunnel in accordance with another embodiment of the invention.

Description of the invention

Fig. 1 shows a perspective view of a mobile unit 10 according to an embodiment of the invention.

The mobile unit 10 includes a dust extraction system 25, which is arranged in parallel to a conveying system (not shown in this perspective view, see Fig. 4). The dust extraction system 25 includes a connector 65 to an exhaust channel of a mining machine (see Fig. 3), a fan unit 40, a filter unit 45 and a diffuser unit 50, arranged in this order along a longitudinal axis of the mobile unit 10.

The mobile unit 10 is further provided with an undercarriage 70, which allows independent movement of the mobile unit 10. The conveying system has a first transfer area 15, located in the forward direction of the mobile unit 10, i.e. close to the mining machine (see Fig. 3) and a second transfer area 20, arranged on a rearward side of the mobile unit 10. The first and second transfer area 15, 20 are, respectively, housed in a first dust collector 30 and a second dust collector 35, which enclose the areas 15, 20 by means of channels 55, 60. The first and second dust collector 30, 35, respectively, are provided such that they, by means of negative pressure, collect dust in the first and second transfer area 15, 20, wherein the resulting dust-laden air is forwarded by the first and second dust collector 30, 35 to the dust extraction system 25.

Fig. 2 shows a side elevation of the mobile unit 10 illustrated in Fig. 1.

As it can be seen, for example, from Fig. 2, the mobile unit 10 rests on the undercarriage 70, which allows a movement of the mobile unit 10 by means of wheels provided on the undercarriage.

In the arrangement of Fig. 2, the mining machine (see Fig. 3) is provided on the left side and provides mined material to the first transfer area 15, while furthermore providing dust-laden air to the connector 65 of the dust extraction system 25. It is not necessarily the case that the channels 55, 60 extend all the way down to the ground level on which the wheels of the undercarriage 70 rest, as long as the channels 55, 60 or more generally the dust collectors 30, 35 sufficiently collect dust generated at the first and second transfer area 15, 20.

The second transfer area 20 is provided on the right side of the arrangement shown in Fig. 2 and is arranged to receive any kind of container such as a truck, into which the mined material is dispensed from the conveying system (see Fig. 3 or Fig. 4).

Fig. 3 shows a schematic illustration of a mobile unit 10 as shown in Figs. 1 and 2 together with a mining machine 75 and a truck 80.

As illustrated in Fig. 3, the mobile unit 25 is provided between the mining machine 75 and the truck 80.

The mining machine 75 provides mined material to the first transfer area 15, where the mined material is received by the conveying system and forwarded to the second transfer area 20, where the mined material is dispensed by the conveying system to the truck 80.

In parallel, dust-laden air is collected by the mining machine 75 in a conventional manner and is forwarded via an exhaust channel 115 of the mining machine 75 and the connector 65 to the dust extraction system 25.

In the dust extraction system 25, dust is extracted or removed from the air and air, from which dust is extracted, is discharged through the diffuser unit 50.

By means of tubing 85 and/or channels 90, fresh air is provided by the mine to the area of the vicinity of the mobile unit 10.

Fig. 4 shows a schematic illustration of a mobile unit 10 according to another embodiment of the invention.

As it can be seen from Fig. 4, in the mobile unit 10, a fan unit 40, a filter unit 45 and a diffuser unit 50 of a dust extraction system are provided in parallel to a conveying system 95 having a first and a second transfer area 15, 20.

The conveying system 95 receives mined material at the first transfer area and dispenses the mined material received at the second transfer area 20, as it is illustrated by the dotted arrows in Fig. 4. In Fig. 4, only the second transfer area 20 is provided with a dust collector 35, wherein channels 60 enclose the transfer area 20.

The dust collector 35 is arranged to forward dust-laden air collected and the second transfer area 20 to the dust extraction system, more specifically to a connector 65 of the dust extraction system.

At the connector 65, the dust extraction system receives dust-laden air, not only from the dust collector 35 but also from the mining machine (see Fig. 3). The air passes through the fan unit 40, which includes an axial fan 105 and a silencer 110. Further, the dust-laden air reaches the filter unit 45, where dust is removed and extracted from the air. The filter unit 45 is furthermore provided with a heat exchanger 100, which is used for cooling parts of the mining machine, as illustrated by the double headed arrow in Fig. 4. Eventually, the air, from which dust is extracted, reaches the diffuser 50, where the air is discharged from the dust extraction system, while the combination of diffuser unit 50 and channel 60 provides a direction of the discharged air as illustrated in Fig. 4.

Fig. 5 shows a flow diagram of a method of conveying material and removing dust in a mine tunnel in accordance with another embodiment of the invention.

In a first step 200 of the method of conveying material and removing dust, a mobile unit according to the invention, i.e. having a conveying system and a dust extraction system, is moved in the mine tunnel to a location such that a first transfer area of the conveying system can receive mined material from a mining machine.

In a first "branch" of the method, by the conveying system, mined material is received (step 205) in the first transfer area, followed by a conveying step 210 of conveying the received mined material to a second transfer area of the conveying system, where, in step 215, the received and conveyed mined material is dispensed.

In parallel, i.e. a second "branch" of the method, the dust extraction system receives, in step 220 dust-laden air from an area of the mining machine. In an extraction step 225, dust is extracted from the dust-laden air, wherein air, from which dust is extracted, is discharged in step 230.

Further, the method includes a step of collecting (step 235) dust-laden air from the first and/or second transfer area, respectively, and a step of supplying (step 240) the collected dust-laden air to the dust extraction system for dust extraction (step 225).

It is to be noted that the processes illustrated here are typically continuous processes, so that in an actual implementation basically all of steps 205 to 240 occurs simultaneously.

In small cross sections, where a cutting machine could not tram back underneath conventional rigid exhaust tubing, an embodiment of the invention allows for an alternative approach in that, for example, a mobile dust extraction unit is positioned directly behind the cutting machine which can tram out of the heading in case of the need for a place change of the cutting machine. The mobile unit in this example includes a mobile dust extractor unit, an axial or radial fan unit, an air discharge diffuser, an integrated conveyor to transfer the cut material from the machine to a truck, integrated dust collection boxes to extract the dust from the conveyor discharge to the truck, and an

undercarriage for independent tramming, wherein there is provided an integration of cooling units for the mining machine into the air discharge diffuser of the dust extractor.

Further, in the example, the dust extractor (including the fan and a diffuser for discharging the clean(ed) air) is equipped with an undercarriage for tramming to be able to move out of a heading together with the mining machine. The diffuser for discharging the clean(ed) air is directed towards a sidewall of the heading in order to allow an exchange with the fresh air supply which is provided by the mine at the opposite side of the heading by a flexible ventilation tubing or via an air channel.

In this mobile unit a conveyor is integrated in order to transfer the cut material from the mining machine in front of the dust extractor to a truck which is positioned behind the unit.

In the discharging part of this transfer-conveyor, a dust collection box to extract the dust from the conveyor discharge to the truck is integrated. Suction devices create an under pressure in this area to collect the dust which is directly fed into the dust extractor unit.

Although in the figures, the above discussed aspects are shown in combination, the different aspects described herein also can be applied separately.

List of Reference Signs

10	mobile unit
15	first transfer area
20	second transfer area
25	dust extraction system
30	first dust collector
35	second dust collector
40	fan unit
45	filter unit
50	diffuser unit
55	channel
60	channel
65	connector to exhaust channel
70	undercarriage
75	external unit / mining machine
80	truck
85	fresh air pipe
90	fresh air channel
95	conveying system
100	heat exchanger
105	axial fan
110	silencer
115	exhaust channel
200	moving
205	receiving mined material
210	conveying mined material
215	dispensing mined material
220	receiving dust-laden air
225	extracting dust
230	discharging air
235	collecting dust-laden air
240	supplying dust-laden air

Claims

1. A mobile unit (10) for a mine tunnel, comprising:
a conveying system (95) having a first and a second transfer area (15, 20), and
a dust extraction system (25),
wherein the conveying system (95) is arranged to receive mined material in the first transfer area (15), to convey the received mined material to the second transfer area (20) and to dispense the received and conveyed mined material at the second transfer area (20),
wherein the dust extraction system (25) is arranged to receive dust-laden air, to extract dust from the dust-laden air and to discharge air from which dust is extracted,
wherein the mobile unit (10) further comprises a first and/or a second dust collector (30, 35) for collecting dust-laden air from the first and/or second transfer area (15, 20), respectively, with the first and/or second dust collector (30, 35) being arranged to supply the collected dust-laden air to the dust extraction system (25) for dust extraction.

2. The mobile unit (10) according to claim 1, further comprising
a heat exchanger (100) arranged for being connected to an external unit (75), the external unit(75) being external to the mobile unit (10),
wherein the heat exchanger (100) is arranged to receive a fluid having a first temperature from the external unit, to cause a heat transfer from the fluid to air flowing inside the dust extraction system and to return the fluid having a second temperature lower than the first temperature to the external unit.

3. The mobile unit (10) according to claim 1 or 2, wherein the dust extraction system (25) includes a fan unit (40), a filter unit (45) and a diffuser unit (50).

4. The mobile unit (10) according to claim 3, wherein the fan unit (40) includes at least one of a radial fan, an axial fan (105) and a silencer (110).

5. The mobile unit (10) according to claim 3 or 4, wherein the filter unit (45) is a dry filter unit.

6. The mobile unit (10) according to any one of the preceding claims, wherein the first and second dust collectors (30, 25) each include a channel (55, 60) for at least partially enclosing the first and second transfer area (15, 20), respectively.

7. The mobile unit (10) according to any one of the preceding claims, wherein the dust extraction system (25) is arranged for being connected to an exhaust channel (115) for receiving dust-laden air.

8. The mobile unit (10) according to any one of the preceding claims, wherein the second transfer area (20) is arranged for dispensing of mined material to a truck (80).

9. The mobile unit (10) according to any one of the preceding claims, further comprising an undercarriage (70) allowing a movement of the mobile unit (10).

10. The mobile unit (10) according to any one of the preceding claims, wherein the dust extraction system (25) is arranged in parallel to the conveying system (95) and arranged to receive dust-laden air from an area forward of the first transfer area (15) and to discharge air from which dust is extracted to an area rearward of the second transfer area (20).

11. A mobile unit (10) for a mine tunnel, comprising:

a conveying system (95) having a first and a second transfer area (15, 20), and

a dust extraction system (25),

wherein the conveying system (95) is arranged to receive mined material in the first transfer area (15), to convey the received mined material to the second transfer area (20) and to dispense the received and conveyed mined material at the second transfer area (20),

wherein the dust extraction system (25) is arranged to receive dust-laden air, to extract dust from the dust-laden air and to discharge air from which dust is extracted,

wherein the dust extraction system (25) includes a dry filter unit (45) for dust extraction.

12. A method of conveying material and removing dust in a mine tunnel, comprising the steps of:

moving (200) a mobile unit (10) having a conveying system (95) and a dust extraction system (25) in the mine tunnel such that a first transfer area (15) of the conveying system (95) is located to receive mined material from a mining machine (75),

receiving (205), by the conveying system (95), mined material in the first transfer area (15),

conveying (200), by the conveying system (95), the received mined material to a second transfer area (20) of the conveying system (95),

dispensing (215) the received and conveyed mined material at the second transfer area (20),

receiving (220), by the dust extraction system (25), dust-laden air from an area of the mining machine (75),

extracting (225) dust from the dust-laden air, and

discharging (230) air from which dust is extracted,

wherein the method further comprises collecting (235) dust-laden air from the first and/or second transfer area (15, 20), respectively, and

supplying (240) the collected dust-laden air to the dust extraction system (25) for dust extraction (225).

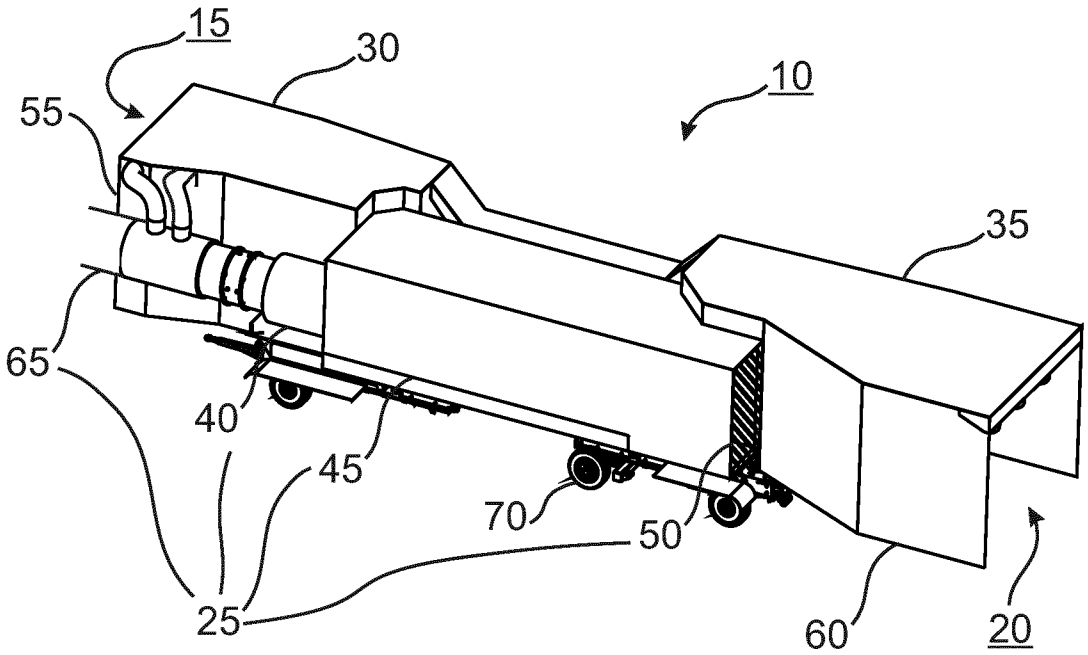

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Fig. 1

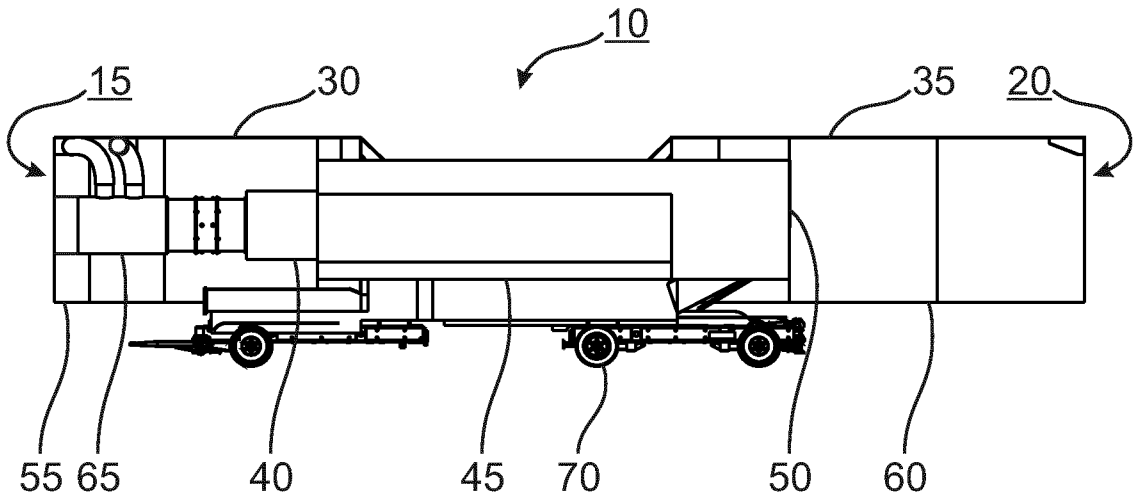

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Fig. 2

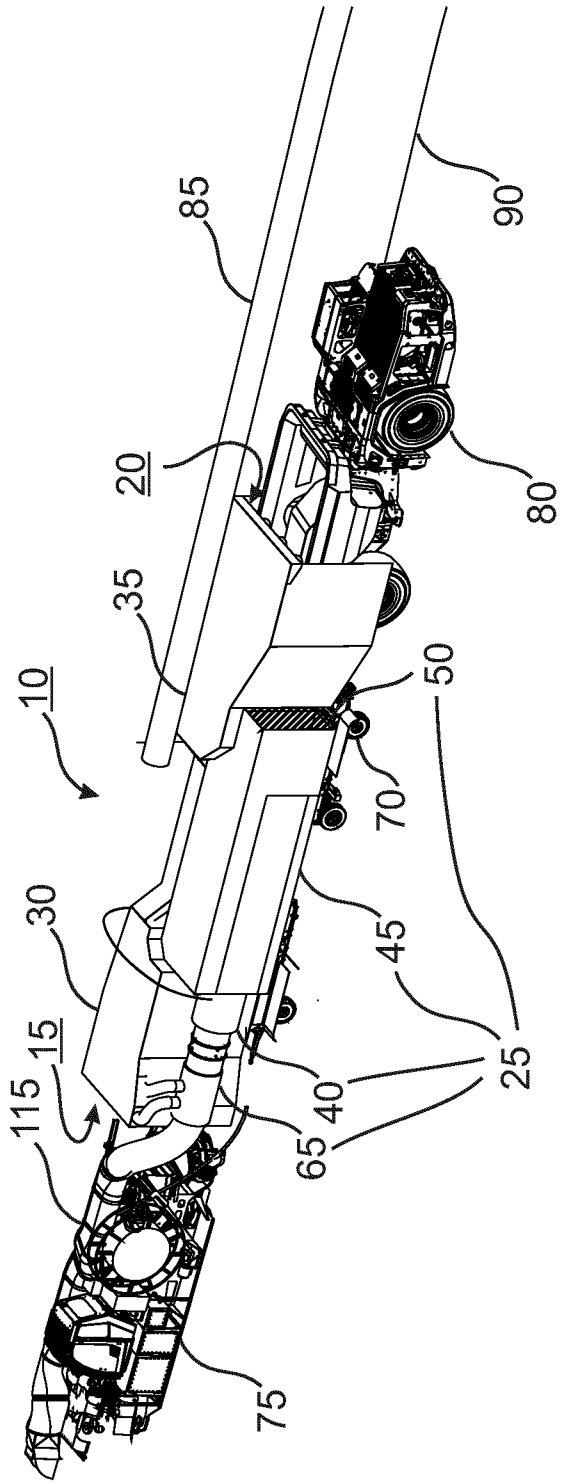


Fig. 3

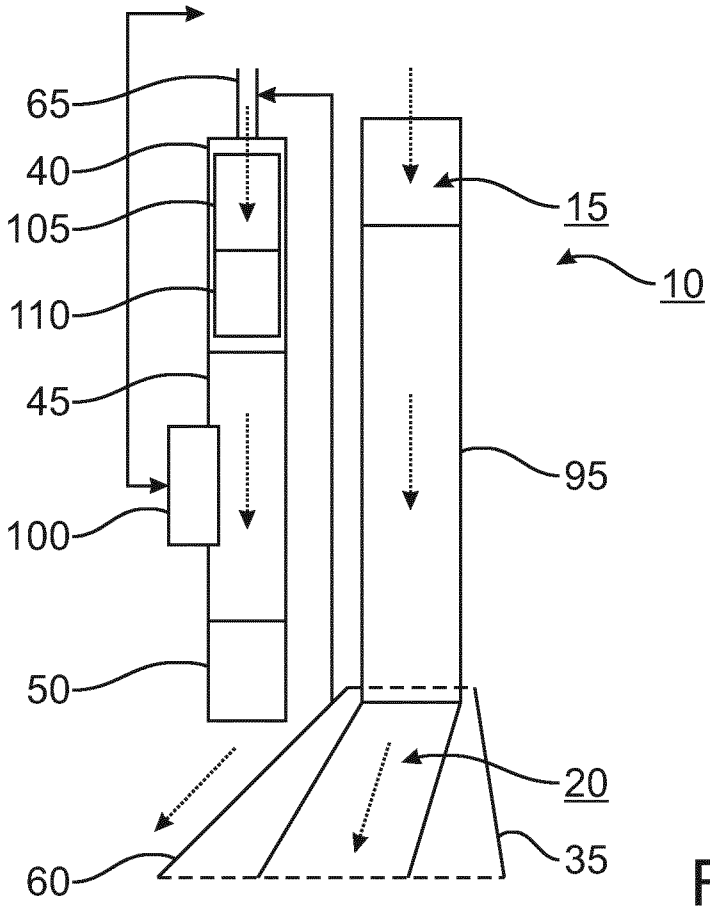

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100
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Fig. 4

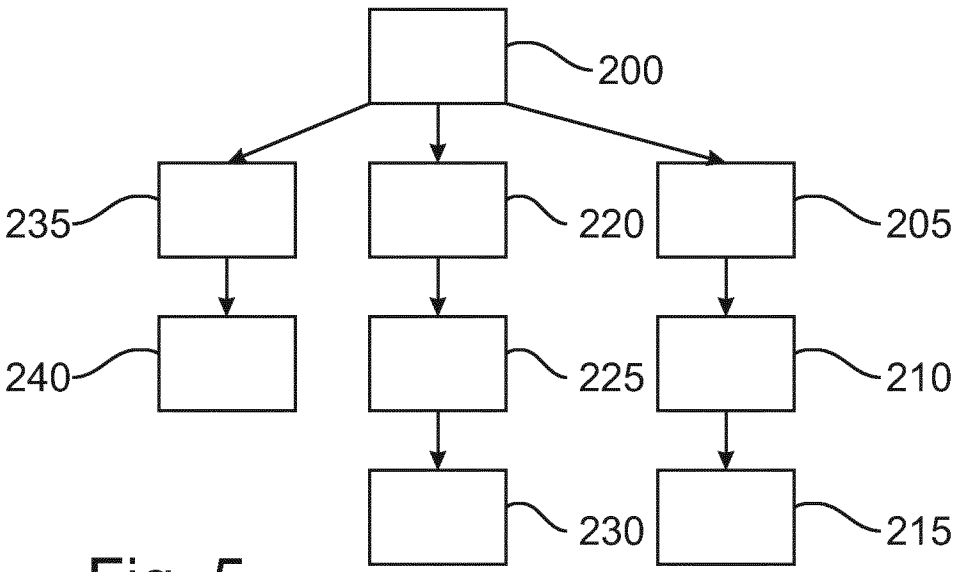

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Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/070481

A. CLASSIFICATION OF SUBJECT MATTER
INV. E21C35/22 E21D9/12 E21F13/06
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E21F E21C E21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2 100 178 A (WHITE JEROME C) 23 November 1937 (1937-11-23) page 2, column 1, line 69 - column 2, line 38; figures 1-4	1,3-10, 12 2
X	US 4 289 509 A (HOELTER HEINZ) 15 September 1981 (1981-09-15) column 2, line 22 - column 3, line 16; figure 1	1,3-10, 12
X Y	US 5 673 974 A (LAMMER EGMONT [AT] ET AL) 7 October 1997 (1997-10-07) column 3, line 37 - column 4, line 52; figures 2-5	11 2
A	DE 24 44 934 A1 (HOELTER HEINZ) 8 April 1976 (1976-04-08) the whole document	1-10,12

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
4 May 2017	15/05/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Pieper, Fabian

3

Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 26 35 405 A1 (HOCHTIEF AG HOCH TIEFBAUTEN) 9 February 1978 (1978-02-09) page 6, line 2 - line 5; figure 1	5,11
A	EP 2 218 871 A2 (CFT GMBH [DE]) 18 August 2010 (2010-08-18) paragraph [0011]; figure 1	5,11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2016/070481

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-10, 12

   Dust collector

   ---

2. claim: 11

   Dry filter

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2016/070481

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2100178 A	23-11-1937	NONE	
US 4289509 A	15-09-1981	NONE	
US 5673974 A	07-10-1997	AT 404284 B	27-10-1998
		BR 9505862 A	21-02-1996
		US 5673974 A	07-10-1997
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DE 2444934 A1	08-04-1976	NONE	
DE 2635405 A1	09-02-1978	NONE	
EP 2218871 A2	18-08-2010	DE 102009008596 A1	19-08-2010
		EP 2218871 A2	18-08-2010