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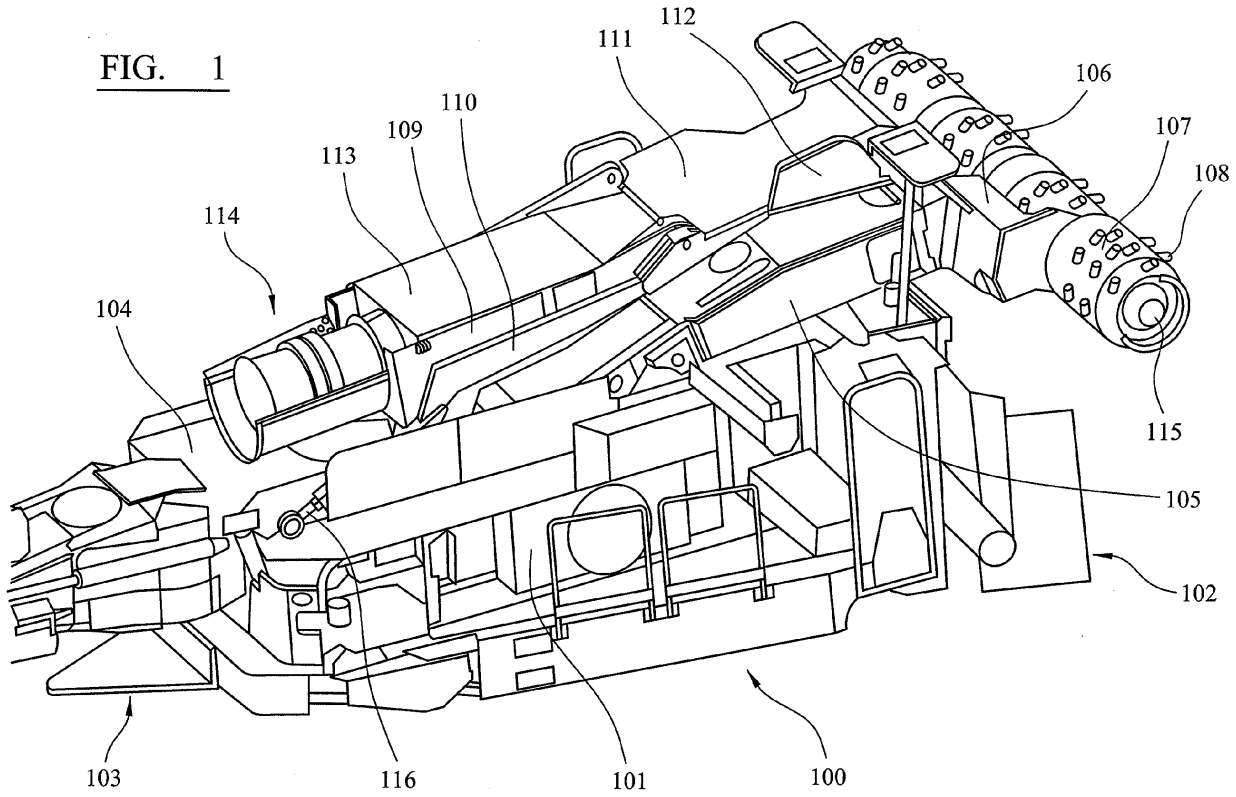
(54) Mining machine filtering unit

(57) A dust filtering unit mountable at a mining machine (100). The filtering unit comprises a filtration duct (113) having a scrubber unit and demister where airflow through the filter unit is driven by an exhaust fan (114). Noise emission from the fan is reduced by a first flexible coupling (502) positioned between the fan unit and a filter duct and a second flexible coupling (703) mounting the fan unit at a filter support frame (109).

FIG. 1



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Description

Field of invention

[0001] The present invention relates to a dust filtering unit mountable at a mining machine, and in particular although not exclusively, to a mining machine having a dust filtering unit configured to minimise transmission of vibration forces between operative components of the filtering unit and/or mining machine.

Background art

[0002] A variety of different methods and machines have been developed to extract minerals and other valuable materials at and below the Earth's surface. Such machines typically operate in mines at great depths.

[0003] In order to maximise excavation and mineral recovery efficiency, mining machines have been developed for specific purposes. Whilst some machines are configured exclusively to cut the mineral from a deposit or seam, other machines are configured to tunnel within the subterranean depth to effectively create the mine and provide passageways for the mineral cutters. In particular, mobile mining machines have emerged as successful apparatus to both provide direct cutting at the seam and as a means of rapid entry roadway development. Typically a mobile mining machine comprises a rotatable cutting or mining head having cutting bits provided on rotating drums to contact the mineral face. The cutting head is conventionally mounted at a moveable boom so as to be adjustable in height relative to the mine floor. As the cutting head is rotated and advanced into the seam, the extracted mineral is gathered and conveyed rearwardly by the mobile machine via conveying apparatus to create discharged stock piles for subsequent extraction from the mine.

[0004] As will be appreciated, as the cutting bits engage the mineral, such as coal, fine airborne particulate contaminants are created which pollute the environment surrounding the mining machine creating in turn a dangerous and harmful environment for mining personnel. Different methods and apparatus have been developed to control and in particular supress such dust. One particularly successful approach involves a machine mounted filter unit that is configured to filter the dust laden air immediately behind the cutting head.

[0005] Example mining machines having dust collecting or filtering units are disclosed in US 3,387,889; US 3,712,678; US 3,743,356; US 5,597,393; GB 2263294 and EP 1486642.

[0006] Conventional filtering units for mining machines comprise a filtration duct having a scrubber unit and demister. An exhaust unit that comprises a fan and a silencer is coupled to the filter duct and drives the airflow through the scrubber and demister in an attempt to separate the air-entrained particulate contaminant and to exhaust a stream of purified air and collect the dust particles. Typically, the exhaust fan unit is bolted directly to the filter duct (scrubber unit) and is additionally mounted at the machine via direct coupling to the machine frame. EP 1503033 and DE 10334600 both disclose the positionally adjustable mounting of a fan unit to a silencer or other upstream component via a flexible duct to accommodate different sized upstream components in turn allowing component to be interchanged.

[0007] However, in a mining environment the operation of the fan unit creates considerable noise which is both unpleasant and dangerous to mining personnel as this noise can itself be damaging to hearing and may also mask other potentially dangerous occurrences that would otherwise be possible to hear. What is required therefore is a filtration unit having an operative fan component configured for reduced noise emission.

Summary of the Invention

[0008] It is an objective of the present invention to provide a filtration unit for a mining machine and in particular a mining machine having a dust filtration unit that is configured to minimise as far as possible noise emission created by the unit operation. The present inventors have identified that a significant proportion of the noise emission of conventional apparatus results from vibration transmission from the exhaust unit (fan) to both the filter duct and the machine frame. Accordingly, it is a further objective to minimise as far as possible the propagation of vibration forces from the exhaust unit (fan) to both the filtration duct (of the mining machine) and the various components of the mining machine including in particular the frame and support structures.

[0009] The objectives are achieved via a plurality of flexible couplings that effectively isolate the exhaust unit from the remaining components of the mining machine. In particular, a first flexible coupling is positioned between the exhaust unit and the filtration duct and a second flexible coupling is positioned between the exhaust unit and a frame of the mining machine. In its isolated *'floating'* mounting position at the machine, the exhaust unit is capable of isolated vibration during use such that the propagation of these vibrations to the remaining components of the mining machine is eliminated and the overall noise emission from the machine reduced.

[0010] According to a specific implementation, the exhaust unit does not comprise further mountings and is exclusively mounted at the machine frame via the present non-rigid flexible couplings. Preferably, the flexible couplings of the present invention comprise a resiliently deformable material such as rubber. However, and as will be appreciated, further materials are suitable that are configured to supress and absorb vibrational forces and eliminate onward transmission to other components of the apparatus.

[0011] According to a first aspect of the present invention there is provided a dust filtering unit mountable at a mining machine having a machine frame, the unit com-

prising: a filter duct having at least one filter to filter airborne contaminants generated by the machine, the filter duct having an inlet to receive an airflow containing the airborne contaminants and an outlet to discharge a filtered airflow; an exhaust unit to drive the airflow through the filter duct, the exhaust unit coupled to a region of the outlet of the filter duct; characterised by: a first flexible coupling positioned between the filter duct and the exhaust unit configured to inhibit transmission of vibration forces from the exhaust unit to the filter duct; and a second flexible coupling mounting the exhaust unit at the machine frame configured to inhibit transmission of vibration forces from the exhaust unit to the frame.

[0012] Reference within this specification to a first and a second flexible coupling encompass a coupling configured to deform elastically and to return to its original shape and configuration. These terms also encompass a coupling having sound absorbing characteristics so as to attenuate sound waves. The present couplings refer to an interconnecting member that is more flexible than the components between which it is positioned, in the present specification such components are typically metal (steel) whilst the present couplings are typically formed from a second and different material to these adjacent components.

[0013] Preferably, the exhaust unit, the filter duct and the first flexible coupling are mounted substantially axially. Optionally, the first flexible coupling comprises a generally tubular duct formed from a resiliently deformable material.

[0014] Preferably, the exhaust unit is suspended from the machine frame via the second flexible coupling. Optionally, the second flexible coupling comprises two flexible mountings positioned laterally at two respective side regions of the exhaust unit.

[0015] Optionally, each flexible mounting comprises a first bracket attached to the exhaust unit, a second bracket attached to the machine frame and at least one resiliently deformable coupling connecting the first and second brackets to suspend the exhaust unit at the machine frame.

[0016] Preferably, the filtering unit further comprising an intake duct attached to the inlet of the filter duct. According to the present configuration, the exhaust unit comprises a fan and a silencer. The fan may comprise any conventional fan component such as a hydraulic exhaust fan having rotating blades that provide a suction effect within the upstream ducting. Reference in this specification to a 'silencer' refers to a sound absorber that typically comprises a sound attenuation material positioned internally within a drum-like structure to absorb noise created by the rotating fan blades and other moving components of the fan.

[0017] Preferably, the filter duct comprises a scrubber unit and a demister unit. As will be appreciated, the filter duct may comprise all manner of filter units and is not restricted to wet filtering of the dust laden airflow. Specifically, the scrubber unit may comprise a typical flooded bed-type scrubber having liquid spray nozzles to direct high velocity liquid spray into the direction of the airflow within the filter ducts. The demister also comprises a conventional design having a plurality of louvers that collect and allow drainage of dust laden moisture.

[0018] Preferably, the first and second flexible couplings comprise a resiliently deformable material. Preferably, the couplings comprise a rubber, an elastomeric, a polymeric or other material having a non-rigid physical and mechanical property and being less hard than the steel components between which the couplings are positioned.

[0019] According to a second aspect of the present invention there is provided a mining machine comprising: a main frame; a moveable boom pivotally attached to the main frame and mounting a cutting boom at one end; a filter support frame moveably attached to the main frame and configured to support a dust filtering unit, the dust filtering unit comprising: a filter duct having at least one filter to filter airborne contaminants generated by the mining machine, the filter duct having an inlet to receive an airflow containing the airborne contaminants and an outlet to discharge a filtered airflow; an exhaust unit to drive the airflow through the filter duct, the exhaust unit coupled to a region of the filter duct outlet; characterised by: a first flexible coupling positioned between the filter duct and the exhaust unit configured to inhibit transmission of vibration forces from the exhaust unit to the filter duct; and a second flexible coupling to mount the exhaust unit at the filter support frame configured to inhibit transmission of vibration forces from the exhaust unit to the filter support frame.

Brief description of drawings

[0020] A specific implementation of the present invention will now be described, by way of example only, and with reference to the accompanying drawings in which:

Figure 1 is a perspective view of a bolter miner machine configured for mineral cutting with simultaneous bolting and material conveying having a filtration unit fitted with an exhaust unit according to a specific implementation of the present invention;

Figure 2 is a perspective view of the filtration duct and exhaust unit attached to a filter unit frame according to a specific implementation of the present invention;

Figure 3 is a plan view of the filter unit components and support frame of figure 2;

Figure 4 is a side elevation view of the filtration unit and filter unit support frame of figure 3;

Figure 5 is a side elevation view of the filtration duct and exhaust unit of figures 1 to 4 having a first flexible

coupling;

Figure 6 is a plan view of the filtration duct and exhaust unit of figure 5;

Figure 7 is a perspective view of a mounting bracket arrangement for the exhaust unit of figure 6 comprising a second flexible coupling;

Figure 8 is a cross section through the mounting bracket assembly of figure 7.

Detailed description of preferred embodiment of the invention

[0021] The present filtration unit will now be described with reference to a preferred embodiment by way of example mounted upon a bolter miner being an electrically powered, track-mounted continuous mining machine designed to excavate roadways and install roof bolts simultaneously. Such mining machines comprise a series of cutter drums mounted on a hydraulically actuated frame to enable independent movement of the drums relative to a main frame and tracks. Accordingly, the present filtration unit is also movably mounted at the machine. The machine also comprises roof and rib bolters mounted on a stationary part of the main frame that can be operated throughout the cutting cycle.

[0022] Referring to figure 1, the mining machine 100 comprises main frame 101 that provides support for an undercarriage or chassis (not shown) that supports a pair of endless driven tracks (not shown) for propelling the machine 100 over the ground and along a seam or cutting face. Main frame 101 comprises a generally forward end 102 and a generally rearward end 103. A conveyor 104 extends substantially from forward end 102 to rearward end 103 and is adapted to carry material dislodged from the cutting face for subsequent discharge and stock piling at a remote location optionally using additional conveying and mining apparatus. A movable boom 105 is pivotally mounted at one end to main frame 101 and comprises a second end 106 mounting a cutting boom 115 that in turn mounts a plurality of rotatable drums 107. Cutting bits 108 project radially from each drum 107 and are specifically adapted to cut into and dislodge the mineral material to be mined from a seam. Boom 105 and in particular end 106 is capable of being raised or lowered relative to main frame 101 and the endless tracks (not shown) to enable machine 100 to cut the seam face over a varying height range above the ground of the mine tunnel. Boom 105 is operated by hydraulic rams (not shown) and other associated components as will be appreciated by those skilled in the art. As indicated, conveyor 104 extends from the region of cutting boom 115 to a discharge end of machine 101 to efficiently transfer the cut material away from the cutting face.

[0023] To inhibit permeation of fine dust particles from the coal face created by the cutting action of bits 108 that pollute the air surrounding the mining machine 100, machine 100 comprises a dust filtering unit for collecting such airborne contaminants. The filtering unit comprises generally a series of ducts into which is drawn the contaminate-laden air for filtration and collection of the entrained dust particles. In particular, the filtration unit comprises a primary filter duct 113 comprising conventional filtering units. According to the specific embodiment, filter duct 113 houses a scrubber unit (not shown) positioned upstream of one or more demister units to effectively wet the contaminated airflow and then to separate the moistened airstream from the entrained dust particles. The contaminated airflow is drawn initially into the filter unit via an intake duct 112 positioned immediately behind cutting boom 115. The airflow through ducts 112 and 113 is driven by a hydraulic exhaust unit 114 located downstream and immediately behind filter unit 113. As illustrated in figure 1, the entire filtration unit 112, 113, 114 is supported by a filter unit frame 109 that is mounted generally at an upper region of main frame 101 and the mining machine 100. Filter unit frame 109 is in turn movably mounted via a machine actuating bracket 110 that comprises a number of pivoting sections and actuating rams 116 that enable bracket 110, frame 109 and filtration unit 112, 113, 114 to be raised and lowered in parallel with boom 105 so as to ensure air intake duct 112 is positioned at the appropriate height immediately behind the cutting boom 115. Boom115 comprises a canopy section 115 positioned generally above intake duct 112. Canopy 111 comprises a generally planar configuration and is adapted for being raised vertically upward from frame 101 with bracket 110 to contact the mine roof to provide structural support as necessary during the cutting and roof bolting operations.

[0024] Referring to Figures 2 to 6 machine bracket 110 comprises a pair of arms 202 that extend either side of filter support frame 109, filter duct 113 and exhaust unit 114. Each arm 202 is mounted at a first end to frame 101 via hydraulic rams 116. A second end of arms 202 is mounted at bracket canopy 111 positioned immediately above air intake duct 112. Duct 112 and in particular canopy section 111 is configured to pivot relative to filter duct 113 and bracket arms 202 via pivot mountings 203. Accordingly the pivot region 203 of the unit illustrated in figures 2 to 4 is raised and lowered relative to main frame 101 via actuation of rams 116 that in turn raises and lowers to varying degrees the filtration unit components 112, 113, 114.

[0025] Filter duct 113 is supported generally by filter frame 109 and intake duct 112 is suspended below and mounted at canopy 111 toward machine front end 102. Filter duct 113 is therefore positioned intermediate intake duct 112 and exhaust unit 114 in a lengthwise direction of machine 100 between forward and rearward ends 102, 103. Exhaust unit 114 is mounted at filter frame 109 via a set of mounting brackets 205 in the form of elongate plates that are bolted to and project rearwardly from a rearward end 204 of filter frame 109. In particular, ex-

haust unit 114 is suspended between elongate brackets 205 via a further pair of mounting brackets 201. Referring to Figures 3 and 4, the elongate brackets 205 are rigidly mounted to elongate support arms 300 that project rearwardly and are bolted to the rearward end 204 of frame 109 via mounting bolts 401.

[0026] As illustrated in figures 2 to 4, intake duct 112 comprises inlet 200 positioned immediately below a forward end of canopy 111 immediately behind rotatable cutting drums 107. An airflow outlet 400 of duct 112 is coupled in communication with an airflow inlet 301 of filter duct 113 positioned approximately below pivot regions 203. Filter duct 113 comprises an airflow outlet 302 provided in fluid communication with a forward end of exhaust unit 114.

[0027] Referring to Figures 5 and 6, filter duct 113 is mounted at frame 109 by a set of forward positioned attachments 500 and a set of rearward positioned attachments 501 that extend laterally each side of duct 113. Exhaust unit 114 comprises a fan connector section 503 having a generally cylindrical configuration. Section 503 is coupled directly to a hydraulic fan unit 504 also having a generally hollow cylindrical configuration with units 503, 504 bolted rigidly together. A second sound absorber (silencer) 505 is positioned at a rearward second end of fan unit 504 and also comprises a generally hollow cylindrical configuration mounted axially with units 503 and 504 to provide a rigid unitary structure. The entire exhaust assembly 503, 504, 505 is mounted at the airflow outlet 302 of filter duct 113 via a flexible coupling 502. Coupling 502 comprises a generally tubular duct configuration having a relatively short axial length relative to units 503, 504, 505. Coupling 502 is formed from a resiliently deformable material and in particular rubber. A pair of annular mounting rims 506 project radially outward from and are mounted at each axial end of the flexible coupling 502 to provide mounting regions with the adjacent upstream filter unit 113 and downstream connector section 503. Accordingly, exhaust unit 114 is non-rigidly attached to filter duct 113 via the axially intermediate and resiliently deformable elastic coupling 502.

[0028] Referring to figures 7 and 8, exhaust unit 114 is suspended from filter frame 109 generally by the pair of first mounting brackets 201 and a second pair of mounting brackets 205. With a further flexible coupling 703 positioned intermediate between brackets 201 and 205 so as to suspend exhaust unit 114 in a 'floating' configuration relative to support frame 109. The second brackets 205 comprise a pair of elongate plates 700 that extend parallel to one another and are spaced apart by a separation distance corresponding to slightly less than a diameter of the cylindrical exhaust unit 114. A pair of attachment plates 701 extend laterally from the outer edges of plates 700 and are orientated to be inclined upward from the upward facing planar surface of each plate 700. Each mounting plate 701 comprises a plurality of holes 703 to receive suitable attachment bolts for mounting at each rearwardly projecting frame arm 300 but is in turn rigidly bolted to end 204 of filter frame 109. First bracket 201 comprises a pair of substantially planar and rectangular plates 702 with each plate positioned vertically above a forward region of plate 700. Each first bracket plate 702 is mounted above each second bracket plate 700 via three deformable couplings 703 formed from a resiliently deformable material being rubber. In particular, three elastomeric and generally cylindrical bushings 703 are sandwiched intermediate between brackets 702 and 700. Accordingly, first bracket plates 702 are flexibly and elastically mounted at second bracket plates 700. An inner edge 707 of plate 702 extends radially inward of a corresponding inner edge 708 of plate 700 relative to a longitudinal axis of exhaust unit 114. Accordingly, exhaust unit 114 is accommodated within region 709 such that plate edges 707 are positioned in contact with and are rigidly welded onto an outer surface of the cylindrical fan unit 504. No other region of exhaust unit 114 is contacted by the mounting bracket arrangement of Figures 7 and 8. A sound dampening material 704, configured to reduce sound emission from fan unit 504, extends between and couples the lengthwise extending plates 700 and follows a generally curved part cylindrical path so as to sit immediately below the lower half region of exhaust unit 114. The forward and rearward ends of sound attenuation material 704 are bordered by an arcuate rigid cover 705 rigidly attached to each lengthwise edge of each plate 700 such that plates 700, material 704 and covers 705 define a part cylindrical, half drum-like configuration.

[0029] Accordingly, exhaust unit 114 via flexible coupling 502 is non-rigidly attached in an axial direction to filter duct 113 and is also non-rigidly mounted at filter frame 109 in a lateral sidewise direction via a set of second flexible couplings 703. Undesirable transmission of body vibrations created by fan unit 504 considerably increases the noise emissions during operation of the exhaust unit 114. In the present configuration, the filtration unit and mining machine 100 is configured for reduced noise emission via elimination or inhibition of the transmission of vibrational forces from the fan unit 504 that would otherwise propagate to the filter unit 113 and filter frame 109. Accordingly, the present invention is configured to reduce noise emissions from fan unit 504 via the non-rigid and isolated mounting of the fan unit 504 relative to filter duct 113 and machine frame 100 (and in particular filter frame 109). That is, the axially positioned first coupling 502 is capable of both radial and axial elastic flexing to absorb any vibrational forces from fan unit 504. Additionally, the series of second flexible couplings 703 allow non-rigid and elastic flexing between the mounting brackets 201 attached rigidly to fan unit 504 and the brackets 205 attached rigidly to filter frame 109.

Claims

1. A dust filtering unit mountable at a mining machine

having a machine frame, the unit comprising:

a filter duct (113) having at least one filter to filter airborne contaminants generated by the machine, the filter duct (113) having an inlet (301) to receive an airflow containing the airborne contaminants and an outlet (302) to discharge a filtered airflow;
an exhaust unit (114) to drive the airflow through the filter duct (113), the exhaust unit (114) coupled to a region of the outlet (302) of the filter duct (113);
characterised by:

a first flexible coupling (502) positioned between the filter duct (113) and the exhaust unit (114) configured to inhibit transmission of vibration forces from the exhaust unit (114) to the filter duct (113); and
a second flexible coupling (703) mounting the exhaust unit (114) at the machine frame (109) configured to inhibit transmission of vibration forces from the exhaust unit (114) to the frame (109).

2. The unit as claimed in claim 1 wherein the exhaust unit (114), the filter duct (113) and the first flexible coupling (502) are mounted substantially axially.

3. The unit as claimed in claims 1 or 2 wherein the first flexible coupling (502) comprises a generally tubular duct formed from a resiliently deformable material.

4. The unit as claimed in any preceding claim wherein the exhaust unit (114) is suspended from the machine frame (109) via the second flexible coupling (703).

5. The unit as claimed in claim 4 wherein the second flexible coupling (703) comprises two flexible mountings (201, 205, 703) positioned laterally at two side regions of the exhaust unit (114).

6. The unit as claimed in claim 5 wherein each flexible mounting (201, 205, 703) comprises a first bracket (702) attached to the exhaust unit (114), a second bracket (700) attached to the machine frame (109) and at least one resiliently deformable coupling (703) connecting the first (702) and second (700) brackets to suspend the exhaust unit (114) at the machine frame (109).

7. The unit as claimed in any preceding claim further comprising an intake duct (112) attached to the inlet (301) of the filter duct (113).

8. The unit as claimed in any preceding claim wherein the exhaust unit (114) comprises a fan and a silencer.

9. The unit as claimed in any preceding claim wherein the filter duct (113) comprises a scrubber unit and a demister unit.

10. The unit as claimed in any preceding claim wherein the first and second flexible couplings (502, 703) comprise a resiliently deformable material.

11. The unit as claimed in claim 10 wherein the material comprises a rubber.

12. A mining machine (100) comprising:

a main frame (101);
a moveable boom (105) pivotally attached to the main frame (101) and mounting a cutting boom (115) at one end (106);
a filter support frame (109) moveably attached to the main frame (101) and configured to support a dust filtering unit, the dust filtering unit comprising:

a filter duct (113) having at least one filter to filter airborne contaminants generated by the mining machine, the filter duct having an inlet (301) to receive an airflow containing the airborne contaminants and an outlet (302) to discharge a filtered airflow;
an exhaust unit (114) to drive the airflow through the filter duct (113), the exhaust unit (114) coupled to a region of the filter duct outlet (302);
characterised by:

a first flexible coupling (502) positioned between the filter duct (113) and the exhaust unit (114) configured to inhibit transmission of vibration forces from the exhaust unit (114) to the filter duct (113); and
a second flexible coupling (703) to mount the exhaust unit (114) at the filter support frame (109) configured to inhibit transmission of vibration forces from the exhaust unit (114) to the filter support frame (109).

13. The machine as claimed in claim 12 wherein the first flexible coupling (502) comprises a generally tubular duct formed from a resiliently deformable material.

14. The mining machine as claimed in claim 12 or 13 wherein the second flexible coupling (703) comprises two flexible mountings (201, 205, 703) positioned laterally at two side regions of the exhaust unit (114); wherein each flexible mounting (201, 205, 703) comprises a first bracket (702) attached to the exhaust unit (114), a second bracket (700) attached to the machine frame (109) and at least one resiliently deformable coupling (703) connecting the first and sec-

ond brackets (702, 700) to suspend the exhaust unit (114) at the machine frame (109).

15. The mining machine as claimed in any one of claims 12 to 14 further comprising an intake duct (112) attached to the filter duct inlet (301).

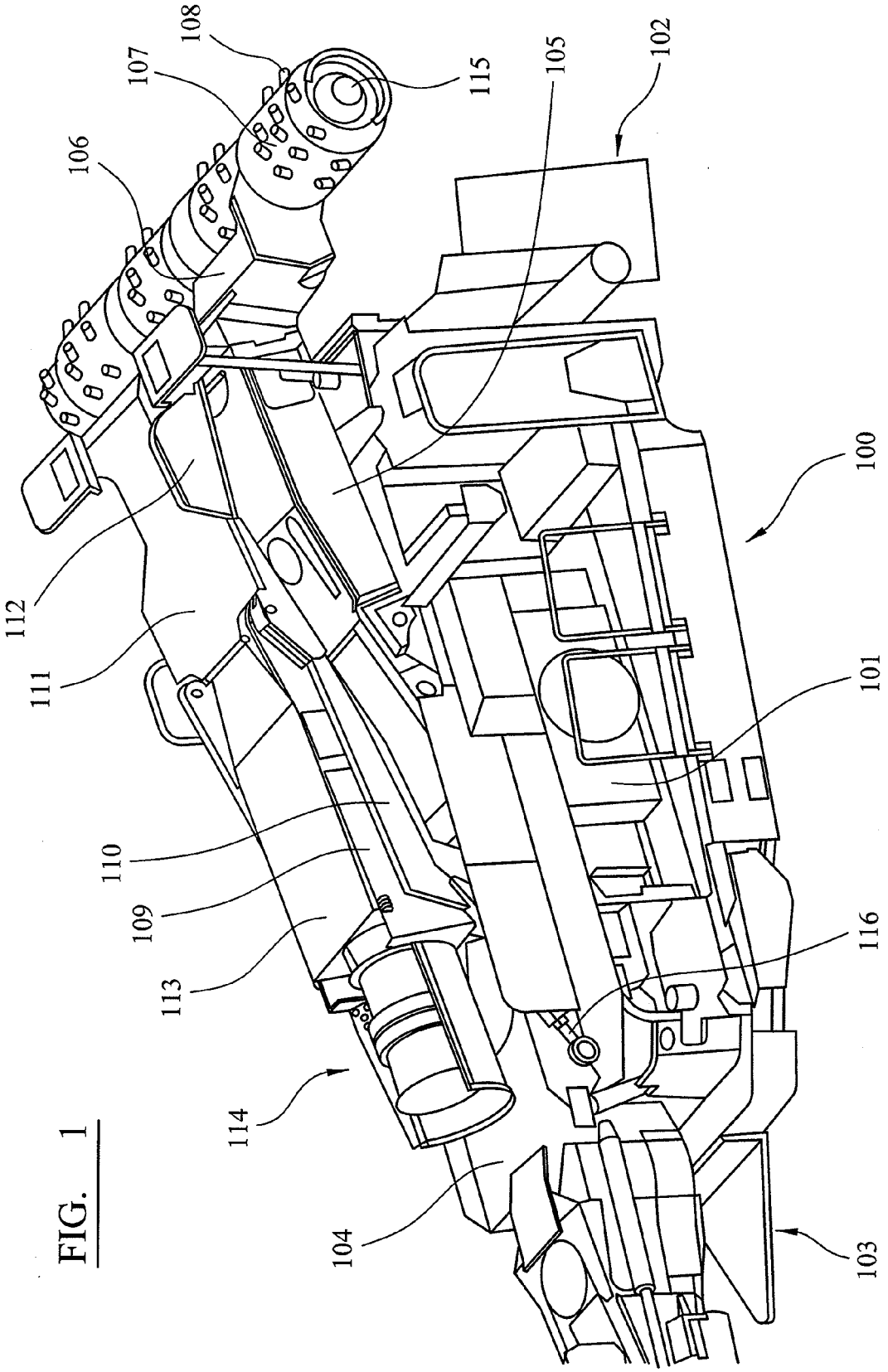
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FIG. 1

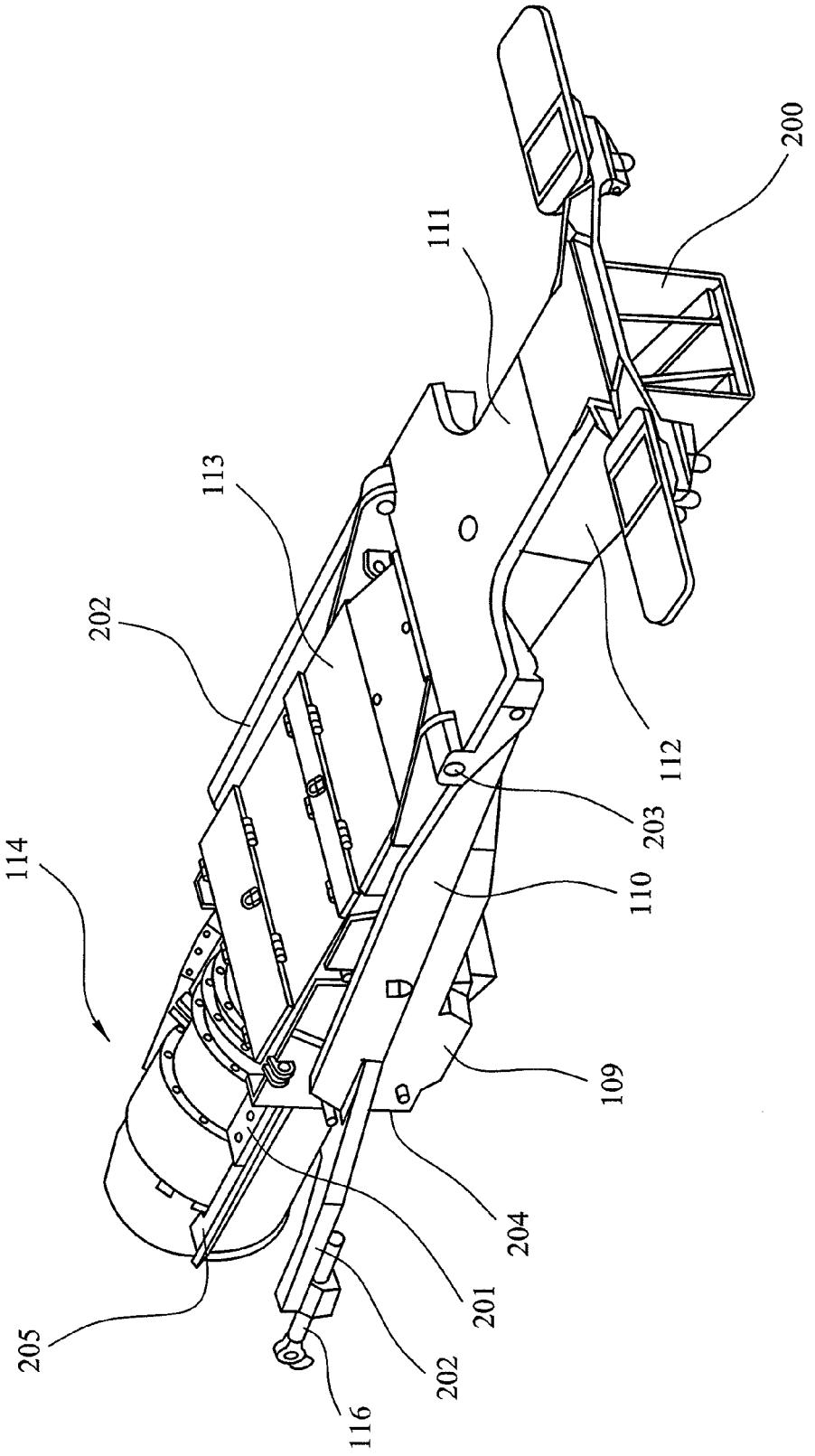

FIG. 2

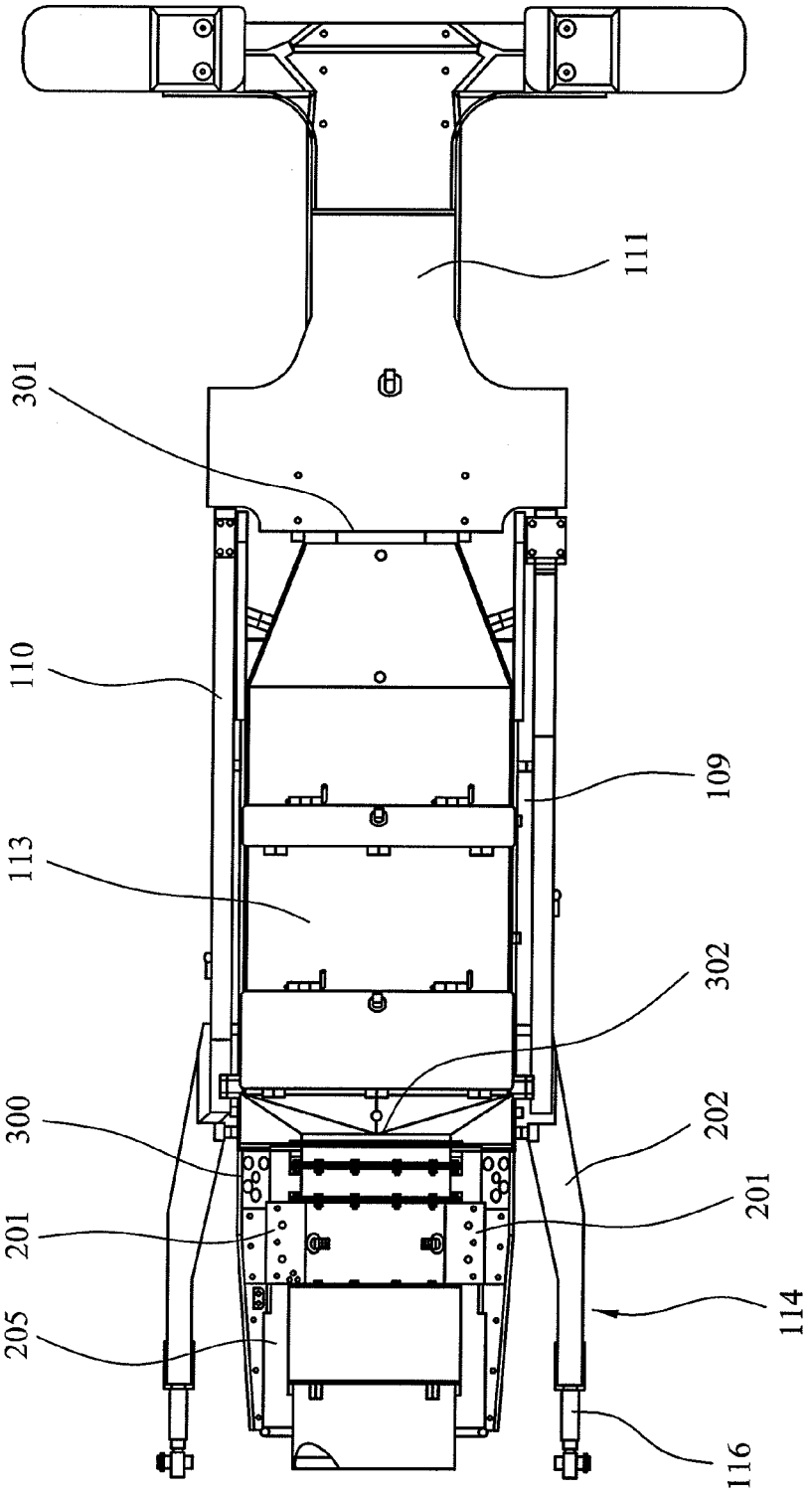

FIG. 3

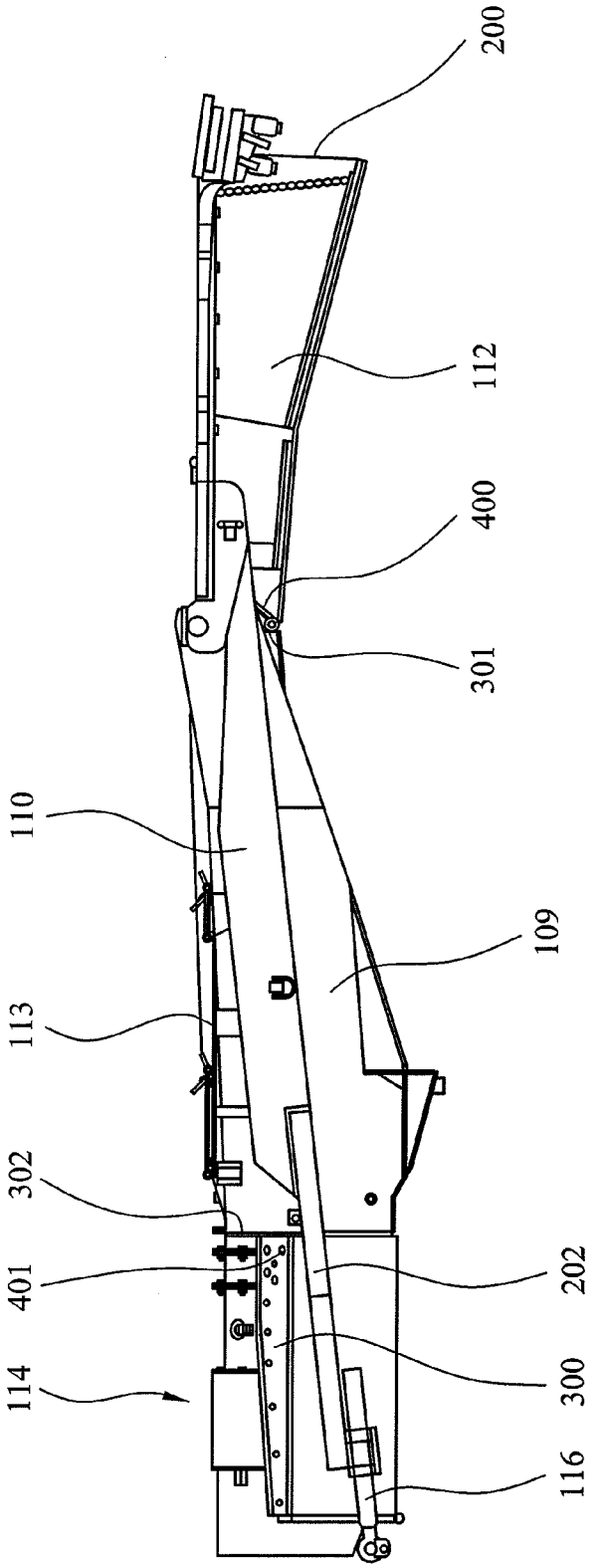

FIG. 4

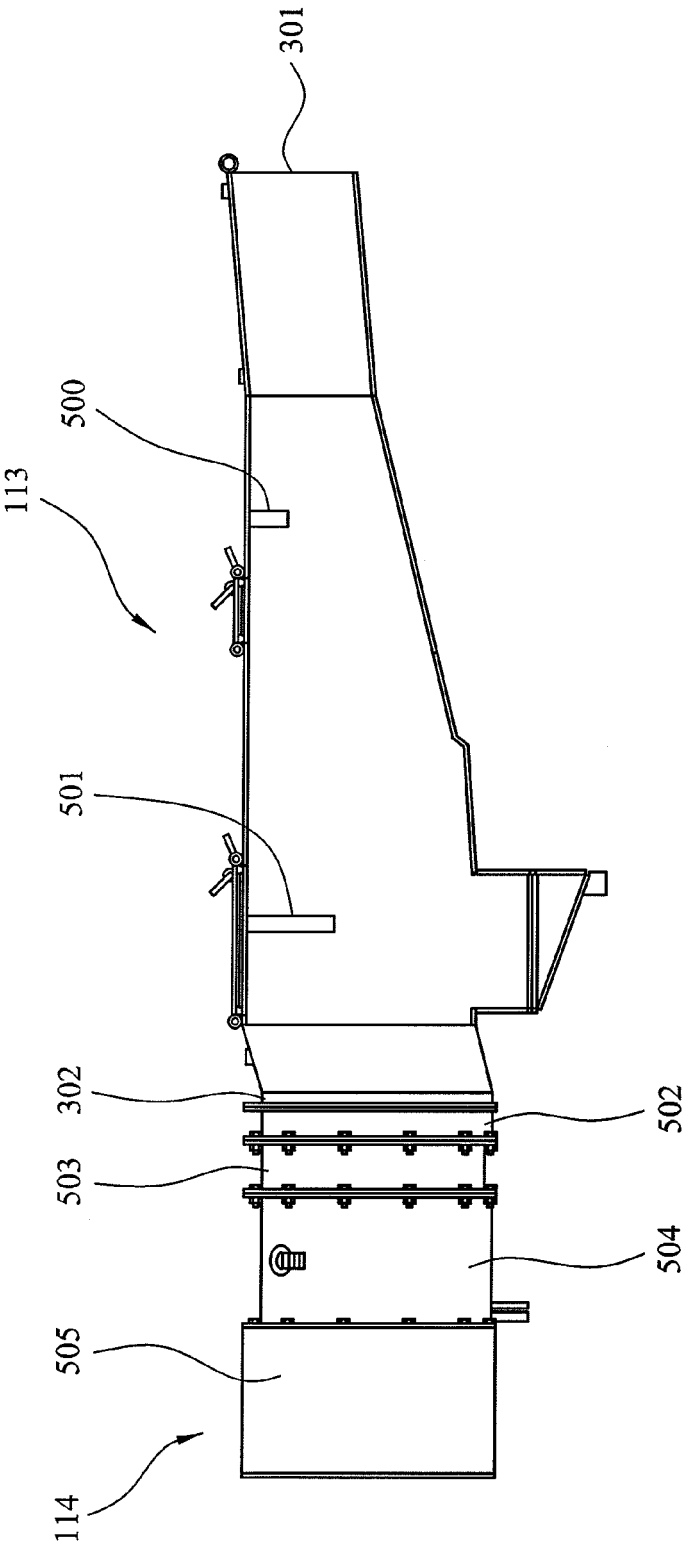

FIG. 5

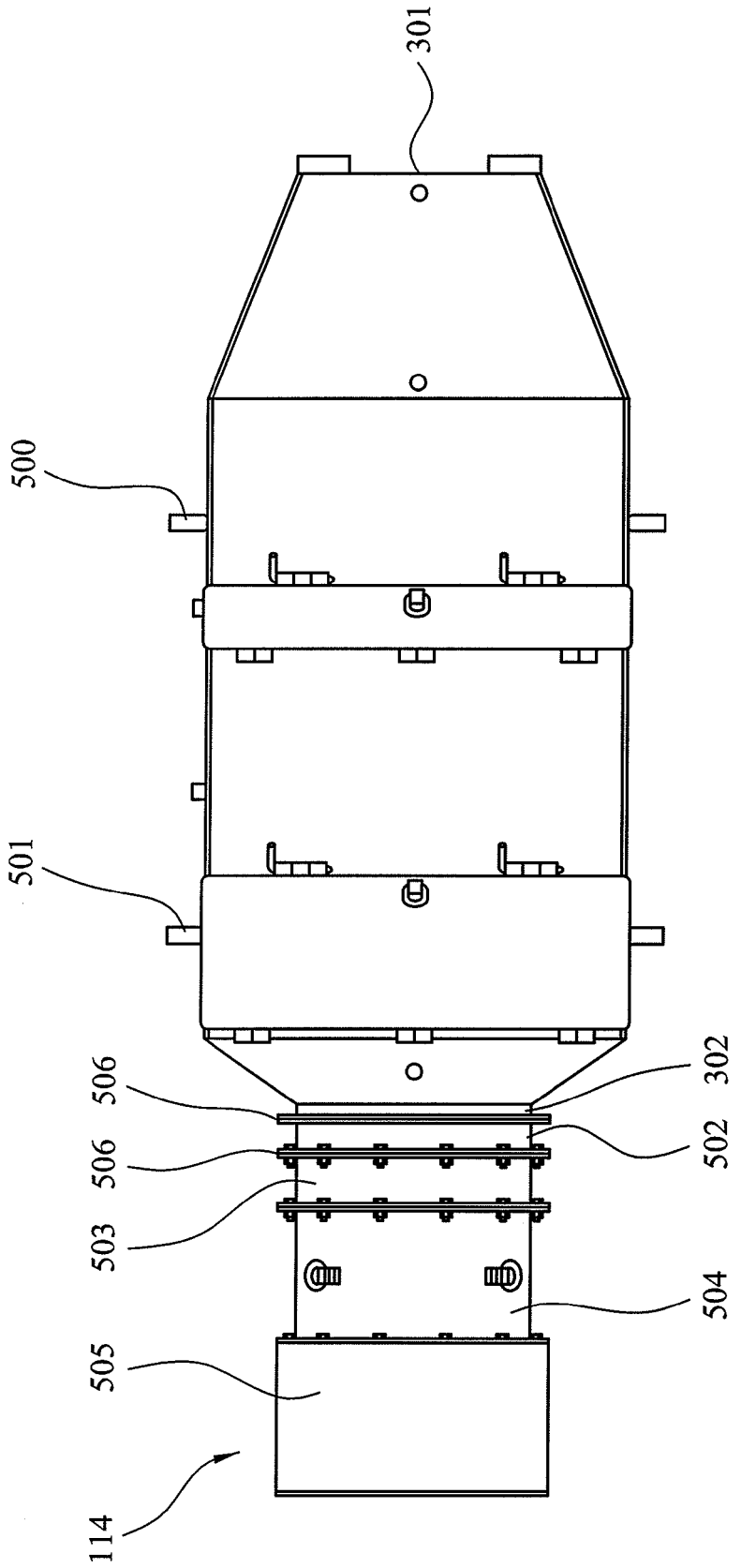

FIG. 6

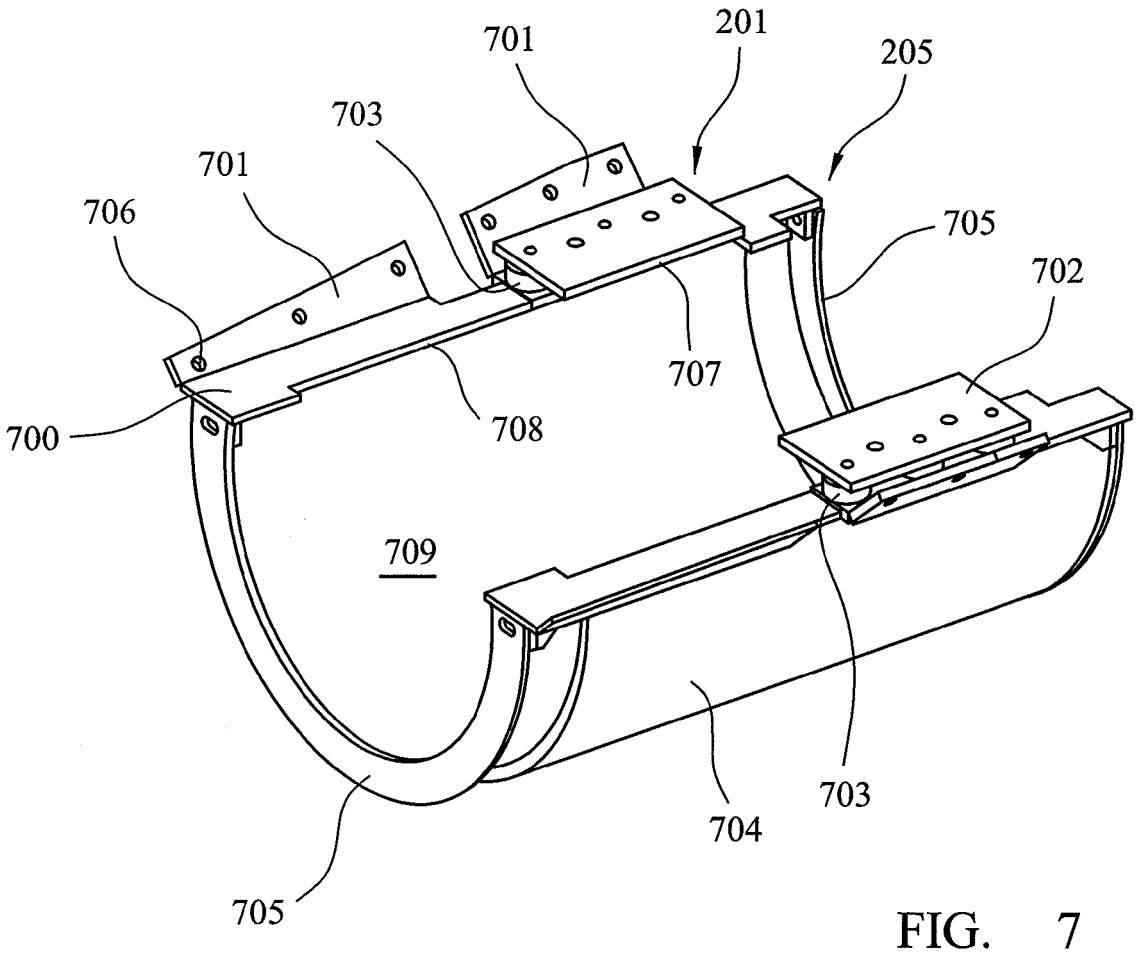
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FIG. 7

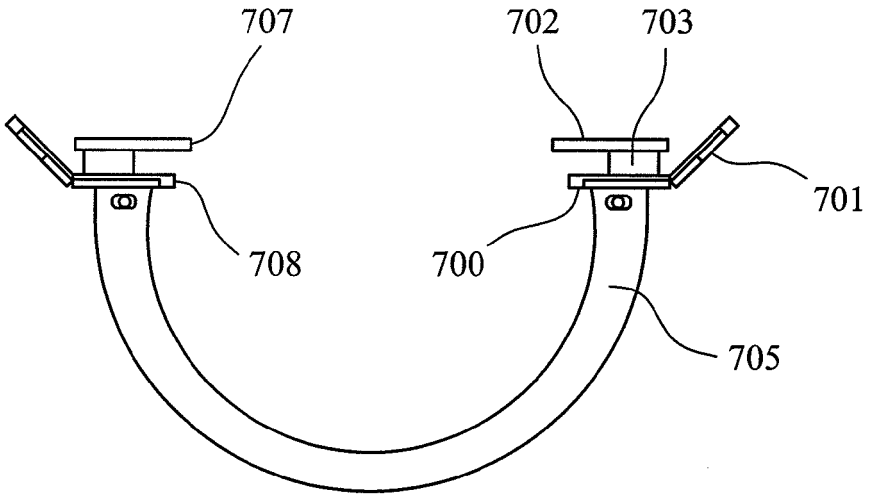
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FIG. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 13 16 2806

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 2004/250520 A1 (BOTH REINHOLD [DE]) 16 December 2004 (2004-12-16) * paragraphs [0006], [0007], [0008], [0010] * -----	1-5, 7-13,15	INV. E21C35/22
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A	EP 1 503 033 A1 (CFT GMBH [DE]) 2 February 2005 (2005-02-02) * paragraph [0019] * -----	1-15	
A	US 4 348 057 A (PARENTI JOSEPH A ET AL) 7 September 1982 (1982-09-07) * abstract * -----	1-15	
			TECHNICAL FIELDS SEARCHED (IPC) E21C E21F

1 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	2 August 2013	Garrido Garcia, M

CATEGORY OF CITED DOCUMENTS

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02-08-2013

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