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(54) Title: A MIXING AND PROCESSING SYSTEM OF VENTILATION AIR METHANE AND COAL MINE METHANE

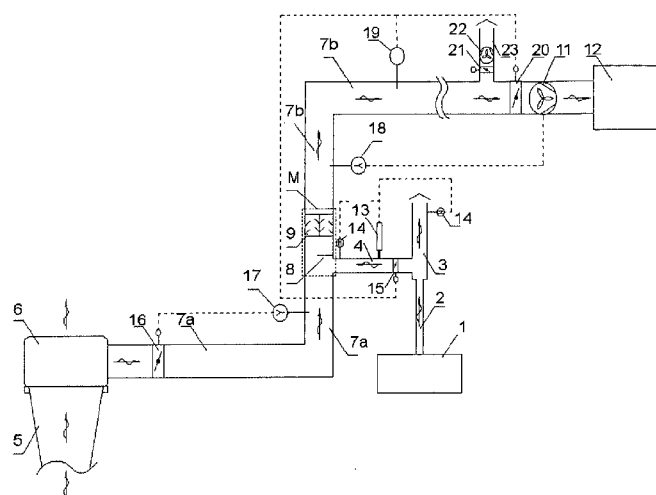


Fig.1

(57) Abstract: The invention refers to a mixing and processing system of ventilation air methane (VAM) and coal mine methane (CMM), which includes a VAM capture hood (6), a VAM duct (7a), a CMM connecting duct (4), a mixing device (M), an enriched VAM duct (7b), an induced draft fan (11), and a mixed gas conversion system; The described CMM connecting duct (4) is connecting with the VAM duct (7a), which makes the CMM being sucked into the VAM duct (7a) through CMM connecting duct (4); The CMM is primarily mixed and diluted with the VAM through the mixing device (M); The enriched VAM is delivered into the mixed gas conversion system through the enriched VAM duct (7b) for the oxidation treatment. The mixing and processing system of VAM and CMM can achieve safe collection, mixing and delivering of the coal mine VAM and the CMM, supply safe gas resource for the subsequent utilization in mixed gas conversion system and then emit to atmosphere in the form of clean oxidation products.

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A MIXING AND PROCESSING SYSTEM OF VENTILATION AIR METHANE AND COAL MINE METHANE

TECHNICAL FIELD

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The invention refers to the technical field of the energy saving and emission reduction of coal mine industry, the coal mine safe production technology and engineering, specifically refers to a mixing and processing system of Ventilation Air Methane (VAM) and Coal Mine Methane (CMM).

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BACKGROUND

During the production of the coal mine, plenty of methane stored in the coal seam will be released to the mining space. In order to assure the ventilation air safety of the underground, huge amount of fresh air is pushed into the coal mine underground and then emitted to the atmosphere with extremely low methane concentration (below 0.75%). The methane mixed with the ventilation air is called ventilation air methane.

Especially in a few high gassy mine, due to the methane concentration at the working surface greatly exceeds the safety standard as stipulated in *Coal Mine Safety Regulation*, it is difficult to restrict the methane concentration at the working surface within the allowable scope purely by adopting the ventilation method; In the coal and gas outburst mine, the outburst danger is a great threat to the coal mine workers' life and the coal mine production safety. In this circumstance, the gas drainage method must be adopted to improve the coal mine production safety condition and alleviate the production pressure.

In order to reduce and relive the threat of the coal mine methane safe production, the mechanical equipment and the special pipelines are utilized to create a negative pressure, which can extract the methane from the coal seam and transport to the ground surface and other safe places. This method is called methane drainage.

According to the statistics, the coal mine in China totally emits more than 24 billion cubic meters methane to the atmosphere annually. The methane gas has great global warming effect, which is equal to 25 times of CO₂. The methane explosive range is 5%~16%. The coal mine methane is divided into high-concentration and

low-concentration methane. The high-concentration methane is of which the methane concentration exceeds 30%. The low-concentration methane is of which the methane concentration is below 30%. More than 60% methane in China is the low-concentration methane with methane concentration below 30%. According to the *Coal Mine Safety Regulation*, the low-concentration coal mine methane is not allowed to be stored in the gasholder and majority of the methane is directly vented into the atmosphere. On the one hand, the direct emission of the low-concentration coal mine methane creates huge waste of non-renewable resources. On the other hand, it exacerbates the air pollution and global warming.

Through collecting and delivering of the VAM and CMM, it can be supplied to the RTO equipment for oxidation treatment and converted to CO₂ and H₂O, which eliminates the methane vented into the atmosphere originally and achieves huge carbon emission reductions. Therefore, it is important as how to collect and deliver the VAM and CMM safely and effectively.

SUMMARY OF THE INVENTION

The purpose of this invention is to reutilize a considerable part of the ventilation air methane (VAM) and coal mine methane (CMM) and thus avoid the methane pollution to the atmosphere. The invention provides a mixing and processing system of VAM and CMM which achieves safe collection, mixing and delivering of the coal mine VAM and the CMM drainage gas, supplies safe gas resource to a mixed gas conversion system, e.g. an mixed gas oxidizer system, preferably a RTO system, for further oxidation and finally vents the oxidized clean CO₂ into the atmosphere.

To achieve the purpose, the invention provides a mixing and processing system of ventilation air methane (VAM) and coal mine methane (CMM). The system includes a VAM capture hood, a VAM duct, a CMM connecting duct, a mixing device, an enriched VAM duct, an induced draft fan and a mixed gas conversion system; The described VAM duct connects with the VAM capture hood, which makes the VAM sucked into the VAM duct through negative pressure; The described CMM connecting duct is connected with the VAM duct and the CMM is sucked into the VAM duct due to negative pressure; The CMM is mixed and diluted with the VAM through the mixing device; The enriched VAM, with enriched methane concentration, is delivered through enriched VAM duct to at least one member of the mixed gas

conversion system, preferably one RTO for oxidation treatment; The power source of described negative pressure delivering of coal mine VAM and CMM comes from the induced draft fan installed upstream the mixed gas conversion system, especially the RTO; The negative pressure is formed inside VAM duct and CMM connecting duct when the described induced draft fan is put into operation. Said mixed gas conversion system preferably performs at least an oxidation reaction on the supplied mixed gas as conversion reaction. Whereas the mixed gas conversion system may preferentially comprise at least one regenerative thermal oxidizer (RTO). Alternatively or additionally, the mixed gas conversion system may comprise at least a combustor, an incinerator, gas-turbine or gas-turbine system with a combustor and/or catalytic convertor and a gas-turbine, and/or a catalytic reactor fed with the mixed gas, namely the VAM/CMM-mixture provided by the inventive mixing and processing system.

After the CMM being sucked into VAM duct, the CMM is rapidly diluted and mixed evenly to mixture gas with a methane concentration threshold below Lower Explosion Limit (LEL), preferably below 1.5%, which makes the gas safely delivered.

As a further improvement of the technical solution, the system also includes CMM venting pipe and CMM capture hood; The CMM venting pipe is normally an up-and-down open duct with its bottom connected with the coal mine ground pumping station; The CMM capture hood is an open hood structure sitting at the outlet of the described CMM venting pipe and one side is open to the atmosphere. One wall of the CMM capture hood is designed with a ventilation hole which is connecting to the gas inlet of the CMM connecting duct.

As a further improvement of the technical solution, the described CMM connecting duct is installed with an explosion-prevention equipment. The explosion-prevention equipment has function of explosion monitoring through two flame sensors installed at CMM connecting duct and CMM capture hood respectively.

As a further improvement of the technical solution, a VAM source modulating valve is installed at the VAM duct near the VAM capture hood. No. 1 pressure sensor is installed upstream or around the intersection point of the VAM duct and CMM connecting duct. The VAM source modulating valve is on closed-loop automatically control according to the before-mixed gas pressure monitored by the No.1 pressure sensor. A constant negative pressure is thus maintained at mixing point near the CMM connecting duct. The CMM is therefore sucked into the VAM duct due to the constant negative pressure in the CMM connecting duct even if the CMM capture

hood is permanently open to the atmosphere.

As a further improvement of the technical solution, No.2 pressure sensor is installed downstream the mixing device. The induced draft fan is on closed-loop VFD control according to the enriched VAM pressure monitored by the No.2 pressure sensor. The gas flow rate in the enriched VAM duct is thus controlled.

As a further improvement of the technical solution, a methane detector is installed downstream the mixing device. The CMM modulating valve is on closed-loop control according to the methane concentration continuously monitored by the methane detector. The methane concentration after mixing is thus controlled preferably below 1.5%.

As a further improvement of the technical solution, at least one mixing device is installed around or downstream the intersection point of VAM duct and CMM connecting duct. The mixing device can be realized in the form of a baffle plate, which is exemplarily installed around the intersection point of VAM duct and CMM connecting duct.

In addition or alternatively the mixing device can be realized in the form of a static mixer, which is exemplarily installed downstream the intersection point of VAM duct and CMM connecting duct which realizes primary mixing of CAM and CMM, and then secondary mixing is conducted by static mixer thereafter. The methane concentration of enriched VAM after mixing is uniform without methane stratification. In other preferred embodiments the mixing device may comprise a combination of at least one baffle plate and/or at least one static mixer, whereby the mixing device or at least one of its elements may be located around or downstream the intersection point of VAM duct and CMM connecting duct. In special embodiments at least one component of the mixing device – such as a baffle plate or a static mixer may alternatively or in addition be located upstream the intersection point of VAM duct and CMM connecting duct.

As a further improvement of the technical solution, the described CMM connecting duct extends into VAM duct and a certain space is left between the duct walls of VAM duct (7a) and the outlet of CMM connecting duct (4).

As a further improvement of the technical solution, a demister can be installed or foreseen downstream the static mixer in order to increase energy efficiency of the process by elimination of water droplets from the gas flow to the RTO. The described demister may be composed of numerous parallel lamellas which provide various

pitches for the VAM flow. Alternatively or in addition, the demister may be composed of or comprise at least a mesh or other structure, preferably other open porous structure, which provides various passages for the VAM flow. When the gas passes through these passages, the water droplets coalesce together, collide on the mesh's
5 or other structure's surface and also form a liquid film. The enriched VAM after removing the water droplet is then delivered into mixed gas conversion system, preferably the RTO.

As a further improvement of the technical solution, an isolation valve is installed upstream the induced draft fan at the mixed gas conversion system inlet, preferably
10 the RTO inlet. The isolation valve is open/closed in the control of the monitoring data of the methane detector. The distance between the described methane detector and isolation valve is over gas delivering length. Gas delivering length is calculated as following: duct length which enriched VAM passes in methane detector reaction time, typically less than 2 seconds, plus closing time of isolation valve, typically 2 seconds.
15 Distance is over gas delivering length to guarantee that, when the monitored methane concentration by the methane detector exceeds a certain threshold value, typically 40% of Lower Explosion Limit (LEL) namely, the isolation valve is closed, which completely isolates the mixed gas conversion system, preferably the RTO, from the enriched VAM duct, thus assures the safety of the whole system.

As a further improvement of the technical solution, an emergency venting pipe is installed upstream the isolation valve. The outlet of the emergency venting pipe connects to the atmosphere and the emergency venting pipe is installed with venting valve and venting fan; After the mixed gas conversion system, preferably the RTO, is out of operation, the venting valve is open and the venting fan is pulling VAM from the
20 VAM capture hood to purge the enriched VAM duct in the control of closed-loop, which clears all the remaining CMM inside the enriched VAM duct and discharges into the atmosphere through the emergency venting pipe, thus assures the safety of the whole system. Throughout the context of this invention "mixed gas conversion system is out of operation/RTO is out of operation" shall be understood as a condition
25 or mode of the mixed gas conversion system, especially an RTO, wherein the respective system is either isolated from the enriched VAM duct, respectively the enriched VAM manifold, or the mixed gas conversion system is shut down.

As a further improvement of the technical solution, an ambient air intake pipe is installed upstream the intersection point of VAM duct and CMM connecting duct; The

described ambient air intake pipe is with its inlet connected to the atmosphere and is installed with pressure equalization valve; After the mixed gas conversion system , preferably the RTO, is out of operation, the pressure equalization valve is on closed-loop automatically open for pressure equalization in VAM duct and CMM connecting duct with atmosphere.

As a further improvement of the technical solution, a venting air intake pipe is installed upstream the isolation valve; The described venting air intake pipe is with its inlet connected to the atmosphere and is installed with venting fan and ambient air valve; An emergency venting pipe with a venting valve is installed upstream the intersection point of VAM duct and CMM connecting duct; After the mixed gas conversion system, preferably the RTO, is out of operation, the venting valve and the ambient air valve are on closed-loop automatically open and the venting fan is started and pushes ambient air in the enriched VAM duct and VAM duct, which clears all the remaining CMM inside the duct and discharges into the atmosphere through the emergency venting pipe.

As a further improvement of the technical solution, a venting pipe is installed upstream the intersection point of VAM duct and CMM connecting duct; The described venting pipe is with its outlet connected to the atmosphere and is installed with multipurpose valve; The described enriched VAM duct is installed with an enriched VAM manifold which connects with the mixed gas conversion system, preferably the RTO units, parallel; A venting air intake pipe is installed at back end of the enriched VAM manifold with one end connected to the atmosphere and is designed with venting fan and ambient air valve. After the mixed gas conversion system, preferably the RTO, is out of operation, the ambient air valve and multipurpose valve are on closed-loop automatically open and the venting fan is started and successively pushes ambient air in the enriched VAM manifold, enriched VAM duct and VAM duct, which clears all the remaining CMM inside the duct and discharges into the atmosphere through the venting pipe; or after the mixed gas conversion system, preferably the RTO, is out of operation the ambient air valve and the multipurpose valve are on closed-loop automatically open and the venting fan is started and pulling ambient air through venting pipe to purge the enriched VAM duct due to negative pressure, which clears all the remaining CMM inside the duct and discharges into the atmosphere through venting air pipe. CMM could be pushed out backwards by means of an ambient air fan, installed at the back end of the enriched

VAM duct, venting CMM in opposite direction than ordinary flow direction.

As a further improvement of the technical solution, a clean gas stack is connected to the mixed gas conversion system, e.g. the RTO, via clean gas duct; Clean gas out of the mixed gas conversion system, e.g. the RTO, is discharged through the clean gas duct and clean gas stack to the atmosphere; The on/off state of the clean gas duct is controlled by clean gas valve.

As a further improvement of the technical solution, a steam boiler and the described clean gas stack are connected to the mixed gas conversion system, e.g. the RTO, via hot gas duct; The steam boiler is used to absorb hot gas released from the mixed gas conversion system, e.g. the RTO, for energy utilization; The described hot gas duct is installed with hot gas valve to control on/off state of hot gas duct and steam boiler, and with hot gas boiler bypass valve to control on/off state between hot gas duct and clean gas stack. Alternatively or in addition, the mixed gas conversion system may comprise a gas-turbine for utilization of energy stored in the mixed gas and/or the hot gas released from another member of the mixed gas conversion system, such as for example an RTO or combustor.

As a further improvement of the technical solution, a piezo meter ring is equipped at the inlet of each induced draft fan for the measurement of VAM flow in the enriched VAM duct.

The mixing and processing system of CMM and VAM has the following advantages:

1. The mixing and processing system of VAM and CMM can achieve safe collection, mixing and delivering of coal mine VAM and coal mine CMM drainage gas, provide a safe gas resource for the RTO and fuel combustion et al. and finally vent the oxidized clean CO₂ into the atmosphere with a function of saving energy at other equipment and reducing emission;

2. The VAM capture hood and CMM capture hood is permanently open to atmosphere. When the induced draft fan inlet of RTO is shutdown, the negative pressure in the VAM duct disappears and the VAM and CMM is vented to atmosphere as usual, which will have no impact on the normal operation of coal mine ventilation system and drainage system and thus ensures the safe coal mine production;

3. The prior art mainly relies on the positive pressure at the outlet of the CMM water-ring pump, which brings additional resistance and pressure to the CMM water-

ring pump to deliver the CMM to mixing point. The invention utilizes the negative pressure in the VAM duct to actively capture the CMM and completely independent from normal operation of the CMM pump. The CMM pumping station is therefore released from CMM delivering outside the pumping station;

- 5 4. The technical solution develops a complete set of gas pressure and methane monitoring control system, which can achieve automatic control of negative pressure inside the VAM duct, the gas flow and methane concentration. The methane concentration after mixing is controlled considerably below Lower Explosion Limit (LEL), typically below 1.5 %, which provides a safe gas resource for further
10 treatment in the RTO system.

DRAWINGS

Figure 1 is the structure diagram illustrating the mixing and processing system of
15 the VAM and CMM in embodiment 1.

Figure 2 is the structure diagram illustrating the mixing and processing system of the VAM and CMM in embodiment 2.

Figure 3 is the structure diagram illustrating the mixing and processing system of the VAM and CMM in embodiment 3.

20 Figure 4 is the structure diagram illustrating the mixing and processing system of the VAM and CMM in embodiment 4.

Figure 5 is the structure diagram illustrating the mixing and processing system of the VAM and CMM in embodiment 5.

25 Figure 6 is the structure diagram illustrating the mixing and processing system of the VAM and CMM in embodiment 6.

Figure 7 is the structure diagram illustrating the piezo meter ring equipped at the inlet of each induced draft fan in embodiment 6.

Figure 8 is the structure diagram illustrating the mixing and processing system of the VAM and CMM in embodiment 7.

30 Figure 9 is the structure diagram illustrating the mixing and processing system of the VAM and CMM in embodiment 8.

Figure 10 is the connected relation diagram illustrating the shaped CMM connecting duct and VAM duct.

Figure 11 is the structure diagram illustrating the first type of shaped CMM

connecting duct.

Figure 12 is the structure diagram illustrating the second type of shaped CMM connecting duct.

5 Figure 13 is the structure diagram illustrating the third type of shaped CMM connecting duct.

Figure 14a is the structure diagram illustrating the fourth type of shaped CMM connecting duct.

Figure 14b is the radial cross section view illustrating the fourth type of shaped CMM connecting duct in Figure 14a.

10 Figure 15a is the structure diagram illustrating the fifth type of shaped CMM connecting duct.

Figure 15b is the radial cross section view illustrating the fourth type of shaped CMM connecting duct in Figure 15a.

Figure label

- | | |
|-------------------------------------|---------------------------------|
| 1. Coal Mine Ground Pumping Station | 2. CMM Venting Pipe |
| 3. CMM Capture Hood | 4. CMM Connecting Duct |
| 5. VAM Shaft | 6. VAM Capture Hood |
| 7a. VAM Duct | 7b. Enriched VAM Duct |
| M. Mixing device | 8. Baffle Plate |
| 9. Static Mixer | 10. Demister |
| 11. Induced Draft Fan | 12. RTO |
| 13. Explosion-Prevention Equipment | 14. Flame Sensors |
| 15. CMM Modulating Valve | 16. VAM Source Modulating Valve |
| 17. Pressure Sensor | 18. measuring device |
| 19. Methane Detector | 20. Isolation Valve |
| 21. Venting Valve | 22. Venting Fan |
| 23. Emergency Venting Pipe | 23b. Venting Air Intake Pipe |
| 24. Ambient Air Valve | 25. Enriched VAM Manifold |
| 26. Clean Gas Duct | 27. Clean Gas Stack |
| 28. Clean Gas Valve | 29. Hot Gas Valve |
| 30. Hot Gas Duct | 31. Steam Boiler |
| 32. Hot Gas Bypass Valve | 33. Temperature Sensor |
| 34. Pressure Equalization Valve | 35. Ambient Air Intake Pipe |
| 36. Piezo Meter Ring | 37. Venting Pipe |
| 38. Multipurpose Valve | 39. Steam Turbine |
| 40. Electric Generator | 41. Cooling Equipment |
| 42. Feed-water Pump | 4*. Shaped CMM Connecting Duct |
| 8*. Shaped Baffle Plate | |

EMBODIMENTS

The followings are detailed embodiments of the mixing and processing system of the VAM and CMM.

5 Embodiment 1

As indicated in Figure 1, the mixing and processing system of the VAM and CMM comprises of: VAM capture hood (6), VAM duct (7a), CMM connecting duct (4), mixing device (M), Enriched VAM duct (7b), induced draft fan (11) and RTO equipment (12) as an preferred example of a mixed gas conversion system (throughout the following description of the embodiments we always refer to a RTO (12) as an example of a mixed gas conversion system which may be used with the inventive mixing and processing system in the synergetic way of this invention and therefore shall not be understood as limiting the invention to a combination with a RTO only) ; The described VAM duct (7a) is connected with the VAM capture hood (6), which makes the VAM sucked into the VAM duct (7a) through negative pressure; The described CMM connecting duct (4) is connecting with the VAM duct (7a) and the CMM is sucked into the VAM duct (7a) due to negative pressure. The CMM is mixed and diluted with the VAM through the mixing device (M) into the enriched VAM, with a methane concentration below 1.5 Vol.-%, preferably at a setpoint of 1.2Vol.-%, which is delivered into at least one RTO (12) for oxidation treatment. The power source of described negative pressure delivering of coal mine VAM and CMM comes from the induced draft fan (11) installed upstream the RTO (12). The negative pressure is formed inside enriched VAM duct (7b), VAM duct (7a) and the CMM connecting duct (4) when the described induced draft fan (11) is put into operation. The enriched VAM duct (7b) is connected at its inlet to the VAM duct (7a) and there is one induced draft fan (11) at least along the enriched VAM duct (7b).

The CMM is sucked into the VAM duct (7a) and rapidly diluted and mixed evenly by the VAM. After mixing and dilution, the methane concentration decreases to a setpoint far below the methane explosive range. The Efficiency of Mixing device (M) is confirmed exemplary by numerical flow modeling.

As indicated in Figure 1, the mixing and processing system based on the above-mentioned structure also includes CMM venting pipe (2) and CMM capture hood (3); The described CMM venting pipe (2) is an up-and-down open cylinder with its bottom connected with the coal mine ground pumping station (1); The CMM capture hood (3)

is an up-and-down open hood structure sitting on top of the described CMM venting pipe (2) and its top is open to the atmosphere. The sidewall of the described CMM capture hood (3) is designed with a ventilation hole which is connecting to the gas inlet of the CMM connecting duct (4).

5 The described CMM connecting duct (4) is optionally installed with explosion-prevention equipment (13). The explosion-prevention equipment (13) has function of explosion monitoring through two flame sensors (14) installed at CMM connecting duct (4) and CMM capture hood (3) respectively. One flame sensor is installed within 5m from the CMM capture hood (3). Another flame sensor is installed within 2m from
10 the VAM duct (7a) and within 20m from the explosion-prevention equipment. Once the flame sensor detects the explosion in the duct, the explosion-prevention equipment automatically starts immediately, suppresses the explosion and cutoffs the explosion diffusion. The total response time is below 12ms. The explosion-prevention equipment (13) adopts active CO₂ explosion suppression mechanism. To generalize
15 the placement of flame sensors and the explosion-prevention equipment according to this embodiment, the placement between the CMM capture hood (3) and the VAM duct (7a) has to allow for a total response time faster than a progression time of flame front propagating through the duct work; so the exact placements depend on the overall size of the mixing and processing system, the gas flow rates, switching
20 speeds of the control valves and the fans.

 The described mixing device (M) can be designed in form of static mixer (9) and/or baffle plate (8); In this embodiment, the mixing device (M) is a combination of static mixer (9) and baffle plate (8), as for the baffle plate (8) is installed around the intersection point of VAM duct (7a) and CMM connecting duct (4), and the static
25 mixer is installed downstream the intersection point of VAM duct (7a) and CMM connecting duct (4). A demister (10) is installed downstream the static mixer (9). The described demister (10) comprises of parallel lamella which forms numerous pitches for gas delivery. When the gas passes through the lamella, the water droplets coalesce together, collide on the lamella surface and form a liquid film. Alternatively
30 or in addition, the demister (10) may be composed of or comprise at least a mesh or other structure which provides various passages for the VAM flow. When the gas passes through these passages, the water droplets coalesce together, collide on the mesh's or other structure's surface and also form a liquid film. The influence of gravity causes the liquid to drain to the bottom of the profiles. After removing the

water droplets, the gas is delivered to the RTO (12) for efficient oxidation treatment which improves the thermal efficiency of the RTO (12). The demister (10) uses the lamella and/or mesh and/or other structure to remove water droplets. Use of electroconductive materials assures avoidance of electrostatic charging as a potential ignition source. The working principle of the above-mentioned mixing and processing system of CMM and VAM is as follows:

Firstly, the CMM from the coal mine ground pumping station (1) is delivered to the CMM venting pipe (2) and CMM capture hood (3) through positive pressure by the CMM pump. When the RTO (12) is out of operation, the VAM duct (7a) and CMM connecting duct (4) is at ambient pressure or slightly higher. The CMM capturing efficiency is 0%. Due to the jet interaction, the CMM connecting duct (4) will form reverse flow and the CMM is vented to the atmosphere through the CMM capture hood (3), which avoids the CMM leaking to the VAM duct (7a). In the meanwhile, the VAM in the VAM shaft (5) is vented to the atmosphere through the VAM capture hood (6). When the RTO (12) is in operation, the VAM is sucked into the VAM duct (7a) due to the negative pressure formed by the induced draft fan (11) installed in the enriched VAM duct (7b). Since negative pressure is also formed near the ventilation hole of the CMM capture hood (3) sidewall, the CMM is therefore sucked into the CMM connecting duct (4) and subsequently into the VAM duct (7a). The methane concentration of the CMM is quickly diluted to below 1.5%. The even mixing of VAM and CMM is achieved through baffle plate (8) and static mixer (9). The enriched VAM is finally delivered to the RTO (12) for oxidation treatment after removal of droplets through the demister (10) and finally converted to H_2O and CO_2 , which is vented to the atmosphere.

Moreover, as indicated in the Fig. 1, the VAM source modulating damper (16) is installed after the VAM capture hood (6). Pressure sensor (17) is installed upstream or around the intersection point of the VAM duct (7a) and CMM connect duct (4). The VAM source modulating valve (16) is on closed-loop automatically control according to the before-mixed gas pressure monitored by the pressure sensor (17). A constant negative pressure is thus maintained at mixing point near the CMM connecting duct (4). Most of the CMM is sucked into the CMM connecting duct (4) due to the constant negative pressure when the CMM venting pipe (2) is open to the atmosphere.

The measuring device (18) or a flow meter is installed downstream the static mixer (9). The induced draft fan (11) is on closed-loop VFD control according to the

gas pressure monitored by the measuring device (18) or a flow meter. The gas flow rate in the enriched VAM duct (7b) is thus controlled. The methane detector (19) with fast response time, preferably an infrared laser type methane detector, is installed downstream the static mixer (9). The CMM modulating valve (15) is on closed-loop automatically control according to the methane concentration continuously monitored by the methane detector (19). The methane concentration downstream mixing is thus controlled below 1.5%.

The described baffle plate (8) is installed around the intersection point of VAM duct (7a) and CMM connecting duct (4). The primary mixing of VAM and CMM is conducted by the baffle plate (8) and then secondary mixing is conducted by static mixer (9), which achieves uniform mixing of VAM and CMM. It is ensured that there is no methane stratification after mixing.

The isolation valve (20) is open/closed in the control of the monitoring data of the methane detector (19). The distance between the described methane detector (19) and isolation valve (20) is over gas delivering length. Gas delivering length is calculated as following: duct length which enriched VAM passes in methane detector (19) reaction time, typically less than 2 seconds, plus closing time of isolation valve (20), typically 2 seconds. Distance is over gas delivery length to guarantee that, when the monitored methane concentration by the methane detector (19) exceeds 1.8 Vol.-%, the isolation valve (20) is closed, which completely isolates the RTO from the enriched VAM duct (7b), thus assures the safety of the whole system.

The emergency venting pipe (23) is installed upstream the isolation valve (20). The top of the emergency venting pipe (23) is open to the atmosphere. The venting valve (21) and venting fan (23) are installed along the emergency venting pipe (23). After the RTO (12) is out of operation, the venting valve (21) is automatically open and the venting fan (23) is pulling VAM from the VAM capture hood (6) to purge the VAM duct in the control of closed-loop, which clears all the remaining CMM inside the VAM duct (7) and discharge into the atmosphere through the emergency venting pipe (23), thus assures the safety of the whole system.

Embodiment 2

As indicated in Figure 2, the mixing and processing system of the VAM and CMM comprises of: VAM capture hood (6), VAM duct (7a), CMM connecting duct (4), mixing device, enriched VAM duct (7b), induced draft fan (11) and RTO (12). Distinct from Embodiment 1, the system also comprises of clean gas stack (27) and steam

boiler (31). The described clean gas stack (27) is connected to RTO (12) via clean gas duct (26); Clean gas out of the RTO is discharged through the clean gas duct and clean gas stack to the atmosphere; The on/off state of the clean gas duct (26) is controlled by clean gas valve (28). The described steam boiler (31) and clean gas stack (27) are connected to the RTO (12) via hot gas duct (26); The steam boiler (31) is used to absorb hot gas released from the RTO (12) for energy utilization; The hot gas duct (26) is installed with hot gas valve (29) which controls on/off state of hot gas duct (30) and steam boiler (31), and with hot gas boiler bypass valve (32) which controls on/off state between hot gas duct and clean gas stack.

Excess energy from high energy input by methane into RTO (12) is released in form of hot gases, normally hotter than 800 °C through a temperature resistant hot gas duct (30) into the steam boiler (31). Energy discharge is typically realized controlled by means of a temperature sensor (33) installed in the combustion chamber of the RTO (12), a hot gas valve (29) and hot gas bypass valve (32). In case no steam boiler or other consumer is connected to the RTO or steam boiler or other consumer is out of operation, hot gases will be bypassed via the hot gas boiler bypass valve (32) to the clean gas duct (26) or clean gas stack (27) directly.

Besides, in this embodiment, the described mixing device is designed as static mixer (9), which is installed downstream the intersection point of VAM duct (7a) and CMM connecting duct (4). No VAM source modulating valve or adapted Pressure Sensor is installed.

Embodiment 3

As indicated in Figure 3, the mixing and processing system of the VAM and CMM comprises of: VAM capture hood (6), VAM duct (7a), CMM connecting duct (4), mixing device, enriched VAM duct (7b), induced draft fan (11) and RTO. Distinct from Embodiment 1, this embodiment also comprises of RTO units (12) (12a, 12b...12x) ; The described enriched VAM duct (7b) is installed with an enriched VAM manifold (25) which is connects RTO units (12) parallel. An isolation valve (20a, 20b...20x) and induced draft fan (11a, 11b...11x) is installed upstream the induced draft fan at each single RTO inlet. RTO units (12a - 12x) can run either all at the same time or one or more units can be taken out of operation in the control of corresponding isolation valve.

Clean gases out of the RTO will be discharged through a clean gas duct (26a, 26b...26x) installed in each RTO to the atmosphere, and hot gas is delivered via hot

gas duct (30a, 30b...30x) for further energy utilization.

Embodiment 4

As indicated in Figure 4, the mixing and processing system of the VAM and CMM comprises of: VAM capture hood (6), VAM duct (7a), CMM connecting duct (4),
5 mixing device, enriched VAM duct (7b), induced draft fan (11) and RTO (12). Distinct from Embodiment 1, this embodiment also comprises of a clean gas stack (27) connected to RTO (12) via clean gas duct (26); Clean gas out of the RTO is discharged through the clean gas duct (26) and clean gas stack (27) to the atmosphere; The on/off state of the clean gas duct (26) is controlled by the clean
10 gas valve (28) installed therein.

Besides, a venting air intake pipe (23b) is installed upstream the isolation valve (20); The described venting air intake pipe (23b) is with its inlet connected to the atmosphere and is installed with venting fan (22a) and ambient air valve (24); An emergency venting pipe (23a) with a venting valve (21a) is installed upstream the
15 intersection point of VAM duct (7a) and CMM connecting duct (4); After the RTO (12) is out of operation, the venting valve (21a) and the ambient air valve (24) are on closed-loop automatically open and the venting fan (22a) is started and pushes ambient air in the enriched VAM duct (7b) and VAM duct (7a) along arrows A in opposite direction than ordinary direction B, which clears all the remaining CMM
20 inside the duct and discharges into the atmosphere through the emergency venting pipe (23a), thus assures the safety of the whole system.

Beside the emergency venting systems described in accordance to the embodiments 1 and 4, other suitable emergency venting solutions can deduced easily by changing flow directions of the venting gas stream through the venting air
25 pipes (23, 23a, 23b) by switching the venting fan direction (e.g. from blowing to suction) and/or change of the installation point of the venting van in then venting air pipes and/or installation of at least an additional venting fan.

Embodiment 5

As indicated in Figure 5, the mixing and processing system of the VAM and
30 CMM comprises of: VAM capture hood (6), VAM duct (7a), CMM connecting duct (4), mixing device, enriched VAM duct (7b), induced draft fan (11) and RTO (12). Distinct from Embodiment 1, this embodiment also comprises of a clean gas stack (27) connected to RTO (12) via clean gas duct (26); Clean gas out of the RTO is discharged through the clean gas duct (26) and clean gas stack (27) to the

atmosphere; The on/off state of the clean gas duct (26) is controlled by the clean gas valve (28) installed therein.

Besides, an ambient air intake pipe is installed upstream the intersection point of VAM duct and CMM connecting duct; The described ambient air intake pipe is with its inlet connected to the atmosphere and is installed with pressure equalization valve; After the RTO is isolated from VAM duct by closing the isolation valve, the pressure equalization valve (34) is on closed-loop automatically open for pressure equalization in VAM duct (7a) and CMM connecting duct (4) with atmosphere. Coal mine ground pumping station (1) is still working providing CMM flow in CMM capture hood (3). High velocity of CMM gas stream in CMM capture hood (3) results in negative pressure in CMM connecting duct (4) so that flow reverses in direction B in case of loss of negative pressure in VAM duct (7a) at connection of CMM connecting duct (4). Due to this jet interaction, CMM doesn't leak into VAM duct (7a) and enriched VAM duct (7b) even if CMM modulating valve (15) is not closed, thus increases safety of the whole system.

Embodiment 6

As indicated in Figure 6, the mixing and processing system of the VAM and CMM comprises of: VAM capture hood (6), VAM duct (7a), CMM connecting duct (4), mixing device, enriched VAM duct (7b), induced draft fan (11) and RTO (12). Distinct from Embodiment 1, this embodiment also comprises of a piezo meter ring (36) is equipped at the inlet of the induced draft fan (11) for the measurement of VAM flow in the enriched VAM duct (7b). As indicated in Figure 7, the VAM flow is calculated by measuring the pressure drop of the cone inlet of the induced draft fan (11) and by closed-loop VFD control of the induced draft fan (11), thus improves enriched VAM flow control.

Embodiment 7

As indicated in Figure 8, the mixing and processing system of the VAM and CMM comprises of: VAM capture hood (6), VAM duct (7a), CMM connecting duct (4), mixing device, enriched VAM duct (7b), induced draft fan (11) and RTO (12). Distinct from Embodiment 1, this embodiment also comprises of RTO units (12) (12a, 12b...12x) ; The described enriched VAM duct (7b) is installed with an enriched VAM manifold (25) which connects RTO units (12) parallel. An isolation valve (20a、20b...20x) and induced draft fan (11a, 11b...11x) is installed upstream of each single RTO inlet. RTO units (12a - 12 x) can run either all at the same time or one or more

units can be taken out of operation in the control of corresponding isolation valve.

Clean gases out of each RTO will be discharged through a clean gas duct (26a, 26b...26x) and clean gas stack (27) to the atmosphere, and hot gases is delivered via hot gas duct (30a, 30b...30x) into the steam boiler (31) for further energy utilization.

The on/off state of each clean gas duct (26a - 26x) is controlled by corresponding clean gas valve (28a, 28b...28x). Each hot gas duct (30a - 30x) is installed with hot gas valve (29a, 29b...29x) which controls on/off state of corresponding hot gas duct and steam boiler (31), and with hot gas boiler bypass valve (32a - 32x) which controls on/off state of corresponding hot gas duct. Energy discharge is typically realized controlled by means of a temperature sensor (33a, 33b...33x) installed in the combustion chamber of each single RTO (12).

Besides, a venting pipe (37) is installed upstream the intersection point of VAM duct (7a) and CMM connecting duct (4); The described venting pipe (37) is with its outlet connected to the atmosphere and is installed with multipurpose valve (38); The described enriched VAM duct (7b) is installed with an enriched VAM manifold (25) which connected RTO units (12) parallel; A venting air intake pipe (23b) is installed at back end of the enriched VAM manifold (25) with one end connected to the atmosphere and is designed with venting fan (22a) and ambient air valve (24);

After the RTO (12) is out of operation, the ambient air valve (24) and multipurpose valve (38) are on closed-loop automatically open and the venting fan (22a) is started and successively pushes ambient air in the enriched VAM manifold (25), enriched VAM duct (7b) and VAM duct (7a), which clears all the remaining CMM inside the duct and discharges into the atmosphere through the venting pipe (37); Or, as alternative or in addition to aforesaid venting after the RTO (12) is out of operation, the multipurpose valve (38) opened for pressure equalization in VAM duct (7a) and CMM connecting duct (4) with atmosphere, Due to the jet interaction, high velocity of CMM gas stream in CMM capture hood (3) results in negative pressure in CMM connecting duct (4) so that flow reverses in direction B in case of loss of negative pressure in VAM duct (7a) at connection of CMM connecting duct (4), which avoids CMM leak into VAM duct (7a) and enriched VAM duct (7b) even if CMM modulating valve (15) is not closed, thus increases safety of the whole system.

In other advantageous adoptions of the inventive concept the venting system described in connection to embodiment 7 may be varied by sucking ambient air into

VAM duct (7a) via the venting pipe (37) for example, whereby the ambient air is pulled through the VAM duct (7a) and enriched VAM duct (7b) and expelled from the system via the air pipe (23b). Other modifications may be realized by placing alternatively or additionally a fan into the venting pipe (37), whereas said fan and/or the venting fan (22a) are used to move, by pulling and/or pushing, the venting gas, e.g. VAM and/or sucked in ambient air, either in positive or negative direction through the VAM duct (7a) and enriched VAM duct (7b).

Embodiment 8

As indicated in Figure 9, the mixing and processing system of the VAM and CMM comprises of: VAM capture hood (6), VAM duct (7a), CMM connecting duct, mixing device, enriched VAM duct (7b), induced draft fan (11) and RTO (12). Distinct from Embodiment 1, this embodiment also comprises of a clean gas stack (27) and steam boiler (31). The described clean gas stack (27) is connected to RTO (12) via clean gas duct (26); Clean gas out of the RTO is discharged through the clean gas duct (26) and clean gas stack (27) to the atmosphere; The on/off state of the clean gas duct (26) is controlled by clean gas valve (28). The described steam boiler (31) and the clean gas stack (27) are connected to the RTO (12) via hot gas duct (30); The steam boiler (31) is used to absorb hot gas released from the RTO (12) for energy utilization; The described hot gas duct (30) is installed with hot gas valve (29) to control on/off state between hot gas duct (30) and steam boiler (31), and with hot gas boiler bypass valve (32) to control on/off state of hot gas duct (30) and clean gas stack (27).

Excess energy from high energy input by methane into RTO (12) is released in form of hot gases, normally hotter than 800 °C through a temperature resistant hot gas duct (30) into the steam boiler (31) for heat exchange; The generated hot vapor drives steam turbine (39), simultaneously turns the electric generator (40) to produce electricity; Condensation water congealed from steam flowing through cooling equipment (41) is delivered back to steam boiler (31) by feed-water pump (42), thus realizes cyclic utilization.

Besides, in this embodiment, the mixing device is designed as a combination of static mixer (9) and shaped baffle plate (8*); The static mixer (9) is installed downstream the intersection point of VAM duct (7a) and CMM connecting duct (4) namely, the shaped CMM connecting duct (4*). As indicated in Figure 10, the shaped CMM connecting duct (4*) extends into VAM duct (7a) and a certain space is left

between the duct walls of VAM duct (7a) and the outlet of CMM connecting duct (4);
The described shaped baffle plate (8*) is fixed on one side of the shaped CMM
connecting duct (4*)

As indicated in Figure 11, the described shaped CMM connecting duct (4*) can
5 be designed as rectangular structure; The shaped baffle plate (8*) and shaped CMM
connecting duct (4*) can be designed together in an integrative structure, which
makes the shaped baffle plate (8*) extend a venting outlet from one side of the
shaped CMM connecting duct (4*); As indicated in Figure 12 and 13, the described
shaped baffle plate (8*) can also extend venting outlets from two sides of the shaped
10 CMM connecting duct (4*).

As indicated in Figure 14a and 14b, the described shaped CMM connecting duct
(4*) can be designed as cylindroid structure; The described shaped baffle plate (8*)
can be tangentially fixed at the venting outlet alongside the outer wall of the shaped
CMM connecting duct (4*). As indicated in Figure 15a and 15b, the shaped baffle
15 plate (8*) and shaped CMM connecting duct (4*) can be also designed together in an
integrative structure, which makes the shaped baffle plate (8*) extends a venting
outlet from one cambered surface of the shaped CMM connecting duct (4*).

Finally, the invention is only used for description of the technical solution rather
than the limitation. Although the invention is illustrated according to the embodiments,
20 the persons skilled in the art should understand that either revision or replacement of
the technical solution of this invention should not be separated from the principle and
range of the technical solution and should not beyond the scope of the invention
claims.

Claim 1. A mixing and processing system of ventilation air methane (VAM) and coal mine methane (CMM) comprising a VAM capture hood (6), a VAM duct (7a), a CMM connecting duct (4), a mixing device (M), an enriched VAM duct (7b) with an induced draft fan (11), and a mixed gas conversion system, especially a regenerative thermal oxidizer (RTO) (12), wherein the described VAM duct (7a) is connected with the VAM capture hood (6), which makes the VAM sucked into the VAM duct (7a) through negative pressure, and wherein the described CMM connecting duct (4) is connecting with the VAM duct (7a) and the CMM is sucked into the VAM duct (7a) due to negative pressure, and wherein the CMM is mixed and diluted with the VAM through the mixing device (M), and wherein the enriched VAM, with an enriched methane concentration, is delivered through the enriched VAM duct (7b) to at least one member of the mixed gas conversion system, preferably to at least one RTO (12), for oxidation treatment and whereby a power source of the described negative pressure for delivering of coal mine VAM and CMM comes from the induced draft fan (11) installed upstream the mixed gas conversion system.

Claim 2. A mixing and processing system according to claim 1, further providing a CMM venting pipe (2) and a CMM capture hood (3), wherein the described CMM venting pipe (2) is connected with its bottom to the coal mine ground pumping station (1) and wherein the CMM capture hood (3) is an open hood structure sitting at an outlet of the described CMM venting pipe (2) and is open to the atmosphere, and wherein one wall of the described CMM capture hood (3) is designed with an ventilation hole which is connecting with the CMM connecting duct (4).

Claim 3. A mixing and processing system according to claim 1 or 2, further providing an installation of an explosion-prevention equipment (13) at a CMM connecting duct (4) between CMM capture hood (3) and VAM duct (7a), and wherein the explosion-prevention equipment (13) provides the function of explosion monitoring through two flame sensors (14) installed at CMM connecting duct (4) and CMM capture hood (3) respectively.

Claim 4. A mixing and processing system according to any of the preceding claims, further comprising an installation of a VAM source modulating valve (16) after the VAM capture hood (6), whereby a pressure sensor (17) is installed upstream or around an intersection point of the VAM duct (7a) and CMM connecting duct (4) and the VAM source modulating valve (16) is on closed-loop automatically control according to the before-mixed gas pressure monitored by the No.1 pressure sensor (17).

Claim 5. A mixing and processing system according to any of the preceding claims further comprising an installation of a measuring device (18) downstream the mixing device (M), whereby the induced draft fan (11) is on closed-loop VFD control according to the value monitored by the measuring device (18) and whereby a gas flow rate in the enriched VAM duct (7b) is controlled.

Claim 6. A mixing and processing system according to any of the preceding claims, further comprising an installation of a methane detector (19) after the mixing device (M), whereby a CMM modulating valve (15) is on closed-loop automatically control according to the methane concentration continuously monitored by the methane detector (19).

Claim 7. A mixing and processing system according to any of the preceding claims, characterized by an installation of a mixing device in form of a baffle plate (8) around the intersection point of VAM duct (7a) and CMM connecting duct (4).

Claim 8. A mixing and processing system according to any of the claims 1 to 7, characterized by an installation of a mixing device in form of a static mixer (9) downstream of the intersection point of VAM duct (7a) and CMM connecting duct (4).

Claim 9. A mixing and processing system according to any of the preceding claims, characterized by an extension of the CMM connecting duct (4) into the VAM duct (7a) and a certain space is left between the walls of VAM duct (7a) and the outlet of CMM connecting duct (4).

Claim 10. A mixing and processing system according to any of the preceding claims, further comprising an installation of a demister (10) downstream of the mixing device (M), whereby the described demister (10) may be composed of or comprise numerous parallel lamellas which provide various pitches for the VAM flow and/or at least a mesh and/or other structure which provides various passages for the VAM flow, and whereby the enriched VAM after removing the water droplets is then delivered into the mixed gas conversion system.

Claim 11. A mixing and processing system according to any of the claims 6 to 10, further comprising an installation of an isolation valve (20) before the induced draft fan (11) at the mixed gas conversion system inlet, whereby the isolation valve (20) is open/close type which is controlled according to the monitoring data of the methane detector (19) and when the monitored methane concentration by the methane detector (19) exceeds a predefined threshold value, the isolation valve (20) is immediately closed, which completely isolates the mixed gas conversion system from the enriched VAM duct (7b).

Claim 12. A mixing and processing system according to claim 11, characterized by an installation of an ambient air intake pipe (35) upstream the intersection point of VAM duct (7a) and CMM connecting duct (4), whereby the described ambient air intake pipe (35) is connected with its inlet to the atmosphere and is installed with a pressure equalization valve (34), so that after the mixed gas conversion system is out of operation, the pressure equalization valve (34) is on closed-loop automatically open for pressure equalization in VAM duct (7a) and CMM connecting duct (4) with atmosphere.

Claim 13. A mixing and processing system according to claim 11, characterized by an installation of an emergency venting pipe (23) upstream the isolation valve (20), whereby the described emergency venting pipe (23) is connected with its outlet to the atmosphere and is installed with venting valve (21) and venting fan (22), so that after the mixed gas conversion system is out of operation, the venting valve (21) is on closed-loop automatically open and due to negative pressure the venting fan (22) is pulling VAM from the VAM capture hood (6) to purge the enriched VAM duct (7b), which clears all the remaining CMM inside the enriched VAM duct (7b) and discharges into the atmosphere through the emergency venting pipe (23).

Claim 14. A mixing and processing system according to claim 11, characterized by an installation of a venting air intake pipe (23b) upstream the isolation valve (20), whereby the described venting air intake pipe (23b) is connected with its inlet to the atmosphere and is installed with venting fan (22a) and ambient air valve (24), and
5 further comprising an emergency venting pipe (23a) with a venting valve (21a) being installed upstream the intersection point of VAM duct (7a) and CMM connecting duct (4), so that after the mixed gas conversion system is out of operation, the venting valve (21a) and the ambient air valve (24) are on closed-loop automatically open and the venting fan (22a) is started and pushes ambient air in the enriched VAM duct (7b)
10 and VAM duct (7a), which clears all the remaining CMM inside the duct and discharges into the atmosphere through the emergency venting pipe (23a).

Claim 15. A mixing and processing system according to claim 11, characterized by an installation venting air pipes (23a, 23b) upstream the isolation valve (20), whereby a first venting air pipe (23a, 23b) is located downstream the intersection
15 point of the VAM duct (7a) and CMM connecting duct (4) and second venting air pipe (23b, 23a) is located upstream the intersection point of the VAM duct (7a) and CMM connecting duct (4), and whereby in at least one of the venting air pipes (23a, 23b) a venting fan (22) is installed and whereby in one of the venting air pipes (23a; 23b) an ambient air valve (24) whereas in the other venting air pipes (23b; 23a) an
20 emergency venting valve (21a) is installed, so that after the mixed gas conversion system is out of operation, the emergency venting valve (21a) and the ambient air valve (24) are on closed-loop automatically open and the venting fan (22a) is started and pushes or sucks ambient air in the enriched VAM duct (7b) and VAM duct (7a) via one of the venting air pipe (23a; 23b), which clears all the remaining CMM inside
25 the duct and discharges into the atmosphere through the other venting air pipe (23b; 23a).

Claim 16. A mixing and processing system according to claim 1, characterized by an installation of a venting pipe (37) upstream the intersection point of VAM duct (7a) and CMM connecting duct (4), whereby the described venting pipe (37) is connected with its outlet to the atmosphere and is installed with a multipurpose valve (38), and whereby a venting air intake pipe (23b) is installed at back end of the enriched VAM duct (7b) with one end connected to the atmosphere and is designed with venting fan (22a) and ambient air valve (24), so that after the mixed gas conversion system is out of operation, the ambient air valve (24) and multipurpose valve (38) are on closed-loop automatically open and the venting fan (22a) is started and successively pushes ambient air in the enriched VAM duct (7b) and VAM duct (7a), which clears all the remaining CMM inside the duct and discharges into the atmosphere through the venting pipe (37) or after the mixed gas conversion system is out of operation, the ambient air valve (24) is on closed-loop automatically open and the venting fan (22a) is started and pulling VAM from the VAM capture hood (6) to purge the enriched VAM duct (7b) due to negative pressure, which clears all the remaining CMM inside the duct and discharges into the atmosphere through the emergency venting pipe (23) or after the mixed gas conversion system is out of operation, the ambient air valve (24) and the multipurpose valve (38) are on closed-loop automatically open and the venting fan (22a) is started and pulling ambient air from the venting pipe (37) through VAM duct (7a) and enriched VAM duct (7b), which clears all the remaining CMM inside the ducts and discharges into the atmosphere through the emergency venting pipe (23).

Claim 17. A mixing and processing system according to claim 16, characterized by including a multipurpose valve (38), which is on closed-loop automatically open for pressure equalization in VAM duct (7a) and CMM connecting duct (4) with atmosphere, after the mixed gas conversion system is out of operation.

Claim 18. A mixing and processing system according to any of the preceding claims, characterized by including a clean gas stack (27) connected to the mixed gas conversion system, preferably to the RTO (12), via clean gas duct (26), whereby a clean gas out of the mixed gas conversion system is discharged through the clean gas duct (26) and clean gas stack (27) to the atmosphere, whereby the on/off state of the clean gas duct (26) is controlled by the clean gas valve (28).

Claim 19. A mixing and processing system according to any of the preceding claims, characterized by including a steam boiler (31) and a clean gas stack (27) connected to the mixed gas conversion system, preferably to the RTO (12), via hot gas duct (30), whereby the steam boiler (31) is used to absorb hot gas released from the mixed gas conversion system for energy utilization and the described hot gas duct (30) is installed with a hot gas valve (29) to control on/off state between hot gas duct (30) and steam boiler (31), and with hot gas boiler bypass valve (32) to control on/off state of hot gas duct (30) and clean gas stack (27).

Claim 20. A mixing and processing system according to any of the preceding claims, characterized by equipment of a piezo meter ring (36) at the inlet of each induced draft fan (11) for the measurement of VAM flow in the enriched VAM duct (7b).

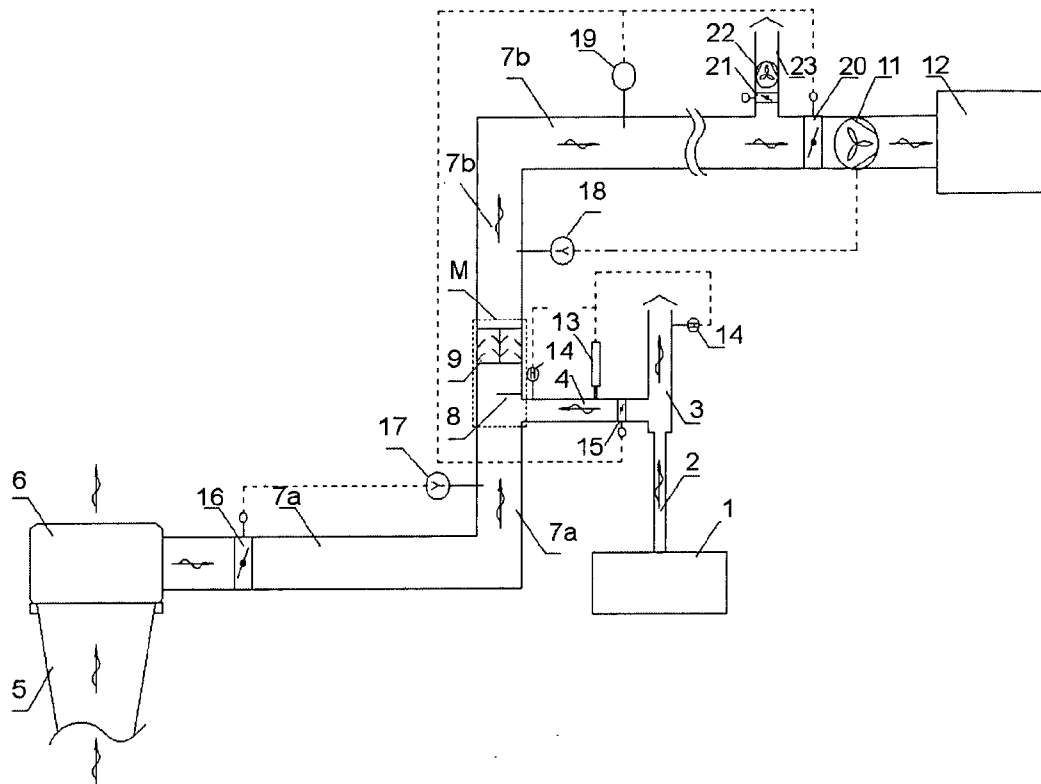


Fig.1

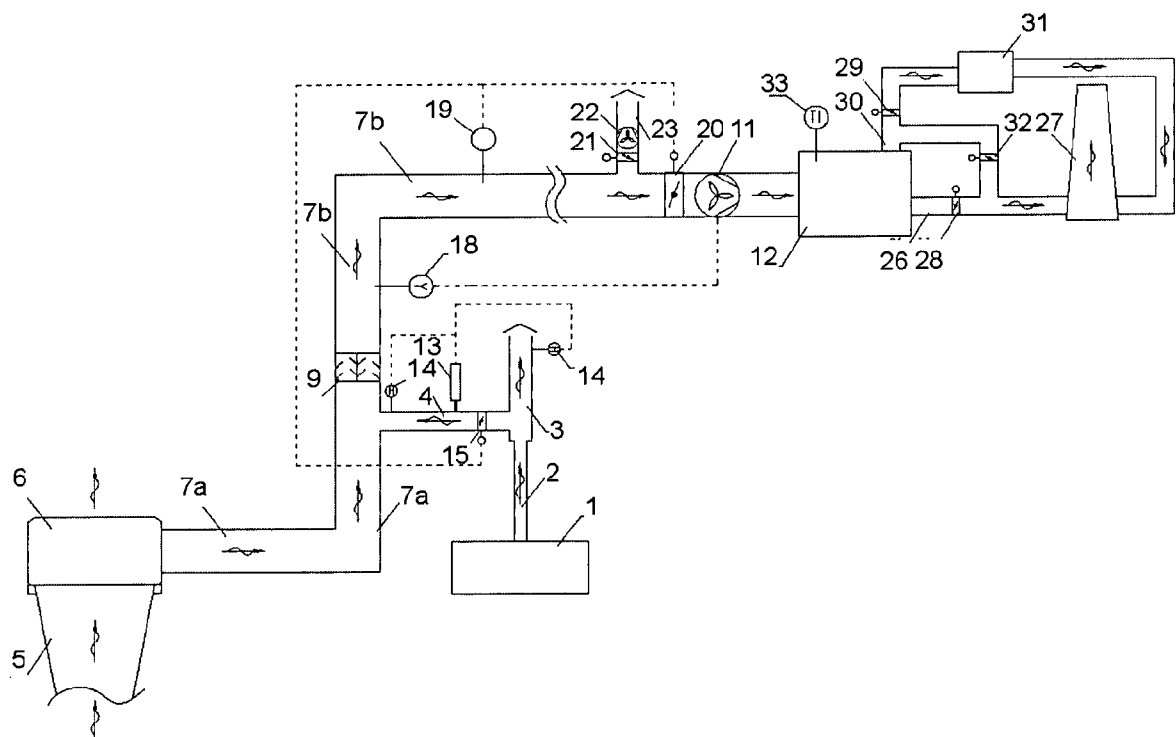


Fig.2

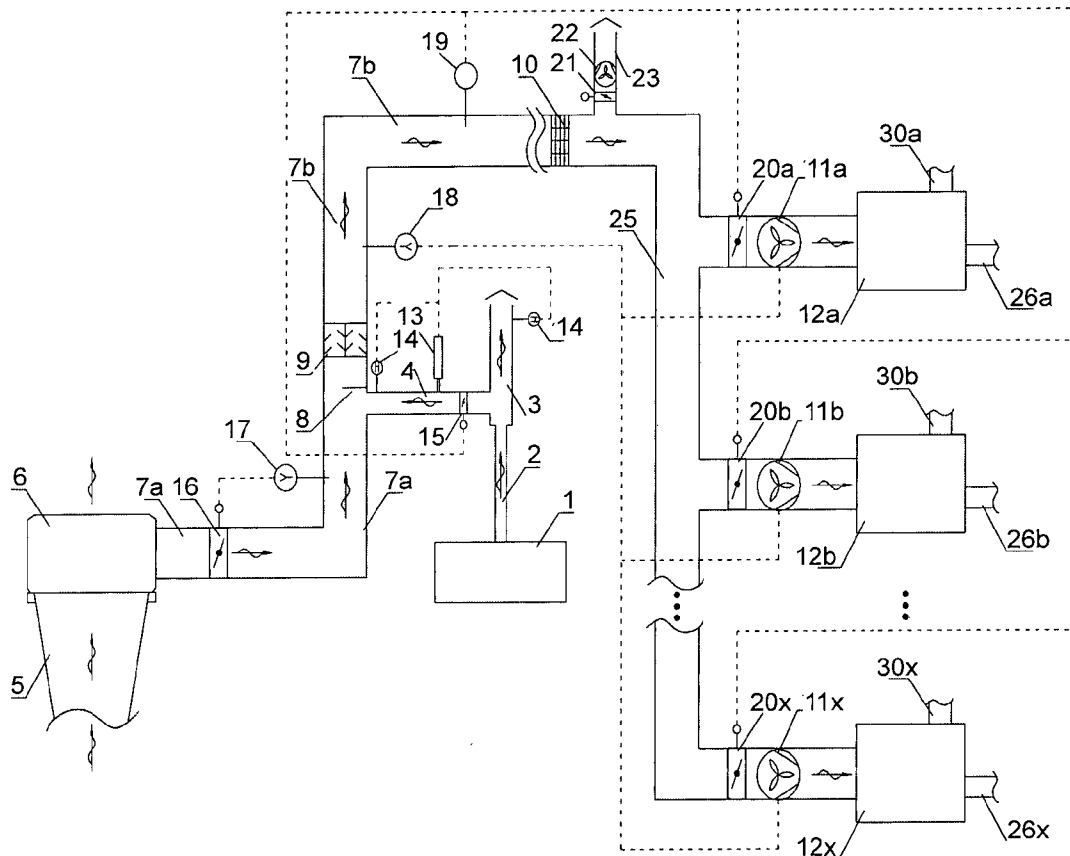


Fig.3

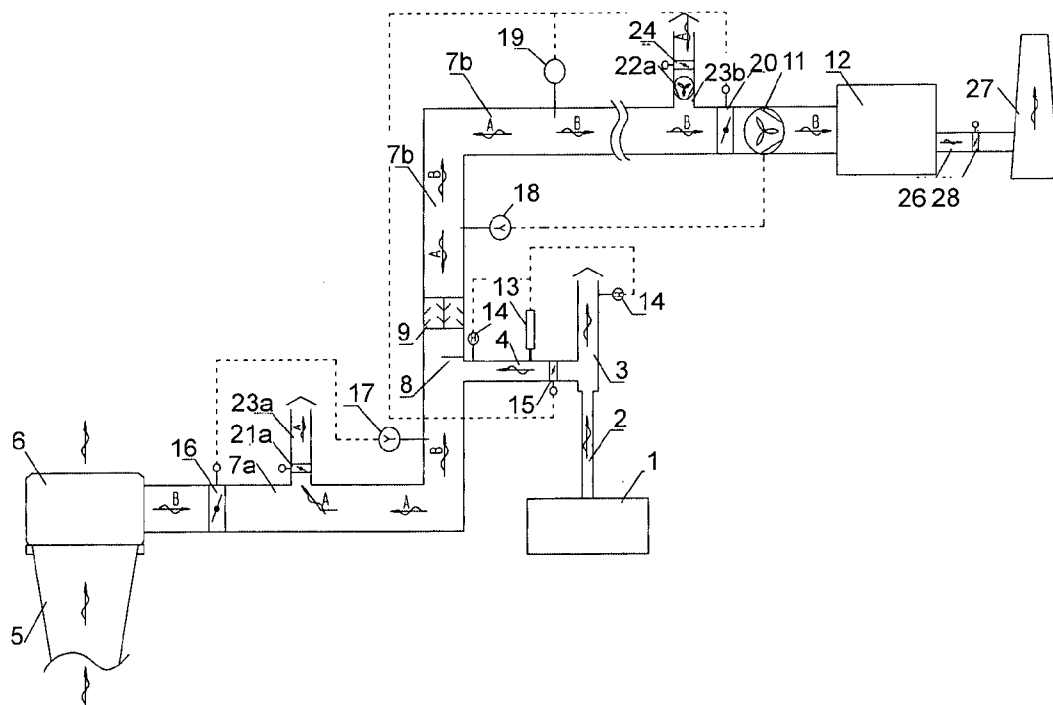


Fig.4

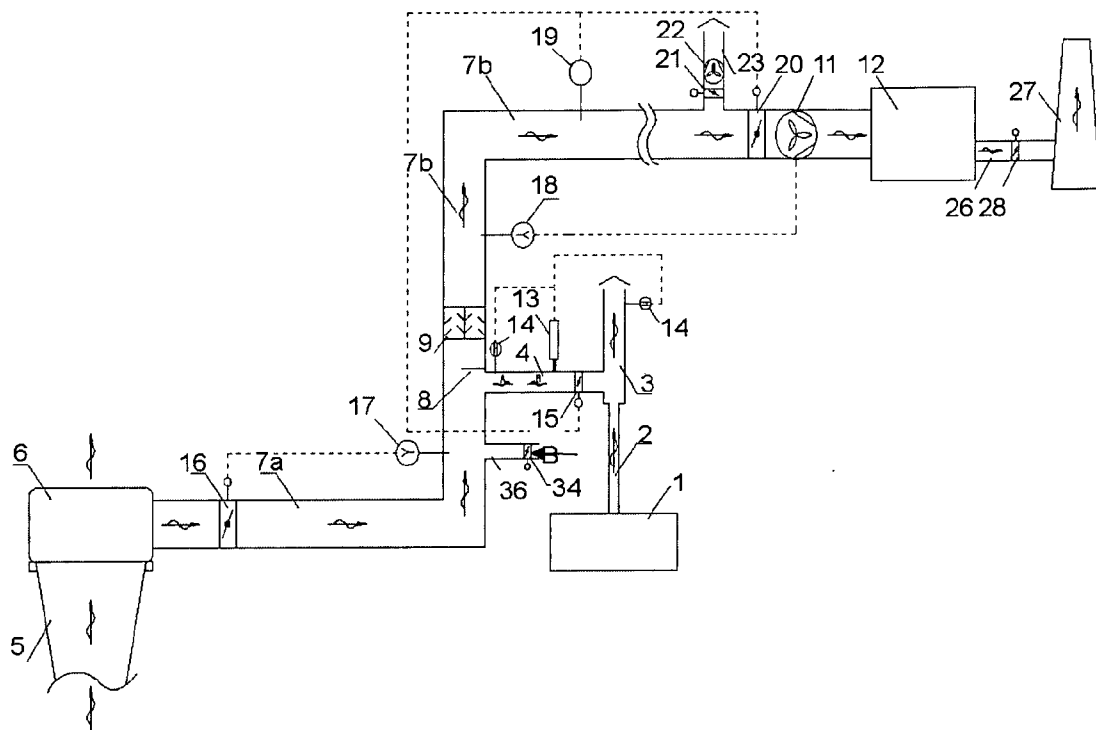


Fig.5

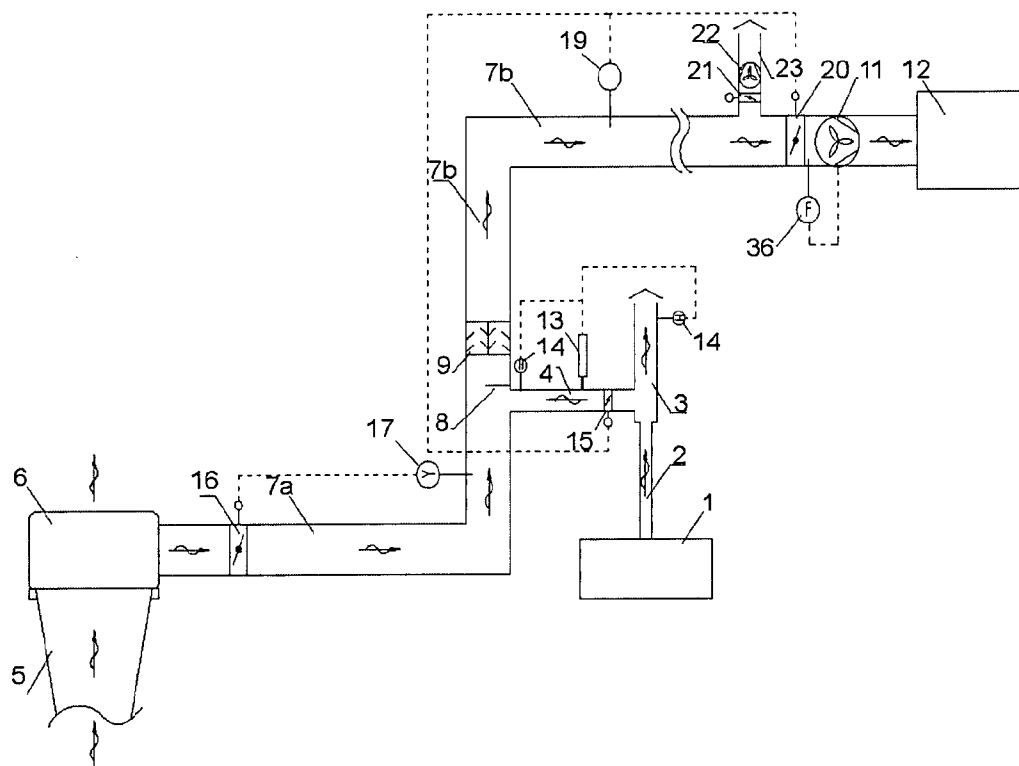


Fig.6

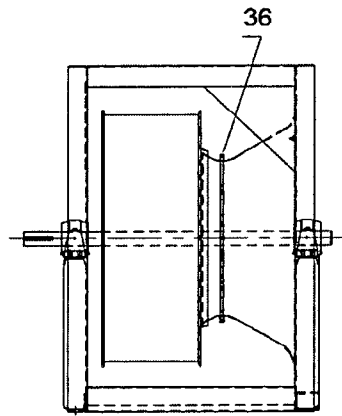


Fig.7

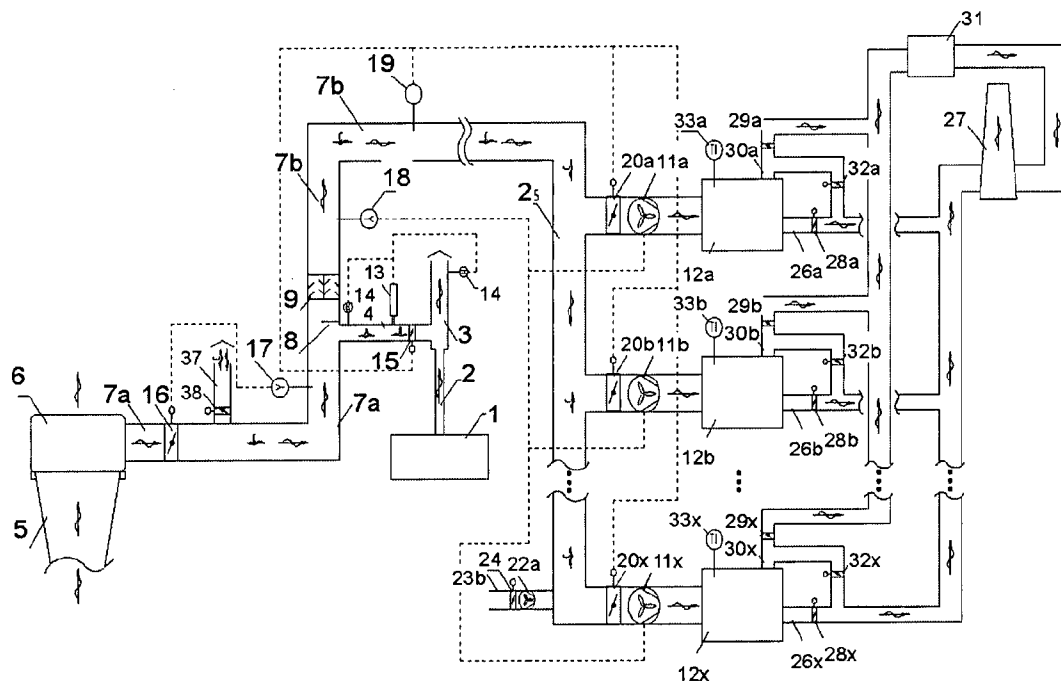


Fig.8

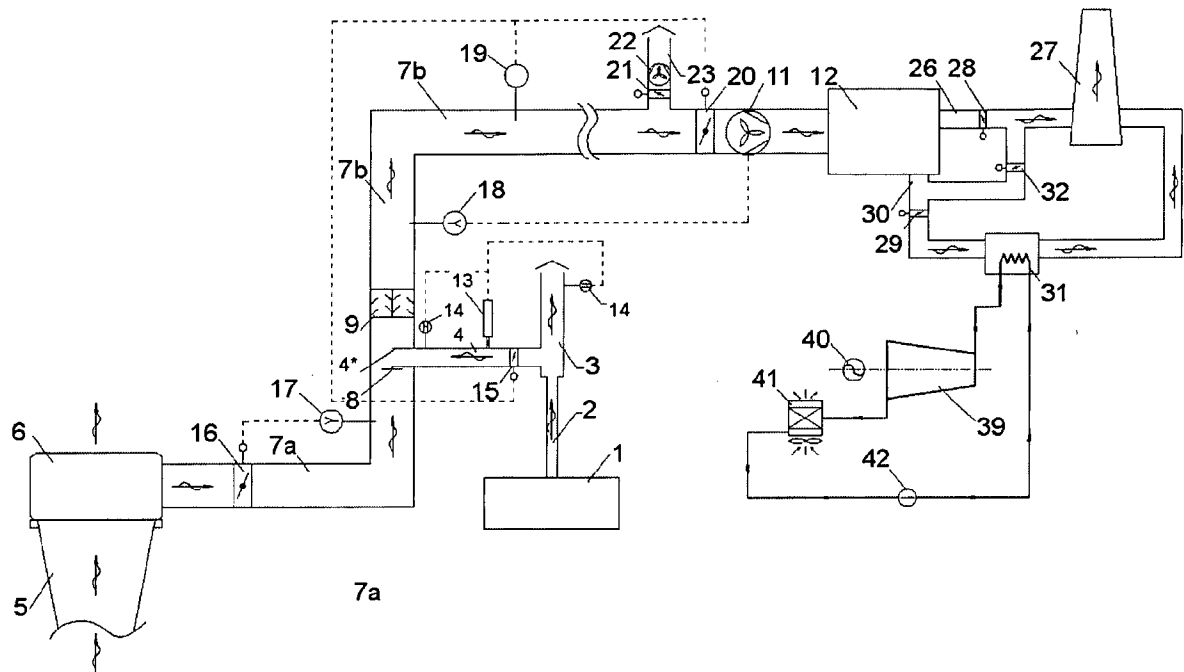


Fig.9

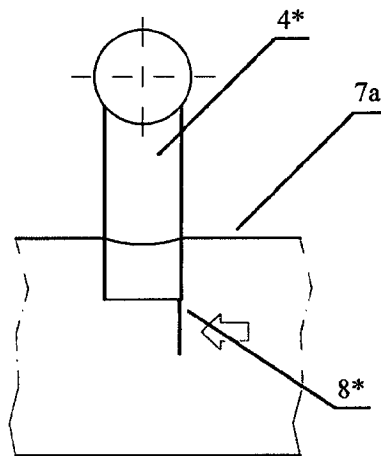


Fig.10

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/079827

A. CLASSIFICATION OF SUBJECT MATTER INV. E21F1/00 E21F7/00 B01F5/04 B01F3/02 F23G7/06 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 E21B B01F B01D F23G 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																				
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X</td> <td>CN 202 690 117 U (ZHEJIANG YIYANG ENERGY TECHNOLOGY CO LTD) 23 January 2013 (2013-01-23)</td> <td>1,2,4-6, 20</td> </tr> <tr> <td>Y</td> <td>the whole document</td> <td>3,7, 10-19</td> </tr> <tr> <td>Y</td> <td>----- CN 104 033 174 A (UNIV CHINA MINING) 10 September 2014 (2014-09-10) figure 1</td> <td>3</td> </tr> <tr> <td>Y</td> <td>----- JP 2015 073971 A (KAWASAKI HEAVY IND LTD) 20 April 2015 (2015-04-20) abstract</td> <td>7</td> </tr> <tr> <td>Y</td> <td>----- US 2013/101401 A1 (SHIMIZU YUICHI [JP] ET AL) 25 April 2013 (2013-04-25) paragraph [0046] ----- -/-</td> <td>10</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X	CN 202 690 117 U (ZHEJIANG YIYANG ENERGY TECHNOLOGY CO LTD) 23 January 2013 (2013-01-23)	1,2,4-6, 20	Y	the whole document	3,7, 10-19	Y	----- CN 104 033 174 A (UNIV CHINA MINING) 10 September 2014 (2014-09-10) figure 1	3	Y	----- JP 2015 073971 A (KAWASAKI HEAVY IND LTD) 20 April 2015 (2015-04-20) abstract	7	Y	----- US 2013/101401 A1 (SHIMIZU YUICHI [JP] ET AL) 25 April 2013 (2013-04-25) paragraph [0046] ----- -/-	10
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Garrido Garcia, M																		

INTERNATIONAL SEARCH REPORT

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