Dec. 6, 1966 K. RENNER 3,289,567

MINE VENTILATING APPARATUS AND METHOD

Filed April 22, 1964 5 Sheets-Sheet 1

FIG. 1

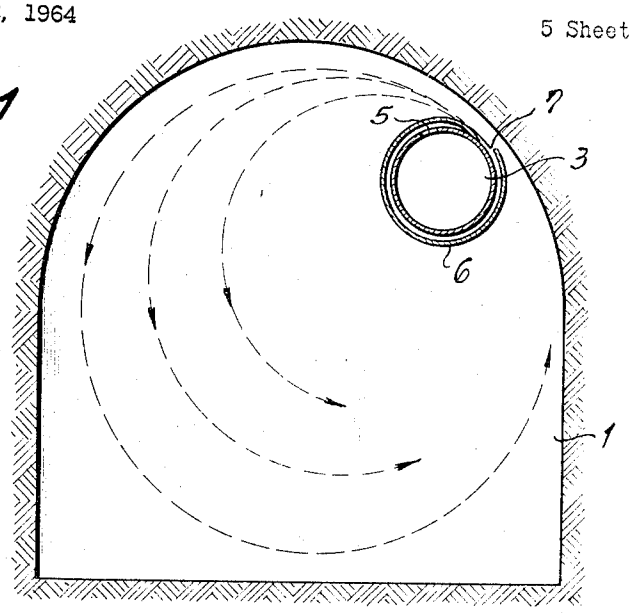
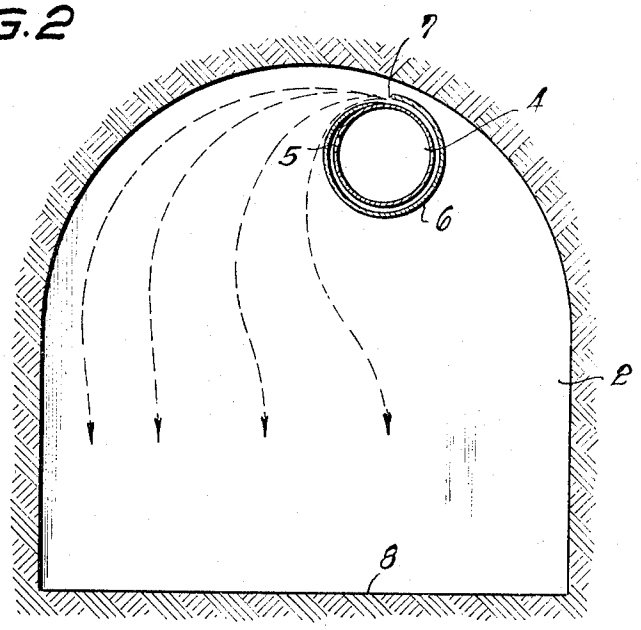


FIG. 2



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Dec. 6, 1966 K. RENNER 3,289,567

MINE VENTILATING APPARATUS AND METHOD

Filed April 22, 1964 5 Sheets-Sheet 2

FIG. 3

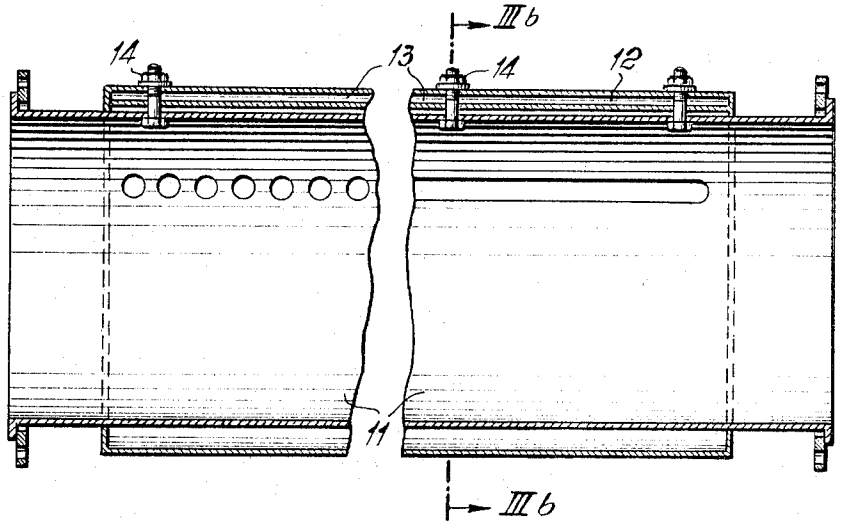
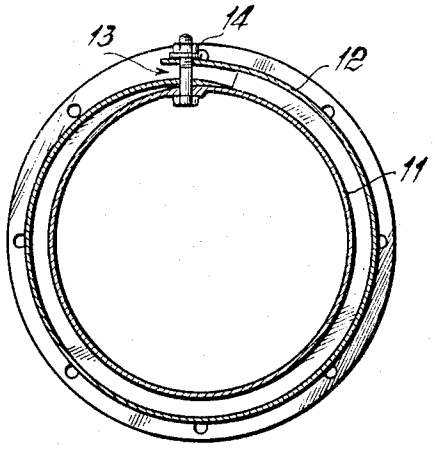


FIG. 3a

FIG. 3b



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Dec. 6, 1966 K. RENNER 3,289,567

MINE VENTILATING APPARATUS AND METHOD

Filed April 22, 1964 5 Sheets-Sheet 3

FIG. 4a

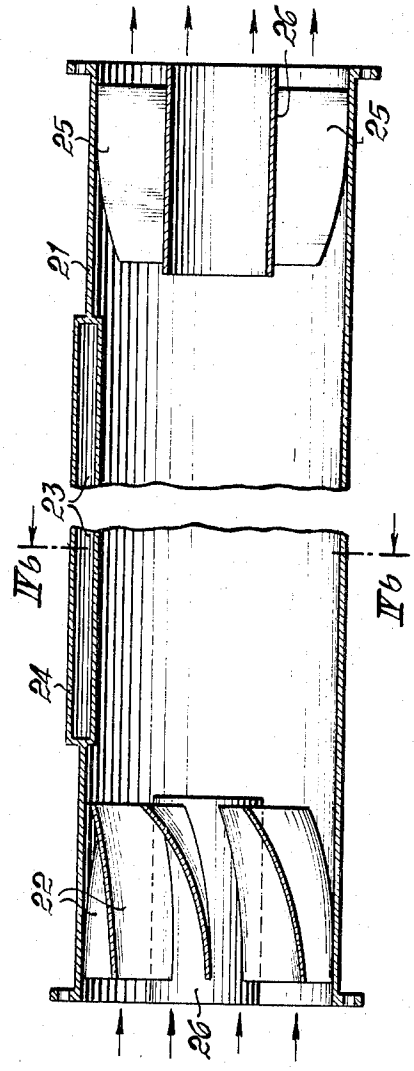


FIG. 5b

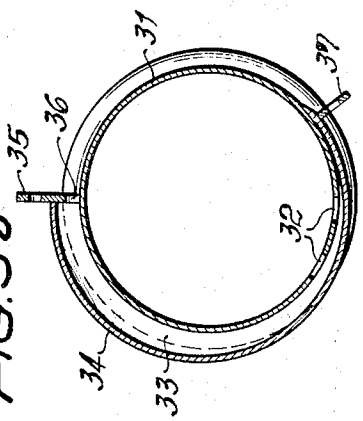
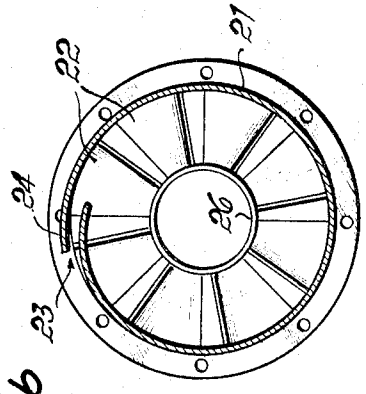


FIG. 4b



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MINE VENTILATING APPARATUS AND METHOD

Filed April 22, 1964 5 Sheets-Sheet 4

FIG. 5a

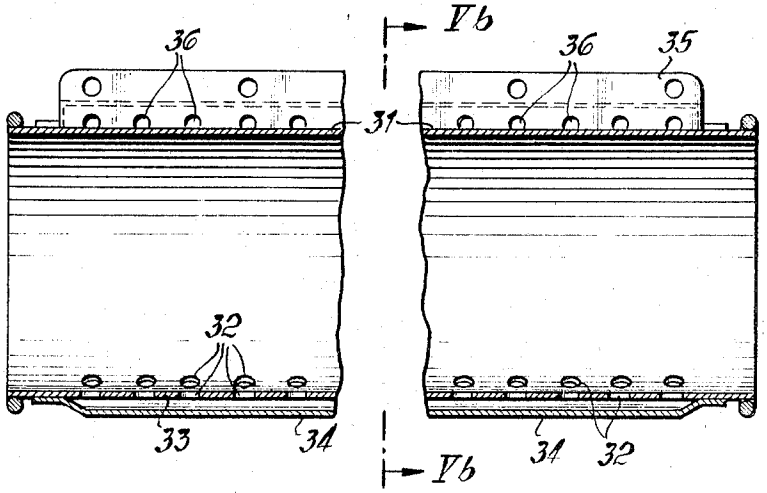
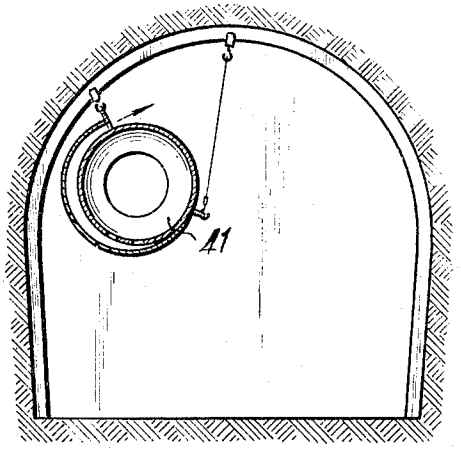


FIG. 6b



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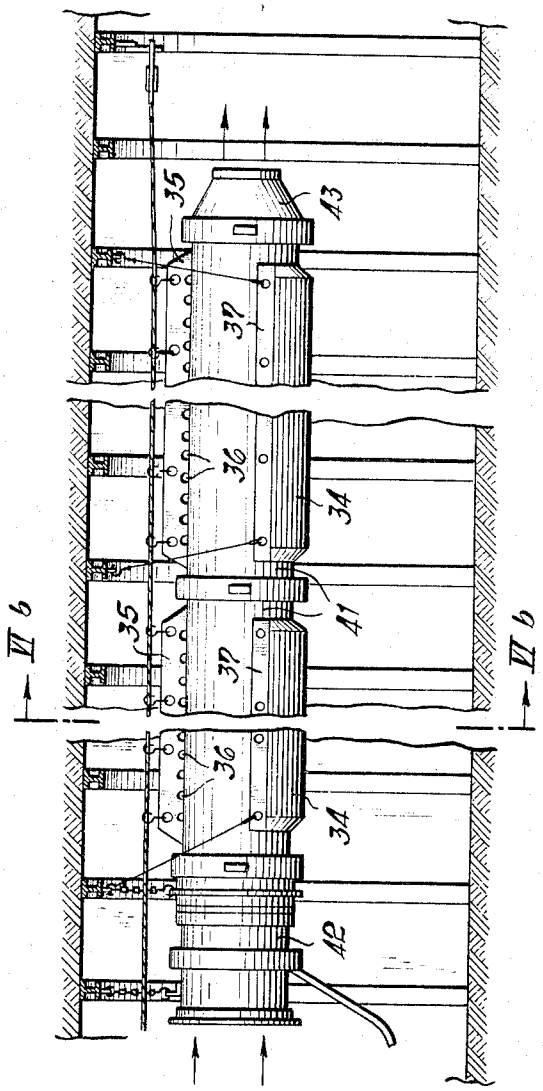
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Dec. 6, 1966 K. RENNER 3,289,567

MINE VENTILATING APPARATUS AND METHOD

Filed April 22, 1964 5 Sheets-Sheet 5

FIG. 6a



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1

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MINE VENTILATING APPARATUS AND METHOD

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Claims priority, application Germany, Apr. 24, 1963,
B 71,625
6 Claims. (Cl. 98—50)

The invention relates to a method of removing dangerous layers of gas from roadways and workings, particularly of layers of methane gas, given off by the rock in air ventilated workings and tending to collect under the roof because of its low specific gravity, or of layers of carbon dioxide gas for example given off by the rock and tending, because it is heavier than air, to accumulate on the floor of the working. For safety reasons such gas layers must be immixed into the ventilating air stream, diluted thereby and carried away as quickly as possible. This is usually done in such workings and roadways by special ventilating systems which blow air out of air ducts.

However, the effect of such special systems is localized and principally confined to the area immediately beyond the outlet opening at the end of the air duct.

It has already been proposed to prevent air flowing out of the open end of the air duct but rather to close the end of the duct and to blow the air out of nozzles distributed around the periphery of the duct. However, even this proposal is inadequate in its effect. A rapid mixture of noxious gas layers into the ventilating air, which for reasons of safety is necessary to ensure that the concentration of the gas-air mixture throughout the working does not reach its ignition point, or that it remains within the limits of safety, is not thus achieved. Although in places where air blows substantially radially out of the air duct high concentrations of gas under the roof are diluted, the diluted gas volume thus formed is necessarily at the same time undesirably expanded and spread along the length of the working in the direction of flow of the ventilating air through the tunnel. This creates the danger of a zone being formed which contains an explosive methane-air mixture, a hazard which is the greater the higher the original concentration of the gas at the point where it enters the working from the rock.

Another drawback of this known arrangement is that the air jets which impinge upon the roof create a localised zone of raised pressure. The pressure of this zone tends to displace the gas issuing at certain points from the rock to other areas of lower local pressure, that is to say into areas in which means for diluting the gas and mixing it into the ventilating air stream are absent.

Furthermore, in tunnels provided with conventional air pipes, as is usually the case in headings which are being advanced, auxiliary ventilation is necessary and the auxiliary fans may then draw in return air already containing an accumulation of gas and blow it under the roof where a dangerous gas mixture is then formed.

All these drawbacks of known systems are overcome by the present invention. Substantially this is achieved by introducing into the main stream of ventilating air which blows through the mine a supplementary component of rotary motion, as in a cyclone, whereby for example in the most important case of an accumulation of methane this lighter gas is directly swept away from its particularly dangerous points of entry under the roof

2

around and along the free cross section of the working or roadway and down to the floor where it is necessarily immixed into the main stream of air, whereas in the case of a heavier gas this is swept upwards from the floor and thus mixed with the main stream of ventilating air in a similar way.

According to the invention this cyclonic swirl about the centre axis of the roadway or working is generated by air blown tangentially out of an air pipe, said air issuing from the pipe at a velocity which is high in relation to the velocity of the main ventilating air current and therefore entraining the gas layers and immixing them into the main intake air. The tangential pattern of flow across the roof and over the sides of the roadway or working upwards or downwards, i.e. across the direction of flow of the main intake air, incidentally also has a suction effect on the gas separated from the open road by brattice cloth and the like and contained in blind ends behind the cloth, and thereby extracts said gas, likewise immixing it into the main current of ventilating air.

The length of the region along the air pipe in which a swirling air motion ought to be generated by the provision of blowing openings from which air issues tangentially is determined according to the previously determinable extent of the region in which layers of gas which must be dissipated are formed by gas entering the road from the rock.

In a preferred mode of carrying the invention into effect a rotary component of motion is imparted to the air in the air duct before it issues into the main stream of ventilating air in the tunnel.

The tangential outlet openings in the air duct may be directly provided in the periphery of the duct. However, according to a preferred feature of the invention the openings are formed by a jacket which partially or completely spirally encloses the air duct and which thus defines a tangential outlet slit, elongated or serially disposed round holes in the air duct proper discharging into said jacket.

In the above described preferred mode of performing the method in which a component of rotary motion is already imparted to the air in the air duct before it issues into the tunnel, swirl generating devices are provided in the regions of the duct which contain the tangentially orientated outlets, said swirl generating devices being located upstream of said outlets. In order to remove the rotary component of motion from the air in the duct in the region downstream of the outlets, further similarly acting swirl generating devices may be provided for removing the rotary component of motion and re-establishing linear flow in the air which continues to flow through the duct downstream of the outlets.

The outlet cross section of the openings in the air duct is preferably arranged to be adjustable to permit the intensity of rotary motion of flow to be controlled in accordance with existing local conditions.

According to another feature of the method proposed by the present invention the vortical motion which is introduced into the main ventilation air stream may also be generated by cross flow fans placed with their axes parallel to the axis of the tunnel and located at suitable points in the roadway cross section. However, this possibility is only available if the extent of the layers of gas which require removal is short enough in the axial direction of the roadway for cross current rotors of sufficient length to be provided for dealing with them.

Details and other features of the invention will now be further described, by way of example, with reference to the accompanying drawings. In the drawings—

FIG. 1 is a schematic representation of the cross section of a tunnel in which equipment according to the invention has been installed, the figure also illustrating the effect of this equipment,

FIG. 2 likewise schematically represents an alternative form of construction of the proposed equipment,

FIG. 3 is a side view of part of a first embodiment of an air duct according to the invention,

FIG. 3*a* is a side view of part of a second embodiment of an air duct according to the invention,

FIG. 3*b* is a section taken on the line III—III in FIG. 3*a*,

FIGS. 4*a* and 4*b* are views similar to FIGS. 3*a* and 3*b* of a second embodiment of an air duct according to the invention, FIG. 4*b* being a section taken on line IV—IV in FIG. 4*a*,

FIGS. 5*a* and 5*b* are views similar to FIGS. 3*a* and 3*b* of third embodiment of an air duct according to the invention, FIG. 5*b* being a section taken on the line V—V in FIG. 5*a*,

FIG. 6*a* is a side view of an air duct according to the invention installed in a section of tunnel, and

FIG. 6*b* is a section taken on the line VI—VI in FIG. 6*a*.

In FIGS. 1 and 2 a tunnel **1**, **2**, respectively, is shown in cross section. An air pipe **3**, **4**, respectively, is installed. In the embodiment according to FIG. 1 the duct is located near the side of the road and has a radial opening **5**. The duct is surrounded by a roughly spiral-shaped jacket **6** into which the openings **5** discharge. The spiral jacket defines an outlet slit **7**. The pattern of flow in the resultant cylindrical vortex about the main tunnel axis is indicated by flow lines in the figure.

In the embodiment according to FIG. 2 the air duct **4** is located close to the top of the roof. Otherwise it is constructed analogously to the duct **3** in FIG. 1. In this position of the air duct **4** the air issuing from the tangential slit-shaped opening **7** formed by the jacket will flow more or less closely around the periphery of the duct according to the particular position of the outlet slit **7**. By suitably locating the outlet slit **7** in relation to the tunnel cross section it is possible to ensure that the issuing air jet will by suction entrain the layer of gas which generally accumulates at the highest point under the roof and blow it directly to the floor **8**. A highly turbulent flow pattern near the floor **8** forms cross vortices which quickly mix the gas into the main ventilation air.

FIGS. 3*a* and 3*b* illustrate the construction of an air duct in greater detail. In these figures the slotted or perforated wall **11** of the air duct is embraced spirally by a jacket **12** forming an outlet slit of a width which can be controlled by an adjusting means **14**.

In the embodiment according to FIGS. 4*a* and 4*b* swirling motion is generated in the air inside the duct **21** by arrays of stationary guide vanes **22**. The air duct itself is formed with a slit **23** which opens tangentially with respect to the periphery of the bank of guide vanes **22**, the slit being formed by overlap of the duct edges **24** along an open longitudinal seam. Moreover, at the end of the air duct it is preferred to provide a system of guide vanes **25** which reestablish an axially parallel pattern of flow of the remaining air which continues to flow through the air duct. The core of the air swirl may remain axially parallel. This is allowed for by the provision of an inner central section of duct **26** which also serves for holding the guide vanes **22** and **25**.

FIGS. 5*a* and 5*b* illustrate another embodiment of an air duct. This may be of rigid sheet metal construction or preferably it may consist of armoured or preferably unarmoured plastics foil or even of cloth. In the illustrated example a jacket forming part of a spiral is provided for generating the rotary air flow. The air issuing

from one or several rows of holes **32** along a longitudinal seam of the peripheral surface **31** of the air duct enters the spiral chamber **33** formed by a flexible jacket **34** welded or fused to the circumference **31** of the duct. The edge forming the blowing slit of this jacket **34** is welded to a wide flange **35** which incidentally serves for suspending the air duct, and which adjacent the pipe circumference **31** is provided with substantially tangential outlet openings **36**. A second flange **37** on the peripheral surface **31** of the ventilation duct likewise serves for attachment of a suspension means and permits the blowing openings to be turned into a required orientation in relation to the cross section of the tunnel to produce air jets directed as desired.

FIGS. 6*a* and 6*b* illustrate the manner in which such an air duct **41** is permanently suspended in a tunnel or movably suspended at the working face. The airstream propelled by an auxiliary fan **42** is used partly for the generation of a vortex in the tunnel and partly for the generation of a sweeping air blast. The provision of a nozzle-shaped headpiece **43** at the blowing end of the duct permits the proportion of air used for each purpose to be controlled.

It will be readily understood that the principle which underlies the invention can be quite generally used with advantage for initiating intense and rapid mixing effects.

It is also within the scope of the present invention, if desirable, to provide groups of openings distributed around the periphery of the jacket for the generation of a plurality of swirling vortices which do not interfere with each other in their respective effects.

I claim:

1. A method of carrying away dangerous layers of gas collecting adjacent the inner wall surfaces of a tunnel or mine working, which is ventilated by an air stream flowing through the tunnel, which comprises blowing air into said layers of gas from the periphery of an air duct, characterized in that the air issues from the air duct in the vicinity of the outer surface of a convexly curved surface on the duct, said surface being near and essentially parallel to the wall of the tunnel, the direction of issuance of the air being tangential to the outer curved surface so that a portion of the issuing air flow is curved away from the wall surfaces of the tunnel thereby introducing into the main air stream of ventilating air a swirling, rotary component of motion transversely of the length of the tunnel which superimposes itself upon the linear motion of the main stream of ventilating air flowing through the tunnel.

2. The method defined in claim **1** which includes a further step of imparting a component of rotary motion to the air flowing through the air duct before it issues therefrom.

3. The method defined in claim **2** wherein the rotary motion to the air flow through the air duct is generated by passing the air from the air duct into a chamber formed circumferentially of the air duct.

4. In combination with the system for carrying away and eliminating layers of dangerous gases in a tunnel or mine working through which a ventilating air stream is caused to pass, an air duct extending along a path generally parallel to the axis of the tunnel and disposed near the wall of the tunnel for conducting ventilating air under pressure; at least one radial opening formed in the wall of said air duct; and jacket means surrounding said duct in the region of the opening, said jacket means being of spiral cross-sectional configuration and having an inlet communicating with the opening of said air duct and an outlet for discharging air tangentially of said air duct and generally normal to the axis of the associated tunnel. said outlet being controllably variable.

5. The combination defined in claim **4** further including swirl generating means in said air duct which imparts a rotary component of motion to the air flowing through

the duct, the outlet of said jacket means being located downstream of said swirl means.

6. The combination defined in claim 5 in which said swirl generating means in said duct consists of an internal tube carrying guide vanes.

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