Nov. 27, 1934. W. R. FRANKS 1,982,470

METHOD OF CLEANING AIR IN ENCLOSED SPACES

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Fig. 1.

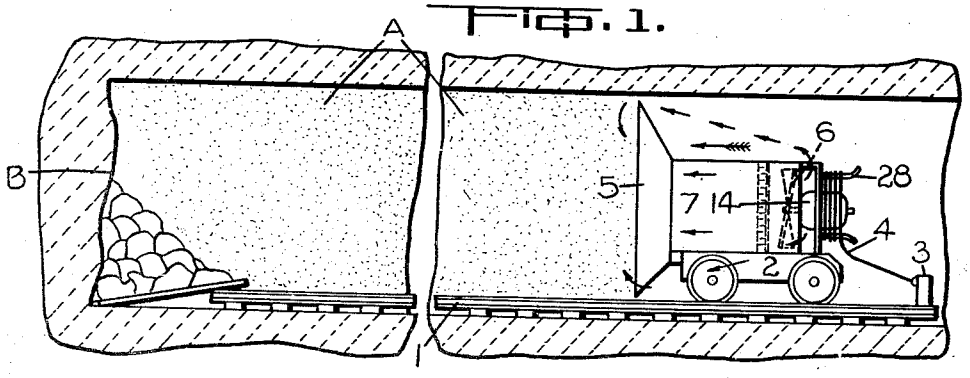

Fig. 2.

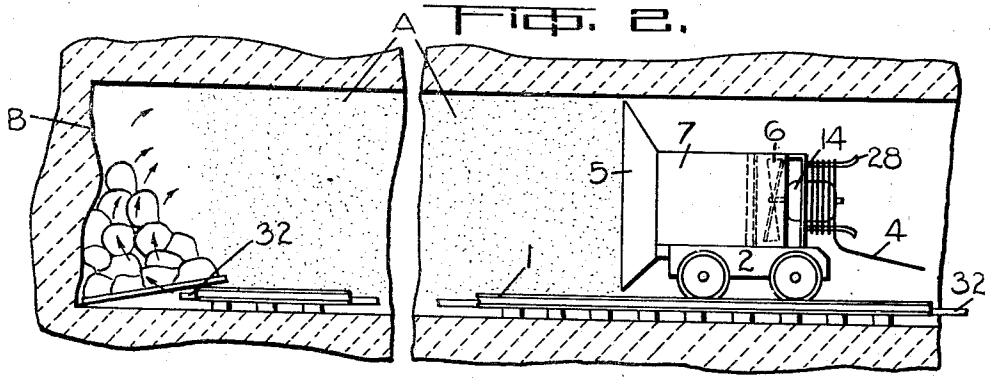

Fig. 3.

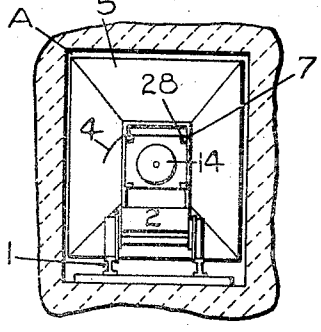

Fig. 6.

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Fig. 5.

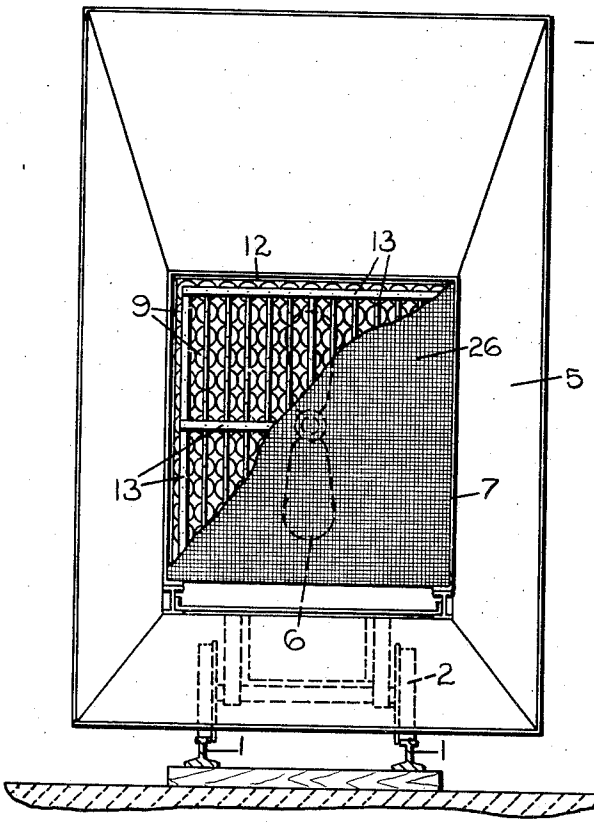
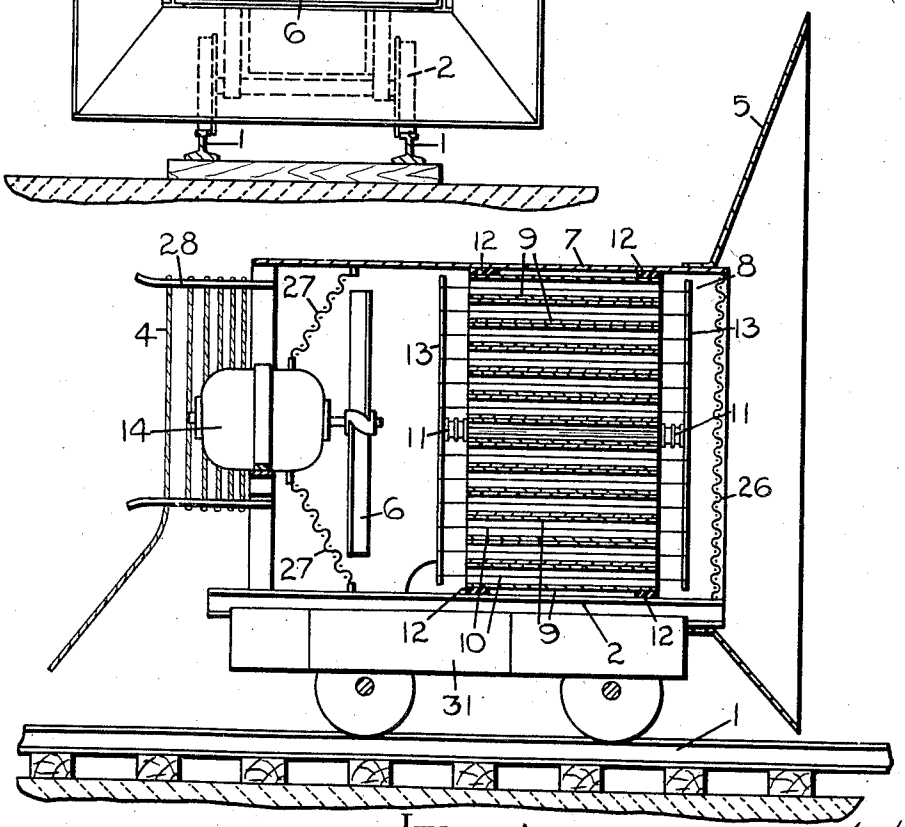


Fig. 4.



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UNITED STATES PATENT OFFICE

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METHOD OF CLEANING AIR IN ENCLOSED SPACES

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Application August 4, 1933, Serial No. 683,603
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16 Claims. (Cl. 183—114)

My invention relates to improvements in methods of cleaning air in enclosed spaces and more particularly to the removal of dust from dust laden air by the employment of a precipitator, preferably of the electric field type, and the object of the invention is to provide a closure for substantially sealing the mouth or opening of such enclosed space whereby the dust laden air in such now completely enclosed space is drawn by suitable means exteriorly thereof into a precipitator or precipitators preferably located behind the closure in proximity thereto or connected therewith, the dust free air from the precipitator being then discharged into the continuation of the space behind the closure and exteriorly of the dust laden zone being treated.

A further object is to provide means whereby the dust laden air from the enclosed space is drawn through an orifice in the closure into a precipitator connected with such orifice.

A still further object is to devise a method in which the closure at least and preferably with its connected precipitator is moved or propelled progressively as a unit into the zone of the dust laden air in the enclosed space until the entire space has been treated.

Alternatively, the closure and the precipitator may be positioned at the rear of the dust laden zone in the enclosed space and by the injection of compressed air at the front of the zone, such dust laden air is forced towards the closure into the precipitator. In either case a progressive cleaning action of the dust laden air in the enclosed space ensues.

An important application of my invention is in mines, particularly those in which rock is blasted or drilled such as in gold or silver mines. In such mines where drifts are driven by drilling and blasting operations, the air therein becomes laden with dust which has a most injurious effect upon miners or others working in such enclosed spaces and which hitherto it has been impossible to overcome effectively by any known means. In mines, for example, where the blasting and drilling operations are carried out on rock containing silicon, the air in the drifts is laden with minute silicate particles which cause those subjected thereto to contract a disease which is commonly known in the medical profession as silicosis.

At present the accepted method of dealing with dust laden air in mines is to inject compressed air into the drift in proximity to the point where the blasting or drilling operation has occurred, but such injection merely causes a dilution of the dust concentration of the dust laden air and does not totally remove the dust content. Consequently it does not afford a remedy to the above condition.

Masks have been tried to overcome the same but, owing to the dust particles being exceedingly minute, they do not prevent the inhalation of at least a large proportion of the dust particles as there is a limit to the effectiveness of the mask on account of the difficulties of respiration and to the fact that the dust collected becomes saturated with moisture and interferes with the filter.

In order to provide a complete remedy to the conditions referred to above the air must be substantially dust free, and this can only be obtained by removing the dust from the air entirely.

I will now describe the preferred apparatus which I employ in carrying out my method. This consists in general of a closure of substantially the cross-sectional dimensions of the drift or space to be treated, and of cowl form having an orifice therethrough which is connected to the casing of an electric field precipitator, which preferably consists of a plurality of horizontally arranged open ended tubes each comprising one electrode of the component precipitator, the electron discharge or remaining electrode of each component precipitator consists of a wire extending centrally through its tube, such wires being of course insulated from the tubes and all connected to a source of electrical supply as will hereinafter appear. At the rear or air discharge end of the multiple precipitator thus formed, a motor driven suction fan is provided for drawing in the dust laden air through the closure and precipitator and whereby the dust free air is discharged from the latter into the drift behind the closure. The closure, precipitator and fan with other parts or apparatus incidental to their functioning are preferably mounted on a carriage or truck which may run on a track disposed on the floor of the drift.

With particular reference to the attached drawings:—

Fig. 1 represents a vertical longitudinal section through a mine drift (broken away intermediately) showing my apparatus therein, said apparatus being capable of longitudinal movement therein.

Fig. 2 is a similar section to Fig. 1 showing the modified method wherein the apparatus, although preferably movable or portable, is adapted to be placed at the rear end of the dust laden zone and is not intended to move during the

treatment of the air, the dust laden air being forced rearwardly in the drift by injection at the front thereof of independent compressed air or the dust free air from the apparatus air exhaust, for instance, in proximity to the location of the blasting or drilling area.

Fig. 3 is a vertical cross-section through the drift showing my apparatus therein.

Fig. 4 is an enlarged vertical longitudinal section through my preferred form of apparatus.

Fig. 5 is an end elevation thereof viewed from the closure end and partly in section to show the precipitator tubes, and

Fig. 6 is a circuit diagram showing the hook up and apparatus employed therein between the supply circuit and the precipitator electron discharge electrode.

Like characters of reference indicate corresponding parts in the different views.

A is the drift or enclosed space, and B is the location of the blasting or drilling operation. The blasting or drilling operation creates a large quantity of dust, the particles of which are suspended in the air in the drift A and which air it is desired to clean. According to the method illustrated in Fig. 1, I initially locate the apparatus on a track 1 at the rear end of the drift sufficiently far away from the blasting as to be safe. This apparatus as above described is preferably mounted on the truck 2 and after the blasting or drilling operation is completed, the truck 2 is pushed or otherwise propelled forwardly into the zone of the dust laden air created by the blast or drilling. The apparatus is connected to a source of electrical supply 3, for instance a 110 v. A. C. supply circuit, connected by a flexible cable 4 and adapted to be paid out as the truck is moved forwardly. The closure 5 which may be, for instance, in the form of a cowl, is located at the forward end of the truck and need not constitute a perfect mechanical seal with the walls, roof and floor of the drift. It will suffice if the closure is of such size as to be substantially the cross-sectional area of the drift leaving a sufficient clearance between its marginal edges and the drift to enable it to be moved without coming into contact therewith. It is, however, a perfect seal or closure for the air in the enclosed space owing to the fact that any air escaping around the closure will be drawn by the suction fan 6 forwardly around the edges of the cowl closure thereinto as indicated by the arrows (Fig. 1).

The precipitator enclosed in a casing 7, preferably directly connected to the orifice 8 in the closure 5, is mounted between the closure and the fan and as above described comprises a plurality of open ended electrode tubes 9 arranged substantially horizontal and the spaces therebetween closed, each electron discharge electrode (i. e. the negative electrode) comprises the wire 10 extending centrally through each tube 9 and insulated therefrom by means of the insulators 11, the tube assembly being supported by interposed conducting members 12 to ground the tubes. The electrodes 10 are connected together by suitable conductors 13.

The fan 6 is driven by an electric motor 14 and is connected into the electric circuit as indicated in Fig. 6 in which the supply circuit 3, one side of which is grounded, is connected to a polarized plug socket 15 to which the plug 16 is adapted to be connected to the double cable 4 which is in turn connected through a "no fuse" cut out (i. e. one of the bi-metallic type) 161 to the electric motor 14 and to the low tension winding 17 of a transformer.

In order to take care of voltage drops in the supply circuit a tap changer 18 is interposed into the circuit and taps 19 extend therefrom to the low tension transformer winding.

A lead 20 extends from one end of the high tension transformer winding 21 to the electron discharge electrodes 10 (only one is shown in Fig. 6) through a condenser of preferably electrostatic type 121 and such electrodes are directly connected to the plate 22 of a thermionic valve 23. The filament 24 of such thermionic valve is connected to a comparatively few turns of the high tension winding 21 of the transformer in order to get a suitably high current for the filament.

The windings of the transformer 17 are suitably grounded and a ground lead 25 extends from the precipitator tubes 9 to the ground or as illustrated to the lead 20.

A screen 26 may be provided for the closure orifice 8 and the fan 6 may have a covering screen 27. The cable 4 may be mounted on the truck on a drum or rack 28.

Referring to the hook-up illustrated in Fig. 6, the supply circuit, as above stated, is in all probability 110 v. A. C. and is rectified into a unidirectional current by means of the rectifier which as illustrated is preferably a thermionic valve. While the stepping up of the voltage by the transformer is dependent upon the requirements necessary to operate the electron discharge electrodes at the maximum efficiency to produce the desired corona it is found by experiment that this stepping up will be probably within a range of 18 to 24 kilovolts. While the rectifier will give a unidirectional current, such current is pulsating and the electrostatic condenser is employed to iron out these pulsations and produce a non-pulsating unidirectional current for the electrodes 10.

Safety switches 29 and 30 are introduced in the circuit and are respectively connected for instance to a door of the main casing and the rectifier casing for throwing the apparatus out of circuit and dissipating the residual charge in the condenser 121 by grounding through the lead 33 connected between the switches 29 and 30 and the lead 20, when opened. The transformer, rectifier and condenser are preferably located in a compartment 31 below the precipitator.

In carrying out my method the dust laden air from the drift is drawn into the cowl closure through the orifice therein and through the tubes 9 of the precipitator by means of the suction fan 6 and is delivered from the latter dust free into the portion of the drift behind the closure. The apparatus is advanced on the track as the air is treated until the entire zone of dust laden air in the drift has been cleaned as illustrated in Fig. 1. It is found that by the use of adequate apparatus of the desired air treating capacity the truck can be advanced at the rate of 100 feet per minute or even faster. Where the entire dust laden zone cannot be cleaned entirely compressed air, as in the alternative method, can be injected at the front of the drift.

In the alternative method as illustrated in Fig. 2 compressed air from a delivery pipe 32 extending to the front of the drift in proximity to the area blasted or drilled is injected into the front portion of the drift. This compressed air forces back the dust laden air which is sucked into the apparatus and cleaned. This operation

is continued until all the dust laden air has been treated.

If desired, in carrying out the method, instead of discharging the dust free air from my apparatus behind the seal or closure, a pipe or other means connected to the air discharge end of the apparatus may be employed to conduct such air forwardly to the vicinity of the front end of the drift wherein it will replace the compressed air from the pipe 32 illustrated in Fig. 2. It will be apparent that such reintroduction of the dust free air to the front of the zone of the dust laden air will be applicable to either method shown and described. In fact the pipe 32 instead of being connected to an independent air pump may be directly connected to the air discharge end of the casing of my apparatus and obviously such pipe may be flexible where required.

The theory and practice of electric field precipitators is generally well known and needs no elaborate explanation.

The dust laden air passes through the tubes of the precipitator and the negatively charged electrodes 10 emanate electrons from their corona which negatively charge the minute particles of dust suspended in the air and these negatively charged particles are attracted to the positively charged tubes 9 being precipitated onto the interior surface thereof. Thus the air from the discharge ends of such tubes is free of dust. The tubes may from time to time, as occasion demands, be taken out and the deposit of dust particles thereon removed, or the electrodes 11 may be removed and the tubes cleaned in much the same manner as the tubes of a steam boiler.

If required, instead of expelling the dust free air from the precipitator directly into the drift the air outlet thereof may be connected to a purifier for purifying such air from any toxic poisonous substances present therein when it may then be delivered to the drift.

The form, construction and hook-up of the apparatus employed as described above is to be taken only in an illustrative sense in connection with my method and may be varied at will to take care of different prevailing conditions.

While I have described my method throughout as applicable to mine drifts it will be quite apparent that it could, with equal facility, be employed in mine stopes and elsewhere where the removal of dust from dust laden air is required.

What I claim as my invention is:

1. In a method of cleaning air in a mine drift or stope, the steps which consist in providing a seal or closure at the rear end of the dust laden air zone in such drift to completely seal such zone, withdrawing the dust laden air from such zone exteriorly thereof, treating the air withdrawn to remove the dust therefrom, and subsequently introducing the dust free air into the drift behind the seal or closure.

2. In a method of cleaning air in a mine drift or stope, the steps which consist in providing an orificed seal or closure at the rear end of the dust laden zone in such drift to completely seal such zone, withdrawing the air from such zone through the orifice in the seal or closure, treating the air by means connected to the closure orifice to remove the dust therefrom, and subsequently introducing the dust free air into the drift behind the seal or closure.

3. In a method of cleaning air in a mine drift or stope, the steps which consist in providing a seal or closure at the rear end of the dust laden air zone in such drift to completely seal such zone, progressively withdrawing the dust laden air from such zone exteriorly thereof, treating the air withdrawn to remove the dust therefrom, and subsequently introducing the dust free air into the drift behind the seal or closure.

4. In a method of cleaning air in a mine drift or stope, the steps which consist in providing an orificed seal or closure at the rear end of the dust laden zone in such drift to completely seal such zone, progressively withdrawing the air from such zone through the orifice in the seal or closure, treating the air by means connected to the closure orifice to remove the dust therefrom, and subsequently introducing the dust free air into the drift behind the seal or closure.

5. In a method of cleaning air in a mine drift or stope, the steps which consist in providing a seal or closure at the rear end of the dust laden air zone in such drift to completely seal such zone, withdrawing the dust laden air from such zone exteriorly thereof, electrically precipitating the dust in the withdrawn air, and subsequently introducing such dust free air into the drift behind the seal or closure.

6. In a method of cleaning air in a mine drift or stope, the steps which consist in providing an orificed seal or closure at the rear end of the dust laden zone in such drift to completely seal such zone, withdrawing the air from such zone through the orifice in the seal or closure, electrically precipitating the dust in the air withdrawn through the orifice in the seal or closure, and subsequently introducing such dust free air into the drift behind the seal or closure.

7. In a method of cleaning air in a mine drift or stope, the steps which consist in providing a seal or closure at the rear end of the dust laden air zone in such drift to completely seal such zone, progressively withdrawing the dust laden air from such zone exteriorly thereof, electrically precipitating the dust in the withdrawn air, and subsequently introducing such dust free air into the drift behind the seal or closure.

8. In a method of cleaning air in a mine drift or stope, the steps which consist in providing an orificed seal or closure at the rear end of the dust laden zone in such drift to completely seal such zone, progressively withdrawing the air from such zone through the orifice in the seal or closure, electrically precipitating the dust in the air withdrawn through the orifice in the seal or closure, and subsequently introducing such dust free air into the drift behind the seal or closure.

9. In a method of cleaning air in a mine drift or stope, the steps which consist in providing a longitudinally movable seal or closure at the rear end of the dust laden air zone in such drift, progressively advancing the seal or closure throughout the length of the dust laden air zone, sucking the dust laden air exteriorly of the dust laden zone, treating such withdrawn air to remove the dust therefrom, and subsequently discharging such dust free air into the drift behind the seal or closure.

10. In a method of cleaning air in a mine drift or stope, the steps which consist in providing a longitudinal movable seal or closure at the rear end of the dust laden air zone in such drift, progressively advancing the seal or closure throughout the length of the dust laden air zone, sucking the dust laden air exteriorly of the dust laden zone, electrically precipitating the dust in the withdrawn air, and subsequently discharging such dust free air into the drift behind the seal or closure.

11. In a method of cleaning air in a mine drift or stope as claimed in claim 10 wherein the sucking and precipitating steps are performed as the seal or closure is advanced into the dust laden zone.

12. In a method of cleaning air in a mine drift or stope, the steps which consist in providing a seal or closure at the rear end of the dust laden air zone in such drift to completely seal such zone, withdrawing the dust laden air from such zone exteriorly thereof, treating the air withdrawn to remove the dust therefrom, and subsequently reintroducing the dust free air into the drift in the vicinity of the front end of the dust laden zone.

13. In a method of cleaning air in a mine drift or stope, the steps which consist in providing a seal or closure at the rear end of the dust laden air zone in such drift to completely seal such zone, progressively withdrawing the dust laden air from such zone exteriorly thereof, treating the air withdrawn to remove the dust therefrom, and subsequently reintroducing the dust free air into the drift in the vicinity of the front end of the dust laden zone.

14. In a method of cleaning air in a mine drift or stope, the steps which consist in providing a seal or closure at the rear end of the dust laden air zone in such drift to completely seal such zone, withdrawing the dust laden air from such zone exteriorly thereof, electrically precipitating the dust in the withdrawn air, and subsequently reintroducing such dust free air into the drift in the vicinity of the front end of the dust laden zone.

15. In a method of cleaning air in a mine drift or stope, the steps which consist in providing a longitudinally movable seal or closure at the rear end of the dust laden air zone in such drift progressively advancing the seal or closure throughout the length of the dust laden air zone, sucking the dust laden air exteriorly of the dust laden zone, treating such withdrawn air to remove the dust therefrom, and subsequently reintroducing the dust free air into the drift in the vicinity of the front end of the dust laden zone.

16. In the method of cleaning air in a mine drift or stope, the steps which consist in providing a longitudinal movable seal or closure at the rear end of the dust laden air zone in such drift, progressively advancing the seal or closure throughout the length of the dust laden zone, sucking the dust laden air exteriorly of the dust laden zone, electrically precipitating the dust in such withdrawn air, and subsequently reintroducing such dust free air into the drift in the vicinity of the front end of the dust laden zone.

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