ON RECENT FIRE DAMP EXPLOSIONS.

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During the past twelve months a number of mining disasters, attended by frightful loss of life, have occurred in coal mines of this country. Three of these disasters have, for American mines, been of a most appalling nature. The first occurred in the new state of Colorado on the 24th day of January in the Crested Butte mine, and 58 souls were lost by it; the second occurred on the 20th

day of February, at the Leisenburg shaft in Pa., killing 19 miners; the third, and one of the most dreadful that ever happened in any country, occurred at the Pocahontas mine in Va., by which the whole underground force was killed, their bodies not being recovered for two weeks after the accident. In the case of the Crested Butte mine there was an abundant ventilation pervading the entire mine, but a dangerous volume of fire-damp accumulated during the night previous to the accident, owing to a defect in the brattice cloth, used for carrying forward fresh air to a part of the workings which daily evolved inflammable air. In the Leisenburg mine there seems to have been negligence on the part of the mine Inspector in enforcing the law in regard to the rules governing fire-damp; in the Pocahontas mine inflammable air was not, it is said, suspected by the manager to be given off at all in any part of the workings, until the explosion occurred and killed every soul underground, startling the whole country with the terrible consequences of the catastrophe. The Pocahontas mine was a drift or level free opening. In such mines fire-damp is seldom found in alarming volumes, and the fact that the manager insisted that explosive gas had not been previously encountered in the Pocahontas mine, has led to the supposition that the accident was not caused by fire-damp, but by the ignition of dry, fine coal dust in the rooms and along the roadways of the mine.

Fire-damp is one of the most dangerous and destructive elements ever encountered in mining enterprises. This gas is the light carburetted hydrogen of chemistry and consists of one volume of the vapor of carbon and two volumes of hydrogen, which are combined into one volume by affinity, or 2 atoms of hydrogen; 2 and 1 atom of carbon; 6, the atomic weight of the compound being 8. This gas seems to have been formed in coal beds during the process of the decomposition and mineralization of the vegetable material from which the coal is derived. Its weight is 562, common air being 1. It is found pent up in the interstices or minute pores of the coal, in a highly compressed state by the counter-poising pressure of the atmosphere, and escapes from the coal in greater volume during a fall of the barometer. Being lighter than the atmosphere by nearly one-half it rises to the roof and higher portions of the mine as it escapes from the coal strata. This gas is not explosive until it is mixed with five times its volume of common

air, and is ceases to be explosive when more than 14 volumes of air are added to one of fire-damp—nine and one-half times the volume of air to one of gas, forming the most powerful explosive mixture. In this condition, when a naked light is carried into the presence of the gas, it explodes with greater or less violence, according to the amount of inflammable air that has been permitted to accumulate. No coal mine ought to be set down as absolutely safe from the presence of fire-damp. A dangerous accumulation of the gas is not apt to occur until the gas has manifested its existence in the presence of feeble blowers of jets, in the accumulation of small quantities in the headways or other working places driven to the rise of the strata, or in the fast—that is, those places driven ahead of the circulating current of air. It is, moreover, apt to be found, if found at all, just beyond a clay vein or horseback.

Frequently, in mines in which great and disastrous explosions of fire-damp occur, the system of ventilation in practice is claimed to be perfect, and, according to the plans exhibited of the workings, the system is all that could be required. Yet the fact that explosion took place proves there was something wrong somewhere, for no mine in the world gives off fire-damp so copiously that it cannot be diluted and rendered harmless by the introduction and circulation of fresh air through the many and intricate ramifications of the mine. The parties responsible for the explosion purposely mystify the cause of accident. They must know the true cause, but, to admit it, would be to convict themselves, which is contrary to human nature. If they do not know the cause then they are ignorant indeed and have no business there.

But explosions occur in mines which give off very small quantities of fire-damp, as well as in mines in which this gas is evolved in copious volumes. Indeed, the most disastrous explosions, which have ever occurred in this country, have taken place in drift mines in which this gas was seldom seen before the accident—certainly was never found in quantity sufficient to cause serious alarm. And all this, to, as in the case of the Pocahontas mine, in which approved plans for the ventilation of the workings had been adopted, though, too evidently, had not been put into daily practice, either from a sense of over-security or by an unforseen obstruction to the air-ways of the mine.

Whenever a disastrous explosion of fire-damp occurs in mines, it is immediately followed by a spirited discussion as to the cause of the catastrophe, and the parties to whom the blame should be attached. These discussions are nearly always carried on in bad temper. Some wisdom and some nonsense are ventilated and soon the whole affair is forgotten. Every such accident should be followed by a thorough investigation of competent, practical mining experts, having no interest one way or the other. If plundering, incompetent or criminal carelessness on the part of the responsible managers caused the accident, such parties should be dealt with vigorously. A man's life is worth a coal bank, and in this country where all men are equal before the law, the miners, through their labor organizations, ought to have representative men watching the investigation.

Drift and shallow shaft mines have been considered by mining experts and others, who have investigated the subject, to be free from dangerous accumulations of fire-damp. Such mines are indeed comparatively free from the accumulation of alarming quantities of this gas; even in the worst cases, were the most ordinary care and attention given to ventilation compared to that given to well regulated mines, which discharge fire-damp copiously—that is, to the manner of properly distributing the air throughout all the workings—there never could be an explosion in a drift or shallow shaft mine at all, unless some condition should arise at present unknown to the art of mining.

It is the manner of distributing the air of mines which forms the essential part of ventilation. Both in the Crested Butte mine and in the Pocahontas mine there were at least four or five times the amount of air entering the downcast and returning to-day through the upcast shaft that was necessary to thoroughly dilute and render harmless the explosive gases generated in the workings. It costs money to ventilate well for it necessitates the building of extra stoppings and brattice, and the driving of air-ways and never-ceasing vigilance, which may be dispensed with where there is no immediate danger of explosion, although under such circumstances the mine's health is slowly but surely undermined by the poisonous gases, and explosion sometimes occurs to alarm the country and throw whole neighborhoods into mourning, as in the case of the mines alluded to.

The cause of the Pocahontas explosion has brought out a great deal of discussion in the mining journals, and several ingenious theories have been advanced in explanation of the catastrophe. Mr. Thomas Brown, late Mine Inspector, of the State of Maryland, who visited the mine shortly after the accident, in a communication to the Mining Herald of Pa., affirmed that the explosion was caused—not by fire-damp at all—that the mine gave off no inflammable gas, but by the spontaneous ignition of fine coal dust lying on the floor of the mine to a depth of several inches and mixed with powder; and a committee of the American Institute of Mining Engineers who also visited the mine, by invitation of the manager, arrived at a similar conclusion. The mine was a very dry one and fine dry coal dust accumulated in the workings and road-ways; the miners, who were not skilled workmen, were careless in the use of powder, spilling it in considerable quantities in filling their cartridges, and the coal was not undermined, but blasted out of the solid.

The disaster was, however, caused by an explosion of fire-damp, and by no other cause, though the power of the explosion may have been aggravated by the presence of fine coal dust found in the mine. The mine must have made fire-damp daily, though, of course, not in such quantities as to alarm the miners or the party in charge of the subterranean workings. Spontaneous combustion or "breeding fires" never burst forth suddenly and with great violence in mines. They are, on the contrary, from the causes which produce them, slow in operation. The same is true of the slack which takes fire of its own accord around the mouths of mines; the idea that powder spilled in loading cartridges should enter as a factor in the cause of the explosion is too absurd to be refuted.

Some years ago, Mr. W. Galloway, one of the English mine inspectors, called attention to the effects of coal dust in increasing the power of an explosion of fire-damp. The French mining engineers have also called attention to the same fact. M. Vital, a French mining engineer, published an account of an explosion which occurred at the Campagnac colliery in the year 1875, by which three miners were badly burned. As the mine had not previously made fire-damp, and the explosion occurred from a shot which blew out the tamping, M. Vital concluded that a cloud of coal dust raised in the air by the influence of the shot exploded

and burned the miners. M. Vital after the accident at the Campagnac colliery, instituted some experiments in the Rodez Laboratory, and, as a result, came to the conclusion that: "Very fine coal dust is a cause of danger in dry working places in which shots are fired; in well ventilated mines it may of itself give rise to disasters; in workings, in which fire-damp exists, it increases the chances of explosion and when an accident does occur it aggravates the consequences." The conclusions of M. Vital are correct so far as they relate to mines which make fire-damp, but not as regards workings which are free from the presence of this gas; for if this were practically true, half the coal mines of the world would be daily burned up. Mr. Galloway states emphatically, as the result of his experiments, that a mixture of air and coal dust is not inflammable at ordinary pressure and temperature, but that it requires a mixture of air, fire-damp and coal dust to form an explosive compound.

Fine coal dust mixed with fire-damp increases the power of an explosion, but fine coal dust even when held in the air of mines by mechanical suspension cannot explode. No mines in the world make more fine dust than those of Maryland, which it was Mr. Brown's duty to inspect. More fine coal dust is, however, made by properly undermining and shearing coal than by blasting it out of the solid. Indeed, the consequences of the influences of fine coal dust mixed with fire-damp have in my judgment been greatly exaggerated. Mr. Galloway's experiments were made from fine coal dust reduced to powder and not from actual dust lying along the roadways and other parts of mines. The coal dust which accumulates along the roadways of dry mines is largely mixed with fine fire-clay dust raised from the floor of the mine, by the constant tramping of men and horses, and practically, this material is not explosive except in air containing an explosive mixture of fire-damp. It requires the presence of burning fire-damp to explode and burn this compound.

A great part of the money spent in the dead-work of mines is spent on ventilation. Air shafts require to be sunk, air-courses to be driven, stoppings built, trap-doors erected, etc. In mines which make fire-damp, additional expense and additional mining skill are required to manage the subterranean excavations or dangerous accumulations of gas will surely occur, and whenever standing gas

is permitted to exist in a mine some careless or ignorant workman is sure to explode it by carrying a naked lamp amongst it, spreading death and destruction to the remotest corner of the subterranean excavations. Daily familiarity with danger breeds contempt. There is but one way to insure absolute safety in mines —never to permit the presence of standing gas. This is easier said than done, but there are numerous examples to show that it can be done even in the most dangerous mines in the world. There is certainly no excuse for the presence of standing gas in any drift or shallow shaft mine in this country, and yet the greatest fire-damp disasters which have ever occurred in the United States have occurred in mines which gave off the smallest quantities of gas, which were either drift mines or shafts less than 100 feet in depth.

Learned mining engineers, who are graduates of famous mining colleges and who *can* write scientifically and well in regard to the nature and properties of the various gases of coal mines, ought to give more attention to the daily routine of subterranean work. It is from this class of men, fully as much as from any practical talent developed in mining, that the majority of improvements must come. Everything is theoretically known and published by these mining professors in regard to the gases of mines, and yet many of such men, if taken into a mine and left without a guide, would lose themselves and never find their way out. What we need in this country is a judicious blending of theory and practice. Certificated mining bosses is a move in the right direction, but in my judgment the art of mining and ventilation of mines ought to be taught in the common schools located in the mining districts, so that miners might understand in advance the nature and properties of the dangerous elements which they are required to encounter. This is essentially the age of coal and iron, which will soon be as necessary as water, and the world's supply of coal and iron will, before the lapse of another century, be mainly drawn from the United States of America.