Report of the Commission appointed to inquire into an investigate the Matters of Explosions in the Coal Mines of Iowa (1902).

# REPORT OF COMMISSION

APPOINTED TO INQUIRE INTO
AND INVESTIGATE THE MAT-
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# EXPLOSIONS IN THE COAL MINES OF IOWA

# REPORT OF COMMISSION.

HON. A. B. CUMMINS, *Governor of Iowa:*

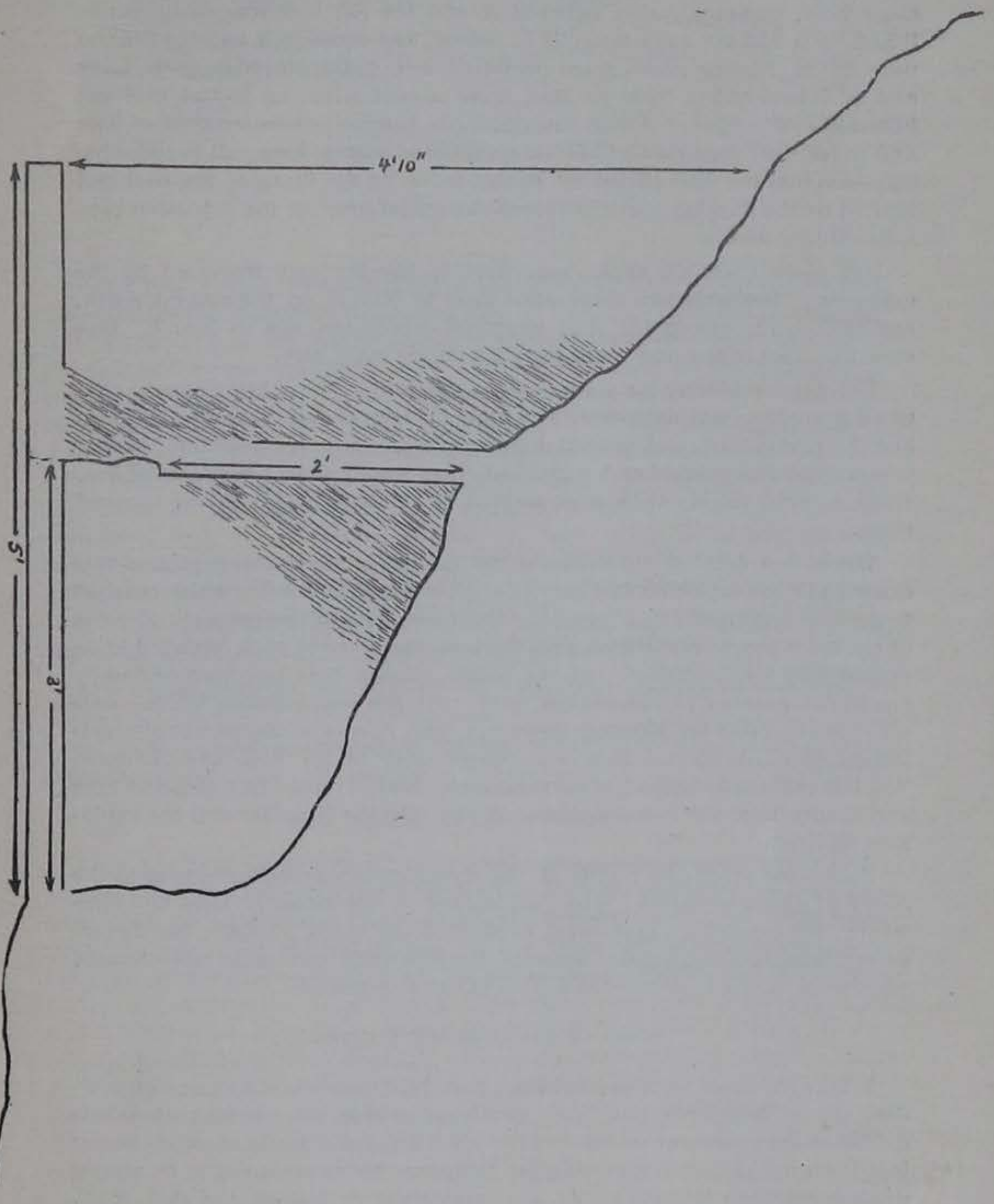
*Sir*,—In compliance with a joint resolution of the Senate and House of Representatives of the Twenty-ninth General Assembly, this commisson respectfully submits to you for your consideration, and for transmission to the senators and representatives of the Twenty-ninth General Assembly, the results of its investigation of the cause of explosions in the coal mines of Iowa, the conditions under which these explosions are likely to occur, together with such other information deemed important enough to incorporate in this report.

The commission has made such recommendations for legislative action as appeared to it necessary and helpful to prevent the occurrence of disastrous explosions in the future. The commission believes that their enactment and enforcement, together with the help given by the operators and miners of this state, will bring to the Iowa mines a degree of safety never before attained.

The commission organized for the work before it on the 17th of February, 1902, by electing Hon. T. J. Phillips chairman, and Mine Inspector John Vernon, secretary. It was thought advisable before taking up the work, to visit Mine No. 2 of the Lost Creek Fuel company in Mahaska county, to afford each member of the commission the opportunity to make a personal examination and investigation as to the condition of the mine and the cause of the explosion which occurred in that mine about noon, January 24, 1902. The mine was visited on February 18th. The damage done by the explosion to doors and stoppings had been repaired, the mine was found in good condition, and its ventilation ample. The evidence of the miners, who had worked in this mine prior to the explosion, and in that part of it affected by it, showed that the air had been well conducted and of sufficient volume to assure efficient ventilation of the working places. It had been and is now the practice to slow down the fan just before firing time and keep it moving slowly until after the completion of the firing.

The explosion undoubtedly started in room No. 10, on the second north on the east side. This room is about 500 feet distant from the hoisting shaft, was driven in the distance of fifty feet from the entry, and had no break-throughs connecting it with the adjacent rooms. Andrew Pash, the miner who worked in No. 10, and who was among the killed, had charged two holes on the forenoon of January 24th, one on the left rib, the other near the right rib of the place. The former hole only was fired and the explosion originated from it. Mr. Jonas Mabie, Jr., a driver, who hauled coal from No. 10 room before the explosion, and whose work caused him to

be in that room on the morning of January 24th, made the positive statement before all the members of the commission, that the hole in question had been fired at quitting time Thursday, January 23d; that it had blown the tamping at that time and had been recharged on Friday forenoon, January 24th. In the opinion of the commission it is very probable that the size of the charge was increased also. The hole was five feet deep, four feet, ten inches on the point, slim heel, coal three feet, eleven inches high below the black jack, which did not shoot with the coal. The shot blew the tamping at the second firing, but the dangerous feature about it, and which proved the real cause of the explosion, was part of an old hole, two feet deep, left on from a former shot, that had been drilled at right angles to the hole on the rib, three feet from the mouth of the latter hole, a little below it, and within seven and one-half inches of tapping the same (see sketch).




SHOT FIRED ON JANUARY 24, 1902, IN NO. 2 MINE, LOST CREEK, IOWA, IN ROOM 10, SECOND NORTH, EAST SIDE.

The side of the hole on the rib was evidently shattered by the charge exploding in it the first time, and when the second charge was fired in the same hole, communication between it and the old hole was easily established, if it had not been established before, and through it and the fissures near it the flaming gases were projected into the room with great force and so intensely hot that the thin layer of coal adhering to the roof was blistered and burned. Along the right rib a considerable amount of soot and coked dust furnished additional evidence of intense heat. It is undoubtedly true that the dust stirred up in this room by the firing of the shot and ignited by the flaming gases increased the initial force of the explosion considerably.

Not more than six shots were fired in the territory traversed by the explosion. Probably two shots were fired in No. 12 on the second north, one in No. 10, one in the stub entry off No. 9, and one in No. 9. One shot was fired in the first room working on the main east.

The flame evidently traveled close to the roof. Not a keg or vessel containing powder was exploded, although in several instances the stoppers had been removed, and several dinner pails found in low positions, having wooden handles painted and varnished, that would show the effects of fire, while covered thickly with soot, showed no evidence of fire having touched them.

There is a decided similarity in the manner in which this explosion was caused and the explosion at Como, Col., on January 9, 1893, which resulted in the death of twenty-four miners. Both were due to the presence of parts of old holes previously drilled and fired in the piece of coal intended to be removed by a second shot. In the Como mine a hole had been drilled by one of the miners and the charge fired. As the place chosen for this hole was not favorable for blowing down the coal, it was a comparatively ineffectual shot. A second hole was placed close to the first and charged. When it exploded, instead of blowing down coal, it broke into the first hole and the flame of the powder extended out into the chamber and the explosion resulted.

Below are given the results of the commission's investigations as to the cause of these so-called "dust" explosions in the mines of Iowa and elsewhere, the conditions that must exist to make them possible, the factors determining their extent and severity, together with such other information, pertaining to them, deemed of sufficient value to present.

## PRIMARY CAUSE OF EXPLOSIONS.

It may be stated, in a general way, that the explosion of a charge of powder, whose full force has been developed within the confines of a hole drilled in the coal, and which force is used up but slightly in either bringing down the coal or in removing the tamping, but is projected in its almost unimpaired vigor into the air in the immediate vicinity of the shot, may, and if other conditions are just right, can produce a disastrous mine explosion. That blasting powder is a very dangerous explosive to use in coal mines is beyond question. Aside from its heat generating power, the necessary attribute of every explosive, the explosion of blasting powder produces not only a greater amount of flame but generates also a number of

combustible and highly explosive gases. The following table of the proportions by volume of the resulting gases from the explosion of blasting powder has been prepared by Prof. Vivian B. Lewes:

| | |
|---|---|
| Carbon Dioxide | 32.15 |
| Carbon Monoxide | 33.75 |
| Nitrogen | 19.03 |
| Sulphureted Hydrogen | 7.10 |
| Carburetted Hydrogen | 2.75 |
| Hydrogen | 5.22 |
| | 100.00 |

From this table it therefore appears that the only two combustible gases produced by the explosion are carbon and dioxide, 32.15 per cent, and nitrogen, 19.03 per cent, or jointly 51.18 per cent, leaving not less than 48.82 per cent of the resultant gases combustible. From the above statement it can readily be seen why a shot, where the product of the combustion of these gases had not been used up in work, in either removing the coal or the tamping, may become dangerous by the explosive gases completing their combustion in the air in the vicinity of such shot. But a large number of shots fired in the Iowa mines have apparently spent their force as above indicated, with no disastrous results, so there must be something else needed, besides the powder exploding, in the development of an explosion.

NECESSARY FACTORS ENTERING INTO THE DEVELOPMENT OF AN EXPLOSION.

1. The intense heat generated by the flame and exploding gases from a shot or shots projected into the mine air with great force.

2. The presence of coal dust in the immediate vicinity of such shot or shots.

3. A fair supply of pure air in the part of the mine where such shot or shots are fired.

## THE INFLUENCE OF COAL DUST.

Coal dust is an important factor in these mine explosions, especially when present in a finely divided state in the place where an ineffectual shot has been fired, or in a place where several shots have been fired simultaneously, for such dust will not only aid in the easier ignition and explosion o the combustible gases produced by the explosion of powder, but it will add by its own combustion more heat and more fire, supplying thereby considerable additional force, that may make it possible to develop an explosion of considerable extent and severity. Whether or not the dust along the path of an explosion will add to its force or cease to be merely a sustaining factor or cease to be a factor altogether, depends upon conditions prevailing in the mine at the time of the explosion. These conditions will be discussed later.

## THE INFLUENCE OF PURE AIR ON THE FORMATION AND PROPAGATION OF AN EXPLOSION.

Next to the explosion of the powder itself, the most influential factor in these so-called "dust" explosions is pure air near its place of origin. It is

the energizing element, and without it disastrous explosions in Iowa mines would become an impossibility. Shots may blow the tamping and dust may be present in abundance, but both will remain comparatively harmless if the mine air is impure.

### CONDITIONS HAVING A TENDENCY TO INCREASE THE SEVERITY OF AN EXPLOSION.

1. Brisk ventilation or high mine pressure.

By looking over the accounts given of explosions that have occurred in Iowa and other western states within the last fifteen years, and comparing conditions and results, the deduction is easily established that a strong current of air going through a mine at the time of an explosion occurring in it, will not only aid materially in developing its initial force, but will increase it in its progress through the mine passages. It should be remembered that at the time of an explosion's duration is counted by seconds and that these seconds number but few. A strong air current meeting an advancing explosion will check its rapid advance, and though the check itself may be slight, it gives time to permit the combustion of a large amount of dust and makes that combustion more fierce and complete. Under this condition the explosion's scope is not only extended, but its destructive force is very much increased.

2. Low mine temperature.

There are three reasons why low mine temperature assists in the formation of an explosion and in increasing its extent and force. The first reason is that under its influence natural ventilation affords the means of better ventilation of the working places in a mine and purify the air in them. The second reason is that it has a decided effect to make a mine more dry and dusty, and the third reason is that the colder the air in the mine the greater its expansive force, when brought in contact with the heat produced by an explosion.

3. Congested or narrow workings.

Just as powder exploded within the narrow confines of a hole developes greater force, than if exploded in the open, so will the initial force of an explosion develop a greater degree of power, if this originates in a part of a mine where the workings are narrow and the rooms driven in only a short distance from the entry, with no break-throughs connecting them. It is a plain proposition that the greater the confinement of a certain amount of heat the greater its intensity.

### CONDITIONS TENDING TO DECREASE THE SEVERITY OF AN EXPLOSION.

1. Sprinkling the roadways.

Sprinkling the haulage roads, while not a preventive by any means, for there is convincing proof to the contrary, is nevertheless of valuable assistance in detracting from an explosion's force, especially if the explosion takes its principal course, as it generally does, along the haulage roads. Sprinkling certainly diminishes the amount of fine dust floating in the air along these roads, and consequently diminishes the supply of available fuel to sustain or increase the explosion's force. The question may arise, if the

sprinkling of a part of a mine promises a certain degree of safety, will not the sprinkling of the whole mine insure a greater measure of safety? It will, but it is a physical impossibility to keep a natural dry mine in damp condition in all its parts by artificial means. More or less coal dust will exist wherever coal is mined. It is impossible to eliminate it. Its accumulation however, should be prevented and every mine should be kept as free from it as practicable.

2. Ample expansion room of wide workings.

The more room there is provided to allow rapid expansion and dissipation of the heat and flame from a shot, that has spent the greater part of its force in the air in its neighborhood, the more remote will be the probability of an explosion of dangerous proportions. It appears that the heat and flame from such shot must at first be confined to close quarters to give the forming explosion the necessary force to project itself through a considerable portion of mine.

3. Reduction of the air volume entering a mine at firing time.

It may appear an anomaly to present the suggestion that a reduction in the air volume entering a mine can lessen the force of an explosion. Many hold that insufficient ventilation, or poorly directed ventilation, is the direct cause of explosions and that it is dangerous, where the occurrence of explosions is feared, to reduce the air volume at any time and especially at firing time. This is true of mines generating firedamp, but there is a wide difference, with the explosion wholly due to gas and an explosion in which firedamp had no part whatever. In the former case a brisk and well directed ventilating current tends not only to obviate the occurrence of an explosion, but in the event of its occurrence, the influence of such current is beneficia because it reduces the danger of additional accumulations of gas being provided to increase the explosion's force. In the other case, where coal dust enters as one of the elements of an explosion, a brisk current going through a mine at the time of its occurrence, which is at firing time, may be made of the conveyor fuel, in the shape of fine coal dust, to the forming explosion; it will certainly aid the more complete combustion of the dust, and besides as already has been remarked, the retarding influence of a strong current to the rapid advance of an explosion affords time for the combustion of a greater quantity of dust.

It has also been stated that a decrease in the air volume, while it may lessen the dust explosion's force, would make the afterdamp more dangerous and deadly. Comparison of the effects of explosions, which occurred in mines where the air supply was reduced and in others where a strong current was going through them at the time of their occurrence, does not sustain that claim. Such comparison further demonstrates the fact that in the latter case the destruction wrought was infinitely greater than in the former. At the time of the Pekay explosion in 1892 the fan was running at its normal speed, producing about 50,000 cubic feet of air per minute. The destructive force developed was very severe, the fan was wrecked and a number of kegs of powder were exploded, showing that the flames must have filled the entries almost completely from top to bottom. The same has been true of other explosions where a like condition existed. At the time of each of the

three explosions at Cleveland, at the time of the explosion at Lost Creek and the recent one in No. 2 mine, Hocking, the fans at these mines were either stopped altogether or were revolving very slowly. In each case, however, there was considerable natural ventilation. Not a keg or vessel containing powder, so far as known, was exploded in any of these explosions, showing that the flame did not fill the entries, but traveled close along the roof, destruction was comparatively small and in no case was the fan incapacitated from immediate service. In the Hocking explosion the flame traveled nearly 1,400 feet from the place where the explosion originated to the top of the hoisting shaft, yet, as soon as the fan had been started full speed, the mine could be entered without delay, and the shotfirers, although severely burned, were brought out alive.

The foregoing, true as it appears to be, is not to be considered an argument for poor or insufficient ventilation. Impure air may prevent an explosion, but it is impracticable, as well as dangerous, to life to resort to it as a remedy.

MOST FAVORABLE TIME FOR THE OCCURENCE OF A "DUST" EXPLOSION.

These explosions generally occur during the colder months of the year. They may occur in the summer, but there is no record of an explosion of this character ever having occurred during the months of June, July and and August. The reason why these explosions are more frequent in the winter than at any other season of the year is due to the fact that the entries and working place, in the mines during the colder months are drier, and more perfectly ventilated and contain purer air than during warm weather. The effect of the conditions on explosions has already been discussed.

Danger arising from firing a recharged hole, or a hole drilled in close proximity to a remaining part of an old shot hole, or to the fissures made by a previously fired shot.

Fully 70 per cent of the disastrous and extensive explosions, which have occurred in the Iowa mines, have been caused by shots charged and fired the second time, or by shots whose explosive force was thrown into the mine air in their immediate vicinity through the remaining parts of an old hole, which had failed to do effective work. The dangerous character of such holes is now fairly well recognized, but the reason why they are so dangerous is as yet not fully understood. Some say that as generally after a shot has blown the tamping, the second charge is larger than the first, the danger lies in that fact. This may be true to a certain extent, but it is reasonable to suppose that the miner, knowing that extra care must be taken to prevent the charge blowing the tamping the second time, will take some pains in properly tamping that hole, counteracting thereby to some extent the increase in the charge; so there must be something else to promote the dangerous characteristics of such shot. It has been shown that nearly 49 per cent of the gases generated by the combustion of powder are of an explosive nature. When a shot blows the tamping, these gases are not entirely ejected from the hole, as may be supposed, but a portion of them is driven into the pores of the coal and the small cracks and fissures opened by the explosion of the powder. The ignition of powder is comparatively slow, and if by any means that ignition can be hastened, its explosive power

will be increased. That is just what is likely to take place when a second charge is fired in a hole. As soon as the ignition of the powder commences, the inflammable gases surrounding it are ignited also, hastening in turn the explosion of the powder and increasing the heat and flame. At the same time they act as a cushion from which the newly formed gases rebound and are thrown into the air with almost unimpaired force. Under these circumstances, if other conditions are favorable, an explosion may result.

In this same manner the force developed by the powder exploding may be greatly increased, should the exploded charge find an outlet through part of an adjacent old hole or through fissures made by a previously fired shot and ignite the gasses contained therein.

That a portion of the gases generated by the combustion of powder is retained in the cracks and fissures of the coal is known to every observant miner working in a mine where coal is blasted from the solid. The foul smell of sulphureted hydrogen reveals to him the presence of that gas and its presence is evidence that the other combustible gas, due to the explosion of powder, are there also. There is a well authenticated case, which occurred some years ago in the North Star mine near What Cheer, and which showed that these gasses are retained in the cracks of the coal for a considerable time and exemplified their dangerous character. Robert Maxwell, a miner, had fired a shot at noon, which did not move the heel, but did some work on the point. It was a tight shot, but he decided to mine it out. About 4 o'clock his pick struck into the crack made by the powder; he only had time to notice the foul smell of the gas as it issued from the aperture, when it fired from his lamp.

## SQUIB AND FUSE.

Seventy-five per cent of the explosions in Iowa mines have been caused by shots ignited by fuse. The danger lies not so much in the fuse itself, as in the improper material used for tamping, and in the insufficiency and looseness of the tamping. By the use of fuse a miner can fire an improperly tamped shot without difficulty, but if he uses the squib he is obliged to tamp the shot well or running the risk of failing to explode the charge. Proper tamping is one of the safeguards against explosions, and in that sense the squib is preferable to the fuse.

The commission has experimented in a limited way with an extension squib recently patented by Henry J. Richards of Wilksbarre, Pa., and while the commission is not ready to endorse its use, it is favorably impressed with the results of the experiment. This squib merits a fair trial, for it seemingly combines the good points of the fuse with the increased measure of safety of the common squib. If it is proved that it will do this, the difficulty and danger attending the use of ordinary squibs in firing more than one shot in a place, will have been overcome, and in that event the use of fuse in Iowa mines should be prohibited.

## THE PROHIBITION OF THE USE OF POWDER IN MINES THE ONE ABSOLUTELY SURE PREVENTIVE OF THESE SO-CALLED "DUST" EXPLOSIONS.

The use of powder is directly responsible for all these explosions, at least so far as their occurance in Iowa is concerned. Its dangerous characteristics

have already been explained, and they are fairly well understood. Professor Lewes has this to say about powder and its use in mines: "The only favorable word that can be said for blasting powder is, it is cheap. It is absolutely unfitted for use in coal mines, and its abolition would do away with more than three-quarters of the number of deaths annually returned as being caused by mining explosives." Yet, true as this undoubtedly is, it has been found advisable to continue its use, because so far no explosive has been produced that can take its place and do the work as well as it.

RULES RELATING TO THE PREPARING AND PLACING OF SHOTS, ETC.

The commission recognizes the difficulty of presenting rules governing the preparing and placing of shots, etc., which can be applied with equal fairness to all mines, and for that reason has deemed it advisable to recommend that such rules be adopted by the operators and the miners of each mine as will best promote the safe working of the same.

RECOMMENDATIONS FOR LEGISLATIVE ACTION TO PREVENT EXPLOSIONS IN THE MINES OF IOWA.

In all mines, where coal is blasted from the solid, competent persons shall be employed to examine all shots, before they are charged. Said examiners to have the power to prohibit the charging and firing of any shot which, in their judgment, is unsafe. Before entering upon the discharge of their duties, said examiners shall give proof of their competency to the state mine inspector of the district in which the mine, where they are employed, is located. The state mine inspector to have the power to refuse to give permission to any person to act as shot examiner who, in his judgment, is not sufficiently competent; or he may revoke the permission granted, should it appear that a shot examiner is negligent, or careless in the performance of his work.

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The miner shall keep his working place and the operator the entries as free from dust as practicable. The entries to be sprinkled as often as necessary to keep them in damp condition.

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Only sand, soil or clay shall be used for tamping and the shot holes shall be tamped solidly from the powderto the mouth of the hole, whether the squib or fuse is used to ignite the powder.

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Any shot having blown the tamping at the first firing, shall not be recharged and fired the second time.

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In addition to the above such rules regarding the use of powder, the preparing and placing of shots, shall be adopted by the operators and miners of each mine, so the blasting of coal may be done with the greatest possible safety.

More than 14,000 persons are engaged in the mining industry of Iowa. The commission suggests that enough copies of this report be ordered printed so as a copy may be placed in the hands of every person connected with or interested in the mining industry of this state.

Respectfully submitted,

T. J. PHILLIPS, *Chairman*,
JOHN VERNER, *Secretary*.
J. E. STOUT,
J. W. MILLER,
JOHN P. WHITE,
JOHN P. REESE,

SUPPLEMENTARY REPORT—BY JOHN P. REESE AND JOHN P. WHITE.

We, the undersigned members of the commission, take pleasure in stating that we agree to all that has been said, both as to the cause of explosions and the recommendations made to prevent them. But we are satisfied that the recommendations do not go far enough, and in behalf of the eleven thousand mine workers of the state whom we have the honor to represent on this commission we make the following recommendotion, and ask that the same be enacted into law, together with the other recommendations of the commission:

RECOMMENDATION.

That all shots must be fired by men employed for the purpose, and shots shall only be fired when all employes, except the shot firers, are out of the mine This recommendation was offered by us in the meetings of the commission, and was rejected by the majority of said commission. And for that reason we submit it in the present form, and we desire to give the following reasons why it should be adopted:

*First.*—We believe that the intent of those who created the commission was to find some way, if possible, of saving the lives of our citizens, who daily enter the bowels of mother earth to produce the fuel that makes it possible to keep the wheels of commerce and industry moving, as well as to find out the cause of explosions and means to prevent them. For it was the enormous sacrifice of human life in the Lost Creek explosion that prompted the legislature to create the commission.

*Second.*—We are firm believers in the doctrine that one of the principal reasons that governments were instituted among men was for the purpose of protecting those who were unable to protect themselves.

*Third.*—The principal reason for making this recommendation is that we believe it possible for so-called dust explosions to occur in the coal mines of Iowa after every recommendation made by the commission has been enacted into law, and the law lived up to by all parties (and in this belief all other members of the commission share); therefore, we believe that the legislature should make it impossible for scores of the mine workers to be killed and injured by one of these explosions, and they can do so by enacting into law the recommendation contained in this report, for experience demonstrated in several places since the Lost Creek explosion, that two men can examinn and fire the shots for one hundred employes at a mine: thus it will be seen

at a glance that under the shot firing system, as recommended in this report, that only two per cent of the employes of a mine would be exposed to the dangers of a so-called dust explosion. As a commission we have proceeded on the theory that one life is as sacred as a thousand, and have recommended all the protection possible and at the same time practicable, for the protection of the one life, but at the conclusion of our investigation we find that it is impracticable to make that one life free from the possibility of an explosion; thorefore, we desire under these conditions to stand on the proposition that if life must be sacrificed, the fewer lives necessary the better for all concerned, and on this proposition we rest our case, believing that the legislature will agree with us, that if Iowa must lose a part of her citizens by these explosions that it is better to lose one life than fifty.

Respectfully submitted,

JOHN P. REESE,
JOHN P. WHITE.