

## THE VULCAN EXPLOSION.

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### A Description of the Mine and the Conditions Existing Therein.

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On Tuesday morning, February 18, 1896, an explosion occurred at the Vulcan mine, operated by The Atchison, Topeka & Santa Fe Coal Company, one and one-half miles southeast of the town of Newcastle, Garfield county, Colo., which resulted in the death of forty-nine men, including James Harrison, the mine foreman; John Funke, assistant mine foreman, and Thomas Larrigan, fire boss.

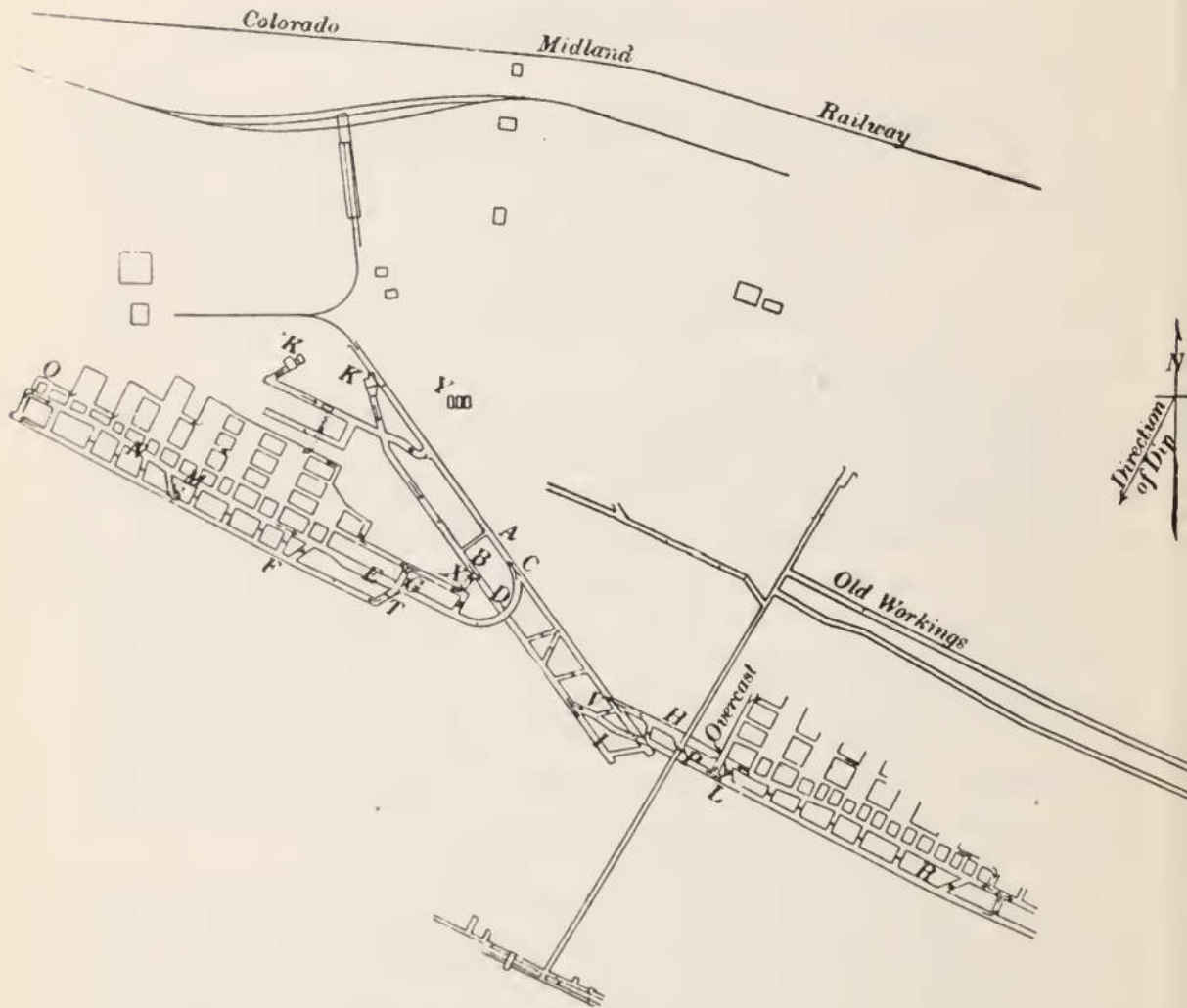
The coal-bearing strata at this mine pitches about  $47\frac{1}{2}^{\circ}$ , and the strike of the seam is southeast and northwest. There are several workable seams of coal on the property, the Wheeler and Allen seams having an aggregate thickness of about 70'.

The mine is under the management of Mr. C. J. Devlin, general manager of The Atchison, Topeka & Santa Fe Railroad Company's coal properties; Mr. Robert T. Herricke, local superintendent, and Mr. Joseph Fletcher, the company's mine inspector, who inspects and reports on all the mines owned by the company about every three months. The immediate officials at the mine were the foreman with an assistant and three fire bosses, who each worked eight-hour shifts.

The accompanying map of the mine on a scale of 400' to the inch will enable the reader to arrive at a good idea of the conditions existing at the mine, and will make clear the statement of my investigations as to the cause of the explosion. The mine is opened by a slope, *A*, driven on a pitch of  $5^{\circ} 43'$  for 250' through the surface wash and the measures underlying the Wheeler seam. At this point the bottom slate of the seam is encountered and the slope is continued in a direct course on the bottom slate diagonally across the pitch. From the point where the slope strikes the bottom slate of the seam, the average pitch is about  $30^{\circ}$ . The air course, *B*, parallel to the slope, is driven on nearly the same pitch as the slope with the exception that near the surface it is driven on about  $40^{\circ}$  pitch, thus shorten-

ing the distance for the connection at the crop entry. The total length of the slope and parallel air course is about 840' from the mouth.

At a point about 460' from the mouth of the slope, the right, or west entry, *C*, is turned off on a pitch of  $27^{\circ}$ , forming a very short curve and a steep grade for haulage. Over this entry a wooden air bridge, *D*, is constructed for the main slope air course, and about 75' above this air bridge a shaft, *X*, is



sunk from the top of the seam to the bottom of the parallel air course, and the right entry is driven to the west boundary line. At 250' from the slope the right entry runs on the strike of the seam and a double parting about 13' wide and 100' long is constructed for the purpose of facilitating the haulage. This is shown at the point *E* on map.

At the outside end of the parting, close to the point of strike, a cross-cut is driven to the top of the seam and from this point another air course, *F*, is driven parallel to the entry and to the



west boundary line. The upper and top slate air courses are connected by an air bridge driven through the solid coal across the main right entry at *G*. At 180' from the outside end of the parting, the first room or breast is turned off. In this entry there are eight rooms and sixteen chutes, as shown on the map, and the inside room is driven up nearly on the boundary line. The distance from the point where the entry begins to run on the strike of the seam to the face is 710'. At a point 730' from the mouth of the slope, the left or east entry, *H*, is turned off on an easy grade and curve. A parallel air course along the top slate is driven through the slope from the main slope air course. (See *I*.) The main left entry and parallel air course are about 920' from the slope. In this entry there are eight rooms and sixteen chutes.

The rooms are all turned off the main entry and on the bottom slate of the seam; they are 40' wide with 40' pillars between them. There are two chutes to each room, thus forming an entry pillar of about 25' between the chutes. At a point about 30' up the pitch, the chutes are connected by a cross-cut and the face of the room is then formed. The miners take out from 7' to 8' of the coal seam and 40' wide in the breast. There is a manway built on each side of the breast about 3'x8', or 24 square feet sectional area for ingress and egress and for ventilation of the face of the workings. The rooms are driven up about 175' from the entry and then stopped, after which all the cut coal is taken out of the room.

Another operation then takes place. Men selected for the purpose, called "topmen," are put to work to cut the seam at right angles to the pitch and up to the top rock, then the whole thickness of the seam, about 45' of coal, is blasted down and taken away through the chute below, care being taken not to draw out too much, so as to give the men something to stand on and keep them close to their work. On arriving at the top of the room in taking down the top coal, the breast is tapered off so that there will not be any point of it higher than the top cross-cut in the bottom coal. This is necessary, because if the top coal was excavated higher than the air current there would be an accumulation of fire-damp. The first operation of working up the room is done by the yard and the top coal men are paid by the day. As soon as the top coal operation is finished, all the coal is taken out as rapidly as possible, because if left for any length of time it is liable to spontaneous combustion. The coal is loaded by men selected for that purpose, who are paid by the day.

At the time of the explosion, the mine was ventilated by two fans, *K K*, of the compressive type. One was a Guibal fan, 12' in diameter, with blades 5' 6" in width, and the other was a double Murphy fan, 6' in diameter. These fans were capable of producing from 38,000 to 40,000 cubic feet of air per minute separately, and from 54,000 to 60,000 cubic feet of air when working together. The interior of the mine was so arranged that if one fan was disabled the one fan would ventilate the whole mine. The right and left entries had separate and distinct currents of fresh air from the outside. Each current was again split in the mine, this giving a separate current for the room workings and the entries. The split currents joined at the face of the entries and returned through the main entries. Air crossings were built or formed in all practical points in order to avoid doors and to keep a continuous air current through the workings. The mode of ventilation and its distribution received great attention and was, in my opinion, well conducted.

The management recognized the danger incident to the presence of coal dust and took the following precautions: Under the brow of the hill and about 50' above the mouth of the mine three large wooden tanks, *Y*, were constructed, into which water from the Grand river was pumped. The tanks are connected with a 6" wrought iron pipe, and the pipes running into the rooms are connected to 4" pipe on the entries, which are reduced to 2" in the rooms. Two-inch valves are used on the room connections; some of the rooms have pipes near the face but generally a hose connection is made and the hose is moved to the point of watering. The hose has a reducing nozzle and by the use of it every section of the mine can be reached from the nearest connection. The altitude of the tanks, which are about 330' or more above the entries, yields a pressure of nearly 140 pounds to the square inch. There was a man engaged for the purpose of extending the pipes and sprinkling. I consider the system as good as can be adopted.

The subject of dampening or sprinkling the dust in the mines of Colorado is gaining favor among the mine officials, and there are very few officials who do not recognize the importance of keeping the dust from contaminating the air current. Some of the extensive mines in the southern part of the state are now watering all their haulage ways, and the officials state that great benefits have been derived; the quantity of air is increased and improved in quality, and besides there is a perceptible decrease of temperature in the mine. Where explosives are used



to mine, the coal dust question is a matter of great importance, and should not be neglected at any time, and it should be borne in mind that sprinkling is not sufficient to overcome this dangerous element. In order to be on the safe side the dust must be well watered. The Prussian fire-damp commission and other authorities say that the dust must be dampened with 50% of its own weight of water before any degree of efficiency is obtained.

Previous to the explosion I made several inspections of the mine in company with Mr. R. T. Hericke, superintendent, and Mr. Connors, who was then the mining boss, and invariably found the mine in good condition. At the time of one visit we discussed the question of safety lamps, and the management informed me that they had decided on the use of the Mueseler lamp to replace the Clanny lamp then in use. I approved of the change, and that was the lamp used by all workmen except the fire bosses at the time of the explosion. On the whole, I considered the mine in excellent condition, and had no suggestion to make to the management whereby a greater degree of safety could be secured. There were no rooms in operation at the times of my visits, all places being worked in eight-hour shifts in order to make speedy developments.

On September 20, 1895, Mr. John D. Jones, deputy inspector, made an examination of every working place in the mine, accompanied by Mr. R. T. Hericke, superintendent; Mr. James Fletcher, inspector of mines in behalf of The Atchison, Topeka & Santa Fe Railroad Company; Mr. James Harrison, mine foreman, and Mr. John Funke, his assistant. This was Mr. Harrison's initiation to the mine. He was anxious to see every place as to its condition, etc., and he was satisfied that everything was well conducted. Deputy Inspector Jones reported as follows: "Quantity of air entering per minute, 32,500 cubic feet. A current of air is carried through all the working faces, also a supply of water to sprinkle the rooms. The haulage ways are well timbered. A new fan will be put up in the near future which will undoubtedly be of great benefit."

This additional fan was put in operation on the 15th of October, 1895, and the two fans gave a combined volume of 50,000 cubic feet of air per minute, with neither fan running at full capacity. We were notified of this by the officials, and we felt assured that another safeguard had been added to the Vulcan mine. On February 8, 1896, I made another inspection of the mine in company with Messrs. Hericke, Harrison and Funke. On this day the mine was not working. There were a few

company men at work in No. 1 room on the left entry. I inquired of Mr. Herricke as to the condition of the mine previous to entering, and he informed me that the mine was in better condition than ever before. We walked down the slope to the left entry and there met Mr. Harrison, and we examined the main and back entry. We then came back and went up to the top coal room where there were five men at work blasting down top coal. Here I found a good current of air and a hose for the purpose of sprinkling the dust. The dust had just been sprinkled at the time and six shots were charged ready to fire. We examined the highest point in the top coal with a Davy safety lamp, but found no traces of fire-damp. I inquired if there were any more rooms in the mine working top coal, and the answer was in the negative. We then came up the slope and the six shots were fired. By the time we arrived on the knuckle we heard the six shots in the top coal room going off quite distinctly. On leaving Mr. Herricke, Mr. Harrison asked me if I had any suggestions to make and I answered no, but that they had a mine to look after that required great care and attention. I did not visit all the working faces, but was satisfied from what I had seen that the local management was doing everything for the safety of life and property. In many cases where the miners are of the opinion that the officials do not comply with the law regarding coal mining, we receive complaints, but in this case we have never received a complaint, either by word or letter.

On the 23d of February I received a communication from Governor McIntire as follows: "I desire to call your attention to the necessity of the most careful and scrutinizing investigation on your part into the causes of the recent terrible disaster at Newcastle so that the responsibility for the awful loss of life may be placed exactly where it belongs. Allow no stone to be left unturned in getting at the exact truth."

I can conscientiously say that I did as the governor directed me. However, my endeavors were fruitless, and I am sorry to say that no definite cause could be found for the disaster. If the exact cause could be found and the blame placed where it belonged we would obtain some satisfaction for the relatives of the ill-fated miners and probably prevent a repetition of a similar accident at this mine or at other mines working under the same conditions.

There are many causes by which an explosion may occur at the mine in question. If a door was left open for a short period, an accumulation of gas would be the result and a de-



fective safety lamp would ignite the mixture. Under the same conditions a careless miner might open his lamp and set off the gas, or a blown-out shot might cause the disaster; a too heavily charged shot may do the same thing. A sudden outburst of gas may take place and impregnate the ventilating current and form an explosive mixture and the same coming in contact with a naked light or a flame cause the explosion. Other modes could be enumerated by which a disastrous explosion might occur in a gaseous and dusty mine. However, I must form an opinion of the cause from obtainable evidence.

As I previously stated, the mine, in my opinion, was in good and safe condition, and there was no accumulation of gas or dust. I will even say more, and that is if the most competent fire boss had examined the mine a minute previous to the explosion he would have proclaimed the mine to be perfectly safe and in a workable condition. By this I mean to say that our present mode of detection of danger is too crude and the danger line is much too high. We are aware that it is impossible to detect less than 2% of fire-damp in the atmosphere of a mine with the common Davy lamp, and generally our fire bosses can not detect less than 4% which in itself is nearly at the explosive point. Experiments prove that even less than 1% is very dangerous in a dusty atmosphere. Some experimenters claim that some kinds of dust, in the absence of any gas, are explosive, others doubt the phenomena. However, all experiments have proved beyond doubt that when both the above ingredients are in the ventilating current (fire-damp being less than 1%) it becomes highly explosive under certain conditions. With these remarks in view, let us consider the conditions existing in the Vulcan mine. Every person that has worked in the mine is well aware that great quantities of gas are constantly transpiring from the strata and that the coal is naturally dusty, and furthermore, explosions have occurred in this field which have been claimed to be due to dust alone. There is no doubt that the dust produced in the Wheeler seam is highly inflammable.

Now the question arises, How could the explosion occur? We admit that gas is emitted freely from the strata in an unknown quantity as to percentage in the air current, but not sufficient to be detected by the Davy lamp, and there must be some small quantity of minute particles of highly inflammable dust in suspension in the air. Such a mixture would be non-explosive in contact with a naked light, but highly explosive if detonated by a blown-out shot, ignition of loose powder,

or a small quantity of fire-damp. From the location of the bodies of Mr. Larrigan and Mr. Funke, and the course taken by the force of the explosion, I am of the opinion that the explosion originated in the right or west entry near one of the chutes between No. 7 and No. 10, shown on the map at points *M* and *N*. The timber from this point was evidently forced inwardly and outwardly. The inward force traversed the entry and forced its way to the parallel air course and backward, some of it going up the man-ways No. 15 and No. 16, at point *O* on map and over the top air course and out through the fan openings. It is evident, however, that in passing through the top air course and rooms, the force was not greatly augmented, because the air course was found in good shape, the only damage done being at the mouth of the fan openings. That the greatest force came through the main right entry is evident by the manner in which the timber was strewn. When the outward force arrived at the air bridge located across this entry at *D*, a weak point of resistance was found and the force expanded, some of it going up and down the main air course parallel to the slope and most of it in contact with the return air from the left entry. The force going up and down the main air course (and intake of the mine) did not get the necessary ingredients to augment its force; it only received a fresh supply of oxygen for the support of combustion. The force on getting in contact with the return air of the left entry received the inflammable ingredients necessary for augmentation, and went down the slope without doing much damage to the timber, etc., only one set of which was knocked out, and this at the entrance into the left entry, and five or six more at the double parting. It is evident that the force going down the air course preceded that going down the slope. This is proven from the fact that the stoppings in the cross-ents were blown outwardly into the left entry, the most conspicuous being that of the regular stoppings between the left air course and the double parting at *P*. Evidence of great violence in the force traveling inwardly through the air-course and entry were found, and I am of the opinion that it was aided by explosions of powder which the miners had in readiness for their use. However, we could not find direct evidence to localize this any more than that the augmentation of the explosion was very great. At the face of the left air course a car was found, the ends and sides of which were smashed into kindling wood. The bodies found near the face of the main entry were badly mutilated. The forces coming in through the air course and the



main entry met at about No. 12, or at point *R*. This, I think, caused great commotion at this point. After expending all the elements of energy the reaction took place, and volumes of smoke came out leisurely through all the openings.

I have as yet omitted to explain how I think the explosion originated. Thomas Larrigan was supposed to examine every place in the mine previous to firing any shots. He was also supposed to fire the shots. Now, I have formed an opinion that one of the chutes in the right entry had become blocked, and in order to remove the stoppage it was necessary to put in a little powder to start the same, and in so doing the explosion occurred. I have no doubt that Mr. Larrigan examined the condition of the place and used his judgment as to the amount of powder, etc., but there may have been a small quantity of fire-damp existing in the chute at a point he could not reach or observe. It is probable that any practical man would have done the same thing he did. Now, assuming the above statement to be correct, I will endeavor to explain how the explosion originated. The explosive used may have been placed on the lump of coal blocking the chute and covered with a small quantity of dust or slack; from this the flame would elongate and set off the small quantity of gas that could not be observed and an explosion on a small scale would be the result, and the compression of the air current due to this would cause the air itself to become explosive, and the agency causing the compression would also ignite the mixture.

On Sunday, March 15, after all the bodies were recovered, we held a conference in the mine, consisting of the following practical miners, all of whom had been aiding in the explorations: M. M. Walsh, mining boss, Blossburg, N. M.; Robert O'Neill, mining boss, Starkville, Colo.; Ed Flynn, superintendent, Rockvale, Colo.; Joseph Fletcher, coal mine inspector, A. T. & S. F.; Robert Herrick, local superintendent; John P. Thomas, mining boss, Rockvale, Colo.; Harry John, fire boss, Rockvale, Colo.; Charles Grant, fire boss, Rockvale, Colo.; George Ward, local fire boss, Rockvale, Colo.; Humphrey Davies, fire boss at Newcastle mine.

Others were invited, but for some reason did not attend. The object of this conference was to try and localize the point of origin of the explosion, but no definite conclusion could be arrived at.

In examining the effect of the explosion, the reason why there were so many different opinions is made manifest. I will here state that my opinion is based upon the most plausible

cause from which it could have occurred. Many are under the impression that it originated from a blown-out shot because it was about firing time when the explosion occurred, but there is no evidence of any shots having been fired except the one fired by Mr. Larrigan in a dog-hole near the face of the left entry. There were several lamp keys found on the bodies, but not a single open lamp. Matches were found on some of the bodies, but there was no evidence found that anybody was lighting a lamp or attempting to smoke. On taking everything into consideration, I am of the opinion that the principal ingredients causing the disaster were dust and gas, but that the known line of danger was not perceptible, and that the cause or origin is only a matter of supposition at best, and will remain a mystery like many other similar disasters.

The effect of the explosion was so violent that I am of the opinion that every man in the mine died instantly, and that not one of them breathed any after-damp. Some of the bodies were burned, but I do not think the burning effects would have resulted in death. The fans located on the surface at *K K* were blown to pieces, and the three openings shown on the map were nearly closed. This was caused by the timbers being blown out and the dirt they sustained caving in. Every wooden stopping and door in the mine was broken except one door in the inside haulage cross-cut in the right entry at *S*. This was forced open and nearly off its hinges; the others were shattered like matchwood. Two stone stoppings were blown out, one between the slope and air course opposite the left entry at *V*, and one between the left main air course and left main entry on the double parting at *P*. Several stone stoppings between the slope and its parallel air course stood the severe test and thus aided us greatly in getting air through the workings after the explosion. On the curve coming out of the right entry nearly all the timber was blown out. Many sets in the inside withstood the violence, not a set being out on the double parting. The slope timbers were undisturbed with the exception of six sets at the mouth and one near the entrance to the left entry. Inside of the parting on the left entry and air course the force was most violent. Nearly every set of timber was blown out and heavy eaves of coal had fallen, which greatly retarded the explorations.

There are some peculiarities in connection with this explosion which caused different opinions as to the ingredients which were predominant in the explosive mixture. It is the opinion of scientists and practical men that if fire-damp predominates



at the time of the explosion intense heat is developed, and that traces of this will be left on all material susceptible to fire, and if the dust in suspension in the air current predominates, that caking or coking results will be found in abundance after the explosion. In this case we have no traces of fire on any susceptible material, such as timber, canvas or brattice cloth. The steam pipes were covered with hay and then wrapped with shredded canvas, which was as dry as tinder and strewn all over, but even on this we could find no trace of fire, and with a very diligent search by myself and others we failed to find any trace of coked dust as a residue. Still, some of the bodies were burned in proximity to some of the susceptible material mentioned above. Such a statement may appear to be absurd, nevertheless, it is true. The only way I can account for these phenomena is that the elements in the explosive were not productive of a long-extended flame, but intense heat was created and the explosion passed through all the workings with lightning rapidity. That there was intense heat I have no doubt, but it must have been of very short duration. Some of the bodies were denuded and horribly mutilated, decapitated and disemboweled. Nearly all of them had to be identified by their wearing apparel or other appurtenances.

On the body of one of the men a watch was found that had evidently stopped instantly, owing to the violence of the explosion, at 11:27 a. m., so we concluded this to be the correct time of the explosion. I was notified of the explosion through the courtesy of Mr. J. A. Kebler, general manager of The Colorado Fuel and Iron Company, at 12:45 p. m., and at 2:05 p. m. received an official telegram from Mr. Herricke, the local superintendent.

In accordance with section 8, coal mines act, myself and my deputy boarded the first available train, and on board the cars we met Mr. Kebler and Mr. Willard, general superintendent of the coal agency of the Atchison, Topeka & Santa Fe, also Mr. Coughlin and Mr. McGourty, both of whom had sons in the ill-fated mine. We arrived at the scene of the disaster about 12:30 p. m. on the following day. At this time some bodies had been brought out of the mine and a fan was in operation. Great credit is due Mr. Herricke, local superintendent; Mr. Paul Blount, superintendent of the Newcastle mine, and his mechanic, Mr. Jas. Buchanan, for the expedition with which they erected this fan, which had to be transported from the Consolidated mine, engine erected, fan cased, etc., it being in opera-

tion in less than twenty-four hours after the explosion. Mr. Choate, the division superintendent of the Rio Grande, sent some carpenters to aid in its construction.

At this time all hopes of rescuing any of the miners alive had been given up, and we waited for the fan to clear out the foul atmosphere in the mine. During this time we held a conference as to how we were to proceed. In this conference were Mr. Kebler, Mr. Blount, Mr. Herrick and myself, and we decided to enter the mine at 2:40 p. m., and that from inside observations we could decide on the mode of action. At the appointed time, Mr. Herrick, Mr. Kebler, George Ward, John Evans, Humphrey Davies and myself entered the mine. George Ward, John Evans and Humphrey Davies were the heroes of the party. The first obstruction we met was the dilapidated air bridge across the right entry at *D*. Ward and Davies passed over the obstruction and penetrated into the right entry about 300 feet. On returning they reported that the narrow entry around the curve was in bad shape, but that the double parting was in good shape and that they had not seen any fire-damp, also that there was a good current of air passing. Evans, owing to an accident (a nail penetrating his foot), returned to the surface, and the remaining five of the party went down the slope as far as the entrance to the left entry. Here we found a set of timber blown out, and about 30' in the left entry fire-damp was found. We then concluded to return to the surface and take immediate steps to remove the fire-damp from the left entry and at the same time have the air bridge over the right entry at *D* temporarily erected.

We had all the voluntary help we needed at this time, and the first work done was the placing of a temporary stopping on the crop entry; this carried all the air produced by the fan, about 40,000 cubic feet per minute, down to the air bridge and returned it through the slope. Then the air bridge proposition was considered and from the amount of work necessary to erect it and the greater number of bodies being in the left entry, it was decided to build a stopping on the entry and have the air down to the left entry as soon as possible.

During this preliminary work, Mr. Kebler acted as consulting engineer, and he coincided with our views and the men under his management were the volunteers. On Wednesday night, February 19, about midnight, Mr. Jos. Fletcher, Santa Fe mine inspector, and Dan. McLaughlin, superintendent of Starkville, arrived with a reinforcement of men, twenty in number, and some of them were immediately put to work building



stoppings, etc. As yet there had been no system adopted as to the hours of work. On Thursday night, February 20, Mr. C. J. Devlin, general manager of the Atchison, Topeka & Santa Fe coal properties, arrived on the scene. All the details then known as to the condition of the mine and mode of procedure were stated to him, and he was satisfied that everything had been done to the best advantage under the circumstances, and that the hours of labor were too long, and that in order to expedite the exploration it would be necessary to systematize the work. On the 22d of February the following notice appeared, signed by Mr. Devlin and approved by me:

#### NOTICE TO MINERS.

"In order to push the work with the greatest speed the following rules will govern:

"1. Shift bosses will each work six hours. Pay in accordance therewith.

"2. Others in mine will work three hours each.

"3. Pay for three hour shifts \$2.75. Pay for shift bosses per shift, \$3. Each man is requested to do his utmost so as to get the bodies out in the shortest possible time."

Previous to this notice the man had been working six hours at a shift and some dissatisfaction was exhibited, but not enough to delay the exploration work. Messrs. Fletcher, Hericke and myself selected eight shift bosses who were men of practical experience and acquainted with the mode of working, etc. They were George Ward, Henry John, John Evans, J. P. Thomas, Joseph Griffiths, William Doyle, Humphrey Davies and J. W. Smart. Two of these men were in charge of the work every six hours; their duty was to direct the men what to do and to watch the fire damp that we knew existed in the mine. When this system was enforced we found it difficult to obtain men for the work and many of the miners had to work six hours in order to keep the work going. If it had not been for The Colorado Fuel and Iron Company closing down their mine it would have been impossible to get the required number of men necessary to carry on the work. On the 23d of February, Mr. Ed. Flynn arrived with twenty-eight men from Rockvale. On the 25th, Mr. Robert O'Neill, of Starkville, arrived with five men, and M. M. Walsh, of Blossburg, N. M., brought seventeen men with him on the same date. We were now well reinforced and everything was done that was necessary to expedite the work. Mr. Devlin left after being there a few days and entrusted Mr. Joseph Fletcher with the

management of the exploration, with the instructions that he was not to consider expense, but to get the bodies out with all possible haste.

After removing some of the gas in the left entry we were able to explore the double parting up to the haulage cross-cut and did not find much obstruction, only a few sets of timbers being out. At the end of the parting we found that a great quantity of coal had fallen and had to be removed. The slope was cleared and the cars were put in motion to remove the fallen coal. The gas in the two parallel entries was removed by placing a temporary stopping in the cross-cuts as we advanced, and all the miners were taken into the intake air course until it was diluted. On the night of the 27th of February the main left entry was all cleared up and examined. During this time work was also carried on in the back entry, but from the fact that there was more coal to handle, etc., it took a few more days to get cleaned up, but some of the explorers went over the fallen coal and found the body of Robert Steiger, track layer, in the face of the back entry. During the time of cleaning up the entries, we knew that the man-ways, cross-cuts between rooms, and some faces, were full of inflammable gas, and this was constantly watched by one of the shift bosses in charge. Preparations for a greater supply of air had been made by repairing and erecting the double Murphy fan, and at 12:30 a. m., March 1, the fan was started and the air current turned up the inside rooms. While doing this a three-hour shift was laid off and only fire bosses allowed to be in the mine. The quantity of air had now been increased at the outlet from 38,000 cubic feet to 50,000 cubic feet per minute, but from the fact that all the stoppings were leaking, the quantity playing on the gas did not exceed 28,000 cubic feet. In removing the great quantity of gas from the rooms, great precaution was used in keeping all lights from the return air and also from the mouth of the slope. By the morning of March 5 all the standing gas had been removed from the left side of the workings and all places thoroughly examined.

On Friday morning, March 6, operations were started on the right entry. While the greatest force of men were working on the left entry, preparations were made for getting into the right in order to be able to split the air current. By doing this the quantity of air in the left entry was greatly reduced. However, enough air was kept there to dilute all the gas that was given off. It is evident that some air had been going through nearly all the workings in the right entry or we would



have found more standing gas than we did. The only place where standing gas was found was at the top slate air course and at the top of No. 8 room at 0. We found things in a much better condition here than we expected, the worst caved place being around the curve outside of the double parting. On the double parting an accumulation of water had taken place, and to remove this it was necessary to have a pump located near it. A pump was already on the ground, and in less than forty-eight hours the water was pumped out and the cleaning up of the entry resumed. On Sunday morning, March 15, the body of Robert Allier was brought to the surface, and this completed the number as reported on the official list. During the exploration work some of the shift bosses resigned and other men were appointed to fill the vacancies; they were Messrs. Thomas Neeson, James Daniels, Charles Grant and George Bunn.

Great credit is due Messrs. Jones, deputy inspector; Herricke, Fletcher, McLaughlin, Flynn, O'Neill and Walsh for the general overseeing of the work and to the shift bosses for their diligence. However, the greatest credit is due the miners who were actually doing the work.

To give the details of the exploration would cause this article to be too voluminous. Suffice to say that the work was very perilous and the surroundings unpleasant. We were fortunate not to have any serious accident to any of the explorers.

Before resuming work at the mine with the full force of men, I recommended Mr. Herricke, local superintendent, to make the following changes:

Have rock stoppings built in all cross-cuts between all parallel entries, and in placing doors on the gangways have them packed or tightened with cement, lime mortar or some other material not liable to fire. Have a fan or fans capable of producing, say 60,000 cubic feet of air per minute, to be distributed to the right and left entries in separate currents and in proportion to requirements. Have the air distributed through the working places the same as it was previous to the explosion. I recommended an exhaust fan as giving better results than a compressive or blower fan. In connection with the use of safety lamps, I am of the opinion that the Mueseler lamp now in use is as good as any. In relighting the lamps in the mines, I recommended that no man be allowed to have a key except the fire boss, and that all lamps be opened in the intake air course. I also recommended that the watering system be kept in good order and in shape to sprinkle all the working places; that such timbering as was

necessary to put the entries in good order be immediately set, and to allow no blasting except at stated periods, when all the men except those actually needed to fire the shots are out of the mine. I also recommended an electric bell or gong in the steam engine house for the purpose of signaling. In case they continued to use steam for pumping purposes I recommended that the present steam pipe covering be removed, and, if the pipes must be covered to keep down condensation, to have them covered with an asbestos composition. I also suggested the use of compressed air for pumping purposes. I requested Mr. Herrick when ready to resume work and the aforesaid improvements were made, to notify me so that I might examine the general condition of the mine.

Our present mode of the detection of gas is too crude, and as there is now on the market a reliable and very sensitive mechanical instrument by which small percentages of gas in air may be detected (namely Shaw's Gas Testing Machine), I think the Mine Inspector should possess one so as to enable him to find the percentage of gas in the air currents of our gaseous mines and have the air currents regulated accordingly. Furthermore, every superintendent of a gaseous mine should have one of these machines so that daily tests can be made of the return air currents and a record thereof be kept in the local office.

In regard to the use of explosives I would recommend the following rules for use in dusty and gaseous mines:

*First*—The powder should be of that brand known as the least productive of flame.

*Second*—All holes should be drilled under the supervision of a competent person.

*Third*—All holes should be charged, tamped and fired by men selected for that purpose. The charge should be in accordance with the burden of the hole, etc., and the tamping should be of material not productive of flame. Before firing the surroundings should be carefully examined as to the presence of dust and gas.

*Fourth*—No shots to be fired or powder detonated anywhere in the mine except at a specified time, and all men to be out of the mine except those actually required for the purpose of firing.

#### LIST OF KILLED AT EXPLOSION AT VULCAN MINE.

No. 1. Ed. Welsh, aged 24; occupation, rope rider; nationality, American; hurt February 18, 1896, at 11:30 a. m.; died 1:45 p. m., February 18,



1896; married, no children; had a fractured skull, bled from both ears, burned about face and head; buried, New Castle; wife, two brothers and two sisters.

No. 2. Joe Dore, aged about 20; occupation, bell-boy; nationality, American; single; killed February 18, 1896, 11:30 a. m.; recovered February 19, 1896, 2:30 a. m.; buried, New Castle.

No. 3. Frank Simonsic, aged about 35; occupation carpenter; nationality, Prussian; single; killed February 18, 1896, 11:30 a. m.; recovered February 19, 1896, 3:30 a. m.; buried, New Castle.

No. 4. Able Dore, Jr., aged about 17; occupation, rustler; nationality, American; single; killed February 18, 1896, 11:30 a. m.; recovered February 19, 1896, 9:30 a. m.; buried, New Castle.

No. 5. Nick Ross, aged about 28; occupation, rustler; nationality, Italian; single; killed February 18, 1896, 11:30 a. m.; recovered February 20, 1896, 7:00 a. m.; buried New Castle.

No. 6. Wm. Dore, aged about 15; occupation trapper; nationality, American; single; killed February 18, 1896, 11:30 a. m.; recovered February 20, 1896, 7:00 a. m.; buried New Castle.

No. 7. Emile Funke, aged 13; occupation, trapper; nationality, American, German descent; single; killed February 18, 1896, 11:30 a. m.; recovered February 20, 1896, 7:00 a. m.; body shipped to Frontinac, Kansas.

No. 8. Robert Cottle, aged 21; occupation, miner; nationality, American; single; killed February 18, 1896, 11:30 a. m.; recovered February 20, 1896, 7:00 a. m.; body shipped to McAllister, Indian Territory. His father worked in the mine.

No. 9. James Harrison, aged 38; occupation, pit boss; nationality, English; married, leaves a wife and four children, two boys and two girls between ages of 12 and infancy; killed February 18, 1896, 11:30 a. m.; recovered February 20, 1896, 3 p. m.; body shipped to Rockvale, Colo. Was a Mason, Odd Fellow and K. of P.

No. 10. Toney Tapro, aged 23; occupation, loader; nationality, Italian; single; killed February 18, 1896, 11:30 a. m.; recovered February 20, 1896, 3:00 p. m.; buried New Castle. Has a mother here; belonged to Sons of Columbus.

No. 11. Jno. Gumbord, aged 30; occupation, loader; nationality, Austrian; single; killed February 18, 1896, 11:30 a. m.; recovered February 20, 1896, 3:00 p. m.; buried, New Castle.

No. 12. Chas. Merchant, aged 24; occupation, loader; nationality, American; single; killed February 18, 1896, 11:30 a. m.; recovered February 20, 1896, 3:00 p. m.; buried, New Castle. Father and mother in Rosaland, B. C., a placer camp.

No. 13. Christ. Brugger, aged 30; occupation, driver; nationality, German; married, leaves widow, no children; killed February 18, 1896, 11:30 a. m.; recovered February 21, 1896, 6:00 a. m.; buried New Castle. Was an Odd Fellow. Owned a ranch between New Castle and Glenwood Springs.

No. 14. Peter Becker, aged 25; occupation, loader; nationality, German; single; killed February 18, 1896, 11:30 a. m.; recovered February 23, 1896, 6:30 a. m.; buried New Castle.

No. 15. Anton Martino, aged 52; occupation miner; nationality, Austrian; single; killed February 18, 1896, 11:30 a. m.; recovered February 25, 1896, 9:45 a. m.; buried New Castle. Found snuff-box and menthol inhaler.

No. 16. Wm. Webb, aged 23; occupation, miner; nationality, American; married, leaves widow, no children; killed February 18, 1896, 11:30 a. m.; recovered February 25, 1896, 2:00 p. m.; buried, New Castle. Sam. Walters, his father-in-law, has charge of his effects.

No. 17. Sampson Jones, aged 38; occupation, pipeman; nationality, English; married, leaves widow and two infant children; killed February



18, 1896, 11:30 a. m.; recovered February 25, 1896, 2:00 p. m.; body shipped to Harvard, Illinois. Found one lamp key; watch found in Leadville, Colo.; "S. J." on back.

No. 18. Fred. Seigmund, aged 35; occupation, miner; nationality, German; single; killed February 18, 1896, 11:30 a. m.; recovered February 25, 1896, 3:00 p. m.; buried New Castle. Body badly mutilated.

No. 19. Daniel Morris, aged 34; occupation, miner; nationality, Welch; single; killed February 18, 1896, 11:30 a. m.; recovered February 25, 1896, 3:00 p. m.; buried New Castle. Wm. Trimble, of New Castle, appointed administrator of his estate; has brother in Wales.

No. 20. Jack Jenkins, aged 27; occupation, miner; nationality, American; single; killed February 18, 1896, 11:30 a. m.; recovered February 25, 1896, 3:00 p. m.; body shipped to Carbonado, Washington. J. W. Smart, New Castle, has charge of his effects.

No. 21. Fred. Rodensky, aged 40; occupation, miner; nationality, German; married, leaves widow and nine children in Gilchrist, Ills.; killed February 18, 1896, 11:30 a. m.; recovered February 25, 1896, 3:00 p. m.; buried, New Castle.

No. 22. Alex. Scaife, aged 17; occupation, miner; nationality, American; single; killed February 18, 1896, 11:30 a. m.; recovered February 26, 1896, 5:30 a. m.; buried New Castle.

No. 23. Angelo Petrie, aged 26; occupation loader; nationality, Italian; single; killed February 18, 1896, 11:30 a. m.; recovered February 26, 1896, 5:30 a. m.; buried New Castle.

No. 24. Robt. Steiger, aged 42; occupation, trackman; nationality, German; married, no children; killed February 18, 1896, 11:30 a. m.; recovered February 28, 1896, 3:00 p. m.; buried New Castle. Nick-named "Bicycle Bob." Found silver watch and \$130.

No. 25. August Mateve, aged 35; occupation, miner; nationality, Italian; married, old country; killed February 18, 1896, 11:30 a. m.; recovered March 1, 1896, 9:00 a. m.; buried New Castle. Belonged to American Order of Forresters; brother in Spring Gulch, Colo., named John; found \$7.00 in coin.

No. 26. Tim. Carney, aged 36; occupation, miner; nationality, Irish; single; killed February 18, 1896, 11:30 a. m.; recovered March 1, 1896, 9:00 a. m.; buried New Castle. Has brother, Peter Carney, at Cripple Creek, Colo.

No. 27. Andy Rolando, aged 30; occupation, miner; nationality, Italian; single; killed February 18, 1896, 11:30 a. m.; recovered March 1, 1896, 3:30 p. m.; buried New Castle. Belonged to Sons of Columbus.

No. 28. Jas. Ferineo, aged 35; occupation, miner; nationality, Italian; married, old country; killed February 18, 1896, 11:30 a. m.; recovered March 2, 1896, 9:00 a. m.; buried New Castle. Belonged to Sons of Columbus. Cousin, Peter Farineo, lives at New Castle.

No. 29. Louis Cinotto, aged 40; occupation, miner; nationality, Italian; married, old country; killed February 18, 1896, 11:30 a. m.; recovered March 3, 1896, 11:00 a. m.; buried New Castle. Belonged to Odd Fellows; found on body, lamp-key, \$26.00; trunk and effects in charge of Odd Fellows' Lodge at New Castle.

No. 30. Anton Petricio, aged 28; occupation, miner; nationality, Italian; wife and four children in Italy; killed February 18, 1896, 11:30 a. m.; recovered March 3, 1896, 3:00 p. m.; buried, New Castle. Has mother in New Castle; effects in charge of his cousin, James Gleese, New Castle.

No. 31. Joe. Otteno, aged 40; occupation, miner; nationality, Italian; married, wife and five children in New Castle; killed February 18, 1896, 11:30 a. m.; recovered March 3, 1896, 3:00 p. m.; buried New Castle.



No. 32. Gabriel Gleese, aged 34; occupation, miner; nationality, Italian; single, killed February 18, 1896, 11:30 a. m.; recovered March 3, 1896, 3:00 p. m.; buried New Castle. Found on the body, Vulcan pay check, \$63.58.

No. 33. Babtiste Chowkett, aged 28; occupation, miner; nationality, Italian; married, old country; killed February 18, 1896, 11:30 a. m.; recovered March 4, 1896, 5:30 p. m.; buried New Castle. Father in New Castle.

No. 34. Frank Russia, aged 30; occupation, miner; nationality, Italian; single; killed February 18, 1896, 11:30 a. m.; recovered March 4, 1896, 6:00 p. m.

No. 35. Dominic Ozzello, aged 24; occupation, loader; nationality, Italian; single; killed February 18, 1896, 11:30 a. m.; recovered March 3, 1896, 11:00 p. m.; buried New Castle. Found on his body, finger-ring and pocket-knife.

No. 36. Philip Recla, aged 28; occupation, miner; nationality, Austrian; single; killed February 18, 1896, 11:30 a. m.; recovered March 7, 1896, 4:00 p. m.; buried New Castle. Found on his person, Vulcan Fuel Co.'s statement for month of January, 1896; has brother at Sheppton, Pa., named R. Recla, general merchant.

No. 37. Jno Scaife, aged 45; occupation, miner; nationality, Welch; married, leaves widow and two children; killed February 18, 1896, 11:30 a. m.; recovered March 7, 1896, 10:00 p. m.; buried New Castle. Found silver watch and pocket knife.

No. 38. Peter Patrico, aged 35; occupation, miner; nationality, Italian; married; wife in Italy, one son and one daughter in New York, just landed; killed February 18, 1896, 11:30 a. m.; recovered March 8, 1896, 7:30 a. m.; buried, New Castle. Found on his person, one pocket book, filled with papers, and a lamp key; effects in charge of Jas. Gleese, at New Castle, his cousin.

No. 39. John Funke, aged 42; occupation, assistant pit boss; nationality, German; married, leaves wife and five children, two boys and three girls. Killed February 18, 1896, 11:30 a. m.; recovered, March 11, 1896, 5 a. m. Body shipped to Frontinac, Kan., care Henry Shurman.

No. 40. Dom. Rosetti, aged 24; occupation, loader; nationality, Italian; single. Killed February 18, 1896, 11:30 a. m.; recovered March 11, 1896, 5 a. m.; buried, New Castle. Sister, Mrs. Thos. Borghetti, at New Castle.

No. 41. Thos. Larrigan, aged ; occupation, fire boss; nationality, Scotch; married, leaves widow and two children at New Castle. Killed February 18, 1896, 11:30 a. m.; recovered March 11, 1896, 5 a. m.; buried, New Castle.

No. 42. Frank McGourty, aged 22; occupation, loader; nationality, American; single. Killed February 18, 1896, 11:30 a. m.; recovered March 11, 1896, 5 a. m.; buried, New Castle.

No. 43. David P. Davis, aged 28; occupation, loader; nationality, Welch; single. Killed February 18, 1896, 11:30 a. m.; recovered March 11, 1896, 5 a. m.; buried, New Castle. Has brother living in Wales. Effects in charge of Belonged to Odd Fellows.

No. 44. Thos. Addison, aged 25; occupation, loader; nationality, English; single. Killed February 18, 1896, 11:30 a. m.; recovered March 11, 1896, 9:15 p. m.; buried, New Castle. Belonged to Knights of Pythias. Myras Stephenson, Rouse, Colo., his brother-in-law.

No. 45. John Coughlin, aged 22; occupation, driver; nationality, American; single. Killed February 18, 1896, 11:30 a. m.; recovered March 11, 1896, 9:15 p. m.; buried, New Castle. Belonged to Knights of Pythias.

No. 46. Alphonse Baldis, aged 24; occupation, miner; nationality, Austrian; single. Killed February 18, 1896, 11:30 a. m.; recovered March 12, 1896, 4 a. m.; buried, New Castle.

No. 47. Peter Tapro, aged 30; occupation, loader; nationality, Italian; single; killed February 18, 1896, 11:30 a. m.; recovered March 12, 1896, 9:30 a. m.; buried, New Castle.

No. 48. Wm. Haggerty, aged 40; occupation, miner; nationality, Irish; married, leaves widow and two children, living on ranch a couple of miles northwest of New Castle; killed February 18, 1896, 11:30 a. m.; recovered March 15, 1896, 5 a. m.; buried, New Castle.

No. 49. Alex. Reno, aged —; occupation, miner; nationality, French; single; killed February 18, 1896, 11:30 a. m.; recovered March 15, 1896, 10 a. m.; buried, New Castle.