JOURNAL
OF THE
FRANKLIN INSTITUTE
OF THE STATE OF PENNSYLVANIA,
FOR THE PROMOTION OF THE MECHANIC ARTS.

VOL. CLVIII, No. 2. 79TH YEAR. AUGUST, 1904

THE Franklin Institute is not responsible for the statements and opinions advanced by contributors to the *Journal*.

THE FRANKLIN INSTITUTE.

*Communicated by the Author to the Stated Meeting, held Wednesday,
April 15, 1903.*

The Mine Explosion at Johnstown.

BY M. G. MOORE,
Mining Engineer in charge of the Mining and Coking Department of the
Cambria Steel Company.

On the tenth day of July, 1902, there was an explosion of fire damp in the Rolling Mill mine of the Cambria Steel Company at Johnstown, Pa., which resulted in the loss of 112 human lives, and was, in this respect, probably the most disastrous that ever occurred in the State of Pennsylvania.

The explosion presents some such peculiar features that a statement of the facts relating to it may possibly be of interest to the members of the Institute.

DESCRIPTION OF ROLLING MILL MINE.

The Rolling Mill mine was opened by the Cambria Iron Company in 1856 to supply their mills and works with coal and, with the exception of the two years of 1888 and 1889,

there are four in the mine. The low-pressure air is carried to the face of each working-room and heading by $1\frac{1}{4}$ -inch iron pipes laid from mains that are from 3 to 7 inches in diameter. There is about 95 miles of low-pressure pipe and 4 miles of high-pressure pipe used to convey and distribute the compressed air to and in the mine. There is also a second opening in the valley of the Stonycreek River, 1,100 feet south of the main entrance to the mine.

Near the mouth of the mine there is a power-house containing boilers and a pair of 20 x 30-inch tail-rope engines, used to haul the coal in trips of seventy cars each from the main siding in the mine, 7,300 feet from its mouth, to the tippie, a total distance of about 10,000 feet. All of the machinery and appliances in use are of the latest pattern and every precaution was taken to assure a thorough ventilation of the entire mine. The airways are all of large area and the velocities of the air currents are low. The air for ventilation is distributed through the mine in splits as required by the law of 1893. The Superintendent's office, the Mine Foreman's office in the mine, both power-houses and the tippie, have telephones and are connected through the exchange of the Cambria Steel Company with the city exchange. The Cambria Company has always been most liberal in providing machinery, tools and appliances to make their mines safe, modern and economical to operate. It has spared no expense to secure the safety of the employees, and with the precaution taken and with the large volume of air in circulation and the rigid rules enforced it was impossible to have such a disaster, except through the criminal recklessness or disobedience of an inside employee.

At the time of the explosion about 650 men were employed in and around the mine. Of these probably 580 were inside men and possibly 450 were in the mine at the time of the accident. The inside men who were not working that day were either on night turn or were idle for some cause. Including drivers and laborers there were in the Klondike at the time of the explosion about 150 men, working in three separate splits of air with a circulation respectively of 20,000, 18,000, and 8,000 cubic feet per minute.

When the Klondike Section was opened to the dip on the left, in 1897, a little gas had been found in the rib workings on the right or high side of the mine; but as the pillars were drawn back and the roof fell in and the area of the gob increased the gas had always disappeared. This was probably due to a more permeable strata of cover being exposed as the slates caved in and allowed the gas over the falls to escape through crevices to the surface. In fact, there was so little gas on the right-hand side of the mine that it was hardly considered, although fire bosses were always employed to look after the safety of the men. The face of the Klondike heading at the time of the explosion was 4,650 feet from the main heading. On the right side four pairs of cross headings had been driven off, practically on water level, and on the left there were five. All the work was opened originally on the double-heading plan, but after explosive gas was encountered the three-heading system was adopted where possible. A third heading or airway was sometimes made by utilizing the abandoned rooms next to and parallel to the main heading.

Of the two maps shown, the outline one is the entire mine at a small scale with the Klondike portion shown by the heavier shading. The other is a detail map of the Klondike. The star indicates the point of origin of the explosion, the crosses the location of the bodies found and the arrows the direction of the air currents. It will be noted (see map of Klondike Section) that between the fifth and sixth headings on the right side coming down there are about 2 acres of gob where pillars had been drawn; beyond this, toward the face of the headings for some distance, are abandoned rooms, then come working-rooms and then the faces of the headings.

All the walls that guide or confine the air were made of brick or slate and cement mortar; all air bridges were made of steel and brick; all important doors were in duplicate and the ventilation was considered to be without a flaw. The mine was always considered to be safe, as will be seen by the following paragraph from the report of the Chief of the Bureau of Mines for the year 1901:

"Ten mines are located in and about Johnstown; some of them are small, but all are well ventilated and drained, and consequently are in good sanitary condition. Five are operated by the Cambria Steel Company, all of which are equipped with the best kind of ventilators. The safety of the mines at this point can be judged by the fact that over 1,000,000 tons of coal were produced during 1901, and but one fatal accident occurred, that being in the Rolling Mill mine, the largest single operation in the district, which produced over 601,000 tons during the year."

EXPLOSION.

The explosion, which was not severe, occurred about 11.20 A.M. in No. 2 room of sixth right heading off the Main south or Klondike heading. There were two men working in the room and five others in the immediate vicinity, all of whom had been given safety lamps in the morning by the fire boss of that section, and were seen going into their rooms with them. The fire boss had made an examination of this place some time previous to 7 o'clock. He found gas as usual on the gob and recorded it in the daily report book at the office. As gas was expected and had been found in that locality for a long time, no precautions other than the usual ones, which were considered ample, were taken that morning. The fire boss had received special instructions some time before to note if the gas was getting stronger, but as he had said nothing about it and as the records, which he faithfully made, show no essential changes, it is safe to infer that the quantity of gas had not increased perceptibly for several months. This is confirmed by the mine foreman, who had examined the place the day before. As the fire boss in charge of this district, in company with others, went into the Klondike after the explosion and lost his life while aiding in the work of rescue, nothing positive concerning the condition of the gas on the morning of the explosion is known other than what is shown by his report book, the record in which was made about four hours before the explosion. The four fire bosses always entered the mine at 3 o'clock in the morning, and each of them examined

all the working places and roads of the district under his charge. They then went to the inside office, entered the result of their examination upon the book, reported verbally to the mine foreman and attended to giving out the safety lamps and getting the men started to work. After the men had all gone to their working places the fire bosses always made a second trip through their respective districts to see if everything was safe, and that all of the men who had been given safety lamps were working with them, and to note any dangers that might have arisen since the time of their first visit. This routine was observed on the morning of the explosion. The fire boss of Klondike and the others returned to the mine foreman's office from their second examination about 11 o'clock; but, as they made no further report to the mine foreman, and made no changes in the written report they had all signed in the early morning, the only inference that can be drawn is that they found everything in a safe and satisfactory condition. The fire boss in charge of the Klondike district was an elderly and especially trustworthy man, who had been employed by Cambria for many years. He had been assigned this more dangerous district on account of his known carefulness and ability, and had he found anything wrong or any unusual condition upon his second round he would undoubtedly have at once taken the men out of the danger and reported the fact to the mine foreman. As he did not do this and said nothing about any changed conditions, it is impossible to believe that he discovered anything out of the way on his second examination.

The men who were working in room No. 2, where the explosion originated, were German Poles, who spoke English fluently. All of them had been employed in Rolling Mill mine for a number of years, and as they had seen the danger constantly and their attention had been called to it frequently, it is impossible to consider them unfitted to work in that place. They had been selected especially for this locality only three days before on account of their superior intelligence and long experience in the mine, after a consultation of the fire bosses and mine foreman. The work of

drawing back the pillars from the sixth heading side, where the men were working, had been started only two days before and, as gas was known to exist, especially careful men were wanted to work in this locality. The seven men who were working there were in rooms Nos. 1 and 2 sixth right and rooms Nos. 1 and 2 long wall, and four of the seven were "butties" or partners. The explosion was felt at the mine foreman's office, which is at the entrance of the Klondike section, just as the four fire bosses were starting out of the mine. The mine foreman immediately sent word to them to come down into Klondike as there had been an explosion, and without a moment's hesitation they, together with the labor boss, mine foreman, assistant mine foreman, machine boss and an assistant fire boss, procured safety-lamps and went into Klondike to restore the ventilation and get the men out. The explosion was so slight that all who heard it at the mine foreman's office thought it was not serious, but to be on the safe side the mine foreman started his assistants to notify the men on the right-hand side of Klondike to go out. They found a number of doors blown down and while some of the officials were trying to replace them, and while others were endeavoring to warn the miners, the poisonous after-damp came upon them, and of the nine who went down, but two succeeded in escaping, and of the remaining seven, five lost their lives. The mine foreman and machine boss were removed from the mine unconscious and after a long siege at the hospital recovered. The fire boss of the Klondike district died in the hospital ten days after the explosion without at any time fully regaining the use of his faculties.

The result of the explosion was not disastrous to the mine. No damage was done except that all the doors on both sides of Klondike, of which there were twenty-one, were blown down and all the stoppings between the sixth and seventh headings and some between the fourth and fifth were blown out. The doors were not blown to pieces, but thrown down flat. The stoppings consisted of brick walls laid in cement, or of double walls 4 feet apart built of flat slate with the inside space filled with coal dust and the outside

plastered with cement to make them air-tight. The mine was damaged so little that cost of replacing all the doors and stoppings damaged or blown out and all other repairs did not amount to \$1,000, and mining operations were resumed on the fourth day after the explosion. The only men that were burned by the explosion were the seven working in the vicinity of the body of gas. A few of the others were instantly killed by being blown against the pillars or gob, and the remainder were all suffocated by carbonic oxide gas.

A careful examination of the workings established the fact that there was a body of gas, which had been reported, on the gob between fifth and sixth right headings, which was probably nearly in its pure state, and when ignited in some manner by the criminal recklessness and disobedience of the men in No. 2 room, burned comparatively slowly, and as oxygen was not supplied in sufficient quantity for complete combustion, burned to carbonic oxide, of which authorities say one-half of 1 per cent. in the air will produce death in one-half hour. There was undoubtedly a very much higher percentage of this poisonous gas in the air which met the miners of Klondike as they tried to escape, as the most of them fell to the ground apparently without a struggle. The stoppings being blown down and the ventilation destroyed the poisonous gas advanced slowly through the workings and headings and cut off the escape of the men who delayed leaving their working places. The careful examination of the mine after the accident showed that the explosion was not complicated in any way by coal dust exploding. The coal contains but 17 per cent. of volatile matter, and dust as low in volatile matter as this is not apt to explode unless suspended in the air in large quantities and subjected to high heat and concussion. The Klondike portion of Rolling Mill mine was quite damp and there was little or no dust suspended in the air.

The greater number of the victims were found on their way out of the mine with their coats on and their dinner buckets in their hands. Those working on the left side of Klondike and in the fifth heading on the right side of

Klondike, after they heard the explosion, carefully put their tools away, put on their coats and leisurely walked out of their rooms into the poisonous atmosphere. One miner testified at the inquest that he was working in a room off the fifth right heading when the explosion occurred; the concussion of the air knocked him down and extinguished his lamp, but he relit it and went back to work. Shortly after one of the fire bosses, who later lost his life, came in and ordered him to go out of the mine at once, which he did, but had a very narrow escape. On the left side of Klondike there were about sixty-three men working; among them were three pair of brothers, Americans, English and Irish, and all very intelligent men, who operated mining machines. Some time after the explosion when the air commenced to get bad, they opened the low pressure air pipes with their valve keys, so that the compressed air would blow into the faces of three rooms, and tried to get the men into these rooms, where they would be in the pure air that came from the pipes. This air was carried in the pipes at a pressure of something less than ninety (90) pounds per square inch, and it is estimated that nearly five times as much air came from the three open pipes as was necessary to preserve the lives of all these men. It was the next afternoon before the rescuing parties were able to get into the left side of Klondike, where they found only fifteen of them alive. Those still living were found at the end of the air pipes, the others, dead or dying, were found all sitting or lying at the mouth of Room No. 17 on the fourth left. Why these men left the faces of the three rooms where there was plenty of pure air and went into the poisonous gas on the heading is inexplicable. A number of them who were rescued were questioned, but their stories disagreed, so that it is impossible to draw conclusions that will satisfactorily explain their action. The men working in the other districts of the mine did not hear the explosion and did not leave the mine until ordered out by the officials, or until they discovered through not getting cars to load that the mine was shut down. Had the concussion been more severe it is very probable that it would have been so alarm-

ing that all of the men working on the left side of Klondike would have hastened from the mine without delay, and thus probably reduced the appalling death list by perhaps two-thirds.

It is a mystery what caused the gas to come in contact with the naked lamps in Room No. 2. It would be possible to account for it by an extensive fall of roof over the gob, but an examination after the explosion showed no fall of magnitude, and as it was shown that the miners working with naked lights had no occasion to go into the gob, the ignition of the gas will probably forever remain a mystery. The mine inspector had examined the mine on the 2d of June, five weeks before the explosion, and could find no fault with it in any way, and made a flattering report of its condition to the Chief of the Bureau of Mines.

THE WORK OF RESCUE.

The officials in charge of the Mining Department of Cambria received word of the explosion a little over one hour after it happened, but the magnitude of the calamity was not known until after they had gotten into the mine and met the after-damp on the main heading coming out with the air. When the extent of the disaster was realized the other mines of the Cambria Steel Company at Johnstown were at once stopped and the foremen and bosses, together with the competent English-speaking men, were rapidly driven to the escapement shaft at Mill Creek, 7 miles, to aid in the rescue.

Promptly after the explosion the fan was by telephone orders speeded up to 220 revolutions, forcing about 250,000 cubic feet of air per minute into the mine. Men were kept at the bearings and oil was used freely so that none of the bearings of engine or fan were unduly heated. The compressors were kept running constantly and the pressure in the two air-pipe systems maintained at 90 and 900 pounds per square inch respectively until the third day after the explosion, when the mine had been fully explored. This precaution undoubtedly resulted in the saving of the lives of

the men in the fourth left who remained in the faces of the rooms where the air-pipes were open.

When the officials of the Cambria Steel Company reached the mine and grasped the situation, brattice cloth, tools, and physicians with cans of oxygen, were immediately ordered and the work of rescue begun in a systematic way. The first regular rescuing party, led by the superintendent, went in the Klondike with physicians and cans of oxygen at about 4 P.M., and pushed ahead of the parties who were putting up brattices, to restore the ventilation. They succeeded in reaching some of the men on the Klondike heading who were still living, and by a liberal use of oxygen, quick trips to the hospital and faithful work on the part of the physicians and nurses, a number were resuscitated. Others were too far gone. The first efforts were to find the living; no attention was given to the dead other than a hasty examination. When life was found to be extinct the party passed on, searching for the living. Others were engaged in stretching brattice cloth and putting up stoppings to restore the ventilation as far as possible. This work was continued systematically night and day until the entire Klondike region had been thoroughly explored. Several attempts were made to enter the left side of Klondike the night of the 10th and morning of the 11th, but the air was in such a condition that it was impossible to live inside the entrance of the cross headings, and it was not until the afternoon of the 11th that a rescuing party, headed by the superintendent, succeeded in finding the men who had collected in No. 4 heading. There were physicians with cans of oxygen with all the rescuing parties and a number of lives were saved by their efforts in the mine. The last bodies removed from the mine on the evening of the 12th were four that had been located on the night of the 10th, but, owing to the rescuers confusing two of the heading numbers, had not been moved. There were about 150 men working in their places in the Klondike at the time of the explosion; of these about 100 lost their lives, 50 escaped, and the remaining 12 are accounted for by the lives lost in the mine foreman's party and by the fact that a number of laborers

went into Klondike after the mine foreman and his party to help restore ventilation. There was circulating in this portion of the mine about 46,000 cubic feet of air per minute, or more than 100 per cent. in excess of the requirements of the mine law.

The Board of Mine Inspectors appointed by the Chief of the Bureau of Mines of the State made a thorough examination of the mine on the 13th, or the third day after the explosion, and on the two following days. In room No. 2, sixth right heading, on their first trip, they found two common miner's lamps and a miner's cap lying near the face of the workings, and another party found shortly after the explosion, while the bodies were being removed, two safety lamps standing alongside of the road, not far from the face of this room, that had evidently been placed there before the explosion. About two months after the inquest a driver made affidavit to seeing the two men in Room No. 2 working with naked lights about ten minutes before the explosion, but he did not report the matter. During the investigation this driver was probably afraid of getting into trouble for not reporting such a gross violation of the Mine Law, so this evidence was not brought out at the inquest.

THE INQUEST:

Shortly after the accident the Coroner impanelled a jury, and the bodies were viewed at the morgue, as required by law. The inquest began on July 23d, and continued for five days. During that period there were thirty-four (34) witnesses called. The investigation at once took a very wide range, and many of the older miners and employees who were familiar with the conditions in the mine, both before and after the explosion, and many others, and all of the mine officials were called upon to testify. It was clearly established that the men working in the rooms where the explosion originated were given locked and lighted safety lamps that morning and took them into their rooms. It was also shown that no defective safety lamps were ever given out, and that no unlocked ones were given out except to experienced men who were authorized to fire blasts.

The last witnesses called were the four mine inspectors, constituting the board that had been appointed by the Chief of the Bureau of Mines to examine the mine to determine and report upon the cause of the explosion. Their report showed conclusively the point of origin of the explosion and its cause. Their testimony and the report was based upon three careful examinations of the mine after the explosion, and the facts observed during the frequent visits of the inspector of the district in which the mine is located. They discovered conclusive evidence that the mining laws and rules of the company had been deliberately and wilfully violated by the men working in room No. 2 sixth right heading, and stated so in their report, which was very complete, impartial and thorough, and showed careful attention to all the obtainable facts relating to the management and operation of the mine and all the conditions surrounding it. The general testimony showed that all of the mine officials and foremen were without exceptions experienced, sober and competent men, holding certificates of competency, and that they all knew of the dangers generally surrounding mining operations, and that they had always fully realized the responsibilities resting upon them. The jury, after deliberating carefully, returned the following verdict:

"We find that these persons (naming them) came to their death as the result of an explosion: that said explosion was caused by person or persons to the jury unknown by taking into room No. 2 sixth right heading, where gas was known to exist, open lamps, and using same in direct violation of the mining rules and regulations of the Cambria Steel Company."

It was shown during the inquest that the Cambria Steel Company had, through their officials, taken particular care to guard against the dangers that might arise in the mine from gas or other causes. Copies of notices calling the attention of each individual man in the mine to the dangers connected with explosive gas were shown, and it was further shown that every inside man had received one of these notices printed in the language with which he was most familiar. A large mass of correspondence between the management and the mine officials, extending over a period

of nearly three years, was shown, in which the mine officials were constantly urged to take every possible precaution for the safety of the men, and were instructed to make any demands upon the company for supplies, machinery, appliances or tools needed to make the mine safe and healthful. Some of the letters called attention to accidents at other mines, and pointed out the lack of attention and care brought out by the different Coroners' inquests held on the bodies of men killed in mine explosions, and cautioned the mine officials against taking risks or hesitating at any expenditure necessary to make the mine safe. These letters were all written in such a way as to bring replies and acknowledgments from the mine officials to the management, showing that they thoroughly understood the conditions and were taking all precautions possible, and that they all realized their responsibilities, and that their first duty was the safety of the men, and that in case of any doubt they were always to take the safe side if it closed the mine down at once.

The only precautions that have been used since the accident that were not taken before, are the absolute prohibition of the use of naked lights in the Klondike region. This portion of the mine is now operated exclusively with safety lamps, but it is only by extreme watchfulness that it is possible to keep naked lamps out of it and make the men strictly obey the rules. One miner was detected smoking in the Klondike in a dangerous place within three months after the explosion, and is now serving a sentence in the county jail for his violation of the mining law.

Each of the victims of the explosion carried one thousand (\$1,000) dollars insurance in the Cambria Mutual Benefit Association, whose accounts are guaranteed by the Cambria Steel Company, which was paid to their families in addition to burial fees. A subscription was started and a small fund collected for the dependent families, but it was quickly seen that it was unnecessary, as their temporary wants were all provided for by the Cambria Steel Company, and the insurance money would be paid to them as soon as the necessary legal formalities could be complied with.

I have outlined as briefly as possible in the above the essential facts relating to this terrible disaster, and can only add that there will probably be such accidents, of a more or less serious nature, as long as only human beings are depended upon to work in the mines. Every precaution was taken at this mine that could be thought of to prevent a disaster, but the inexcusable disobedience of the strict rules by one employee resulted in his death and that of over one hundred of his fellow-workmen.

JOHNSTOWN, PA., April 6, 1903.

MECHANICAL APPLIANCES AT BLAST FURNACES.

The use of mechanical appliances for handling raw materials and fuel at blast furnaces, and of casting machines for the iron product, has made such an advance that it is estimated by good authority that a modern furnace can turn out 10 tons of finished product with the same number of workers that was needed to turn out 1 ton forty or fifty years ago.

PRECIOUS METALS IN THE ARTS.

One of the difficult problems to solve is the determination of the quantity of gold and silver used in the arts. The statistical departments of several European countries have tried to solve this problem, and have given it up. The U. S. Treasury Department has for several years endeavored to get accurate statistics on this point, but its figures are still far from complete, chiefly because it is impossible to determine the quantity of coin melted by jewelers and others. There seems to be a special secretiveness developed among those who use gold and silver in their trades.—*Engineering and Mining Journal*.

TWO NEW ELEMENTS?

Dr. Baskerville, whose position as professor of chemistry at a prominent Southern university entitles his utterances to every consideration, recently announced that he had discovered what are probably two new elements associated with thorium, both of them radio-active. The two new substances have been christened carolinium and berzelium. Samples of the substances isolated by Professor Baskerville have been sent to Sir William Crookes, who will doubtless confirm or disaffirm the assertion that they are new elements.

The importance of the discovery, if it should ultimately appear that the two new substances are elements, can hardly be overestimated; for the number of radio-active substances is now increased to about six. Sir William Ramsay is reported as having every confidence in Dr. Baskerville's announcement.—*Scientific American*.